NCMJ

NORTH CAROLINA MEDICAL JOURNAL

a journal of health policy analysis and debate

Respiratory Diseases in North Carolina

Also in this issue

Asbestosis and silicosis hospitalization trends in North Carolina

Prevalence, characteristics, and impact of COPD in North Carolina

NCIOM issue brief: Promoting Healthy Weight for Young Children: A Blueprint for Preventing Early Childhood Obesity in North Carolina

A TIP ABOUT SECONDHAND SMOKE

DON'T BE SHY ABOUT TELLING PEOPLE NOT TO SMOKE AROUND YOUR KIDS.

Aden, Age 7
Jessica, His mother
New York
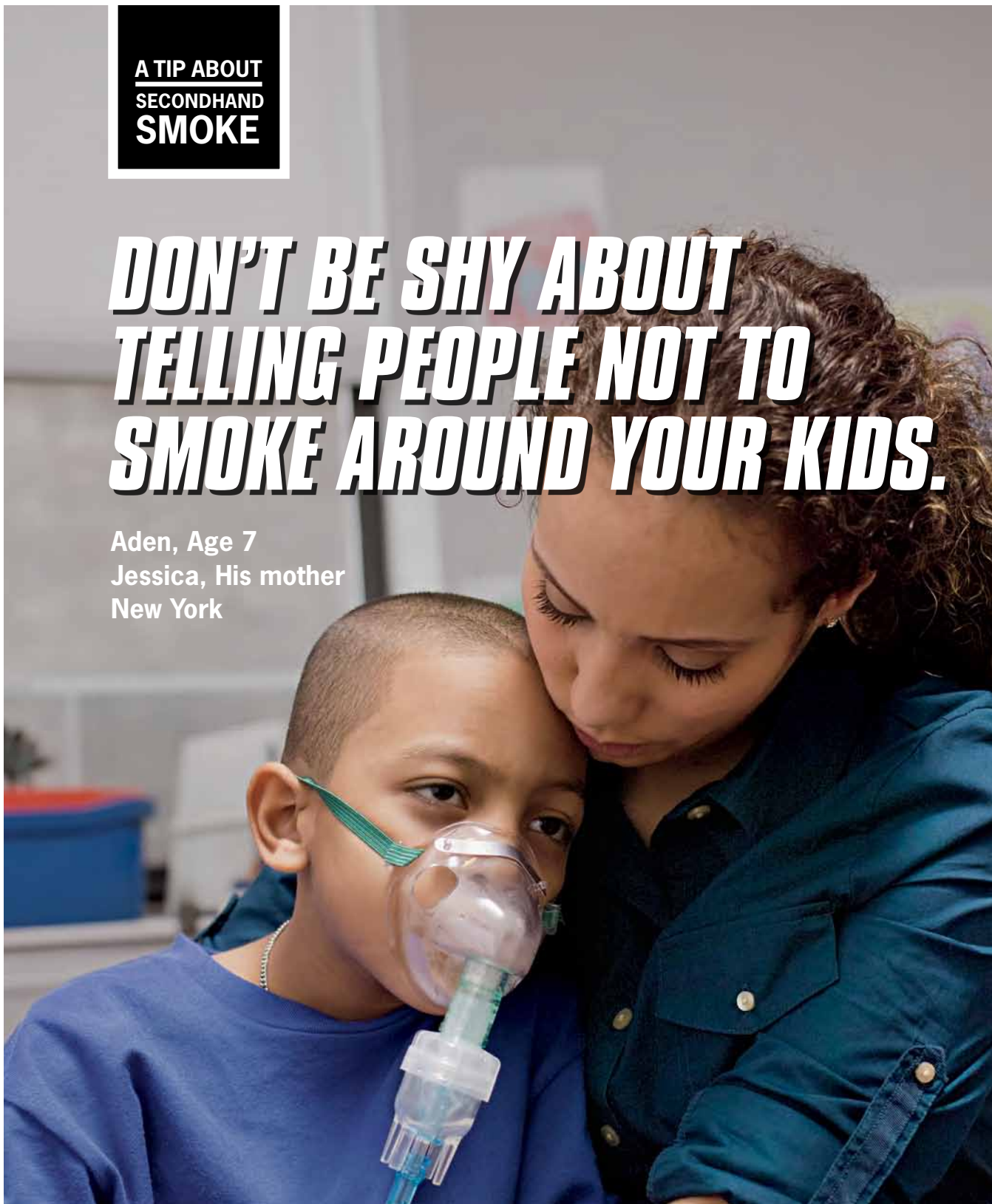
Half of U.S. kids are exposed to secondhand smoke. For Aden, it triggers his asthma attacks. Keep kids smoke-free. If someone you know wants free help, call **1-800-QUIT-NOW**.

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
www.cdc.gov/tobacco

Fighting for:

cleaner energy sources and the power to change.

The American Lung Association is fighting for a day when we can all breathe easier. That's why we support cleaner energy sources that make the air we breathe safer. The American Lung Association is fighting for air in more ways than ever before. Join the fight at FightingForAir.org.

AMERICAN LUNG ASSOCIATION®
Fighting for Air

Publishers of the *North Carolina Medical Journal*

The North Carolina Institute of Medicine

In 1983 the North Carolina General Assembly chartered the North Carolina Institute of Medicine as an independent, quasi-state agency to serve as a nonpolitical source of analysis and advice on issues of relevance to the health of North Carolina's population. The Institute is a convenor of persons and organizations with health-relevant expertise, a provider of carefully conducted studies of complex and often controversial health and health care issues, and a source of advice regarding available options for problem solution. The principal mode of addressing such issues is through the convening of task forces consisting of some of the state's leading professionals, policymakers, and interest group representatives to undertake detailed analyses of the various dimensions of such issues and to identify a range of possible options for addressing them.

NCIOM North Carolina Institute of Medicine
shaping policy for a healthier state

The Duke Endowment

The Duke Endowment, headquartered in Charlotte, NC, is one of the nation's largest private foundations. Established in 1924 by industrialist James B. Duke, its mission is to serve the people of North Carolina and South Carolina by supporting programs of higher education, health care, children's welfare and spiritual life. The Endowment's health care grants provide assistance to not-for-profit hospitals and other related health care organizations in the Carolinas. Major focus areas include improving access to health care for all individuals, improving the quality and safety of the delivery of health care, and expanding preventative and early intervention programs. Since its inception, the Endowment has awarded $2.9 billion to organizations in North Carolina and South Carolina, including more than $1 billion in the area of health care.

THE DUKE ENDOWMENT

NCMJ

NORTH CAROLINA MEDICAL JOURNAL

a journal of health policy analysis and debate

Include the NCMJ in your social network.

Visit the NCMJ Web site to access the journal's Twitter feed and Facebook page and to register for a free subscription to the journal's electronic edition.

Tar Heel Footprints in Health Care

*A periodic feature that recognizes individuals whose efforts—
often unsung—enhance the health of North Carolinians*

Jenny Faulkner

As the public information officer for Alamance-Burlington schools, Jenny Faulkner is responsible for communications, marketing, media relationships, and community relations for 36 schools and 22,500 students and their families. According to colleagues, Faulkner is quick to volunteer to work in the community and consistently provides strong leadership. Therefore, when a pertussis outbreak began in Alamance County schools in November 2011, Faulkner became the point person to coordinate communication efforts between the local health department, school administrators and staff members, students, parents, and the Alamance community. [For details on this outbreak and the public health response, see the commentary by Bass and Turpin-Saunders on pages 420-424.]

Faulkner states that the greatest challenge during the management of this outbreak was its timing, as most of the communication efforts coincided with the school system's winter break. Pat Lynn, retired Director of Student Data, recalls, "For well over an hour, on that Christmas Eve afternoon, [Faulkner] read off children's names, and I provided her with all the contact information I could find for each child so health department officials could make phone calls to families. Had parents not been contacted immediately, the outbreak would have spread."

In the following weeks, Faulkner and her colleagues worked closely with Alamance County Health Department staff members to identify students with pertussis and to notify others who may have been exposed. Once a confirmed case was reported, Faulkner reached out to the Transportation Department to determine whether the student rode a school bus; if so, staff members identified the student's bus route and determined which children were exposed in transit. Similarly, staff members in the Student Information Services department gathered information about possible contacts in the school and also reported back to Faulkner. Over the course of the outbreak, hundreds of students with connections to the pertussis outbreak were identified, and most received prophylactic antibiotics. Having an efficient protocol allowed Faulkner and her coworkers to help direct the public health response and answer any questions that came their way. The outbreak protocol was used throughout the remainder of the 2011–2012 school year for subsequent incidents of pertussis.

Lucy Kernodle, the lead nurse for Alamance-Burlington schools, worked closely with Faulkner throughout the pertussis outbreak. Kernodle remembers Faulkner's positivity and calm demeanor. "She realized the importance of collaborating with the Health Department and the importance of the overall public health of our community," said Kernodle. "She did this never seeking any recognition or attention. She is truly an unsung hero and Alamance County is a safer, healthier community because of her contributions." NCMJ

ORIGINAL ARTICLE

Descriptive Review of Asbestosis and Silicosis Hospitalization Trends in North Carolina, 2002–2011

Gregory T. T. Dang, Nirmalla Barros, Sheila A. Higgins, Ricky L. Langley, David Lipton

BACKGROUND Asbestosis and silicosis are debilitating pulmonary conditions resulting from inhalation of asbestos fibers or silica dust.

PURPOSE We provide a descriptive analysis of asbestosis and silicosis hospitalizations in North Carolina to assess trends over a 10-year period.

METHODS Events were defined as inpatient hospital discharges during the period 2002–2011 with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code of 501 or 502. Using statewide discharge data for 2002–2011, we calculated asbestosis and silicosis hospitalization rates in North Carolina (by demographics, hospital length of stay, cost, and payment type) and compared them with national rates.

RESULTS In North Carolina, average annual age-standardized hospitalization rates for asbestosis and silicosis were 71.2 hospitalizations per 1 million residents and 6.2 hospitalizations per 1 million residents, respectively. Rates for asbestosis and silicosis decreased significantly ($P<.01$ for both conditions) between 2002 and 2011, by 46% and 67%, respectively. Men had significantly higher rates than women ($P<.01$), more than half of hospitalizations were among persons aged 65–84 years, and Medicare was the predominant payment source. The highest silicosis rates by county were clustered in Western North Carolina; no geographic patterns were observed for asbestosis. The estimated average annual cost statewide for these hospitalizations was $10,170,417 for asbestosis and $886,143 for silicosis.

LIMITATIONS ICD-9-CM misclassification and duplicate hospitalization records may have biased the observed rates of asbestosis and silicosis.

CONCLUSIONS Decreases in hospitalization rates in North Carolina may be due to misdiagnosis, underreporting, or the declining use of asbestos in industries. Obtaining complete exposure histories at diagnosis is useful for continued public health surveillance.

Pneumoconioses are a group of pathologic conditions resulting from inhalation of substances into the lungs. The predominant pneumoconioses are asbestosis, silicosis, and coal workers' pneumoconiosis, which are caused by inhalation and deposition in the lungs of respirable asbestos fibers, silica dust, or coal dust, respectively. Except for rapidly progressive forms of silicosis, there is a latency period of up to 10 to 20 years between exposure and the development of clinically apparent disease. Severe pneumoconiosis can lead to lung impairment, disability, and premature death. Pneumoconioses are predominantly associated with chronic occupational exposure [1, 2]. This paper examines asbestosis and silicosis hospitalizations in North Carolina over a 10-year period.

Asbestosis

Asbestos is the name given to 6 naturally occurring fibrous minerals that have been used for many years in the manufacturing of many types of products because of their low cost and desirable qualities—such as heat and fire resistance, wear and friction characteristics, strength, and insulation capabilities. Use of asbestos boomed from the early 20th century to the mid-1900s; it was used in the manufacturing of pipes, coatings, flooring, friction materials, insulation, asphalt emulsions, gaskets, packings, plastics,

roofing, and textile materials. From the 1930s through the mid-1990s, significant asbestos exposure sources existed for workers in North Carolina. The state had one of the largest concentrations of asbestos textile mills in the nation, and the state's industries imported large quantities of asbestos from other countries, such as Canada and South Africa. To a lesser extent, asbestos was also actively mined in North Carolina. As a result of these activities, during the 20th century North Carolina was ranked among the top production states for asbestos [3-5].

After 1973, asbestos-related health concerns began to strongly affect demand, causing national production to stagnate. In 2002, the last asbestos mines in the United States closed. Asbestos has been phased out of most products, except for gaskets, friction products, and some roofing materials. Occupational exposures to asbestos still occur in the construction industry and in ship repair, particularly when asbestos materials are removed during renovation,

repairs, or demolition. Workers are also likely to be exposed to asbestos during the manufacturing of asbestos products and while doing automotive brake and clutch repair work [1, 6, 7].

Asbestosis occurs when airborne fibers are inhaled and irritate structures and tissues in the lungs. Several factors affect the initiation and progression of asbestosis, including the size and type of fiber, intensity and duration of exposure, history of cigarette smoking, and individual susceptibility. Once the disease process begins, it may progress regardless of whether there is continued exposure to asbestos; the disease eventually leads to severe fibrosis of the lungs that can cause breathing difficulties. Asbestos inhalation can also cause lung cancer and mesothelioma, the latter of which is a cancer that affects the protective membrane surrounding the lung and other organs. Other cancers associated with exposure to asbestos include gastrointestinal cancers [1]. There is no known treatment for asbestosis. Workers with this condition should be removed from exposure, and contributing factors, such as smoking, should be reduced or eliminated [8].

Silicosis

Silicosis results from inhalation of silicon dioxide, or silica, in crystalline form. Silica is a component of rocks and sand. Occupational exposures to silica occur across a broad range of industries, including mining, manufacturing, construction, maritime work, and agricultural industries. Exposure to silica can occur as part of common workplace operations involving the dissociation (crushing) of stone and rock products and in operations that use sand, such as glass manufacturing, foundries, and sand blasting [6, 9, 10].

Silicosis can be either acute or chronic. Acute silicosis is a rapidly progressive condition that occurs when workers are exposed to very high concentrations of respirable free silica dust. This condition can be life threatening, as the lungs become densely fibrotic and fill with fluid, making breathing difficult. In chronic forms of silicosis, which have a latency period of 2 to 10 years or longer, nodules form in the lung tissue. Chronic silicosis may be uncomplicated, when it is a mild form of the disease with fewer symptoms, or complicated, when it is a more serious form of the disease involving fibrosis of the lungs. Possible complications of silicosis include tuberculosis and pulmonary fungal diseases [8]. A report by the World Health Organization (WHO) has shown a link between silica exposure and lung cancer [11]. As with asbestosis, silicosis has no known treatment, and workers with this condition should be removed from the environment in which silica exposure is occurring.

Monitoring of Asbestosis and Silicosis

North Carolina has taken steps to monitor asbestosis and silicosis in the workplace. From 1938 to 2002, the North Carolina Division of Public Health operated the Dusty Trades program, which monitored exposure and carried out medical screening for workers exposed to asbestos and silica hazards. In addition, the North Carolina Division of Public Health has considered both asbestosis and silicosis to be reportable conditions since 1994, and it conducted case-based surveillance until 1998. Despite these efforts, data to address the burdens of asbestos and silica exposure among working adults in North Carolina have been limited since these pneumoconiosis surveillance programs ceased to function in 2002 [12]. In addition, efforts to examine these conditions in North Carolina are not recent or are limited in scope [13-17].

Asbestosis and silicosis are serious, debilitating conditions. Surveillance of these conditions is important for identifying and decreasing their burden in North Carolina, through targeted prevention strategies and regulatory enforcement programs. This paper provides a descriptive analysis of asbestosis and silicosis hospitalization trends in North Carolina, which can shed light on the current burden of asbestosis and silicosis on workers throughout the state.

Methods

We conducted a retrospective review of asbestosis and silicosis inpatient hospitalizations for a 10-year period (2002–2011) using data from the North Carolina Inpatient Hospital Discharge Database (NCIHDD) and from the National Hospital Discharge Survey (NCHS). The NCIHDD, which is managed by the North Carolina State Center for Health Statistics, contains case-specific discharge data for all patients admitted to and discharged from any nonfederal hospital facility in North Carolina. Data include information regarding demographics, hospital admissions, diagnostics, care, and payment. Analyses were performed on variables indicating sex, age, county of residence, length of hospital stay, payment source, and charges associated with the visit.

We adapted methods for case selection and calculation of age-standardized rates of asbestosis and silicosis from the Council for State and Territorial Epidemiologists (CSTE) data collection methods for the national occupational health indicator "hospitalizations from or with pneumoconiosis" [18, 19]. Cases were defined as all inpatient hospital discharges from 2002 to 2011 with a primary or contributing diagnosis of asbestosis (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] code 501) or silicosis (ICD-9-CM code 502) among North Carolina residents aged 15 years or older.

Annual rates were calculated via direct standardization to remove effects of age confounding, using US standard population estimates for the year 2000 [20]. These methods are consistent with the CSTE methods for calculating national occupational health indicators. The total number of hospital discharges for patients diagnosed with asbestosis or silicosis was divided by the annual US Census Bureau population estimate for North Carolina for the same calendar year. Population data were obtained from the US Census Bureau population estimates for the periods 2000–2009

and 2010–2012 [21, 22]. Means were calculated across the 10-year period. Mean case counts by age group were calculated by dividing the total number of cases in each 10-year age group by the state population estimate for each age group.

SAS 9.3 software was used to perform Poisson regression to determine annual age-standardized rate trend significance for asbestosis and silicosis hospitalizations; 1-way analysis of variance (ANOVA), Tukey test, and 2 independent sample t-tests were used to compare annual age-standardized hospitalization rates for North Carolina, stratified by sex and age group, with rates for the United States. Mean rates of hospitalization by county were calculated across the 10-year period using the county of residence at the time of hospitalization. National data were only available for the years 2002–2010. Statistical significance was defined as a P-value less than .05.

Results

A total of 5,003 hospitalizations for asbestosis and 442 hospitalizations for silicosis were reported across the 10-year study period (2002–2011), for an average of 500 asbestosis hospitalizations and 44 silicosis hospitalizations per year. The mean annual age-standardized rate of hospitalization was 71.2 hospitalizations per 1 million residents for asbestosis (standard deviation [SD] = 16.0; range, 46.9–92.4) and 6.2 hospitalizations per 1 million residents

for silicosis (SD = 2.1; range, 2.8–8.5). The age-standardized hospitalization rate for asbestosis steadily decreased from 2003 to 2011, after increasing from 2002 to 2003. The age-standardized hospitalization rate for silicosis showed steady decreases for the entire study period (2002–2011). The data showed a 46% overall decrease in the rate of asbestosis hospitalizations between 2002 and 2011, with an average rate change of 8% per year. For silicosis, there was a 67% overall decrease in the rate of hospitalizations between 2002 and 2011, with an average rate change of 10% per year. Poisson regression results showed that overall trends significantly decreased for both asbestosis (P<.01) and silicosis (P<.01) over the 10-year period (Figure 1).

Figure 2 compares annual age-standardized asbestosis and silicosis hospitalization rates in North Carolina with the annual age-standardized rates in the United States. For asbestosis, North Carolina's mean age-standardized hospitalization rate for the 9-year period 2002–2010 was 73.9 hospitalizations per 1 million residents, which was not significantly different from the US mean rate of 64.2 hospitalizations per 1 million residents (t = 1.15; P = .27). For silicosis, North Carolina's mean age-standardized hospitalization rate for the 9-year period 2002–2010 was 6.6 hospitalizations per 1 million residents, which again was not significantly different from the US mean rate of 4.6 hospitalizations per 1 million residents (t = 1.86; P = .08).

When data for North Carolina were stratified by sex,

FIGURE 1.
Case Counts and Age-Standardized Rates of Hospitalization for Asbestosis and Silicosis in North Carolina, 2002–2011
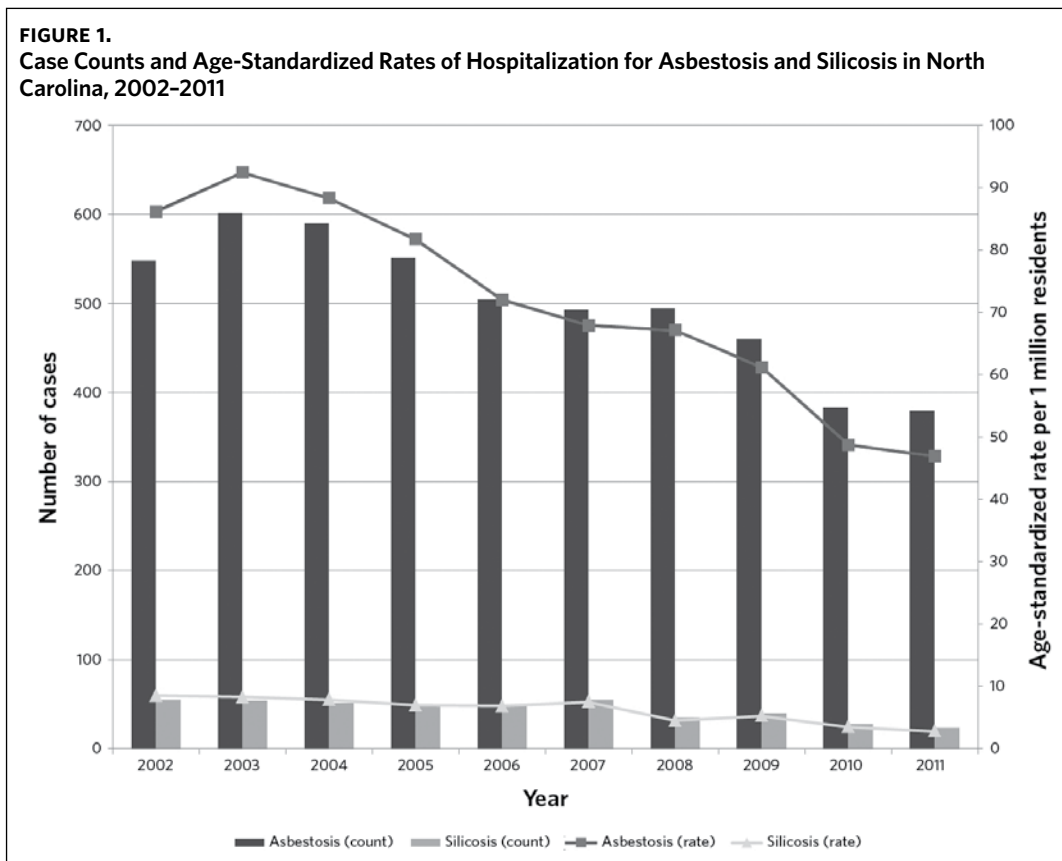
FIGURE 2.
Age-Standardized Hospitalization Rates for Asbestosis and Silicosis in North Carolina and in the United States, 2002–2010
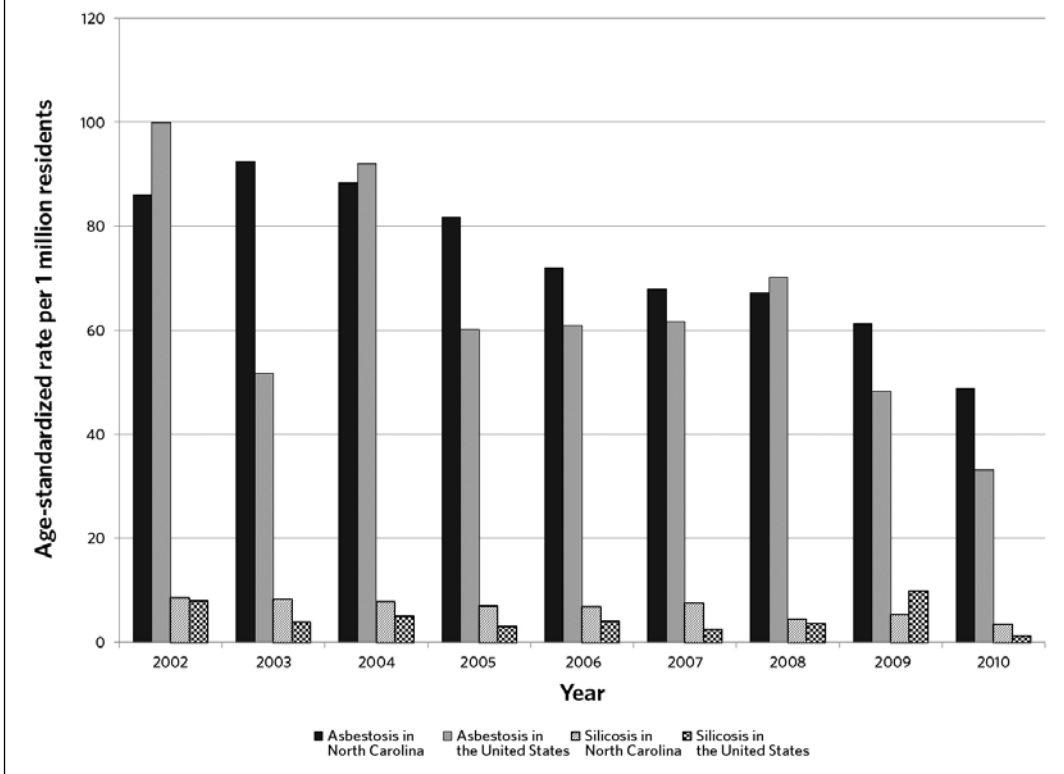
annual age-standardized hospitalization rates for both conditions during the period 2002–2011 were significantly higher for men than for women. For asbestosis, men had a mean hospitalization rate of 66.7 hospitalizations per 1 million residents, and women had a mean hospitalization rate of 4.6 hospitalizations per 1 million residents (t = –13.59; P<.001). For silicosis, men had a mean hospitalization rate of 5.5 hospitalizations per 1 million residents, and women had a mean hospitalization rate of 0.7 hospitalizations per 1 million residents (t = –8.88; P<.001).

The mean age of asbestosis patients was 72 years (SD = 10.0; range, 32–101), and the mean age of silicosis patients was 68 years (SD = 11.6; range, 24–98). For asbestosis, 68% of hospitalizations occurred among individuals aged 65–84 years (Figure 3). Significant differences in mean hospitalization rates for asbestosis were found between the following age categories: 15-45 years, 55–64 years, 65–74 years, and 75–85+ years (F = 182.08; P<.001); the highest mean hospitalization rate was 48.7 hospitalizations per 100,000 residents for the age group 75–84 years (SD = 11.84; range, 30.56–64.95). For silicosis, 60% of hospitalizations occurred among individuals aged 65–84 years (Figure 4). The mean hospitalization rate for silicosis for those aged 15-64 years differed significantly from the rate for those aged 65–85+ years (F = 16.35; P<.001); the highest mean hospitalization rate was 3.3 hospitalizations per 100,000 residents for those aged 85 years or older

(SD = 2.63; range, 0.70–7.85).

The 3 counties with the highest average rates of hospitalization for asbestosis for the period 2002–2011 were Washington, Rowan, and Haywood, which had 579.9, 402.7, and 271.0 hospitalizations per 1 million residents, respectively. The 3 counties with the highest average rates of hospitalization for silicosis were Yancey, Mitchell, and Swain, which had 165.2, 88.9, and 67.9 hospitalizations per 1 million residents, respectively.

When hospitalization cost trends during this time period were assessed, decreases were seen both for asbestosis hospitalizations (t = 9.65; P<.001) and for silicosis hospitalizations (t = 3.74; P<.01). The estimated average total statewide cost per year during the period 2002–2011 was $10,170,417 for asbestosis hospitalizations and $886,143 for silicosis hospitalizations. The estimated mean annual cost charged to individual patients who were hospitalized during the 10-year period 2002–2011 was $20,332.70 for patients with asbestosis (SD = $21,487; range, $524–$347,227) and $20,048 for patients with silicosis (SD = $25,505; range, $930–$299,854).

The major payment source for these hospitalizations was Medicare, which was documented as the primary payment source for 77% of asbestosis patients and 68% of silicosis patients. Private insurers that were not health maintenance organizations (HMOs) or preferred provider organizations (PPOs) were documented as the primary payment source

FIGURE 3.
Mean Case Counts and Mean Rates of Hospitalization for Asbestosis in North Carolina by Age Group, 2002–2011
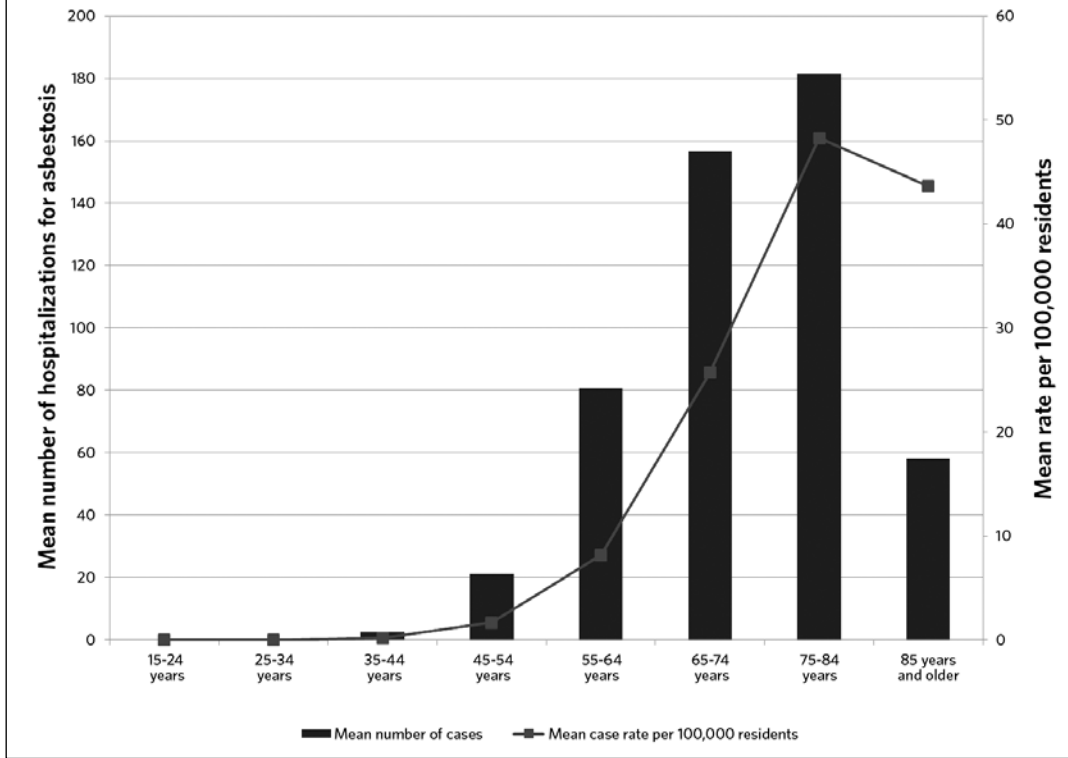
FIGURE 4.
Mean Case Counts and Mean Rates of Hospitalization for Silicosis in North Carolina by Age Group, 2002–2011
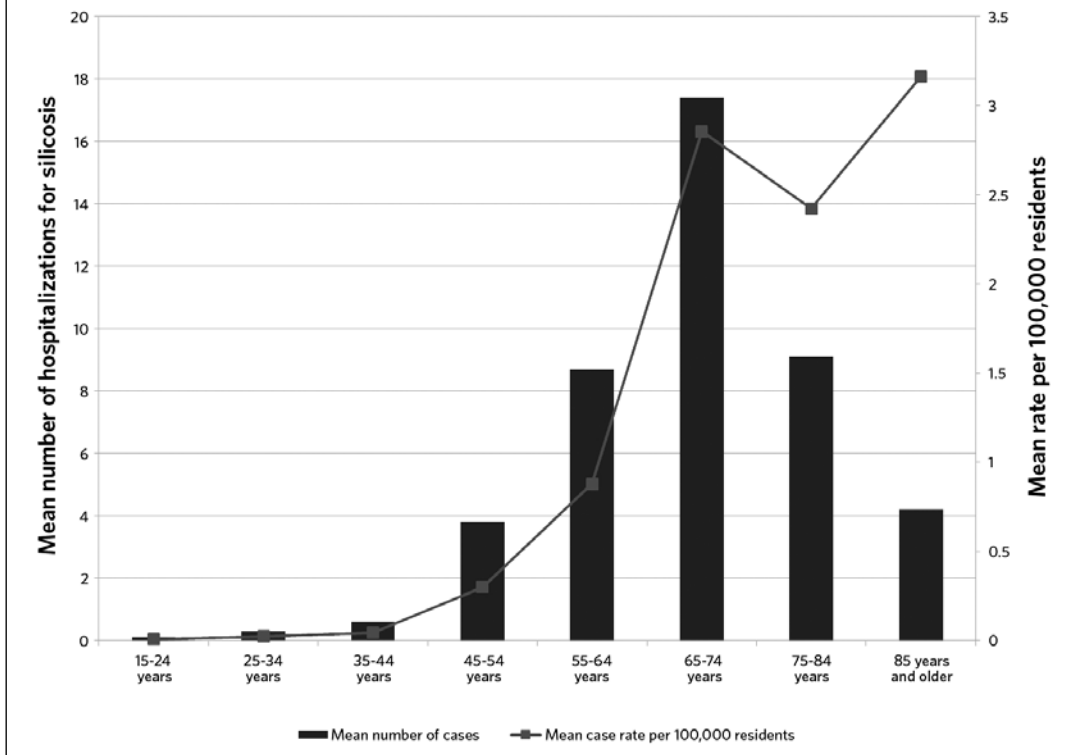
for 11% of asbestosis patients and 13% of silicosis patients; HMOs and PPOs were documented as the primary payment source for 6% of asbestosis patients and 8% of silicosis patients; and workers' compensation or other government insurance plans were documented as the primary payment source for 2% of asbestosis patients and 4% of silicosis patients.

During the period 2002–2011, the mean length of stay was 4.9 days for an asbestosis hospitalization (SD = 4.66; range, 1–94) and 4.9 days for a silicosis hospitalization (SD = 5.47; range, 1–87). More than half of patients (61% of those with asbestosis and 61% of those with silicosis) were hospitalized for 4 days or less.

Discussion

This study describes trends in annual hospitalization rates for asbestosis and silicosis in North Carolina over a 10-year period. Overall, the age-standardized hospitalization rates for asbestosis and silicosis decreased significantly during this period. Observed decreases in asbestosis hospitalizations may have been due to a decline in the use of asbestos in industries, leading to a decrease in worker exposure to asbestos. A 2006 US Geological Survey report [3] estimated that the amount of asbestos consumption in the United States was 51% of world production in 1950, but this percentage declined to 19% in 1970, 13% in 1975, 4% in 1985, and less than 1% in 2000. The decline in the rates of hospitalization for both asbestosis and silicosis may also result from cases being misdiagnosed as a result of incomplete patient exposure histories; because of the long disease latency period, the patient history needs to collect information about exposures over a sufficiently long timeframe. In addition, other conditions may present with similar chest radiograph findings; these conditions include sarcoidosis, pulmonary nodules in rheumatoid disease, carcinomatosis, military tuberculosis, deep fungal infections, and idiopathic pulmonary fibrosis [23].

North Carolina and the United States showed similar overall trends in mean annual age-standardized rates for asbestosis and silicosis hospitalizations throughout the 9-year period 2002–2010. Annual hospitalization rates were significantly higher for men than women for both conditions, for every year from 2002 through 2011. These rates are consistent with previous trends for diseases resulting from occupational exposures, and this finding is unsurprising since men constitute a greater proportion of the workforce in industries with potential asbestos and silica exposure [24, 25]. Higher hospitalization rates for both diseases were also found among older individuals, which is consistent with the latency periods associated with these conditions and with the decreased pulmonary reserves of elderly individuals.

The incidence of pneumoconiosis varies geographically, based largely on local industrial activities and migration of affected individuals [15, 16, 22]. There does not appear to be any clustering of asbestosis hospitalizations within North Carolina. Silicosis hospitalizations appear to have been concentrated in the westernmost part of the state, which had the highest county rates of silicosis. However, rates for observed silicosis hospitalizations over the 10-year period were small, so the apparent concentration of cases in this region may have been due to chance. As of 2012, estimated employment in asbestos-related industries in North Carolina was greatest in Guilford County, which had 365 jobs; Mecklenburg County, with 244 jobs; and Wake County, with 168 jobs. Estimated employment in silica-related industries for 2012 was greatest in Mecklenburg County, which had 5,605 jobs; Wake County, with 4,447 jobs; and Guilford County, with 1,232 jobs [26, 27]. Future ecological studies comparing these counties and measuring worker exposure within these industries longitudinally may yield interesting results.

Although decreases in the rates of asbestosis and silicosis hospitalizations were observed, exposure to asbestos and respirable silica still occurs. Asbestosis and silicosis are largely preventable by limiting exposure to asbestos fibers and respirable silica dust. Prevention begins with recognizing which tasks create airborne asbestos fibers and/or respirable silica dust and implementing controls to limit exposure before workers come into contact with these substances, in accordance with the federal standards for air contaminants [28]. Controls include exhaust ventilation to collect and remove dust from the environment, wet methods that limit production of airborne dust, and other engineering or administrative controls. Other hazard reduction steps include training and educating workers about the hazards of airborne asbestos and respirable silica dust, and making personal protective equipment available when other control measures are not feasible [28].

Currently, state programs help to monitor and reduce workplace exposure to asbestos and silica. Occupational exposure to asbestos and silica hazards in general industry and in construction is federally regulated by the Occupational Safety and Health Administration in the US Department of Labor. The Health Hazards Control Unit (HHCU) of the North Carolina Division of Public Health also administers an Asbestos Hazard Management Program in accordance with legal requirements [29]. This program accredits individuals who perform asbestos management activities (inspection, removal, and air monitoring), approves asbestos training courses, issues permits for asbestos removal projects and demolition notifications, inspects asbestos removal and demolition projects, reviews asbestos management plans for schools, and investigates citizens' complaints [29].

Limitations

Multiple hospitalization records for patients were not de-duplicated during analysis, which may overestimate the number of hospitalizations. On the other hand, diagnoses made in federal facilities (eg, Veterans Affairs hospitals, military base hospitals, and mental hospitals), in outpatient

clinics, or in facilities in other states (for North Carolina residents) were not included in the calculations for this study, which may have led to underestimation of the number of hospitalizations.

Furthermore, because asbestosis and silicosis have a long latency period (10 to 20 years) from the time of exposure to apparent symptoms, hospitalization rates for a given year during the 10-year study period are not indicative of exposure to asbestos or silica during that year. Indeed, it may be many years before a reduction in exposure affects the rate of hospitalization for these conditions.

Finally, trend analysis using racial data would have been helpful to determine whether different racial groups were disproportionately affected by these conditions. However, information on race in hospital discharge files was not collected consistently via standardized methods until 2010. Therefore, racial data were not considered in this study.

Conclusions

Asbestosis and silicosis hospitalizations continue to be an important social and economic burden for workers and the health care system. Continuing state-level monitoring and regulation of occupational exposure to asbestos and respirable silica are necessary to help protect the health of workers. Although asbestos-related industrial activities may have decreased, naturally occurring asbestos deposits can be a public health concern with the encroachment of people and development into natural environments. North Carolina workers also continue to be exposed to respirable silica in a variety of industries and occupations. Physicians can help identify cases of asbestosis and silicosis by comprehensively recording occupational or environmental exposures when considering pneumoconioses in the differential diagnoses of lung diseases. NCMJ

Gregory T. T. Dang, DrPH, CPH occupational health epidemiologist, Occupational and Environmental Epidemiology Branch, Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.
Nirmalla Barros, PhD, MPH environmental epidemiology surveillance lead, Occupational and Environmental Epidemiology Branch, Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.
Sheila A. Higgins, RN, MPH, COHN-S occupational health nurse consultant, Occupational and Environmental Epidemiology Branch, Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.
Ricky L. Langley, MD, MPH public health physician, Occupational and Environmental Epidemiology Branch, Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.
David Lipton, MS, CIH industrial hygiene consultant, Occupational and Environmental Epidemiology Branch, Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.

References
1. US Department of Health & Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Asbestos. Atlanta, GA: ATSDR; 2001. http://www.atsdr.cdc.gov/toxprofiles/tp61.pdf. Accessed March 8, 2013.
2. Centers for Disease Control and Prevention (CDC). Pneumoconioses. CDC Web site. http://www.cdc.gov/niosh/topics/pneumoconioses/. Updated August 21, 2012. Accessed September 10, 2013.
3. Virta RL. Worldwide Asbestos Supply and Consumption Trends from 1900 through 2003. Reston, VA; US Geological Survey (USGS); 2006. USGS Circular 1298. http://pubs.usgs.gov/circ/2006/1298/c1298.pdf. Accessed April 3, 2013.
4. Brobst DA, Pratt WP. United States Mineral Resources: Geological Survey Professional Paper 820. Washington, DC: US Government Printing Office;1973. http://archive.org/stream/unitedstatesmine00brob/unitedstatesmine00brob_djvu.txt. Accessed August 20, 2013.
5. Conrad SG, Wilson WF, Allen EP, Wright TJ. Anthophyllite Asbestos in North Carolina. Raleigh, NC: North Carolina Department of Conservation and Development; 1963. Division of Mineral Resources Bulletin 77.
6. North Carolina Department of Labor, Division of Occupational Safety and Health. Operational Procedure Notice 135: Special Emphasis Program for Exposures to Health Hazards. http://www.nclabor.com/osha/compliance/publicopn/opn135f.pdf. Published January 4, 2012. Accessed March 8, 2013.
7. US Department of Labor, Occupational Safety and Health Administration (OSHA). Asbestos. OSHA Web site. http://www.osha.gov/SLTC/asbestos/. Accessed March 8, 2013.
8. LaDou J, ed. Current Occupational and Environmental Medicine. 4th ed. New York, NY: McGraw-Hill; 2007.
9. US Department of Labor, Occupational Safety and Health Administration (OSHA). National Emphasis Program—Crystalline Silica. OSHA Instruction Directive No. CPL 03-00-007. OSHA Web site. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3790#b. Published January 4, 2008. Accessed March 8, 2013.
10. US Department of Labor, Occupational Safety and Health Administration (OSHA). Silica, Crystalline. OSHA Web site. http://www.osha.gov/dsg/topics/silicacrystalline/index.html. Accessed March 8, 2013.
11. World Health Organization, International Agency for Research on Cancer (IARC). Silica: Summary of Data Reported and Evaluation. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, vol. 68. 1997:41. http://monographs.iarc.fr/ENG/Monographs/vol68/volume68.pdf. Accessed August 20, 2013.
12. Lattimore B. Memorandum to Dusty Trades Program employers regarding status of Dusty Trades Program. July 2, 2002. http://www.ic.nc.gov/ncic/pages/0702memo.htm. Accessed June 28, 2013.
13. The National Institute for Occupational Safety and Health (NIOSH). Work-Related Lung Disease Surveillance System (eWoRLD). NIOSH Web site. http://www2a.cdc.gov/drds/WorldReportData/. Accessed March 8, 2013.
14. Maxfield R, Alo C, Reilly MJ, et al. Surveillance for silicosis, 1993—Illinois, Michigan, New Jersey, North Carolina, Ohio, Texas, and Wisconsin. MMWR CDC Surveill Summ. 1997;46(1):13-28.
14. Amandus HE, Shy C, Castellan RM, Blair A, Heineman EF. Silicosis and lung cancer among workers in North Carolina dusty trades. Scand J Work Environ Health. 1995;21(suppl 2):81-83.
16. Rice C, Harris RL Jr, Lumsden JC, Symons MJ. Reconstruction of silica exposure in the North Carolina dusty trades. Am Ind Hyg Assoc J. 1984;45(10):689-696.
17. Easom HF, Trice MF. Development of an industrial hygiene program in a state health department. Am J Public Health Nations Health. 1938;28(5):610-615.
18. Council of State and Territorial Epidemiologists (CSTE). Putting Data to Work: Occupational Health Indicators from Thirteen Pilot States for 2000. Atlanta, GA: CSTE; 2005. http://c.ymcdn.com/

sites/www.cste.org/resource/resmgr/OccupationalHealth/CST
EOHIndicators.pdf. Accessed March 5, 2013.

19. NIOSH-CSTE Surveillance Planning Work Group. The Role of the
States in a Nationwide, Comprehensive Surveillance System for
Work-Related Diseases, Injuries, and Hazards. Atlanta, GA: Nation-
al Institute of Occupational Safety and Health; 2001. http://c.ymcdn
.com/sites/www.cste.org/resource/resmgr/OccupationalHealth/
NIOSH.pdf. Accessed March 5, 2013.

20. Klein RJ, Schoenborn CA. Age adjustment using the 2000 project-
ed US population. Healthy People 2010 Stat Notes. 2001;(20):1-
10. http://www.ibisph.org/trac/export/4511/adopters/nm/trunk/
src/main/webapps/ibisph-view/docs/PHStatistics/statnt20.pdf.
Accessed April 3, 2013.

21. US Census Bureau. Population estimates: historical data. US Census
Bureau Web site. http://www.census.gov/popest/data/historical/
index.html. Accessed April 3, 2013.

22. US Census Bureau. Population estimates: current estimates data.
US Census Bureau Web site. http://www.census.gov/popest/data/
index.html. Accessed April 3, 2013.

23. Leung CC, Yu IT, Chen W. Silicosis. Lancet. 2012;379(9830):2008-
2018.

24. Davis C, Vijaykumar J, Lackovic M, Diaz JH. Asbestosis in Louisiana:
a descriptive review and demographic analysis of hospitalizations
for asbestosis, 1999-2009. J LA State Med Soc. 2011;163(6):336-341.

25. Wootton BH. Gender differences in occupational employment. Mon
Labor Rev. 1997;120(4):15-24.

26. North Carolina Commission on Workforce Development. State
of the North Carolina Workforce, 2011–2020. Raleigh, NC: North
Carolina Commission on Workforce Development; 2011. http://
www.nccommerce.com/Portals/11/Documents/Reports/2011%20
SOTW%20Full%20Final%20Report%2052311%20909am.pdf.
Accessed March 30, 2013.

27. US Department of Labor, US Bureau of Labor Statistics. Geographic
Profile of Employment and Unemployment, 2012. Bulletin 2775.
Washington, DC: US Bureau of Labor Statistics; 2013. http://www
.bls.gov/opub/gp/pdf/gp12full.pdf. Accessed September 13, 2013.

28. US Department of Labor, Occupational Safety and Health Admin-
istration. Regulations (Standards—29 CFR). Part 1910, Occupa-
tional Safety and Health Standards. Subpart Z, Toxic and Hazardous
Substances. Standard 1910.1000: Air contaminants. http://www
.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9991&p_
table=STANDARDS. Accessed April 4, 2013.

29. Asbestos Hazard Management Program. NCGS §130A-444-452.
http://epi.publichealth.nc.gov/asbestos/pdf/Asbestos%20statute
%20Article19.pdf. Accessed April 2, 2013.

The Prevalence, Characteristics, and Impact of Chronic Obstructive Pulmonary Disease in North Carolina

Roy A. Pleasants, Harry Herrick, Winston Liao

BACKGROUND Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality. We describe the prevalence, characteristics, and impact of COPD in North Carolina.

METHODS We determined the prevalence of self-reported COPD and characteristics of affected persons using data from the 2009 North Carolina Behavioral Risk Factor Surveillance System (BRFSS) survey. We also determined the number of persons with COPD in nursing homes and adult care or family care homes. We drew conclusions about the impact of COPD from data regarding mortality, hospitalizations, emergency department visits, prednisone use, and health impairment.

RESULTS The age-adjusted prevalence of COPD among BRFSS survey respondents was 5.6%, and about 10,000 adults in nursing homes, adult care homes, or family care homes had COPD; thus we estimate that nearly 408,000 adults in North Carolina had COPD in 2009. Rates of self-reported COPD were highest among elderly individuals, smokers, individuals with less education, and those with lower incomes. Mental and physical impairment were significantly worse in those with COPD, two-thirds of whom reported that dyspnea affected their quality of life. Prednisone use was reported by 27.4% of persons with COPD, 11.4% of respondents with COPD had been hospitalized for this condition within the preceding year, and COPD admissions accounted for 1.44% of all hospital charges. Asthma, heart disease, stroke, and diabetes mellitus were significantly more common in persons with COPD. In terms of mortality, COPD was the fourth leading cause of death (n = 4,324); 77% of COPD deaths were among persons who had no education beyond high school, and 53% of those who died were women. COPD was reported in 17.1% of deaths from all causes, 21% of deaths from asthma, 10.1% of deaths from lung cancer, and 6.7% of deaths from heart disease.

LIMITATIONS These data are based on population and health care database estimates and are approximations.

CONCLUSION COPD has substantial effects on the health of North Carolinians.

Chronic obstructive pulmonary disease (COPD) constitutes more than 95% of all cases of chronic lower respiratory disease, which in 2008 surpassed stroke to become the third leading cause of death in the United States [1]. Since the 1990s, substantial national and state-based efforts have targeted asthma, likely contributing to the stabilization or decrease in the numbers of emergency department (ED) visits, hospitalizations, and deaths due to that disease [2]. Similarly, greater efforts with regard to the prevention, recognition, and management of COPD are needed to decrease its growing impact.

In 2007 and 2009, COPD-related questions were incorporated into North Carolina's principal annual health survey, the Behavioral Risk Factor Surveillance System (BRFSS) survey, to help define the prevalence and impact of COPD in the state [3]. Although the BRFSS survey gives insight into the prevalence, patient characteristics, and impact of COPD from the patient's perspective, it lacks some very important measures—such as data regarding mortality, ED visits, and hospitalizations—and it does not survey institutionalized persons. The purpose of this paper is to describe the burden of COPD in North Carolina using various health-related databases.

Methods

We chose to estimate the burden of COPD in North Carolina for the year 2009 because data for that year were available in the desired databases. This paper presents information from a variety of sources: data that we collected ourselves, our analysis of the 2009 BRFSS survey results, North Carolina vital statistics mortality data, and data from other published reports [4-8]. We estimated the total number of persons in North Carolina with COPD in 2009 by combining the age-adjusted prevalence of self-reported COPD among noninstitutionalized adults (using BRFSS data), the number of residents in nursing homes with a diagnosis of COPD [3], and the estimated number of adults with COPD living in adult care or family care homes [4].

The BRFSS survey is an annual telephone health survey that is conducted in each state and is coordinated by the Centers for Disease Control and Prevention (CDC). The survey includes more than 90 core questions that address chronic illnesses and health behaviors of noninstitutionalized adults [9]. In 2007 and 2009, the North Carolina

COPD Task Force collaborated with the North Carolina State Center for Health Statistics to add a COPD prevalence question to the BRFSS survey; a module of 5 questions assessing the impact of COPD was also added. Two COPD-related questions from the 2007 North Carolina BRFSS survey were modified for the 2009 survey to better address hospitalizations and acute exacerbations of COPD. Table 1 shows these and other BRFSS questions that produced the information used in our analysis.

Using a script, trained interviewers collected BRFSS data using an independent, random-digit-dialed probability sample of noninstitutionalized persons in households contacted through landline telephones [9]. A separate interviewer validated selected questions in a random selection of 5% of completed surveys. In 2009, the North Carolina BRFSS oversampled 23 of the state's largest counties as well as Native American census tracts in 6 counties because of small sample size in these categories; the remainder of the sample was then apportioned to 3 regions of the state—Western, Piedmont, and Eastern. Response and cooperation rates for eligible households in North Carolina in 2009 were 62.50% and 80.48%, respectively [10]. The BRFSS has been approved as exempt research by the CDC's institutional review board.

Residents of nursing homes, adult care homes, and family care homes are excluded from the BRFSS survey, but most persons in these facilities are elderly, so we included these individuals in our estimate of the number of COPD patients. The number of COPD patients in North Carolina nursing homes in 2009 was obtained (using a diagnosis of COPD or emphysema) through the Centers for Medicare & Medicaid Services Minimum Data Sets (MDS) 2.0 Active Resident Information Report for the fourth quarter of 2009 [4].

Because there is not a similar database that can be used to estimate the number of COPD patients in adult care or family care homes in North Carolina, we used a 2009 report from the North Carolina Institute of Medicine (NCIOM) that estimated the number of these residents [5]. The vast majority of the estimated 28,500 such residents were older than 65 years. Thus we used a COPD prevalence of 10%, based on the BRFSS COPD data for that age group.

Finally, to estimate the overall number of persons with COPD in the state, we combined the number of persons from these 3 sources, using the BRFSS age-adjusted prevalence rate to calculate the number of persons with COPD among the estimated 7,102,917 adults living in North Carolina in 2009 [11]. Persons not included in our estimate of COPD prevalence were those living in correctional facilities, college dormitories, or military barracks. There were about 40,000 inmates in correctional facilities in North Carolina in 2009; more than 60% were aged 25–44 years and 90% were men [12], so they were unlikely to contribute significantly to the overall number of persons with COPD.

The number of acute care visits related to COPD in 2009 was calculated using hospitalization data from the North

Carolina Department of Health and Human Services [6], ED data collected by the North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) [7], and BRFSS data relating to survey questions about overnight hospital stays and prednisone use (Table 1). We considered the use of prednisone to be a surrogate marker for acute exacerbations of COPD. Prednisone is considered to be a standard of care for exacerbations requiring acute care visits, but it is also used long term by a small percentage of COPD patients.

To determine COPD-related deaths in relationship to

TABLE 1.

Questions on the 2009 Behavioral Risk Factor Surveillance System Survey That Produced Information Used in Our Analysis

Questions in the chronic obstructive pulmonary disease module

- Have you ever been told by a doctor or health professional that you have chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis?
- Have you ever been given a breathing test, which measures how much air you can breathe out through a tube, to diagnose your COPD, chronic bronchitis, or emphysema?
- Would you say that shortness of breath affects the quality of your life?
- Other than a routine visit, have you had to see a doctor in the past 12 months for symptoms related to shortness of breath, bronchitis, or other COPD, or emphysema flare?
- During the past 12 months, have you stayed in a hospital overnight because of shortness of breath, COPD, or emphysema flare?
- Prednisone is a medicine that helps people with breathing problems breathe easier. It is sometimes called Deltasone or Medrol. During the past 12 months, has a doctor ever prescribed prednisone for your breathing problems?

Core questions

- Would you say that in general your health is excellent, very good, good, or poor?
- Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?
- Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?
- Have you ever been told by a doctor that you have diabetes?
- Has a doctor, nurse, or other health professional ever told you that you had a heart attack, also called a myocardial infarction?
- Has a doctor, nurse, or other health professional ever told you that you had angina or coronary heart disease?
- Has a doctor, nurse, or other health professional ever told you that you had a stroke?
- Have you ever been told by a doctor, nurse, or other health professional that you had asthma?
- Do you still have asthma?
- Have you smoked at least 100 cigarettes in your entire life?
- Do you now smoke cigarettes every day, some days, or not at all?
- How long has it been since you last smoked cigarettes regularly?
- Have you ever been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?
- Have you ever been told by a doctor, nurse, or other health professional that you have some form of kidney disease?

Source: North Carolina 2009 Questionnaire Version 2, Behavioral Risk Factor Surveillance System, September-December 2009. North Carolina State Center for Health Statistics Web site. http://www.schs.state.nc.us/schs/brfss/pdf/BRFSSQ09_ver2.pdf. Accessed August 23, 2013.

selected mortalities, as well as primary versus secondary cause of death, we used the 2009 raw mortality data from the Vital Statistics Section of the North Carolina State Center for Health Statistics. COPD-related mortality was also determined from a report published by the Vital Statistics Section of the North Carolina State Center for Health Statistics [8]. We looked at the frequency of COPD as a primary cause of death (International Classification of Diseases, 10th Revision [ICD-10] mortality codes J420–J440) or as a secondary diagnosis when the primary cause of death was one of the following: all deaths; deaths due to heart disease (ICD-10 codes I20–I25); deaths due to cancers of the trachea, bronchus, or lung (ICD-10 codes C32–C34); or deaths due to asthma (ICD-10 codes J450–J460). Health impairment was determined based on responses to the BRFSS questions that asked how many days during the past 30 days a person's mental or physical health was not good and the question that asked about dyspnea affecting quality of life (in those with self-reported COPD only).

Descriptive statistics were used to report data for ED visits; hospitalizations; impact of dyspnea on quality of life; mortality; and number of persons in nursing homes, adult care homes, or family care homes. All BRFSS analyses were weighted using SAS-callable SUDAAN software, version 10 (Research Triangle Institute) to account for the complex sampling design. The prevalence of self-reported COPD among 2009 BRFSS survey respondents was age-adjusted to the 2000 US Census. To assess the association between COPD prevalence and respondent characteristics, we determined the prevalence ratio and 95% confidence interval (CI) for each association using a separate multivariate logistic regression model that included respiratory category, race/ethnicity, education level, income level, and smoking status. The relationship between health-related impairment and presence of COPD was assessed using chi-square analysis of the proportion of those reporting 14 or more days of poor physical health and the proportion of those reporting 14 or more days of poor mental health in the preceding month. The relative risk of prednisone use in the past 12 months among respondents with self-reported COPD was determined to assess the impact of other comorbidities on acute exacerbations of COPD. Among those with COPD, we calculated the risk of prednisone use for those with and without other chronic or comorbid diseases, such as cardiovascular disease (CVD). In this case, the numerator includes those with CVD who were prescribed prednisone versus those without CVD who were prescribed prednisone. P-values less than .05 were considered statistically significant.

Results

Of the 13,277 adults in North Carolina who were interviewed during the 2009 BRFSS survey, 12,165 respondents provided complete data. Based on the responses of those 12,165 adults, the age-adjusted prevalence of self-reported

COPD in the adult population of North Carolina was determined to be 5.6%. A large proportion (82.2%) of these persons with COPD indicated that they had been given a breathing test to diagnose their disease. Table 2 shows the geographic distribution of age-adjusted COPD prevalence by Area Health Education Center (AHEC) region.

Table 3 shows the characteristics of those BRFSS respondents with self-reported COPD—that is, those who answered *yes* to the question "Have you ever been told by a doctor or health professional that you have chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis?" The prevalence of COPD was not significantly different between women and men (6.1% versus 5.1%) or between whites and African Americans (5.5% versus 5.4%). There were significant differences (*P*<.05) in COPD prevalence between persons with more than a high school education compared with those who reported less than a high school education (4.2% versus 10.0%), between persons with annual household incomes less than $15,000 compared with those whose incomes were greater than or equal to $15,000 (11.7% versus 6.4%), between current smokers and never smokers (12.3% versus 2.6%), and between former smokers and never smokers (6.2% versus 2.6%).

Additional information about smoking was obtained but is not reported in Table 3. A positive history of tobacco use (an affirmative answer to the question "Have you smoked at least 100 cigarettes in your entire life?") was reported by 71.4% of respondents with COPD, compared with 47.5% of those who did not have COPD. Also, current cigarette use was 20.3% among all respondents compared with 36.1% among those with COPD. Data from the Centers for Medicare & Medicaid Services [4] show that nearly 10% of nursing home residents were current smokers in 2009.

Tables 4 and 5 show 2 different aspects of the relationship between COPD and comorbidities. Table 4 shows the

TABLE 2.

Mean Age-Adjusted Prevalence of Self-Reported Chronic Obstructive Pulmonary Disease in North Carolina, by Area Health Education Center Region, 2009

AHEC region	Mean age-adjusted prevalence of self-reported COPD (%)
Southern Regional	6.8
Mountain	6.8
Eastern	6.4
Northwest	6.3
South East	6.1
Greensboro	5.5
Charlotte	5.3
Area L	4.3
Wake	4.0

Note. AHEC, Area Health Education Center; COPD, chronic obstructive pulmonary disease.
Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.

TABLE 3.
Age-Adjusted Prevalence and Multivariable-Adjusted Prevalence Ratio of Self-Reported Chronic Obstructive Pulmonary Disease Among Adults in North Carolina in 2009

Characteristic	COPD prevalence (95% CI)	Prevalence ratio[a] (95% CI)
Age in years		
18–44	2.9% (2.1–3.7)	1.0
45–54	6.7% (1.6–8.8)	2.2 (1.5–3.4)[b]
55–64	7.5% (6.2–8.8)	2.4 (1.7–3.6)[b]
65–74	9.8% (8.3–11.4)	3.1 (2.1–3.5)[b]
≥75	9.8% (7.9–11.7)	3.2 (2.2–3.7)[b]
Sex		
Male	5.1% (3.9–6.3)	1.0
Female	6.1% (5.3–6.9)	1.25 (0.91–1.71)
Race		
White	5.5% (4.7–6.1)	1.0
African American	5.4% (3.3–7.7)	0.93 (0.56–1.4)
Other	5.7% (3.5–8.5)	1.04 (0.47–1.46)
Educational level		
Some college or technical school	4.2% (3.5–4.9)	1.0
High school graduate	7.4% (5.6–9.2)	1.36 (0.57–1.89)
Less than high school graduate	10.0% (7.6–12.5)	1.52 (1.02–1.95)[b]
Annual household income		
≥$15,000	6.4% (5.3–7.5)	1.0
<$15,000	11.7% (9.3–14.1)	1.76 (1.2–2.43)[b]
Smoking status		
Never smoker	2.6% (1.9–3.3)	1.0
Former smoker	6.2% (4.4–8.0)	2.38 (1.66–3.41)[b]
Current smoker	12.3% (10.0–16.1)	4.99 (3.31–7.51)[b]

Note. CI, confidence interval; COPD, chronic obstructive pulmonary disease.
Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.
[a]Multivariate-adjusted prevalence ratios (PRs) were obtained from a multivariate logistic regression model that included age, sex, race/ethnicity, education, household income, and smoking status as covariates. The prevalence is only age-adjusted and was obtained with the direct method, using the 2000 US census population in North Carolina for age-standardization. The overall age-adjusted prevalence of COPD was 5.6%.
[b]P<.05 compared with referent (PR = 1.0).

likelihood of concomitant chronic health conditions, and Table 5 shows the likelihood that a person with COPD and a particular comorbidity had received prednisone during the preceding year. Overall, CVD was more common in persons with COPD than in those who did not have COPD. Also, having either angina or coronary heart disease was associated with a higher likelihood of having received prednisone during the preceding year; however, no such association was found for myocardial infarction. Diabetes was more common in persons who had COPD than in those without COPD; however, prednisone was used less frequently by persons with COPD and diabetes.

Among the 36,626 residents in North Carolina nursing homes during the fourth quarter of 2009 [4], 19.7% had a diagnosis of COPD (n = 7,215); this rate was stable throughout 2009. According to a report from the NCIOM

[5], 28,500 persons lived in adult care or family care homes in 2009, and the majority of these individuals were 65 years of age or older. Therefore we estimated that there were 2,850 persons with COPD in these settings. Using an estimate that the adult population of North Carolina was 7,102,917 in 2009, and multiplying that figure by the prevalence of COPD found using data from the BRFSS survey, we estimated that there were 397,763 noninstitutionalized adults with COPD in 2009. There were an additional 7,215 persons with COPD residing in nursing homes, and we estimated that another 2,850 persons with COPD lived in adult care or family care homes. Together, these figures gave us a total estimate of nearly 408,000 adults in North Carolina who have been diagnosed with COPD.

The proportion of adults reporting that they had experienced 14 or more days of poor physical health during the preceding month was greater among persons who had COPD than among those who did not (45% versus 17%; P<.05), Similarly, the proportion of respondents who reported that they had experienced 14 or more days of poor mental health during the preceding month was greater among those with COPD than among those without (29% versus 14%; P<.05). Health impairment in persons with COPD was also evidenced by the fact that 66.3% (95% CI, 59.9–73.7) of persons with self-reported COPD indicated that dyspnea affected their quality of life.

Of 964,898 ED visits in 2009, COPD was the primary diagnosis (excluding patients with concomitant asthma) in 46,889 of these visits [7]. In addition, COPD was a secondary diagnosis for approximately 130,000 ED visits. COPD was listed as a disease for 4.1% of all ED visits. Charges were not reported for these ED visits. For the 20,586 hospitalizations in 2009 in which COPD was the primary diagnosis, the average length of stay was 4.4 days; total hospital charges were $337,503,859 (for an average charge of $16,397 per case), and this sum accounted for 1.44% of all hospital charges [6]. Of the 2009 BRFSS survey respondents with COPD, 11.4% reported that in the preceding 12 months they had stayed in the hospital for at least 1 night because of shortness of breath or an exacerbation of COPD. The BRFSS survey also included 2 other measures of acute exacerbations of COPD: use of prednisone in the preceding 12 months, which was reported by 27.4% of respondents with COPD; and a visit to a health care provider for either shortness of breath or an exacerbation of COPD in the preceding 12 months, which was reported by 43.2% of respondents with COPD.

In 2009 chronic lower respiratory diseases were the fourth leading cause of death in North Carolina, with 4,324 deaths; in comparison, there were 17,476 deaths from cancer, 17,133 deaths from CVD, and 4,391 deaths from stroke [8]. More than 95% of the deaths from chronic lower respiratory disease were caused by COPD. Among individuals for whom COPD was the primary cause of death, 77% had a high school education or less, 53% were women, 88% were white, 10.8% were African American, and 87% were

65 years of age or older. Of the 88 persons in North Carolina for whom asthma was the primary cause of death in 2009, 21% were reported to also have COPD. COPD was listed as a comorbidity in 727 (6.7%) of the 10,922 cases in which heart disease was the primary cause of death and in 548 (10.1%) of the 5,433 deaths due to cancers of the trachea, bronchus, or lung. COPD was a primary or secondary cause of death in 17.1% (13,008 of 76,250) of all deaths.

Discussion

We have provided a comprehensive estimate of the prevalence and burden of COPD in North Carolina in 2009. Until recently, there was a paucity of state-based data on COPD, and prior prevalence estimates were based on national cross-sectional studies [13, 14]. According to the 2009 BRFSS survey, about 1 in 18 adults in North Carolina reported having COPD; about one-third of them also reported that they continued to smoke, despite having a markedly impaired quality of life. Nearly 50% of adults in North Carolina reported a history of smoking, which puts them at risk for COPD. Our findings are consistent with those of national population-based studies in that the prevalence of COPD was highest among elderly individuals, smokers, persons with low socioeconomic status, and residents of nursing homes. The burden of the disease was evidenced by frequent exacerbations leading to numerous acute care visits, substantial impairment of health status, and rising mortality. In addition to being the fourth leading cause of death in North Carolina in 2009, COPD was present in 1 out of every 6 adults who died in the state. Comorbid chronic health conditions, particularly asthma and heart disease, were common in those with COPD, which certainly contributes to the burden of the disease.

Although North Carolina has a long and substantial tobacco history, the prevalence of COPD in the state in 2009 (5.6%) is similar to the prevalence of COPD found in national cross-sectional data [13, 14]. Geographically, the prevalence of COPD was fairly uniform across the state, except that rates were lower in the Wake AHEC region and (surprisingly) in the Area L AHEC region (Table 2). This pattern was also present in the 2007 BRFSS survey data for North Carolina. The 2011 BRFSS survey revealed a higher prevalence of COPD in North Carolina (6.5%) [15] than that found on the 2009 BRFSS survey. In 2011 the BRFSS survey method used in most states was modified to include cell phone numbers, and additional statistical weighting adjustments were made based on sex and socioeconomic status, leading to a higher overall prevalence of COPD and to a wider difference between men and women [15] compared with the prevalence and sex difference found using 2009 data. Of note, our analysis is the first estimate of COPD frequency to include persons in nursing homes, adult care homes, and family care homes.

Limited data have been published regarding COPD in residents of nursing homes, adult care homes, or family care homes. In 2009 nearly 20% of nursing home residents in North Carolina had a diagnosis of COPD, which is similar to the 21.5% prevalence reported in a recent study of skilled nursing homes nationwide [16]. According to that study, nearly 50% of cognitively impaired nursing home residents with COPD were being treated with short-acting beta-agonists alone, which likely indicates undertreatment. The use of long-acting bronchodilators and anti-inflammatory drugs has been shown to decrease the risk of COPD exacerbations [17]. The high prevalence of COPD and the possible underutilization of drug therapies for COPD in nursing homes warrants additional research in this population.

The BRFSS survey is a unique COPD surveillance tool for several reasons: a large number of adults are surveyed every year (more than 12,000 in North Carolina); the survey includes a wide range of demographic and health-related questions; information about health status is captured from the patient's perspective; and the survey is state-based. Responses to the 2009 BRFSS survey indicate that the typical person with COPD in North Carolina is 65 years of age or older, is a current or former smoker, has a low annual house-

TABLE 4.
Age-Adjusted Prevalence and Multivariate-Adjusted Prevalence Ratio of Self-Reported Chronic Obstructive Pulmonary Disease Among Adults with Comorbidities in North Carolina in 2009

Comorbid health condition	COPD prevalence (95% CI)	Prevalence ratio[a] (95% CI)
Any cardiovascular disease[b]		
Yes	18.1% (14.2–22.0)	2.15 (1.51–3.07)[c]
No	5.3% (4.1–6.5)	1.0
Ever diabetes mellitus		
Yes	23.4% (17.5–28.2)	1.68 (1.41–1.90)[c]
No	8.4% (8.0–8.4)	1.0
Arthritis[d]		
Yes	59.8% (58.4–61.1)	1.51 (1.39–1.74)[c]
No	28.9% (28.0–29.9)	1.0
Ever stroke		
Yes	7.4% (7.0–7.7)	1.79 (1.38–2.03)[c]
No	2.5% (2.1–2.9)	1.0
Current asthma		
Yes	41.6% (37.8–45.3)	4.12 (3.67–4.64)[c]
No	9.4% (8.7–10.0)	1.0
Obesity (BMI≥30 kg/m²)		
Yes	6.7% (5.6–6.2)	1.1 (0.7–1.3)
No	5.9% (5.2–6.5)	1.0

Note. BMI, body mass index; CI, confidence interval; COPD, chronic obstructive pulmonary disease.
Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.
[a]Multivariate-adjusted prevalence ratio (PR) for each chronic disease was obtained from a multivariate logistic regression model that included age, race/ethnicity, education, and smoking status as covariates. The prevalence is only age-adjusted and was obtained with the direct method, using the 2000 US census population in North Carolina for age-standardization. The overall age-adjusted prevalence of COPD was 5.6%.
[b]Based on responses to the questions in Table 1 about heart attack, angina, or coronary heart disease.
[c]P<.05 compared with referent (PR = 1.0)
[d]Based on responses to the question "Have you ever been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

TABLE 5.
Relative Risk of Prednisone Use by Adults in North Carolina with Self-Reported Chronic Obstructive Pulmonary Disease Who Have Comorbidities, 2009

Comorbid health condition	Relative risk of prednisone use (95% CI)
Arthritis	1.15 (0.89–1.48)
Diabetes mellitus	0.73 (0.47–1.11)
Myocardial infarction	1.0 (0.6–1.68)
Angina/coronary heart disease	1.86 (1.02–3.38)[a]
Stroke	1.28 (0.67–2.43)
Kidney disease	1.77 (0.77–4.07)
Current asthma	1.48 (1.08–2.03)[a]
3 or more of these comorbidities	1.44 (0.95–2.2)

Note. CI, confidence interval.
Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.
[a]$P<.05$.

hold income, has a high school education or less, and is likely to have comorbidities. Low socioeconomic status is known to be a risk factor for cigarette use; low income is therefore associated with a greater probability of developing tobacco-related diseases, including COPD [18]. Women may be more susceptible than men to the effects of tobacco smoke on lung function [19], which may partly explain why women are increasingly being affected by COPD. Notably, nearly 3% of persons in North Carolina aged 18–44 years who responded to the 2009 BRFSS survey reported that they had COPD; these individuals were likely responding to the chronic bronchitis component of the question used to determine the COPD prevalence (see Table 1). Although the prevalence of COPD was highest in elderly persons, it was substantial (6.7% or greater) in those aged 45–64 years, indicating a need for clinicians to consider the diagnosis in middle-aged persons.

The BRFSS survey also showed that comorbidities were more common in persons who had COPD than in those who did not. A different analysis of comorbidities in COPD using the 2009 North Carolina BRFSS data has also been reported [20]. Substantial research has shown a strong relationship between COPD and other diseases, particularly heart disease, lung cancer, and asthma [21, 22]. COPD is now considered to be a systemic disease related to the effects of impaired lung function and systemic inflammation. Thus, comorbidities such as heart disease, diabetes, cancer, and asthma are common [21, 22]. Obesity is no more frequent in persons with COPD than in those who do not have COPD, but obesity still plays an important role in the illness, because obese patients often have airflow restriction, obstructive sleep apnea, greater dyspnea associated with activities of daily living, and increased risk for CVD [23]. The higher incidence of diabetes in persons with COPD may be related to obesity and other factors [21, 22]. The higher likelihood of prednisone use in persons with concomitant asthma, angina, or coronary artery disease also indicates that COPD patients with

these comorbidities likely experience more severe and/or frequent acute exacerbations of COPD.

"Overlap syndrome" is a term used to describe persons who have both asthma and COPD [24-26]. The 2009 BRFSS data for North Carolina show that about 40% of respondents with COPD had overlap syndrome. The number of ED visits recorded by NC DETECT is an underestimate of the number of ED visits by COPD patients, because those with overlap syndrome were not included. There are multiple reasons why persons "develop" overlap syndrome: some smokers with asthma develop COPD; adults with obstructive lung disease who are frequent users of health care are likely to be seen by multiple providers and to receive both diagnoses; and persons with long-term severe asthma can develop clinical and other characteristics of COPD [26]. Notably, 1 out of 5 asthma deaths in North Carolina in 2009 had COPD listed as a contributory cause of death. Overlap syndrome is now recognized as one of the most important phenotypes of obstructive lung disease [24].

The BRFSS survey is unique because it provides the patient's perspective on health impairment, which is not available through most other health care databases. Health impairment from COPD is the result of numerous factors, including dyspnea, deconditioning from inactivity, and the presence of comorbidities [27]. Physical impairment associated with COPD was indicated by the number of days on which respondents' physical health had not been good, and by the frequency with which dyspnea affected respondents' quality of life. Although the North Carolina BRFSS questionnaire for 2009 did not include a question about depression, respondents with COPD reported a greater number of days on which their mental health had not been good. Anxiety and depression are common in COPD and cause significant morbidity [23].

Health care utilization related to COPD was substantial, with high numbers of acute exacerbations of COPD, hospitalizations, ED visits, and nursing home stays. The BRFSS survey results showed that nearly half of respondents with COPD reported having visited a health care provider for worsening symptoms in the preceding 12 months, and 1 in 9 respondents with COPD reported at least 1 overnight stay in the hospital for shortness of breath. Studies have found that COPD is associated with an increase in hospital readmissions within 30 days of discharge [28, 29], which is a particularly important consideration today due to new Medicare quality initiatives. Up to 50% of health care costs for COPD are for care of acute exacerbations [30]. Interventions that can decrease the frequency of such exacerbations include smoking cessation, pulmonary rehabilitation, and optimization of drug therapies [17].

Unlike mortality rates for other leading causes of death in the United States—such as heart disease and stroke—mortality from COPD continues to rise [1]. In contrast, mortality from asthma appears to be declining nationally [2]. Chronic lower respiratory illness surpassed stroke to become the third

leading cause of death in the United States in 2008 [1], and it became the third leading cause of death in North Carolina in 2011 [31]. This may be related to better strategies for the prevention and treatment of stroke, as well as to increasing mortality from COPD, particularly among women. COPD was also present in many deaths, either as the primary cause of death, or as a contributing factor in deaths due to concomitant heart disease, asthma, or cancer of the respiratory tract.

Studies have shown that having both COPD and CVD is associated with a higher risk of mortality [29]. The 2009 North Carolina BRFSS survey responses showed that COPD patients with asthma, angina, or coronary artery disease were more likely to have acute exacerbations of COPD as measured by prednisone use; targeting these important patient phenotypes may help to decrease mortality.

Similarly, it has been documented that COPD, especially emphysema, is associated with an increased risk of lung cancer [32]. In addition, 90% of COPD deaths in North Carolina occurred among whites, while only 9% of deaths occurred among African Americans. This finding is noteworthy because the prevalence of tobacco use and COPD is similar in those 2 races in North Carolina, even considering that only about 20% of the adult population of the state is African American. North Carolina mortality data indicates that African Americans are more likely to die from other tobacco-related diseases, such as heart disease and cancers [8]; this warrants additional research.

One weakness of our analysis is the lack of spirometry testing to confirm the diagnosis of COPD in BRFSS survey respondents. In addition, we did not identify persons with undiagnosed COPD. (We recently completed a different study using BRFSS survey results to try to identify persons who are at risk for COPD based on symptoms and tobacco exposure.) We also did not attempt to report specific health care data using national ambulatory care surveillance tools or Medicare records for North Carolina. Because the basic statistics available for residents of adult care or family care homes are not robust, our estimate of COPD prevalence needs to be validated. We could have included more specific data for hospitalizations and ED visits, but the general data was adequate to describe their contribution to the burden of COPD in North Carolina.

Conclusion

The health care and economic burden of COPD in North Carolina is apparent in health care and population-based surveillance data. By all measures, COPD is one of the most important lung diseases in our state. COPD is preventable in about three-fourths of patients because of its relation to tobacco use. With improved interventions—including treatments to facilitate tobacco cessation, optimization of drug therapies, pulmonary rehabilitation, and screening of high-risk populations—there is substantial opportunity to decrease both the prevalence and impact of COPD. To do so, North Carolina needs to take a comprehensive approach involving public health practitioners and health care providers, similar to the approach taken for asthma. NCMJ

Roy A. Pleasants, PharmD associate professor, Division of Pharmacy Practice, College of Pharmacy and Health Sciences, Campbell University, Buies Creek, North Carolina; clinical assistant professor, Division of Pulmonary, Allergy, and Critical Care Medicine, Duke University, Durham, North Carolina; and co-chair, North Carolina COPD Task Force, Cary, North Carolina.
Harry Herrick, MSW, MSPH, MEd survey analyst, State Center for Health Statistics, North Carolina Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.
Winston Liao, MPH member, North Carolina COPD Task Force, Cary, North Carolina.

References
1. Miniño AM, Murphy SL, Xu J, Kochanek KD. Deaths: final data for 2008. National Vital Statistics Reports. 2011;59(10):1-126. Hyattsville, MD: National Center for Health Statistics; 2011. http://www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_10.pdf. Accessed August 22, 2013.
2. Akinbami LJ, Moorman JE, Liu X. Asthma Prevalence, Health Care Use, and Mortality: United States; 2005-2009. National Health Statistics Report; no. 32. Hyattsville, MD: National Center for Health Statistics; 2011. http://www.cdc.gov/nchs/data/nhsr/nhsr032.pdf. Accessed August 22, 2013.
3. Centers for Disease Control and Prevention (CDC). Chronic obstructive pulmonary disease and associated health-care resource use—North Carolina, 2007 and 2009. MMWR Morb Mortal Wkly Rep. 2012;61(8):143-146.
4. Centers for Medicare & Medicaid Services (CMS). Minimum Data Sets (MDS) 2.0. Public Quality Indicator and Resident Reports. CMS Web site. http://www.cms.gov/Research-Statistics-Data-and-Systems/Computer-Data-and-Systems/MDSPubQIandResRep/index.html?redirect=/MDSPubQIandResRep/02_qmreport.asp. Page last modified June 18, 2012. Accessed September 18, 2013.
5. North Carolina Institute of Medicine (NCIOM). Short- and Long-Term Solutions for Co-Location in Adult and Family Care Homes: a Report of the NCIOM Task Force on the Co-Location of Different Populations in Adult Care Homes. Morrisville, NC: NCIOM; 2011. http://nciom.org/wp-content/uploads/2010/10/AdultCareHomes_wcover.pdf. Accessed August 22, 2013.
6. North Carolina Department of Health and Human Services, State Center for Health Statistics (NCSCHS), and the Office of Healthy Carolinians/Health Education. 2011 County Health Data Book, North Carolina Community Health Assessment Process. NCSCHS Web site. http://www.schs.state.nc.us/schs/data/databook/2011/. Accessed August 22, 2013.
7. The UNC Department of Emergency Medicine Carolina Center for Health Informatics report. Overview and Analysis of NC Detect Emergency Department data, 2009. Chapel Hill, NC: Carolina Center for Health Informatics, Department of Emergency Medicine, University of North Carolina at Chapel Hill; 2011. http://www.ncdetect.org/FINAL_2009NCDETECT_ANNUALREPORT_BLACKANDWHITE.pdf. Accessed September 24, 2013.
8. North Carolina Department of Health and Human Services, Division of Public Health, North Carolina State Center for Health Statistics (NCSCHS). North Carolina Vital Statistics 2009. Volume 2: Leading Causes of Death. NCSCHS Web site. http://www.schs.state.nc.us/schs/deaths/lcd/2009/pdf/Vol2_2009_PRT.pdf. December 2010. Accessed August 22, 2013.
9. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System Operational and User's Guide. Atlanta, GA: Centers for Disease Control and Prevention; 1998.
10. Centers for Disease Control and Prevention. Behavioral Risk Fac-

tor Surveillance System 2009 Summary Data Quality Report. CDC Web site. ftp://ftp.cdc.gov/pub/data/brfss/2009_Summary_Data_Quality_Report.pdf. Revised February 18, 2011. Accessed August 22, 2013.

11. US Census Bureau. Vintage 2009: State Tables. US Census Bureau Web site. http://www.census.gov/popest/data/historical/2000s/vintage_2009/state.html. Accessed September 18, 2013.

12. Keller A, Sullivan NE. 2009–2010 Annual Statistical Report. North Carolina Department of Correction. http://randp.doc.state.nc.us/pubdocs/0007066.PDF. Accessed September 18, 2013.

13. Mannino DM, Gagnon RC, Petty TL, Lydick E. Obstructive lung disease and its low lung function in adults in the United States: data from the National Health and Nutrition Examination Survey, 1988-1994. Arch Intern Med. 2000;160(11):1683-1689.

14. Akinbami LJ, Liu X. Chronic obstructive pulmonary disease among adults aged 18 and over in the United States, 1998–2009. NCHS Data Brief. 2011;(63):1-8.

15. Centers for Disease Control and Prevention (CDC). Chronic obstructive pulmonary disease among adults—United States, 2011. MMWR Morb Mortal Wkly Rep. 2012;61(46):938-943.

16. Zarowitz BJ, O'Shea T. Chronic obstructive pulmonary disease: prevalence, characteristics, and pharmacologic treatment in nursing home residents with cognitive impairment. J Managed Care Pharm. 2012;18(8):598-606.

17. Global Initiative for Chronic Obstructive Disease. Global strategy for the diagnosis, management, and prevention of COPD, revised 2011. http://www.goldcopd.org/uploads/users/files/GOLD_Report_2011_Feb21.pdf. Accessed August 24, 2013.

18. Eisner MD, Blanc PD, Omachi TA, et al. Socioeconomic status, race and COPD health outcomes. J Epidemiol Community Health. 2011;65(1):26-34.

19. Prescott E, Bjerg AM, Andersen PK, Lange P, Vestbo J. Gender difference in smoking effects on lung function and risk of hospitalization for COPD: results from a Danish longitudinal population study. Eur Respir J. 1997;10(4):822-827.

20. Chronic Obstructive Pulmonary Disease (COPD) and Comorbidities: North Carolina 2009. Surveillance Update No. 4. April 2011. http://www.schs.state.nc.us/schs/pdf/BRFSS_SU4_COPD_WEB.pdf. Accessed September 18, 2013.

21. Barnes PJ, Celli BR. Systemic manifestations and comorbidities of COPD. Eur Respir J. 2009;33(5):1165-1185.

22. Patel AR, Hurst JR. Extrapulmonary comorbidities in chronic obstructive pulmonary disease: state of the art. Expert Rev Respir Med. 2011;5(5):647-662.

23. Cecere LM, Littman AJ, Slatore CG, et al. Obesity and COPD: associated symptoms, health-related quality of life, and medication use. COPD. 2011;8(4):275-284.

24. Hardin M, Silverman EK, Barr RG, et al. The clinical features of the overlap between COPD and asthma. Respir Res. 2011;12(1):127-132.

25. Blanchette CM, Gutierrez B, Ory C, Chang E, Akazawa M. Economic burden in direct costs of concomitant chronic obstructive pulmonary disease and asthma in a Medicare Advantage population. J Manag Care Pharm. 2008;14(2):176-185.

26. Silva GE, Sherrill DL, Guerra S, Barbee RA. Asthma as a risk factor for COPD in a longitudinal study. Chest. 2004;126(1):59-65.

27. Hu J, Meek P. Health-related quality of life in individuals with chronic obstructive pulmonary disease. Heart Lung. 2005;34(6):415-422.

28. Khawaja FJ, Shaw ND, Lennon RJ, et al. Factors associated with 30-day readmission rates after percutaneous coronary intervention. Arch Intern Med. 2012;172(2):112-117.

29. Sidney S, Sorel M, Quesenberry CP Jr, Deluise C, Lanes S, Eisner MD. COPD and incident cardiovascular disease hospitalizations and mortality: Kaiser Permanente Medical Care Program. Chest. 2005;128(4):2068-2075.

30. Sullivan SD, Ramsey SD, Lee TA. The economic burden of COPD. Chest. 2000;117(2 suppl):5S–9S.

31. North Carolina Department of Health and Human Services, Division of Public Health, North Carolina State Center for Health Statistics (NCSCHS). North Carolina Vital Statistics 2011. Volume 2: Leading Causes of Death. NCSCHS Web site. http://www.schs.state.nc.us/schs/deaths/lcd/2011/pdf/Vol2_2011_PRT.pdf. January 2013. Accessed August 24, 2013.

32. Turner MC, Chen Y, Krewski D, Calle EE, Thun MJ. Chronic obstructive pulmonary disease is associated with lung cancer mortality in a prospective study of never smokers. Am J Respir Crit Care Med. 2007;176(3):285-290.

POLICY FORUM

Staying Just a Step Ahead

Introduction

Respiratory diseases are as timeless and ubiquitous as the air we breathe. Hippocrates knew of pneumonia in the 4th century and Maimonides described it in the 12th century, yet pneumonia still plagues us in the 21st century. Indeed, chronic obstructive pulmonary disease, pneumonia, and influenza are still among the top 10 causes of death in the United States.

Science has helped us to move beyond signs and symptoms to treat the causes of these diseases. We know the bacteria, viruses, atypical bacteria, fungi, and parasites responsible for many of these illnesses are *Streptococcus pneumoniae*, influenza, *Mycoplasma pneumonia*, *Histoplasma capsulatum*, *Mycobacterium tuberculosis*, and *Plasmodium malariae*. In addition to naming and understanding the causative organisms, we have also learned how to better detect these illnesses. Radiographs, examination of sputum, and culture of organisms initially did not change the dread (and death) associated with these illnesses. But eventually professional care, antibiotics, and respiratory support began to make a difference, although we still have a long way to go before the scourge of these diseases is eliminated.

This issue of the NCMJ considers a wide range of respiratory diseases, including both ancient nemeses and emerging diseases, all of which are constantly mutating and evolving to confuse the clinician and overwhelm the body. Thus, the authors in this issue describe the changes and evolution of both organisms and treatment. To cure these illnesses and improve patients' quality of life, the goal is always to stay just a step ahead. **NCMJ**

Peter J. Morris, MD, MPH, MDiv
Editor in Chief

Respiratory Diseases:
Meeting the Challenges of Screening, Prevention, and Treatment

Lydia H. Chang, M. Patricia Rivera

Respiratory conditions, both acute and chronic, continue to have a significant impact on worldwide health because of their high prevalence, the high disease burden they place on individual health, and their enormous cost to the health care system. There are also unmeasured indirect economic costs due to loss of productivity. Despite advances in our understanding of the complex pathophysiology of respiratory diseases, as well as the availability of relatively straightforward primary prevention measures, the prevalence of chronic respiratory diseases continues to rise. In addition, periodic outbreaks of acute infectious respiratory conditions result in significant cost and even mortality, and the incidence of these conditions fluctuates widely from year to year. Although we have seen recent developments in medical therapies for respiratory diseases, and there are established and well-publicized disease management guidelines, morbidity and mortality remain high. One intervention that has lagged behind has been smoking prevention and cessation, which is the mainstay of prevention for chronic obstructive pulmonary disease and lung cancer. The persistence of these conditions underscores vulnerabilities within our national and regional health care systems. Several of the articles in this issue of the NCMJ describe innovative programs to address these challenges.

Asthma

The prevalence of asthma in the United States has increased steadily since the Centers for Disease Control and Prevention (CDC) began tracking this statistic. Between 1980 and 1996, the prevalence of asthma increased by 73.9% [1], and it has increased by 2.9% per year over the past decade [2]. In 2010 the estimated prevalence of asthma in the United States was 8.4%, with 25.7 million individuals affected [2, 3]. Asthma accounted for 479,300 hospital discharges in the United States in 2009 [2], as well as 2.1 million emergency department visits [2] and $56 billion in total societal costs [4]. In North Carolina, asthma is especially prevalent; the lifetime prevalence of asthma in the state was estimated to be 16.8% in 2010, compared with 12.6% nationwide [5]. In North Carolina, 10.3% of children [5] and 7.8% of adults [6] have asthma.

The pathophysiology of asthma is complex, but the primary risk factor is sensitization to environmental aeroallergens, which leads to allergic inflammation. The rapid rise in the prevalence of asthma in developing countries has been ascribed to the "hygiene hypothesis," which holds that urbanization, treatment with antimicrobials, and early childhood exposure to cockroach and dust mite antigens result in an imbalance of 2 opposing populations of helper T cells, with the balance tipping in favor of the T_H2 phenotype over the T_H1 phenotype, the latter of which is associated with protective immunity. Additionally, exposure of very young children to environmental pollution, in particular traffic-related pollutants, may be associated with later development of asthma. Exposure early in life to nitrogen dioxide has been found to be associated with a diagnosis of asthma in minority children in urban areas [7]. Research has also reported a modest positive association between development of childhood asthma and exposure to air pollution from traffic during the first year of life [8]. This exposure to traffic-related air pollution may increase the risk of pollen sensitization [9, 10].

The National Asthma Education and Prevention Program (NAEPP) of the National Heart, Lung, and Blood Institute has established clear recommendations regarding the diagnosis, evaluation, and management of asthma [11]. Safe and effective controller therapy in the form of inhaled corticosteroids is the cornerstone of therapy for all patients with persistent asthma. Adherence to inhaled corticosteroid therapy is clearly associated with better patient outcomes, including decreased risk of asthma-related death. In one large cohort study looking at asthma-related deaths [12], the authors calculated that risk of death declined by 21% for every additional canister of inhaled corticosteroids used in the preceding 12 months. Another study [13] suggested that regular use of inhaled corticosteroids is associated with a 31% decrease in risk of hospitalization. A wide assortment of

options for inhaled corticosteroid therapy is currently available, which enables clinicians to mitigate side effects that may impact adherence to therapy, such as dysphonia and thrush. Additionally, patients with severe persistent asthma have newer nonsteroidal treatment options, such as omalizumab. The US Food and Drug Administration (FDA) is also currently reviewing mepolizumab, another biologic agent that has been evaluated as a treatment for asthma [14].

Despite advances in therapy, there were 479,300 hospitalizations for asthma in 2009, and another 3,388 individuals died of asthma [2]. A recent study found that half of asthma deaths in children in the Eastern Region of the United Kingdom occurred in children with mild to moderate asthma [15]. Asthma is a treatable illness, and the majority of patients can achieve adequate control with adherence to guidelines; the persistence of uncontrolled asthma and asthma-related complications underscores vulnerabilities within our health care system. One large survey study [16] found that 49% of patients with asthma were not using controller medications because of either undertreatment or nonadherence. In 2 other large survey studies [17, 18], more than 70% of individuals with asthma did not meet guideline-defined criteria for adequate control. Undertreatment by physicians remains an issue and is even more marked in elderly individuals [19, 20]. Even when patients are treated, adherence can be a problem. Many patients do not regard asthma as a chronic condition and may resist treatment for mild or moderate disease. This intentional nonadherence may be related to beliefs about disease and medications that are difficult to dispel without direct provider-to-patient counseling. There may also be practical barriers resulting in unintentional nonadherence.

Asthma disproportionately affects minorities and underserved populations. A 2010 CDC survey of children and adults with asthma revealed that 35.1% of children and 48.9% of adults aged 18–65 years were either uninsured or had insurance coverage for only part of the year [21]. Blacks are 1.9 to 2.5 times more likely to require hospitalization for asthma than are whites [2]. Lack of access to health care is associated with higher overall disease prevalence, poorer asthma outcomes, higher requirement for emergency medical services, and greater risk of asthma-related death.

Most of the triggers of acute asthma—including allergens, tobacco smoke, exercise, air pollutants/particulates, and respiratory tract infections—may be avoidable, or at least modifiable through a combination of individual treatment, counseling, and public health intervention [22]. Although a constructive provider-patient relationship is integral to disease management, asthma is often triggered by environmental factors, so a truly comprehensive approach must address the home and community context. In a sidebar in this issue of the NCMJ, Attorney General Cooper discusses how North Carolina took legal action against the Tennessee Valley Authority to address pollution that was threatening the health of residents in the western portion of the state [23].

Another effective legislative approach has been the institution of smoking bans. In one Texas municipality, a significant decrease is asthma-related hospital discharges among whites was observed following the institution of a citywide ban on smoking [24]. In Ireland, a national ban on smoking in the workplace was similarly associated with a decrease in the rate of hospital admissions for pulmonary illness, from 439 to 396 per 100,000 population, with the greatest impact seen in the younger age groups and in admissions due to asthma [25]. Similar results were reported in England, where a significant drop in the admission rate for asthma was observed among children in all socioeconomic groups [26].

In a sidebar in this issue, Shuler and Russell [27] describe the Regional Asthma Disease Management Program of Mission Children's Hospital, an award-winning program that incorporates multiple strategies to enhance the care of underserved children with asthma in Western North Carolina. The program moves beyond individual care in the clinical setting to include community-based interventions and educational efforts. Patient homes, child care centers, and schools are evaluated to look for potential environmental triggers, including specific allergens and airway irritants. The program partners with community organizations to provide families with access to cleaning supplies, pest control services, and social assistance. The multipronged effort has led to a decrease in emergency room visits and hospitalizations and a 52% increase in school attendance.

Another innovative, large-scale endeavor is the comprehensive asthma management program of Community Care of North Carolina (CCNC), which is discussed in a commentary by Tilson [28]. CCNC provides care for more than 1.3 million Medicaid patients in North Carolina. Over the past decade, CCNC has developed a primary care–based asthma management program. The CCNC Informatics Center provides data support to health care providers and enables data queries on both the individual and population levels. For example, a data query could provide a list of patients who have requested frequent refills for rescue medication and/or failed to refill prescriptions for controller medications. High-risk patients are able to work individually with interdisciplinary care providers. Also, as in the Regional Asthma Disease Management Program at Mission Children's Hospital, CCNC care managers can move outside the clinical setting to the home environment, where they can achieve a better understanding of barriers to disease management. For enrolled patients with persistent asthma, the prescription rate for controller medication has exceeded 90%.

Chronic Obstructive Pulmonary Disease

Chronic lower respiratory disease—primarily chronic obstructive pulmonary disease (COPD)—was the third leading cause of death in the United States in 2011, accounting

for 143,382 deaths [29]. The prevalence of COPD in adults is estimated to be 6.3% nationally, based on responses to the 2011 Behavioral Risk Factor Surveillance System survey [30]. COPD affects 5.7% of all North Carolinians, with 14.9% reporting an emergency department visit or hospitalization for COPD-related symptoms within the previous year [31]. The estimated direct cost of COPD is $29.5 billion in the United States [32]. In North Carolina during the period 2003–2007, a total of 33,507 hospital discharges were related to COPD, at a total cost of $421 million [33]. Gegick, Coore, and Bowling deliver an excellent review of the epidemiology and management of COPD in their commentary in this issue [34].

The Global Initiative for Chronic Obstructive Lung Disease (GOLD), a task force of world experts, has established clear, coherent guidelines for the evaluation and management of individuals with COPD, the latest iteration of which was made available earlier this year [32]. Disease management strategies include both nonpharmacologic and pharmacologic approaches. Nonpharmacologic therapy should include oxygen therapy for any patient with hypoxemia, and pulmonary rehabilitation and appropriate vaccination should be considered for all patients. The intensity of pharmacotherapy depends on disease severity, functional impairment, and the patient's risk profile. In patients with moderate to severe disease (GOLD grades 2, 3, or 4), the use of long-acting beta-agonists and/or long-acting muscarinic antagonists can decrease symptoms, decrease the number of acute exacerbations, and improve quality of life. The addition of inhaled corticosteroids to the treatment regimen may be beneficial in patients with severe disease who have had 2 or more exacerbations within the previous year. The FDA approved roflumilast, a phosphodiesterase-4 inhibitor, for treatment of COPD in 2011. This drug has been shown to decrease the number of acute exacerbations in patients with moderate to severe disease [35]. Long-term macrolide therapy may also decrease the number of acute exacerbations in individuals with moderate to severe disease [36].

Despite increases in the population disease burden, the rate of hospitalization for COPD decreased by 18% over the 10-year period 1999–2008 [37]. Mortality following hospitalizations may also be improving, as suggested by a cohort study looking at patients discharged between 1996–1997 and 2003–2004 [38]. Although established patients with COPD are benefiting from improvements in disease management, the increasing prevalence of the disease calls attention to continued shortfalls in disease prevention. A 2010 review of the literature showed that the proportion of patients in whom the disease could be directly attributed to tobacco use ranged from 39.6% to 76.2% [39]. Thus smoking cessation remains the mainstay of COPD prevention. Despite widespread public health campaigns to raise awareness about the health perils of tobacco, approximately 43.8 million Americans (about 19% of the population) still smoked in 2011 [40]. At the present time, 20.9% of adults and 10.8%

of young people in North Carolina are current smokers [41]. Smoking remains the leading cause of preventable death in the nation and in the state; every year, more than 12,000 individuals in North Carolina die of a smoking-related condition, and 443,000 people die nationally [40, 41].

Nonsmokers account for 3% to 15% of patients with COPD [39]. Nontobacco risk factors for COPD include patient-specific factors such as genetic predispositions and underlying asthma. Inhalation of particulate matter in an occupational setting or at home is also associated with the development of COPD. Use of biomass fuel for an open-fire stove in a poorly ventilated home can result in high concentrations of particulate matter in the immediate vicinity (usually the kitchen), which is correlated with the development of obstructive airways disease, especially in women. Similarly, some coal miners and hard rock miners work in settings with high particulate density, which puts them at risk for the development of COPD. Finally, longitudinal studies have found air pollution to be associated with the development of COPD. A stronger association has been found between daily variation in outdoor air pollution levels and acute exacerbations of COPD [39, 42].

A 2007 report of the Institute of Medicine of the National Academies [43] recommended that states fund comprehensive tobacco control programs, and the CDC proposed such funding that same year in the book *Best Practices for Comprehensive Tobacco Control Programs* [44]. These CDC-defined best practices are largely based on the successful statewide program implemented in California, where the rate of smoking among adults fell from 22.7% in 1988 to 13.3% in 2006 [44]. A comprehensive statewide program should include both population-based measures and support for individual counseling and treatment.

In this issue, Harrill-Smith, Ripley-Moffitt, and Goldstein discuss the systems changes needed to effect smoking cessation, and they emphasize the need for all health care providers to screen for and treat tobacco addiction [45]. Documentation of tobacco-use screening, counseling, and treatment is required by the meaningful use guidelines of the Centers for Medicare & Medicaid Services, which may increase provider-initiated tobacco interventions. In a sidebar in this issue, Halladay and Gianforcaro describe a pilot study of a clinic-based tobacco-use treatment intervention program that was developed using quality improvement techniques [46]. In order to assist providers in identifying patients who wish to address smoking cessation during their clinic visit, this pilot study provided readiness assessment forms and educational tools for use during the clinic visit. A formal referral system was also created to help patients who were interested in receiving additional smoking cessation counseling. The pilot study rapidly implemented practice changes and has increased the number of referrals to the North Carolina tobacco use quit line (QuitlineNC) and the number of cessation medications prescribed to current smokers.

Respiratory Infections

In another commentary, Reddick and Howe discuss the positive effect that pneumonia guidelines and core measures have had on patient-oriented outcomes [47]. Pneumonia remains the leading cause of infectious disease–related death in the United States. In 2010 approximately 50,000 individuals died of pneumonia in the United States, and 1,700 died in North Carolina [48]. There were 1.1 million hospital discharges related to pneumonia [49], and in 2005 the estimated direct cost of pneumonia and influenza to the health care system was more than $34 billion [50]. Adherence to pneumonia management guidelines established by the Infectious Diseases Society of America and the American Thoracic Society is associated with decreases in hospital mortality and hospital length of stay. Accrediting bodies and third-party payers have embraced key recommendations from these guidelines as performance standards for hospitals and physicians. As a result, health care systems have implemented processes to achieve specific core metrics. Pneumococcal vaccination rates have also increased substantially. Over the past decade, both the incidence of pneumonia and the pneumonia mortality rate have decreased. Furthermore, improvements have been seen even in traditionally disadvantaged minority groups. As Reddick and Howe emphasize, the considerable progress that has been made may be largely due to external pressures on health care systems and providers to adhere to best practices, rather than being due to the development of new treatment options. However, further progress can be made; as they point out, more than 37% of elderly patients did not receive pneumococcal vaccine in 2011 [51].

As described in a commentary by Stout [52], tuberculosis is another disease for which a successful disease control program must integrate public health policy and individual patient care. In 2012 the number of cases of active tuberculosis was at a historic low, with only 9,951 cases nationally [53] and 211 cases in North Carolina [52]. In contrast to pneumonia prevention and treatment, where frontline care providers and local health care systems work to achieve national performance standards, tuberculosis control is primarily effected by state-funded health departments. The advantages of this model are manifold. The management and treatment of tuberculosis is complex, and the challenges can be immense; for instance, significant barriers to care often occur because tuberculosis disproportionately affects economically disadvantaged and non–English speaking individuals. A core group of designated health providers becomes expert in managing tuberculosis and in helping patients overcome barriers to care. Additionally, there is a direct line of communication between state policymakers and the core care providers who implement the policies. This enables a nimble response to new data, encourages innovations, and allows public health teams to set new goals and execute new action plans.

In a sidebar, Keener [54] describes the development of new strategies for improving adherence to treatment of latent tuberculosis infection. Health departments have adopted new, shorter effective regimens for selected individuals, such as directly observed treatment with iso-nicotinylhydrazine and rifapentine weekly for 12 weeks, or rifampin daily for 4 months. Keener notes that deployment of public health personnel for directly observed therapy for latent tuberculosis in Mecklenburg County resulted in an additional 30% of patients completing therapy. This model of direct, state-managed disease control has worked exceptionally well, resulting in a fairly low prevalence of disease.

The pertussis outbreak that occurred in Alamance County in 2011–2012 provides a model of a rapid response by health officials to an unexpected public health threat, including a successful transition from immediate treatment and prophylaxis to preventive population measures. Pertussis (whooping cough) is a disease that was thought to be well controlled through vaccination. However, recent data from the CDC indicate that there has been a resurgence of pertussis in the past few years. In 2012 almost 42,000 cases of pertussis were reported in the United States, which was the highest number of cases reported nationally since 1955, and there were 566 cases reported in North Carolina [55]. A commentary by Bass and Turpin-Saunders [56] describes the community response to the Alamance County outbreak in 2011. The initial health department response was to administer antibiotic prophylaxis to all close contacts of individuals with pertussis; officials also took the very important step of activating an Incident Command System to streamline their response and to coordinate dissemination of information and execution of action plans within the community. When close surveillance revealed that prophylaxis was not effective in containing the spread of the disease, health department officials shifted their strategy to widespread administration of booster doses of the Tdap vaccine (which protects against tetanus, diphtheria, and pertussis) to all individuals in need of vaccination. Vaccine restrictions and cost barriers were lifted. Although these efforts were aimed at all individuals, specific at-risk populations have greater numbers of infection-related complications. In a sidebar, Curran [57] describes the challenges of protecting newborns from pertussis by vaccinating pregnant women at the appropriate gestational age.

Vaccination is a cornerstone of prevention for respiratory infections. Barriers to widespread vaccination include public misperceptions that the vaccine may be risky or ineffective. A major surmountable barrier is lack of access to vaccinations. A sidebar by Gatton [58] discusses the advantages of involving pharmacists in the vaccination process. States that allow pharmacists to administer a particular vaccine have higher vaccination rates for that vaccine than states that do not allow vaccination by pharmacists. This is likely because pharmacist-facilitated vaccination increases the availability of vaccination to the population at risk; pharmacy hours are

often more convenient than those of physician offices and health care clinics.

As outlined by Simeonsson and Moore in their commentary [59], the prevention and control of influenza remains a public health challenge. This is partly due to yearly variability in circulating strains of influenza, which results in significant variability in the effectiveness of each year's vaccine. Additionally, the most vulnerable patient populations (immunocompromised individuals and elderly adults) have a less effective immune response to vaccination. Thus, influenza-related deaths vary, ranging from 3,349 in the 1986–1987 influenza season to 48,614 in the 2003–2004 influenza season [60], and there are enormous direct and indirect health care costs associated with this illness.

Influenza vaccination is recommended for all individuals aged 6 months or older. Despite this recommendation, vaccination compliance remains an issue and will require creative solutions. Even among health care personnel—a well-informed group that is a high priority for vaccination, given potential exposure and transmission within the health care setting—compliance with influenza vaccination in the 2011–2012 season was only 66.9% [61]. In a sidebar, Floyd [62] reports remarkable success from the implementation of a mandatory vaccination program for employees in the Vidant Health system; during the first year of this program, compliance with influenza vaccination increased to 99.9% from less than 75%, and there was only 1 acute hospitalized case of influenza.

Lung Cancer

Lung cancer is one of the most lethal of all illnesses. Projections show that there will be 246,210 new cases of lung cancer in the United States in 2013, and 163,890 people will die from the disease [63]. In North Carolina, projections for 2013 show that there will be 8,040 new cases of lung cancer and 5,660 deaths from the disease [63]. Lung cancer is the leading cause of cancer deaths in the United States, killing more people each year than colon cancer, breast cancer, prostate cancer, and pancreatic cancer combined [63]. In the late 1980s, lung cancer surpassed breast cancer as the more common cause of cancer deaths in women in the United States; currently, lung cancer kills more women each year than do uterine cancer, ovarian cancer, and breast cancer combined [63].

Established risk factors for lung cancer include cigarette smoking, exposure to secondhand smoke, exposure to occupational lung carcinogens such as radon and asbestos, exposure to radiation, exposure to indoor and outdoor pollution, a family history of lung cancer, and acquired lung diseases such as COPD [64]. Cigarette smoking is by far the major cause of lung cancer. Although the prevalence of smoking in the United States has decreased in men by almost 50% from its peak in the 1950s, the prevalence of smoking has decreased less in women, from 33.9% in 1965 to 21% in 2000 [65]. The percentage of white men who are current

smokers has been decreasing since the Surgeon General's report in 1964, which first linked cigarette smoke to lung cancer. Conversely, the prevalence of smoking among women is projected to rise in many low-income and middle-income countries [66]. It is reported that about 800 million men and 250 million women in the world are daily smokers [67].

Without a doubt, changes in smoking habits have contributed to the increasing relative risks for lung cancer. A recent publication [68] measured temporal trends in mortality across 3 time periods (1959–1965, 1982–1988, and 2000–2010) and found that, during the period 1959–1965, lung cancer mortality among male smokers 55 years of age or older was more than 12 times that of men who had never smoked; the relative risk for smokers doubled to about 25 during the period 1982–1988 and then plateaued. More alarmingly, deaths from lung cancer among female smokers increased by a factor of 16.8 over the entire 50-year period; about half of the deaths from lung cancer in women occurred between 1990 and 2010 [68].

Given the high incidence of lung cancer and the high mortality rates associated with this disease, ongoing efforts at tobacco control, including smoking prevention and cessation, are paramount. Smoking cessation is associated with substantial health benefits, which include reduction in cancer risk. Peto and colleagues [69] analyzed national statistics in the United Kingdom, as well as the results of 2 case control studies, and they concluded that people who stop smoking well into middle age avoid most of their subsequent risk of lung cancer, and those who stop before middle age avoid more than 90% of the risk attributable to tobacco.

Lung cancer is comprised of non–small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). The majority (85%) of all new lung cancers diagnosed each year are NSCLC. Tremendous progress in the diagnosis, staging, and treatment of all stages of NSCLC has been witnessed over the past 2 decades. These advances include a revision of the international staging system, development of diagnostic techniques such as endobronchial ultrasound and electromagnetic navigation bronchoscopy, combined modality therapy for locally advanced NSCLC, adjuvant chemotherapy for selected patients with early-stage lung cancer, minimally invasive surgical techniques, stereotactic radiosurgery, and better understanding of the molecular biology of NSCLC. Together, these advances have allowed for recognition of the fact that NSCLC is a heterogeneous, molecularly driven disease, which has shifted the diagnostic and therapeutic landscape of NSCLC.

Despite this progress, the estimated 5-year survival rate for all lung cancer patients is 16%, and this figure has not changed much over the past several decades [63]. Why is there such poor survival? The answer lies in the fact that the majority of patients with SCLC present with advanced stage disease and the majority of patients with NSCLC have locally advanced (stage IIIa or IIIb) or metastatic (stage IV) disease at the time of diagnosis; only about 26% of NSCLC patients

present with stage I disease, which is the most curable stage [70]. For decades, screening for breast cancer, cervical cancer, colon cancer, and prostate cancer has been the standard of care, but screening for lung cancer was not recommended because no study had demonstrated that it decreased mortality. This changed when results of the prospective randomized National Lung Screening Trial (NLST) were published in 2011 [71]. In a commentary on screening for lung cancer, Christensen and Tong [72] discuss the results of the NLST, the first study to determine the impact of low-dose computed tomography (LDCT) screening on lung cancer–associated mortality. The NLST was a randomized study of 53,454 high-risk individuals; participants were 55–74 years old, had a smoking history of at least 30 pack-years, and were current smokers or had quit within the preceding 15 years. The study compared 3 annual screenings with either LDCT or single-view chest radiography, and it found a relative reduction in lung cancer–specific mortality of 20% over a median follow-up period of 6.5 years in patients randomized to the LDCT screening arm compared with patients in the chest radiography arm.

As Christensen and Tong note, the benefit of screening must be weighed against potential harms. Overdiagnosis is a concern, because an estimated 6% to 17% of the cancer cases detected by screening would not have otherwise been detected in the patient's lifetime [73, 74]. Another important fact of lung cancer screening is the rate of false-positive results. In the LDCT group, 96.4% of the positive screening results were false-positive results [71]. Despite the reduction in mortality, the significant number of false-positive scans in this study is worrisome. Investigation of these false-positive results could lead to unnecessary evaluations, with potential complications and needless anxiety. Christensen and Tong also discuss issues regarding implementation of screening, follow-up of benign lesions, risk of radiation exposure, and cost effectiveness.

Guidelines from the American Cancer Society (ACS) [75] and the American College of Chest Physicians (ACCP) [76] favor screening for patients who meet the NLST criteria—that is, individuals aged 55–74 years who have at least a 30 pack-year history of smoking and who currently smoke or who quit in the preceding 15 years. Recently, the US Preventive Services Task Force (USPSTF) issued a grade B recommendation for annual LDCT lung cancer screening for adults aged 55–79 years who have a 30 pack-year history of smoking and who currently smoke or who quit in the past 15 years [77]. A grade B recommendation means that the USPSTF believes that "there is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial" [78]. This recommendation is expected to pave the way for reimbursement of lung cancer screening by Medicare and private insurance companies. The USPSTF recommends screening until the age of 79 years because the NLST enrolled individuals up to the age of 74 years and then continued to screen partici-

pants for several years afterward. It is important to note that the ACS, the ACCP, and the USPSTF advise caution in recommending screening to patients with significant comorbid conditions. As mentioned by Christensen and Tong, the USPSTF also warns about the downside of detecting small nodules, given the high rate of repeat scans and the biopsy of lung nodules that turn out to be benign. This underscores the importance of screening appropriate individuals in the context of a structured multidisciplinary process that can manage abnormal scan results. Screening is not a substitute for smoking cessation, and it is imperative, in our opinion, that all lung cancer-screening programs incorporate smoking cessation into their programs.

Conclusion

Asthma, COPD, bacterial pneumonia, tuberculosis, and lung cancer account for a significant number of respiratory illnesses, and together they take a tremendous toll on individual health and place significant burdens on the health care system and society. The prevalence of asthma in the United States is on the rise, and this disease disproportionately affects underserved patients. Enhancing the care of underserved children with asthma and developing primary care–based asthma programs have resulted in significant improvements in asthma care in North Carolina. COPD remains the third leading cause of death in the United States; however, improvements in our understanding of the epidemiology of this disease and advances in treatment have led to decreases in the rates of hospitalization and death. Pneumonia remains a serious illness associated with a high mortality rate, but adherence to management guidelines has resulted in improved outcomes. Tuberculosis is an excellent example of improved outcomes and successful disease control resulting from the integration of local, state-funded health care policies and individual patient care. Improving vaccination rates to prevent viral illnesses can be achieved by involving pharmacists in the administration of vaccines. Lung cancer remains a serious illness with a high mortality rate. Recent data shed promising light on screening for lung cancer in select individuals; however, the benefit of screening must be weighed against potential harms, including overdiagnosis. Tremendous effort and progress has been made in the institution of smoking bans in the United States and other countries, which has resulted in a decrease in respiratory illnesses. Smoking prevention and smoking cessation remain the mainstay of prevention for COPD and lung cancer. NCMJ

Lydia H. Chang, MD assistant professor of medicine, Division of Pulmonary and Critical Care Medicine, Department of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.
M. Patricia Rivera, MD professor of medicine, Division of Pulmonary and Critical Care Medicine, Department of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

References

1. Mannino DM, Homa DM, Akinbami LJ, Moorman JE, Gwynn C, Redd SC. Surveillance for Asthma—United States, 1980-1999. MMWR Surveill Summ. 2002;51(SS01):1-13. http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5101a1.htm. Accessed August 17, 2013.

2. Moorman JE, Akinbami LJ, Bailey CM, et al. National Surveillance of Asthma: United States, 2001–2010. National Center for Health Statistics. Vital Health Stat. 2012;3(35):1-58. http://www.cdc.gov/nchs/data/series/sr_03/sr03_035.pdf. Accessed August 17, 2013.

3. Akinbami LJ, Moorman JE, Bailey C, et al. Trends in Asthma Prevalence, Health Care Use, and Mortality in the United States, 2001-2010. Hyattsville, MD: National Center for Health Statistics (NCHS); 2012. NCHS Data Brief No. 94. http://www.cdc.gov/nchs/data/databriefs/db94.pdf. Accessed August 17, 2013.

4. Barnett SB, Nurmagambetov TA. Costs of asthma in the United States: 2002-2007. J Allergy Clin Immunol. 2011;127(1):145-152.

5. North Carolina Department of Health and Human Services (NCD-HHS), Division of Public Health. The North Carolina Asthma Epidemiology Update. Summer 2012. NCDHHS Web site. http://www.asthma.ncdhhs.gov/docs/AsthmaEpidemiologyUpdateSummer-2012.pdf. Accessed August 17, 2013.

6. North Carolina Department of Health and Human Services (NCD-HHS), Division of Public Health. Asthma in North Carolina: Adult Prevalence, Emergency Department Visits, and Hospitalization. The Asthma Epidemiology Update. Summer 2011. NCDHHS Web site. http://www.asthma.ncdhhs.gov/docs/AsthmaEpiUpdateSummer-2011.pdf. Accessed August 17, 2013.

7. Nishimura KK, Galanter JM, Roth LA, et al. Early life air pollution and asthma risk in minority children: the GALA II and SAGE II studies. Am J Respir Crit Care Med. 2013;188(3):309-318.

8. Gruzieva O, Bergström A, Hulchiy O, et al. Exposure to air pollution from traffic and childhood asthma until 12 years of age. Epidemiology. 2013;24(1):54-61.

9. Gruzieva O, Bellander T, Eneroth K, et al. Traffic-related air pollution and development of allergic sensitization in children during the first 8 years of life. J Allergy Clin Immunol. 2012;129(1):240-246.

10. Nordling E, Berglind N, Melén E, et al. Traffic-related air pollution and childhood respiratory symptoms, function and allergies. Epidemiology. 2008;19(3):401-408.

11. National Heart, Lung, and Blood Institute; National Asthma Education and Prevention Program. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. Bethesda, MD: US Department of Health and Human Services, National Institutes of Health, National Heart, Lung and Blood Institue; 2007. NIH Publication No. 07-4051. http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.pdf. Accessed August 18, 2013.

12. Suissa S, Ernst P, Benayoun S, Baltzan M, Cai B. Low-dose inhaled corticosteroids and the prevention of death from asthma. N Engl J Med. 2000;343(5):332-336.

13. Suissa S, Ernst P, Kezouh A. Regular use of inhaled corticosteroids and the long term prevention of hospitalisation for asthma. Thorax. 2002;57(10):880-884.

14. Pavord ID, Korn S, Howarth P, et al. Mepolizumab for severe eosinophilic asthma (DREAM): a multicentre, double-blind, placebo-controlled trial. Lancet. 2012;380(9842):651-659.

15. Anagnostou K, Harrison B, Iles R, Nasser S. Risk factors for childhood asthma deaths from the UK Eastern Region Confidential Enquiry 2001-2006. Prim Care Respir J. 2012;21(1):71-77.

16. Colice GL, Ostrom NK, Geller DE, et al. The CHOICE survey: high rates of persistent and uncontrolled asthma in the United States. Ann Allergy Asthma Immunol. 2012;108(3):157-162.

17. Carlton BG, Lucas DO, Ellis EF, Conboy-Ellis K, Shoheiber O, Stempel DA. The status of asthma control and asthma prescribing practices in the United States: results of a large prospective asthma control survey of primary care practices. J Asthma. 2005;42(7):529-535.

18. Murphy KR, Meltzer EO, Blaiss MS, Nathan RA, Stoloff SW, Doherty DE. Asthma management and control in the United States: results of the 2009 Asthma Insight and Management survey. Allergy Asthma Proc. 2012;33(1):54-64.

19. Navaratnam P, Jayawant SS, Pedersen CA, Balkrishnan R. Physician adherence to the national asthma prescribing guidelines: evidence from national outpatient survey data in the United States. Ann Allergy Asthma Immunol. 2008;100(3):216-221.

20. Navaratnam P, Jayawant SS, Pedersen CA, Balkrishnan R. Asthma pharamacotherapy prescribing in the ambulatory population of the United States: evidence of nonadherence to national guidelines and implications for elderly people. J Am Geriatr Soc. 2008;56(7):1312-1317.

21. Centers for Disease Control and Prevention (CDC). AsthmaStats: Insurance coverage and barriers to care for people with asthma. CDC Web site. http://www.cdc.gov/asthma/asthma_stats/insurance_coverage.htm. Page last updated May 3, 2013. Accessed August 8, 2013.

22. Vernon MK, Wiklund I, Bell JA, Dale P, Chapman KR. What do we know about asthma triggers? a review of the literature. J Asthma. 2012;49(10):991-998.

23. Cooper R. Air pollution ignores state borders. N C Med J. 2013;74(5):396-397 (in this issue).

24. Head P, Jackson BE, Bae S, Cherry D. Hospital discharge rates before and after implementation of a city-wide smoking ban in a Texas city, 2004-2008. Prev Chronic Dis. 2012;9:E179.

25. Kent BD, Sulaiman I, Nicholson TT, Lane SJ, Moloney ED. Acute pulmonary admissions following implementation of a national workplace smoking ban. Chest. 2012;142(3):673-679.

26. Millett C, Lee JT, Laverty AA, Glantz SA, Majeed A. Hospital admissions for childhood asthma after smoke-free legislation in England. Pediatrics. 2013;131(2):e495-e501.

27. Shuler M, Russell DW. Mission Children's Hospital's Regional Asthma Disease Management Program. N C Med J. 2013;74(5):394-395 (in this issue).

28. Tilson EC. Community Care of North Carolina's approach to asthma management. N C Med J. 2013;74(5):393-400 (in this issue).

29. Hoyert DL, Xu J. Deaths: preliminary data for 2011. National vital statistics report. National Vital Statistics Reports. 2012;61(6):1-51. Hyattsville, MD: National Center for Health Statistics; 2012. http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_06.pdf. Accessed August 18, 2013.

30. Centers for Disease Control and Prevention. Chronic obstructive pulmonary disease among adults—United States, 2011. MMWR Morb Mortal Wkly Rep. 2012;61(46):938-943.

31. Centers for Disease Control and Prevention. Chronic obstructive pulmonary disease and associated health-care resource use—North Carolina, 2007 and 2009. MMWR Morb Mortal Wkly Rep. 2012;61(8):143-146.

32. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease (updated 2013). GOLD Web site. http://www.goldcopd.org/uploads/users/files/GOLD_Report_2013_Feb20.pdf. Accessed August 5, 2013.

33. Easley C, Peterson R, Holmes M. The health and economic burden of chronic diseases in North Carolina. N C Med J. 2010;71(1):92-95.

34. Gegick S, Coore HA, Bowling MR. Chronic obstructive pulmonary disease: epidemiology, management, and impact on North Carolina. N C Med J. 2013;74(5):411-414 (in this issue).

35. Calverley PM, Rabe KF, Goehring UM, Kristiansen S, Fabbri LM, Martinez FJ; M2-124 and M2-125 study groups. Roflumilast in symptomatic chronic obstructive pulmonary disease: two randomised clinical trials. Lancet. 2009;374(9691):685-694.

36. Albert RK, Connett J, Bailey WC, et al; COPD Clinical Research Network. Azithromycin for prevention of exacerbations of COPD. N Engl J Med. 2011;365(8):689-698.

37. Baillargeon J, Wang Y, Kuo YF, Holmes HM, Sharma G. Temporal trends in hospitalization rates for older adults with chronic obstructive pulmonary disease. Am J Med. 2013;126(7):607-614.

38. Almagro P, Salvadó M, Garcia-Vidal C, et al. Recent improvement in long-term survival after a COPD hospitalisation. Thorax. 2010;65(4):298-302.

39. Eisner MD, Anthonisen N, Coultas D, et al. An official American Thoracic Society public policy statement: novel risk factors and the global burden of chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2010;182(5):693-718.

40. Center for Disease Control and Prevention. Current cigarette smoking among adults—United States, 2011. MMWR Morb Mortal Wkly Rep. 2012;61(44):889-894.

41. Centers for Disease Control and Prevention. Tobacco Control State Highlights, 2010. Atlanta, GA: US Department of Health and Human

Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2010. http://www.cdc.gov/tobacco/data_statistics/state_data/state_highlights/2010/pdfs/highlights2010.pdf. Accessed September 22, 2013.

42. Sunyer J. Urban air pollution and chronic obstructive pulmonary disease: a review. Eur Respir J. 2001;17(5):1024-1033.

43. Institute of Medicine of the National Academies. Committee on Reducing Tobacco Use: Strategies, Barriers, and Consequences; Board on Population Health and Public Health Practice. Bonnie RJ, Stratton K, Wallace RB, eds. Ending the Tobacco Problem: A Blueprint for the Nation. Washington, DC: The National Academies Press; 2007.

44. Centers for Disease Control and Prevention (CDC). Best Practices for Comprehensive Tobacco Control Programs—2007. Atlanta: US Department of Health and Human Services, CDC, National Center for Chronic Disase Prevention and Health Promotion, Office on Smoking and Health; 2007. http://www.cdc.gov/tobacco/stateandcommunity/best_practices/pdfs/2007/bestpractices_complete.pdf. Accessed August 18, 2013.

45. Harrill-Smith C, Ripley-Moffitt C, Goldstein AO. Tobacco cessation in 2013: what every clinician should know. N C Med J. 2013;74(5):401-405 (in this issue).

46. Halladay J, Gianforcaro R. Engaging a network of primary care practices in an effort to better assist patients in quitting tobacco use. N C Med J. 2013;74(5):402-403 (in this issue).

47. Reddick B, Howe K. The impact of pneumonia guidelines and core measures on patient-oriented outcomes. N C Med J. 2013;74(5):434-437 (in this issue).

48. Murphy SL, Xu J, Kochanek KD. Deaths: final data for 2010. Natl Vital Stat Rep. 2013;61(4):1-167. Hyattsville, MD: National Center for Health Statistics; 2013. http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_04.pdf. Accessed August 19, 2013.

49. Centers for Disease Control and Prevention (CDC). FastStats. Pneumonia. CDC Web site. http://www.cdc.gov/nchs/fastats/pneumonia.htm. Page last updated April 5, 2013. Accessed August 8, 2013.

50. American Lung Association, Research and Program Services, Epidemiology and Statistics Unit. Trends in pneumonia and influenza morbidity and mortality. http://www.lung.org/finding-cures/our-research/trend-reports/pi-trend-report.pdf. Published April 2010. Accessed August 19, 2013.

51. National Health Interview Survey, 2011. Data from the National Health Interview Survey. Vital Health Stat 10(255). Hyattsville, MD: National Center for Health Statistics; 2012. http://www.cdc.gov/nchs/data/series/sr_10/sr10_255.pdf. Accessed August 19, 2013.

52. Stout JE. The race to eliminate tuberculosis. N C Med J. 2013;74(5):415-419 (in this issue).

53. Centers for Disease Control and Prevention. Trends in Tuberculosis—United States, 2012. MMWR Morb Mortal Wkly Rep. 2013;62(11):201-205.

54. Keener SR. Treatment of latent tuberculosis infection in North Carolina: strategies for improving adherence. N C Med J. 2013;74(5):416-417 (in this issue).

55. Centers for Disease Control and Prevention (CDC). 2012 Provisional Pertussis Surveillance Report. CDC Web site. http://www.cdc.gov/pertussis/downloads/Provisional-Pertussis-Surveillance-Report.pdf. Published March 19, 2013. Accessed August 19, 2013.

56. Bass JB Jr, Turpin-Saunders SR. Coughing up answers: a community's response to pertussis. N C Med J. 2013;74(5):420-424 (in this issue).

57. Curran D. Tdap vaccination in pregnancy: new guidance, new challenges. N C Med J. 2013;74(5):421-422 (in this issue).

58. Gatton OD. Pharmacists: medication experts who help prevent disease. N C Med J. 2013;74(5):428-429 (in this issue).

59. Simeonsson K, Moore Z. Prevention and control of influenza: no easy task. N C Med J. 2013;74(5):425-433 (in this issue).

60. Centers for Disease Control and Prevention. Estimates of deaths associated with seasonal influenza—United States, 1976-2007. MMWR Morb Mortal Wkly Rep. 2010;59(33):1057-1062.

61. Centers for Disease Control and Prevention. Influenza vaccination coverage among health-care personnel—2011–12 influenza season, United States. MMWR Morb Mortal Wkly Rep. 2012;61(38):753-757.

62. Floyd B. Mandatory influenza vaccination program proves successful in its first year. N C Med J. 2013;74(5):426 (in this issue).

63. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2013. CA Cancer J Clin. 2013;63(1):11-30.

64. Alberg AJ, Brock MV, Ford JG, Samet JM, Spivack SD. Epidemiology of lung cancer: diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest. 2013;143(5 suppl):e1S-e29S.

65. Giovino GA. Epidemiology of tobacco use in the United States. Oncogene. 2002;21(48):7326-7340.

66. Hitchman SC, Fong GT. Gender empowerment and female-to-male smoking prevalence ratios. Bull World Health Organ. 2011;89(3):195-202.

67. Mackay J, Eriksen MP, Shafey O. The Tobacco Atlas. 2nd ed. Atlanta, GA: American Cancer Society; 2006.

68. Thun MJ, Carter BD, Feskanich D, et al. 50-year trends in smoking-related mortality in the United States. N Engl J Med. 2013;368(4):351-364.

69. Peto R, Darby S, Deo H, Silcocks P, Whitley E, Doll R. Smoking, smoking cessation, and lung cancer in the UK since 1950: combination of national statistics with two case-control studies. BMJ. 2000;321(7257):323-329.

70. Morgensztern D, Ng SH, Gao F, Govindan R. Trends in stage distribution for patients with non-small cell lung cancer: a national cancer database survey. J Thorac Oncol. 2010;5(1):29-33.

71. The National Lung Screening Trial Research Team; Aberle DR, Adams AM, Berg CD, et al. Reduced lung cancer mortality with low-dose computed tomographic screening. N Engl J Med. 2011;365(5):395-409.

72. Christensen JD, Tong BC. Computed tomography screening for lung cancer: where are we now? N C Med J. 2013;74(5):406-410 (in this issue).

73. Chan CK, Wells CK, McFarlane MJ, Feinstein AR. More lung cancer but better survival. Implications of secular trends in "necropsy surprise" rates. Chest. 1989;96(2):291-296.

74. Dammas S, Patz EF Jr, Goodman PC. Identification of small lung nodules at autopsy: implications for lung cancer screening and over-diagnosis bias. Lung Cancer. 2001;33(1):11-16.

75. Wender R, Fontham E, Barrera E Jr, et al. American Cancer Society lung cancer screening guidelines. CA Cancer J Clin. 2013;63(2):107-117.

76. Detterbeck FC, Mazzone PJ, Naidich DP, Bach PB. Screening for lung cancer: diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest. 2013;143(5 suppl):e78S-e92S.

77. Humphrey LL, Deffebach M, Pappas M, et al. Screening for lung cancer with low-dose computed tomography: a systematic review to update the US Preventive Services Task Force Recommendation [published online ahead of print July 30, 2013]. Ann Intern Med. doi:10.7326/0003-4819-159-6-201309170-00690.

78. US Preventive Services Task Force (USPSTF). Grade definitions. USPSTF Web site. http://www.uspreventiveservicestaskforce.org/uspstf/grades.htm. Published May 2008. Accessed August 19, 2013.

Community Care of North Carolina's Approach to Asthma Management

Elizabeth Cuervo Tilson

Community Care of North Carolina (CCNC) takes a comprehensive approach to asthma management. Support from CCNC helps providers follow evidence-based practice guidelines; data guide continuous quality improvement initiatives and inform the care of individual patients and populations; and care managers work with high-risk patients.

Asthma is one of the most common chronic diseases of childhood, second only to dental disease. Data from the Child Health Assessment and Monitoring Program (CHAMP) Survey show that prevalence rates of asthma are highest in children aged 5–17 years, and approximately 1 child in 10 was living with asthma in North Carolina in 2011 [1]. Prevalence rates for adults in North Carolina in 2011 were slightly lower, at 8.8% [2]. Prevalence rates of asthma in North Carolina vary with race or ethnicity and with insurance status. Racial or ethnic minority populations and children covered by public insurance have higher prevalence rates of asthma than do white, privately insured individuals [1].

Asthma has a significant economic and social impact. In the United States in 2010, asthma accounted for 439,000 hospital discharges, 1.2 million hospital outpatient visits, 2.1 million emergency department (ED) visits, 10.6 million physician office visits, and $56.0 billion in economic costs [2]. Asthma is the leading cause of missed days of school in North Carolina [3].

The etiology of asthma is multifactorial, and evidence of the importance of environmental exposures is accumulating [4]. Thus, it is important to have a comprehensive approach to asthma management.

A Comprehensive Approach to Asthma Management

Community Care of North Carolina (CCNC) is a statewide, provider-led primary care medical home and care coordination system that has been growing for the past 10 years. It is a private-public partnership with 14 networks covering all 100 counties in the state. It rests on the framework of Carolina ACCESS Medicaid, a managed care program in which Medicaid recipients are linked to a primary care medical home. CCNC activities are added to that framework to further increase access to high-quality, cost-effective, coor-

dinated care. By helping providers care for patients, CCNC has shown that it can improve health, reduce rates of ED visits and hospitals admissions, and save money. Statewide, more than 5,000 providers and more than 1.2 million Medicaid patients are part of CCNC [5].

Asthma management is one of CCNC's statewide disease management initiatives. As with all disease management initiatives, the asthma initiative is based on nationally recognized evidence-based or best-practice guidelines. Specifically, the National Heart, Lung, and Blood Institute Guidelines for the Diagnosis and Management of Asthma published in 2007 [4] inform the initiative. Metrics that align with the guidelines are developed and approved by the CCNC network clinical directors and CCNC clinical staff members; when possible, these metrics are also aligned with national metrics.

CCNC takes a comprehensive approach to asthma management. The measures developed for asthma include the percentage of patients with asthma who receive a continued care visit with assessment of symptoms; the percentage who undergo assessment of triggers; the percentage who receive a written management plan; the percentage of patients with persistent asthma for whom controller medicines are prescribed; the rate of asthma-related ED visits; and the rate of asthma-related hospitalizations.

Providers are given support and tools to foster high-quality asthma care. Educational sessions and resources on best-practice guidelines are available to practice staff members and providers. Asthma symptom questionnaires, which can be completed by the patient or a parent, are provided to facilitate assessment of asthma control. Asthma management plans and other education materials are made available to practices for use with patients.

Clinicians have access to robust patient information in the CCNC Provider Portal, including a dashboard view of patient data provided by the CCNC Informatics Center. Individual-level information helps guide care of a specific

Mission Children's Hospital's Regional Asthma Disease Management Program

Melinda Shuler, Donald W. Russell

The Regional Asthma Disease Management Program at Mission Children's Hospital in Asheville, North Carolina, was designed to address health care disparities in underserved and impoverished children with asthma in the western part of the state. The program acknowledges the local population's health care habits and asthma care needs, and it delivers asthma education and interventions beyond the clinical setting—in homes, schools, child care centers, and other care facilities.

The Regional Asthma Disease Management Program implements the 6 key recommendations of a 2008 report from the National Asthma Education and Prevention Program: assess asthma severity, assess and monitor asthma control, use inhaled corticosteroids, use a written asthma action plan, control environmental exposures, and schedule follow-up visits [1]. Through its various components, the program provides clinical assessments (lung spirometry, exhaled nitric oxide, etc.); patient education (using culturally appropriate and literacy-sensitive materials); medication assessments; development and implementation of an asthma action plan; environmental assessments; communication of pertinent information to physicians, families, and others; and educational programs and activities.

Key collaborators include the North Carolina Asthma Program; the Asthma Alliance of North Carolina; school systems and child care centers in Western North Carolina; the North Carolina Department of Health and Human Services, Environmental Health Section, Children's Environmental Health Branch; the National Center for Healthy Housing; the National Asthma Control Initiative of the National Heart, Lung, and Blood Institute of the National Institutes of Health; the Asthma and Allergy Foundation of America; primary care providers in Western North Carolina; and the Cherokee Indian Hospital Authority. The Regional Asthma Disease Management Program has a strong presence outside its clinical settings, having built long-term relationships with faith-based organizations, community agencies, and others.

In Western North Carolina, more than 1 child in 4 lives in poverty [2]. Western North Carolina also has a large minority population that includes Native Americans, African Americans, and Hispanics. Minorities and groups with lower income-to-poverty ratios have the highest prevalence of asthma [3]. Social determinants of health must be addressed, because impoverished children are at risk for lower school performance, decreased attendance, fragile nutritional status, and inadequate housing.

In 2010, 10.3% of children in North Carolina had asthma [4], compared with 8.4% of children nationally [3]. Asthma is the leading chronic health condition among students in North Carolina schools; in the 2009–2010 school year, 52% of all students with a chronic health condition had asthma [5].

Because of the state's temperate climate—which supports more than 100 species of trees and 1,600 species of flowering plants—plus the prevalence of cigarette smoking and high levels of poverty, children in North Carolina face significant exposure to environmental triggers that exacerbate asthma severity, which leads to relatively high rates of pediatric asthma. The Regional Asthma Disease Management Program uses a multifaceted approach to help families build skills in managing environmental triggers and to connect them with other community resources.

Environmental assessments are conducted at child care centers and school sites, as well as in the homes of children diagnosed with asthma. Each assessment lasts 1–3 hours, and results are discussed with the administrator of the site or the homeowner. An 8-page home environmental assessment questionnaire, which was developed in partnership with the National Center for Healthy Housing, is administered. This questionnaire uses a multipronged strategy to identify allergens and irritants to which the patient is sensitive. The Regional Asthma Disease Management Program uses faith-based organizations and charitable community partners to address the psychosocial needs of patients and to provide cleaning supplies, pest control services, and home remediation. Additional follow-up is conducted if remediation is required.

patient. For example, the "medication fill" history can inform the conversation between provider and patient about medication compliance. Practice-level data can foster population management. For example, practices can download a list of patients with asthma-related care alerts, which are triggered by the detection of asthma-related ED visits, asthma-related hospitalizations, frequent refills of rescue medications, or failure to fill a prescription for a controller medication.

Quality improvement specialists and support are available to foster continuous quality improvement activities and workflow processes within practices. Processes that may be addressed include how to integrate asthma management tools into the practice workflow, how to facilitate recommended visit frequency, what must be documented in electronic health records (EHRs) to meet the meaningful use criteria of the Centers for Medicare & Medicaid Services (CMS), how to use data to inform the care of individual patients and populations, and how to use existing community resources (eg, care managers, child care health consultants, and school nurses) to help with patient care. Feedback is given to track progress and to identify areas for improvement or the need for additional resources. An example of

Regional workshops are used to take the program's message into the community; this message promotes asthma awareness and the identification of indoor and outdoor environmental triggers. Residents throughout Western North Carolina are invited to attend these workshops, which are usually held in schools, child care centers, and primary care offices. From 2009 through 2011, nearly 3,500 children received "asthma friendly" environmental interventions, and 259 staff members were educated. Asthma community initiatives throughout Western North Carolina impacted an additional 2,767 individuals from 2009 through 2011.

In 2009, the Regional Asthma Disease Management Program was 1 of 13 national asthma demonstration sites chosen by the National Heart, Lung, and Blood Institute. Fifty children were enrolled in the institute's National Asthma Control Initiative from 2009 through 2011. These children's medical charts were audited to assess several different indicators of program effectiveness. Unpublished data from the initiative show statistically significant improvements across all variables. Decreases in the rates of emergency department visits and hospitalizations for asthma resulted in cost reductions exceeding $800,000. Participating patients also showed statistically significant improvements on lung spirometry and exhaled nitric oxide measures. School attendance improved 52%.

The Regional Asthma Disease Management Program emphasizes compassion and patient advocacy. The program's ultimate goals are to improve patients' subjective quality of life, decrease school absenteeism, and decrease emergency department utilization and inpatient admissions for asthma.

In 2012 the program was the premier health care provider recipient of the US Environmental Protection Agency's National Environmental Leadership Award in Asthma Management. This was the first time that the award had been won by a program in the Southeastern United States. NCMJ

Melinda Shuler, BSBA, RCP, HHS, AE-C regional clinical program supervisor and principal investigator, Regional Asthma Disease Management Program, Mission Children's Hospital, Asheville, North Carolina.

Donald W. Russell, MD supervising physician, Regional Asthma Disease Management Program, Mission Children's Hospital, Asheville, North Carolina.

References
1. National Asthma Education and Prevention Program. Partners Putting Guidelines into Action: Guidelines Implementation Panel Report for: Expert Panel Report 3—Guidelines for the Diagnosis and Management of Asthma. Washington, DC: US Department of Health & Human Services, National Institutes of Health, and National Heart, Lung, and Blood Institute; 2008. NIH publication no. 09-6147. http://www.nhlbi.nih.gov/guidelines/asthma/gip_rpt.pdf. Accessed June 26, 2013.
2. KIDS COUNT Data Center: A Project of the Annie E. Casey Foundation. Children in poverty in North Carolina counties. 2009 data. KIDS COUNT Web site. http://datacenter.kidscount.org/data/tables/2238-children-in-poverty?loc=35&loct=5#detailed/5/4910-5009/false/867,133,38,35,18/any/4680,12873. Accessed June 27, 2013.
3. Moorman JE, Akinbami LJ, Bailey CM, et al. National Surveillance of Asthma: United States, 2001–2010. Washington, DC: National Center for Health Statistics; 2012. Vital and Health Statistics, Series 3, Analytic and Epidemiological Studies, no. 35. HHS publication no. (PHS) 2013-1419. http://www.cdc.gov/nchs/data/series/sr_03/sr03_035.pdf. Accessed June 27, 2013.
4. North Carolina State Center for Health Statistics (NCSCHS). 2010 North Carolina Statewide CHAMP Survey Results. Asthma. Does (CHILD) still have asthma? NCSCHS Web site. http://www.schs.state.nc.us/schs/champ/2010/ASM_CUR.html. Accessed June 27, 2013.
5. North Carolina Department of Health and Human Services (NCDHHS), Division of Public Health, Women's and Children's Health Section, Children and Youth Branch, School Health Unit. North Carolina Annual School Health Services Report: 2009–2010. Raleigh, NC: NCDHHS; 2011. http://www.ncdhhs.gov/dph/wch/doc/stats/SchoolHealthServicesAnnualReport-2009-2010.pdf. Accessed June 27, 2010.

successful collaboration between the quality improvement support staff of one CCNC network (Northwest Community Care Network) and a network practice (Wake Forest Baptist Health's Downtown Health Plaza) to address asthma care was described in a recent issue of the NCMJ [6]. Process measures aligning with best-practice recommendations showed marked improvement, and rates of ED visits and hospitalizations for asthma decreased.

Finally, multidisciplinary care managers—including nurses, social workers, and pharmacists—are available to work one-on-one with high-risk patients. Providers can make direct referrals to local care managers in their networks. Connections to hospitals via either the in-person presence of CCNC staff or via information technology (IT) system link-

ages can alert care managers when a patient is hospitalized or comes to the ED for an asthma-related illness. As part of the IT linkage, information about admissions, discharges, and transfers from 57 hospitals across the state allows for data on ED visits and hospitalizations to be fed into the Informatics Center twice daily. In addition, claims-based, risk-adjusted analytics can predict which patients are likely to experience potentially preventable costs related to their asthma. Care managers can use this report to proactively reach out to patients and offer care management services.

The main goals of care management are to promote self-management of chronic diseases and to strengthen the link between patients and providers, especially primary care providers. The local, on-the-ground, care manager staff-

Air Pollution Ignores State Borders

Roy Cooper

A decade ago, residents of Western North Carolina did not need any special equipment to tell them that their air was polluted. They could see the pollution and smell it; on some days, they could even taste it. On those days, their mountains were shrouded in gray—not a morning mist, but a haze of ozone, sulfur dioxide, nitrogen dioxide, and toxic particulates that caused asthma and even death. This chemical fog was killing trees and forming mercury compounds that seeped into the ground and into the water, thus contaminating fish. Worst of all, people were being poisoned in their own backyards with every breath they took. If the situation remained unchanged, local doctors would have to continue to tell their patients with asthma or other respiratory illnesses to stay indoors on days when pollution levels were high. Employers would continue to lose money because of employee illnesses, students would continue to miss school due to asthma attacks, and hospitalizations for respiratory illnesses would continue to rise. The problem was clear but difficult questions remained: What should be done? Who should be held accountable?

Coal-fired plants run by the Tennessee Valley Authority (TVA) were pumping pollution over the state border and into North Carolina's mountains. The utility had promised to clean up the pollution but had moved slowly, and the damage it caused was spreading. As North Carolina Attorney General, in 2006 I filed suit against the TVA on behalf of the state, saying that the pollution was a public nuisance and demanding that it stop. The lawsuit was a last resort. Our office had tried negotiating with the utility, but without the power of a court order, we had no way to ensure results.

Within its borders, North Carolina was already doing its part to slow pollution. With urging from the governor and from our office, North Carolina legislators and utilities had agreed on the provisions of the 2002 Clean Smokestacks Act [1]. This act required North Carolina utilities to reduce coal-fired plant emissions and to speed cleanup. However, we could make no such requirements of our upwind neighbors. Thus, the TVA—the nation's largest public utility, with plants not just in Tennessee but also in nearby states—was continuing to pump toxic fumes into Great Smoky Mountains National Park, the counties of Western North Carolina, and beyond.

The Clean Smokestacks Act directs the state to "use all available resources and means . . . to induce other states and entities, including the Tennessee Valley Authority, to achieve reductions in emissions" [1]. The legal theory we used was not new, but the scale of the case was. Our claim was that the TVA's pollution had reached such a stage that it was literally a nuisance to the public. In general terms, this kind of lawsuit is used when public health and safety are endangered and cost-effective solutions are readily available.

Our research showed that the health of North Carolinians was threatened. Experts estimated that if the TVA reduced particulate matter and other airborne toxins, it could prevent 19,000 exacerbated asthma attacks, 99 early deaths, and dozens or even hundreds of emergency department visits and hospital admissions every year in North Carolina [2]. When neighboring states were included in the affected area, the health benefits were expected to reach tens of thousands of people. In addition,

ing allows for a wide range of care management activities designed to achieve these goals. Care managers can work with families over the phone or in person. They can accompany a patient to medical appointments, which can help the care manager understand the care plan recommended by the provider and can help the family operationalize that plan. Care managers can provide extra asthma education on topics such as the physiology of asthma, triggers, symptom recognition, how and when to use medicines and delivery devices (eg, spacers), and how to follow an asthma management plan. Care managers can also make home visits that help them to understand the social and environmental context in which the family is trying to manage this chronic disease. Environmental triggers in the home can be identified, and advice on how to mitigate those triggers can be provided. The care manager can also address barriers to care—lack of transportation, for example. Finally, the care manager can help the family organize the home in a way that facilitates consistent chronic disease management—for instance, they can help the family decide where to store medicines and where to post the asthma management plan.

Local Initiatives and Collaborations

Local initiatives and collaborations further add to statewide activities. Strong evidence supports the effectiveness of home-based, multi-trigger, multicomponent interventions with an environmental focus, because such interventions can improve asthma symptoms, quality of life, and productivity for children and adolescents with asthma [7, 8]. For example, one CCNC network, Community Care of Wake and Johnston Counties, is working in partnership with Wake County Environmental Services and Wake County Human Services to deliver a multidisciplinary, home-based, environmental trigger assessment and mitigation initiative led by a registered sanitarian and a nurse care manager. This initiative shows an average of $700 in savings per patient, secondary to decreased rates of ED visits and hospitalizations for asthma. In addition, this initiative achieved substantial decreases in network-wide asthma ED rates (from 40 visits per 1,000 member-months in 2003 to 17 visits per 1,000 member-months in 2012) and asthma hospital admission rates (from 8.3 hospitalizations per 1,000 member-months

the pollution was causing our state and its businesses to lose billions in health care dollars and lost workdays [3]. The state was also losing tourism dollars when Grandfather Mountain and the views from the Biltmore Estate were obscured by smog [4]. It was clear to me that action was needed.

After a hard-fought trial, Judge Lacy Thornburg saw it our way, setting limits on emissions and deadlines for improvement at several plants. The TVA fought our attorneys on appeal, but in the end we agreed on a landmark settlement [5], which required the TVA to either close its coal-fired plants or speed installation of pollution control equipment. The TVA also agreed to send $11.2 million to North Carolina to fund energy efficiency programs. What is most important is that the settlement is reducing harmful emissions and significantly improving views of the mountains. The dollar value of the health benefits alone is estimated to be $672 million per year [3].

Meanwhile, the fight for clean air continues, with a case about the Cross-State Air Pollution Rule of the Environmental Protection Agency (EPA) going to the Supreme Court of the United States this year. Having obtained a federal court order in 2008 to force the EPA to adopt stricter clean air guidelines [6], North Carolina is now fighting alongside the EPA to ensure that upwind states promptly control their pollution. Specifically, our attorneys are arguing that the federal Clean Air Act demands that states *proactively* mitigate their impacts on other states, rather than putting off their responsibilities to downwind states and waiting for the EPA to solve their problems for them.

In the end, the case we brought under the Clean Smokestacks Act was a success for the public health and the economy of North Carolina. The TVA is making changes for the better. Although collaboration and negotiation should always be the first choice, litigation can be an effective tool when widespread damage to public health and the economy goes unabated. NCMJ

Roy Cooper, JD Attorney General of North Carolina, Raleigh, North Carolina.

References
1. 2002 N.C. Sess L. 4. http://www.ncleg.net/EnactedLegislation/SessionLawsCD/SessionLaws/2002SessionLaws.pdf. Accessed September 12, 2013.
2. Spengler JD, Levy JI. Public Health Benefits of Additional Emission Controls on Tennessee Valley Authority Coal-Fired Power Plants. Newton, MA: Environmental Health & Engineering, Inc.; 2006.
3. Deck LB. Economic Benefits Analysis of the Health Effects from Controlling Emissions from Tennessee Valley Authority Coal-Fired Power Plants. Washington, DC: Stratus Consulting Inc.; 2006. http://www.ncdoj.gov/getdoc/979aa6a8-b000-4938-9ccd-ece0eb0a4fe4/Deck-Expert-Report.aspx. Accessed September 12, 2013.
4. Matthews L. Blue Ridge Parkway Scenic Experience Project: Results Synthesis. Phase I Southwest Virginia and Phase II Northern North Carolina. April 2004.
5. Consent Decree, State of Alabama et al. v. Tennessee Valley Authority (No. 3:11-cv-00170, E.D. Tenn., June 30, 2011). http://www.ncdoj.gov/getdoc/bdf66401-8137-4be2-bd20-57e89b570c1a/TVA-signed-consent-decree.aspx. Accessed September 18, 2013.
6. State of North Carolina v. Environmental Protection Agency, 591 F3d 896 (DC Cir 2008). http://www.utexas.edu/law/journals/tlr/sources/Issue%2090.1/Markoff/Markoff.fn086.NC%20v%20EPA%20531%20F3d%20896.pdf. Accessed June 28, 2013.

in 2003 to 1.9 hospitalizations per 1,000 member-months in 2012). This collaboration received a 2013 Achievement Award in Health from the National Association of Counties. Other CCNC networks—including Northern Piedmont Community Care, Northwest Community Care Network, and Community Care of the Lower Cape Fear—are beginning similar activities to address environmental asthma triggers. The Healthy Homes training offered by the University of North Carolina's Gillings School of Global Public Health is helping to spread these activities.

Quality Metrics

Chart review and claims-based measures are used to foster continuous quality improvement initiatives within practices, networks, and the statewide CCNC program. Improvements in all metrics have been achieved. Figure 1 shows chart-review measures, including the percentage of patients with documentation of at least 1 continued care visit with assessment of symptom control, trigger assessment, and provision of a written asthma management plan. An additional measure noting the percentage of patients with persistent asthma with documentation of a prescription for controller medicine was added in 2011. This measure is the only one with a comparable national HEDIS (Healthcare Effectiveness Data and Information Set) benchmark, and CCNC results show high rates of performance on this measure. In 2011, 93.6% of patients with persistent asthma were prescribed a controller medication. This percentage increased to 95.5% in 2012. These percentages exceed the 90th percentile for national 2011 HEDIS benchmarks for Medicaid Managed Care Organizations, which is 90.6%.

In early evaluations of CCNC's asthma initiatives, 2 published studies [9, 10] found sizeable decreases in rates of hospitalization and ED use for asthma. An evaluation by the University of North Carolina's Cecil G. Sheps Center for Health Services Research [9] showed substantially lower rates of ED visits and inpatient admissions during the period 2000–2002 for Carolina ACCESS Medicaid patients who were enrolled in CCNC than for those who were not. A subsequent study [10] showed a 16.6% decline in the rate of ED visits and a 40% decrease in the rate of inpatient admissions for CCNC-enrolled patients with a diagnosis of asthma

FIGURE 1.

Statewide Results for the Quality of Asthma Care for Patients Enrolled in Community Care of North Carolina, 2009–2012
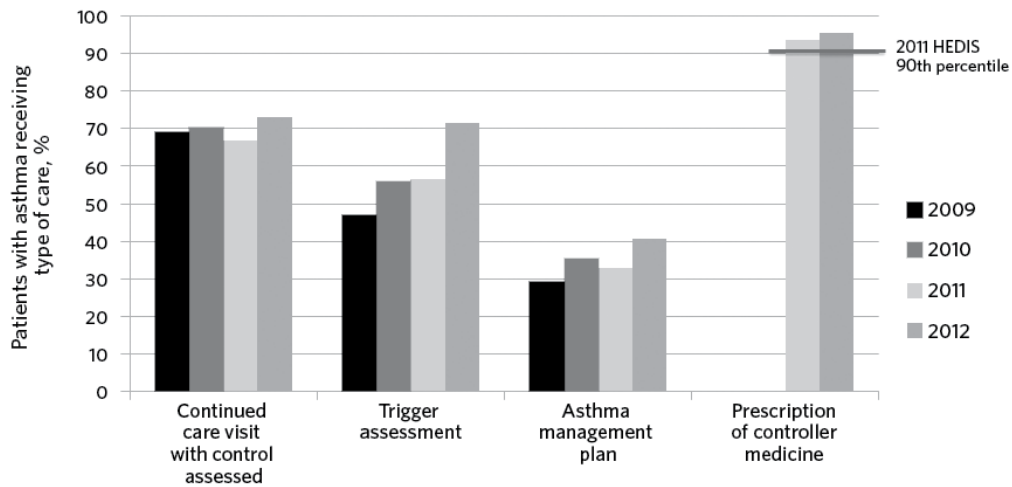
Note. HEDIS, Healthcare Effectiveness Data and Information Set.

between fiscal years (FYs) 2003 and 2006.

While ED utilization rates have continued to rise for Medicaid recipients with asthma who are not enrolled in CCNC, rates have remained consistently lower within the CCNC program. Additionally, while asthma-related inpatient admission rates have remained steady for Medicaid recipients who are not enrolled in CCNC, inpatient rates have continued to decline for CCNC-enrolled patients (Figure 2). In 2012 the ED visit rate was 38% lower and the inpatient admission rate was 65% lower for Medicaid recipients with asthma who were enrolled in the CCNC program compared with those who were not enrolled in CCNC (Figure 3).

Future Directions and Emerging Initiatives

To further facilitate population management, an asthma disease registry is under development as a resource for practices engaged in asthma quality improvement work. This registry will couple claims data (such as ED visit and medication fill data) with clinical data from EHRs—for example, data regarding asthma management plans and allergy and

FIGURE 2.

Rates of Asthma-Related Emergency Department Visits and Inpatient Admissions for North Carolina Medicaid Recipients
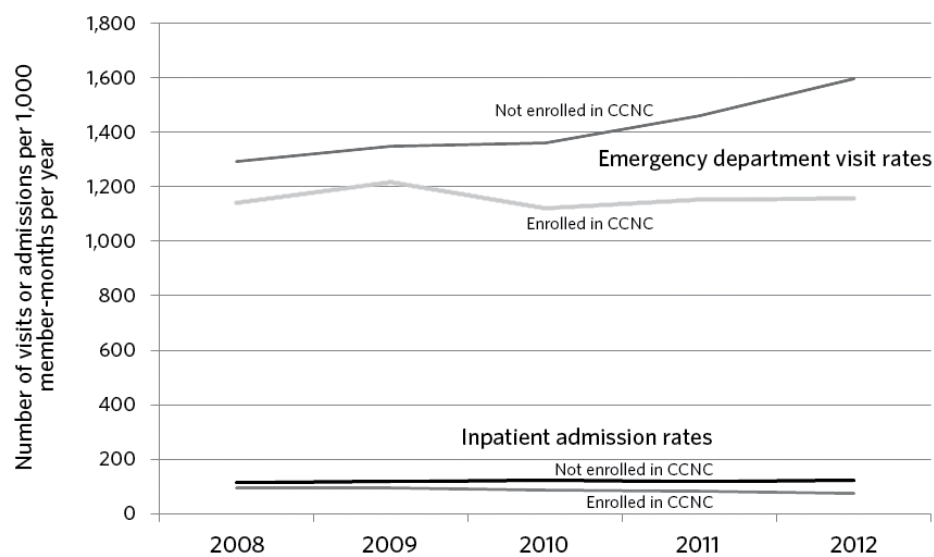
Note. CCNC, Community Care of North Carolina.

FIGURE 3.

Percent Difference Between Medicaid Recipients Enrolled in CCNC and Those Not Enrolled in CCNC, for Rates of Asthma-Related Emergency Department Visits and Inpatient Admissions, 2008–2012

Note. CCNC, Community Care of North Carolina.
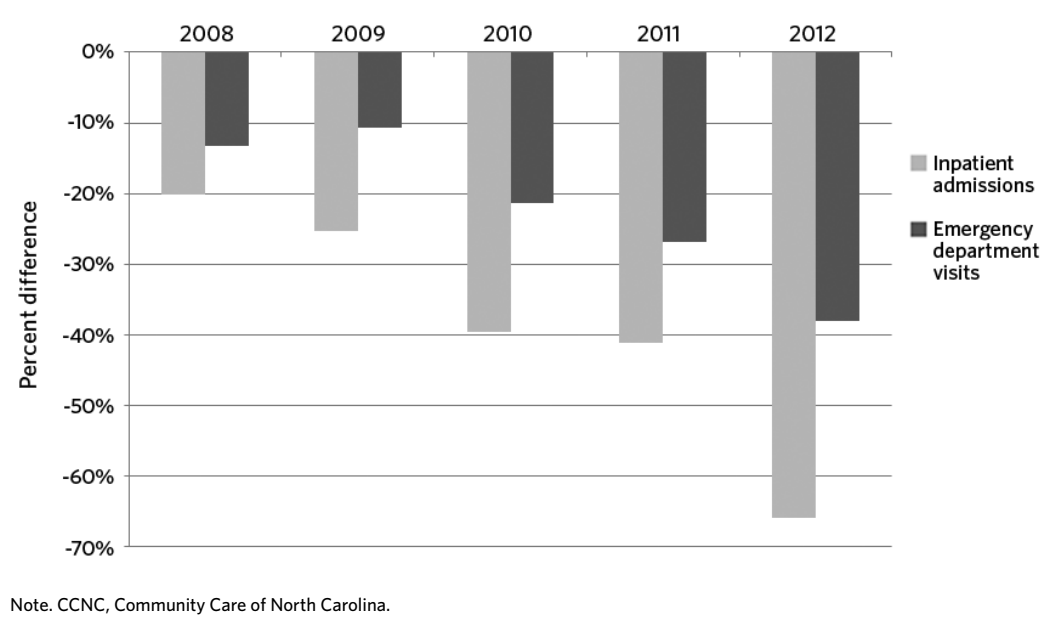
trigger management. Initially, the registry will be accessed through the CCNC Provider Portal, and claims information and clinical information will be provided by the North Carolina Health Information Exchange. A next step will be to integrate all of the information into a single view and to develop an interactive dashboard tool for the asthma registry that will enable real-time manipulation of data related to asthma and asthma care. Future capabilities will also include the integration of care alerts to prompt action for asthma management. The registry will also support asthma-related reporting requirements to help practices meet the meaningful use criteria established by CMS.

Another emerging initiative involves exploring effective ways to disseminate patient-centered tools for shared decision making (SDM) that have been shown to produce positive changes in asthma outcomes [11, 12]. The Asthma SDM Toolkit includes a tool to assess baseline asthma control; a guide for eliciting the patient's goals for treatment priorities; educational materials about asthma; a tool to guide the negotiation process and to jointly develop a treatment regimen that accommodates the patient's goals and preferences; and an asthma action plan that has been developed by a Carolinas Healthcare System team and has been shown to improve asthma outcomes [13]. Through a grant from the Patient-Centered Outcomes Research Institute and in partnership with Carolinas Healthcare System, CCNC will test a novel dissemination process to spread the Asthma SDM Toolkit to primary care practices. Facilitators will work with selected practices to individually tailor the toolkit to the practice's unique circumstances. Patients receiving care at practices where the toolkit is being implemented

will be compared with control patients at nonparticipating practices using quantitative outcomes data (from EDs, hospitals, outpatient clinics, and pharmacies) as well as qualitative data (regarding provider and patient satisfaction, for instance). The knowledge gained from this initiative and the partnerships formed between practice-based research networks and CCNC practices will facilitate the dissemination of effective SDM patient education materials to other CCNC practices statewide. NCMJ

Elizabeth Cuervo Tilson, MD, MPH primary care pediatrician, Wake County Human Services, and medical director, Community Care of Wake and Johnston Counties, Raleigh, North Carolina.

References
1. North Carolina State Center for Health Statistics. 2011 North Carolina Statewide CHAMP Survey Results. Asthma. Does (CHILD) still have asthma? North Carolina State Center for Health Statistics Web site. http://www.schs.state.nc.us/schs/champ/2011/ASM_CUR.html. Accessed June 25, 2013.
2. American Lung Association, Epidemiology and Statistics Unit, Research and Program Services Division. Trends in Asthma Morbidity and Mortality, Table 12. September 2012. http://www.lung.org/finding-cures/our-research/trend-reports/asthma-trend-report.pdf. Accessed June 25, 2013.
3. North Carolina Department of Health and Human Services, Division of Public Health, Women's and Children's Health Section, School Health Unit. North Carolina Annual School Health Services Report for Public Schools: Summary Report of School Nursing Services, School Year 2006-2007. October 2007. www.nchealthyschools.org/docs/data/reports/2006-07eoy.pdf. Accessed June 25, 2013.

4. National Heart, Lung, and Blood Institute (NHLBI), National Asthma Education and Prevention Program. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. Washington, DC: US Department of Health and Human Services, National Institutes of Health, NHLBI; 2007. http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm. Accessed June 25, 2013.
5. The Community Care Story: Why a Community-Based System Really Works. Community Care of North Carolina Web site. https://www.communitycarenc.org/about-us/. Accessed September 12, 2013.
6. Garrison KB, Brown CT. Collaborative quality improvement efforts yield success for asthma patients. N C Med J. 2013;74(2):143-144.
7. Asthma Control: Home-Based Multi-Trigger, Multicomponent Environmental Interventions. The Guide to Community Preventive Services Web site. http://www.thecommunityguide.org/asthma/multicomponent.html. Reviewed June 2008. Accessed June 26, 2013.
8. Crocker DD, Kinyota S, Dumitru GG, et al. Effectiveness of home-based, multi-trigger, multicomponent interventions with an environmental focus for reducing asthma morbidity: a community guide systematic review. Am J Prev Med. 2011;41(2 suppl 1):S5-S32.
9. Ricketts TC, Greene S, Silberman P, Howard HA, Poley S. Evaluation of Community Care of North Carolina Asthma and Diabetes Management Initiatives: January 2000-December 2002. Chapel Hill, NC: North Carolina Rural Health Research and Policy Analysis Program, Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill; 2004.
10. Community Care of North Carolina (CCNC). Asthma Disease Management Program Summary. Raleigh, NC: CCNC; 2007. https://www.communitycarenc.com/media/related-downloads/asthma-management.pdf. Accessed June 26, 2013.
11. van der Meer V, Bakker MJ, van den Hout WB, et al. Internet-based self-management plus education compared with usual care in asthma: a randomized trial. Ann Intern Med. 2009;151(2):110-120.
12. Wilson SR, Strub P, Buist AS, et al. Shared treatment decision making improves adherence and outcomes in poorly controlled asthma. Am J Respir Crit Care Med. 2010;181(6):566-577.
13. Tapp H, Alkhazraji T, Kuhn L, et al. Evaluating asthma management in primary care: impact of the chronic care model and shared decision making on outcomes for poorly controlled patients with asthma. Poster presented at: 40th North American Primary Care Research Group Annual Meeting; December 1-5, 2012; New Orleans, LA.

Tobacco Cessation in 2013:
What Every Clinician Should Know

Carrie Harrill-Smith, Carol Ripley-Moffitt, Adam O. Goldstein

Given the many deaths caused by smoking, clinicians should offer evidence-based treatment to every patient who uses tobacco. This commentary discusses health system changes that promote treatment for tobacco use, new protocols for tobacco cessation therapies, and emerging tobacco products that are being marketed as harm-reduction tools.

Chronic lower respiratory disease is the third leading cause of death in North Carolina, and chronic obstructive pulmonary disease (COPD) is the leading cause of mortality within that disease family [1, 2]. An estimated 85% to 90% of COPD deaths are caused by smoking [2]. Smoking-attributable deaths among North Carolina adults aged 35 years or older total more than 12,000 annually [3]; smoking thus contributes to about 1 in 5 deaths in the state [4]. Federal and state public health initiatives that have contributed to decreases in smoking prevalence include legislation to raise the cigarette excise tax, clean air laws prohibiting smoking in indoor environments, media campaigns to discourage tobacco use by youth and adults, and support for tobacco cessation resources such as telephone quit lines [5].

Although public health efforts and legislation have raised awareness of tobacco-related illnesses and the benefits of quitting, 21.7% of adult respondents to the 2011 North Carolina Behavioral Risk Factor Surveillance System survey reported that they continue to smoke, which translates to about 1.6 million current smokers [6]. The result is that $3.3 billion is spent in health care costs for tobacco-related illnesses every year in the state [7]. Tobacco use is increasingly concentrated among those with mental illness; individuals with a mental health or substance abuse disorder represent only 24.8% of adults but smoke 39.6% of all cigarettes [8]. Fortunately, increased awareness of and research regarding tobacco use treatment for this population has begun to address this disparity.

Implementing best practices to address tobacco addiction in medical practice requires not only individual change but also changes in health systems—changes in policies, programs, and allocation of resources that can be made by provider practices, health care administrators, managed care organizations, and purchasers of health plans. Tobacco cessation efforts are changing radically as a result of health care reform, quality improvement initiatives, and new research on best practices for treatment of tobacco use. In addition, new tobacco products that are promoted as harm-reduction aids are altering the landscape of tobacco use, raising questions about how these new products work, how they are marketed, and what effects they may have on tobacco use, illness, and smoking cessation.

Changes in Health Systems

All providers should employ evidence-based treatment for tobacco use, which includes asking patients about tobacco use at every clinic visit and offering a combination of counseling and medication to support patients in quitting [9]. Unfortunately, counseling and medication continue to be offered at unacceptably low rates. Identified barriers include lack of clinician time, lack of clinician awareness of updated medication protocols, and the misconception on the part of some specialists that primary care providers bear sole responsibility for offering tobacco use treatment [10]. Studies show that changes made at a health system level affect the behavior of individual providers. In 2007 the University of North Carolina (UNC) Health Care System outpatient clinics began including smoking status in the electronic health record (EHR) vital signs, as well as asking patients who smoked if they planned to quit. Researchers found that, among patients who smoked and were asked about their readiness to quit, a significantly greater proportion received documented cessation counseling compared with smokers who were not asked about their readiness to quit [11]. More recently, the vital signs were modified to include a reminder for providers to advise patients who smoke to quit, and to check the kinds of assistance offered (eg, counseling, quit line referral).

The Centers for Medicare & Medicaid Services' guidelines for meaningful use of EHR systems now require documentation of every patient's tobacco use status, as well as evidence that patients who smoke are being offered counseling

Engaging a Network of Primary Care Practices in an Effort to Better Assist Patients in Quitting Tobacco Use

Jacqueline Halladay, Robert Gianforcaro

Primary care practices are critical partners in helping people enjoy tobacco-free lives. Clinical practice guidelines recommend combining behavioral counseling and pharmacotherapy in a model of care that recognizes the chronic nature of tobacco dependence [1]. To successfully implement these guidelines, providers and office staff members need efficient tools that enable practice change and that work within their unique settings.

Investigators at the University of North Carolina (UNC) School of Medicine, including J.H., partnered with members of the UNC Physicians Network (UNCPN), including R.G., over the course of a year to develop and pilot a clinic-based treatment intervention for tobacco use; this intervention was developed using quality improvement techniques. We formed a team that included health care providers, information technology personnel, practice managers, other office staff members, and the UNC researchers.

The researchers from UNC worked with UNCPN leaders and with one UNCPN practice to establish how we would conform with the privacy and security rules regarding protected health information set forth in the Health Insurance Portability and Accountability Act of 1996 (HIPAA); to create a memorandum of understanding; and to schedule team meetings at which to devise and test a protocol for assisting tobacco users in quitting. We used survey data and interviews with clinic staff to understand the practice's current processes for identifying smokers, offering behavioral counseling, prescribing cessation medications, and billing for tobacco use counseling; we also sought to find out what challenges staff members faced in carrying out these activities. We devised an educational curriculum that could be delivered during 5 lunchtime sessions; topics included the latest information regarding cessation medications and use of motivational interviewing.

Although several changes were made by the pilot practice, 2 changes were particularly important. Providers needed a better system for identifying patients who were truly interested in using their office visit to discuss cessation strategies. To address this need, we provided sample "readiness assessment" forms and patient educational tools that had been developed at the UNC Family Medicine Center. We collaboratively refined these to develop a 3-question form that assesses the patient's willingness to address tobacco use during the office visit, the importance to the patient of quitting tobacco use, and the patient's confidence in making a quit attempt. This 3-question form is shown on page 404 of the commentary by Harrill-Smith and colleagues (in this issue); it can also be found, along with other tools and resources, on the Web site of the UNC Nicotine Dependence Program (www.ndp.unc.edu). Another key change involved creating a more formal referral system for patients who are interested in receiving additional smoking cessation

or medication. Because clinic and physician reimbursement are tied to compliance with these guidelines, larger numbers of patients should be offered cessation counseling [12]. Other quality improvement programs, such as the patient-centered medical home (PCMH), encourage preventive care and chronic disease management, which includes the use of patient self-management tools. Tobacco use remains the leading preventable cause of disease, making it an ideal candidate for PCMH behavioral change interventions.

Additional measures that are effective on the population level, such as referring patients to tobacco cessation quit lines, should be adopted by all practices. QuitlineNC, a free telephone/online coaching service, allows providers to fax a referral requesting that QuitlineNC initiate a call to a patient who has indicated that he or she is ready to make a quit attempt. The fax referral form can be customized and integrated into the flow of an office visit by training nurses and medical assistants to offer patients a fax referral to QuitlineNC, assigning a staff member to keep QuitlineNC information brochures and fax referral forms stocked in each exam room, and deciding who will fax the referrals each day. Patients also have the option to contact QuitlineNC directly, by calling 1-800-QUIT-NOW (1-800-784-8669).

Another practice-based change involves use of a decision support tool, which offers a visual reminder for providing tobacco use treatment. This tool would prompt questions (eg, how many cigarettes smoked per day, scales to assess importance and confidence) and actions to be completed by clinic staff and providers (eg, educational materials provided, pneumococcal vaccine given, medication prescribed). Much like chronic disease registries, this tool prompts physicians to offer appropriate evidence-based counseling and pharmacotherapy at each visit. These prompts can also be built into EHR systems to eliminate paper forms. Alternatively, a decision support tool might be a simple questionnaire that assesses a patient's readiness to quit (Figure 1), which could be completed by the patient and given to the provider to stimulate conversations and fax referrals.

Health system changes can also support tobacco use treatment during inpatient care. When patients who are addicted to tobacco are hospitalized, they can be encouraged to maintain the abstinence begun during their hospitalization with continued cessation after they are discharged. The Joint Commission measures for assessing and treating tobacco use by patients with pneumonia, myocardial infarction, or coronary heart disease have been expanded to include a

counseling. To do this, we tested and implemented the North Carolina Tobacco Use Quitline (QuitlineNC) fax referral process.

To assess the practice's progress with implementing change, the UNC team reviewed data with the practice's staff members on a monthly basis; these data included the number of readiness assessments completed, the number of referrals to the quit line, and the number of office visits during which tobacco use counseling was provided or smoking cessation medication was prescribed. We also reached out to other providers in the UNCPN to assess their interest in a Continuing Medical Education webinar on tobacco use treatment. We gathered ideas about content and solicited input regarding the best time of day to hold such an event. The webinar covered topics such as tobacco cessation pharmacotherapy, motivational interviewing techniques, and how to align tobacco use treatment with the recognition process for patient-centered medical homes. With support from the North Carolina Translational and Clinical Sciences Institute, we evaluated the webinar and assessed its value to clinical and network leaders.

The pilot practice rapidly implemented practice changes and has steadily increased the number of readiness assessments, quit line fax referrals, and prescriptions of cessation medications. Practice managers have begun disseminating the tools and resources to other UNCPN practices. Although we are still in the implementation phase of this project, our team of practice staff members, network leaders, and academic partners plans next to engage patients as team members, which should allow for further high-value improvements in this care delivery process. By engaging an even broader group of stakeholders, we hope to increase the number of quit attempts and patients' rates of success in becoming tobacco-free. **NCMJ**

Jacqueline Halladay, MD, MPH assistant professor, Department of Family Medicine, School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.
Robert Gianforcaro, DO adjunct clinical professor, School of Medicine, University of North Carolina at Chapel Hill, and executive medical director, UNC Physicians Network, Chapel Hill, North Carolina.

Reference
1. Fiore MC, Jaén CR, Baker TB, et al. Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline. Rockville, MD: US Department of Health & Human Services. Public Health Service; 2008. http://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/tobacco/clinicians/treating_tobacco_use08.pdf. Accessed August 13, 2013.

voluntary set of measures applicable to all patients who smoke or use tobacco [13]. Hospitals that adopt The Joint Commission inpatient tobacco measures will increase the evidence-based care offered. UNC Health Care's Nicotine Dependence Program offers tobacco cessation counseling to hospitalized inpatients, outpatients, employees, and those with cancer, ensuring that patients receive comprehensive counseling support and individualized medication support facilitated by trained tobacco treatment specialists.

New Protocols for Pharmacotherapy

In addition to counseling patients about treatment for tobacco use, clinicians can utilize new pharmacotherapy protocols that double and sometimes triple quit rates over those achieved a generation ago [9]. Varenicline, which was approved by the US Food and Drug Administration (FDA) in 2006, blocks nicotinic receptors and decreases cravings for and enjoyment of tobacco use. While varenicline has the highest effectiveness of any monotherpy, it also has a black-box warning due to potential neuropsychiatric side effects [14]. Combination therapies using more than one nicotine replace-

ment product have shown greater effectiveness than use of a single form of nicotine replacement therapy (NRT) and have quit rates comparable to those for varenicline. Having recognized that most people who use NRT cut down on the amount they smoke but do not quit immediately, the FDA recently allowed manufacturers to remove the warnings that had stated that NRT products should not be used by consumers who continued to use tobacco [15]. Using NRT to cut down on tobacco use prior to a quit attempt has been demonstrated to increase quit rates [16]. Individuals who are using a nicotine patch or some other form of NRT and are still having "breakthrough cravings" should be encouraged to use combination NRT.

These new protocols for medication use are especially pertinent for individuals with COPD, because smoking cessation can prevent the progression of COPD and can improve survival rates. In a study of 472 patients with severe COPD, counseling along with varenicline was shown to be the most effective treatment, with a 58.3% continuous abstinence rate in Weeks 9–24. This was followed by a 55.6% quit rate with counseling and bupropion, and a 38.2% quit rate with

FIGURE 1.

Sample Form Used to Assess Willingness to Quit Using Tobacco

Figure 1. Example of Readiness Assessment

Name_____ Date of Birth_____
Today's Date_____

You have indicated that you smoke cigarettes or use other tobacco products. Please take a minute to answer the questions below and give this to your doctor.

Would you be willing to talk with your doctor today about how we can support you in becoming tobacco free?

☐ Yes   ☐ No

Thank you, we're here to help when you are ready!

1) How **important** do you feel it is for you to stop smoking or using tobacco?

0 1 2 3 4 5 6 7 8 9 10
Not at all   Extremely
Important   Important

2) How **confident** are you in being able to quit all tobacco use?

0 1 2 3 4 5 6 7 8 9 10
Not at all   Extremely
Confident   Confident

FOR OFFICE STAFF ONLY	Accepted	Declined
Patient Self-Management Materials	☐	☐
QuitlineNC Fax Referral	☐	☐

counseling and NRT [17]. In an analysis of 5,587 patients from the US Lung Health Study, patients who quit smoking were found to have better lung functioning and a higher survival rate than those who smoked [18].

Emerging Products

New nicotine products that have emerged on the market over the past few years include snus and electronic cigarettes (e-cigarettes). These products are often promoted as safer alternatives to traditional cigarettes. Both products provide continued delivery of nicotine. Snus is a small pouch of steam-pasteurized tobacco placed under the upper lip. E-cigarettes are battery-operated devices that resemble the size and shape of a cigarette and produce a nicotine vapor. Even though individuals who use these products may not be exposed to all of the harmful chemicals and carbon monoxide associated with cigarette smoking, it is unclear whether these products are safe, whether they promote continued tobacco use rather than cessation, whether they are associated with dual tobacco use, and whether they entice young people who otherwise would not have started using tobacco.

The FDA does not yet regulate e-cigarettes, and these products are marketed with highly attractive promotions, such as colorful packaging that is likely to attract young individuals. Sales of e-cigarettes have risen exponentially across the United States; there are more than 250 brands, many with fruit names or fruit flavoring [19]. The lithium batteries in e-cigarettes could potentially overheat and cause burns [20]. There are additional concerns that e-cigarettes may have short-term or long-term adverse pulmonary effects [21]. Many smokers view electronic cigarettes as a safer alternative to cigarettes and use them in places where cigarette smoking is banned. However, insufficient research exists about their long-term safety and effectiveness in promoting tobacco cessation. North Carolina and many other states have banned the sale of e-cigarettes to minors [22].

Conclusion

Smoking cessation is the most effective way of preventing or slowing the progression of COPD and other tobacco-associated diseases. Tobacco cessation saves lives and increases quality of life. Practitioners can encourage cessation efforts by implementing a 3-minute, evidenced-based assessment: ask patients about their tobacco use at every visit; discuss the benefits of quitting and encourage the use of NRT (using combination NRT when appropriate); and connect them to follow-up care, which can be easily done by faxing a referral to QuitlineNC [23]. Health system changes—such as adopting the practice of checking vital signs related to smoking and following meaningful use guidelines—can be implemented to ensure that patients are receiving support at every visit. Physicians may receive reimbursement for tobacco counseling lasting 3–10 minutes and additional reimbursement for counseling lasting longer than 10 minutes. New products such as e-cigarettes and snus are being researched to test their efficacy as harm-reduction products or cessation aids, but at the current time, providers should follow evidence-based best practices and only recommend FDA-approved pharmacotherapy. The UNC Nicotine Dependence Program provides smoking cessation support both to individuals and to institutions. Contact the program's Web site (www.ndp.unc.edu) for information on implementing changes that make providing tobacco cessation support simple, efficient, and effective. **NCMJ**

Carrie Harrill-Smith, BA social work intern, UNC Nicotine Dependence Program, Department of Family Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.
Carol Ripley-Moffitt, MDiv, CTTS program director, UNC Nicotine Dependence Program, Department of Family Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.
Adam O. Goldstein, MD, MPH professor, Department of Family Medicine, and medical director, UNC Nicotine Dependence Program, Department of Family Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

References
1. North Carolina State Center for Health Statistics (NCSCHS). North Carolina Vital Statistics Volume 2: Leading causes of death—2011. Table A: Leading causes of death by age group: North Carolina residents, 2011. NCSCHS Web site. http://www.schs.state.nc.us/schs/

deaths/lcd/2011/pdf/TblsA-F.pdf. Published January 2013. Accessed August 5, 2013.

2. American Lung Association (ALA). Chronic Obstructive Pulmonary Disease (COPD) Fact Sheet. February 2011. ALA Web site. http://www.lung.org/lung-disease/copd/resources/facts-figures/COPD-Fact-Sheet.html. Accessed August 6, 2013.

3. Centers for Disease Control and Prevention (CDC). State-specific smoking-attributable mortality and years of potential life lost—United States, 2000-2004. MMWR Morb Mortal Wkly Rep. 2009;58(2):29-33.

4. North Carolina State Center for Health Statistics. North Carolina Vital Statistics 2004. Volume 1. Raleigh, NC: NC Department of Health and Human Services, Division of Public Health, State Center for Health Statistics; 2005. http://www.schs.state.nc.us/schs/vitalstats/volume1/2004/NCVS_Vol1_2004.pdf. Accessed September 19, 2013.

5. Centers for Disease Control and Prevention. Best Practices for Comprehensive Tobacco Control Programs—2007. Atlanta, GA: US Department of Health & Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2007. http://www.cdc.gov/tobacco/stateandcommunity/best_practices/pdfs/2007/bestpractices_complete.pdf. Accessed August 13, 2013.

6. North Carolina State Center for Health Statistics (NCSCHS). 2011 BRFSS Survey Results: North Carolina. Tobacco Use. Smoking Status. http://www.schs.state.nc.us/schs/brfss/2011/nc/all/_smoker3.html. Accessed August 13, 2013.

7. Rumberger JS, Hollenbeak CS, Kline D. Potential costs and benefits of smoking cessation for North Carolina. April 30, 2010. http://www.lung.org/stop-smoking/tobacco-control-advocacy/reports-resources/cessation-economic-benefits/reports/NC.pdf. Accessed August 6, 2013.

8. Substance Abuse and Mental Health Services Administration (SAMHSA). National Survey on Drug Use and Health (NSDUH). Adults with Mental Illness or Substance Use Disorder Account for 40 Percent of All Cigarettes Smoked. The NSDUH Report Data Spotlight, March 20, 2013. SAMHSA Web site. http://www.samhsa.gov/data/spotlight/Spot104-cigarettes-mental-illness-substance-use-disorder.pdf. Accessed August 7, 2013.

9. Fiore MC, Jaén CR, Baker TB, et al. Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline. Rockville, MD: US Department of Health & Human Services, Public Health Service; 2008. http://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/tobacco/clinicians/treating_tobacco_use08.pdf. Accessed August 14, 2013.

10. Jamal A, Dube SR, Malarcher AM, Shaw L, Engstrom MC; Centers for Disease Control and Prevention (CDC). Tobacco use screening and counseling during physician office visits among adults—National Ambulatory Medical Care Survey and National Health Interview Survey, United States. MMWR Morb Mortal Wkly Rep. 2012;61(suppl):38-45. http://www.cdc.gov/mmwr/pdf/other/su6102.pdf. Accessed August 7, 2013.

11. McCullough A, Fisher M, Goldstein AO, Kramer KD, Ripley-Moffitt C. Smoking as a vital sign: prompts to ask and assess increase cessation counseling. J Am Board Fam Med. 2009;22(6):625-632.

12. Centers for Medicare & Medicaid Services (CMS). Meaningful use. CMS Web site. http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Meaningful_Use.html. Page last modified April 17, 2013. Accessed August 8, 2013.

13. Fiore MC, Goplerud E, Schroeder SA. The Joint Commission's new tobacco-cessation measures—will hospitals do the right thing? N Engl J Med. 2012;366(13):1172-1174. http://www.nejm.org/doi/full/10.1056/NEJMp1115176. Accessed August 14, 2013.

14. US Food and Drug Administration (FDA). Varenicline (marketed as Chantix) and Bupropion (marketed as Zyban, Wellbutrin, and generics). FDA Web site. http://www.fda.gov/Safety/MedWatch/SafetyInformation/SafetyAlertsforHumanMedicalProducts/ucm170090.htm. Page last updated August 29, 2013. Accessed September 19, 2013.

15. US Food and Drug Administration (FDA). Nicotine replacement therapy labels may change. FDA Web site. http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm345087.htm. Published April 1, 2013. Page last updated April 17, 2013. Accessed August 6, 2013.

16. Chan SS, Leung DY, Abdullah AS, Wong VT, Hedley AJ, Lam TH. A randomized controlled trial of a smoking reduction plus nicotine replacement therapy intervention for smokers not willing to quit smoking. Addiction. 2011;106(6):1155-1163.

17. Jiménez Ruiz CA, Ramos Pinedo A, Cicero Guerrero A, Mayayo Ulibarri M, Cristobal Fernández M, Lopez Gonzalez G. Characteristics of COPD smokers and effectiveness and safety of smoking cessation medications. Nicotine Tob Res. 2012;14(9):1035-1039. http://ntr.oxfordjournals.org/content/14/9/1035.abstract. Accessed September 20, 2013.

18. Tønnesen P. Smoking cessation and COPD. Eur Respir Rev. 2013;22(127):37-43.

19. Benowitz NL, Goniewicz ML. The regulatory challenge of electronic cigarettes [published online ahead of print July 13, 2013]. JAMA. Doi: 10.1001/jama.2013.109501. Accessed August 7, 2013.

20. CBS News Staff. Electronic cigarette explodes in man's mouth, causes serious injuries. CBS News. 2012. http://www.cbsnews.com/8301-504763_162-57379260-10391704/electronic-cigarette-explodes-in-mans-mouth-causes-serious-injuries. Published February 16, 2012. Accessed August 6, 2013.

21. Vardavas CI, Anagnostopoulos N, Kougias M, Evangelopoulou V, Connolly GN, Behrakis PK. Short-term pulmonary effects of using an electronic cigarette: impact on respiratory flow resistance, impedance, and exhaled nitric oxide. Chest. 2012;141(6):1400-1406.

22. McKenzie A. New law bans electronic cigarette sales to minors. News14 Carolina Web site. http://triangle.news14.com/content/news/697079/new-law-bans-electronic-cigarette-sales-to-minors. Published August 1, 2013. Accessed August 9, 2013.

23. Vidrine JI, Shete S, Cao Y, et al. Ask-Advise-Connect: a new approach to smoking treatment delivery in health care settings. JAMA Intern Med. 2013;173(6):458-464.

Computed Tomography Screening for Lung Cancer:
Where Are We Now?

Jared D. Christensen, Betty C. Tong

Low-dose computed tomography (LDCT) screening has been shown to result in detection of earlier-stage lung cancers, with a 20% reduction in cancer-related deaths. LDCT screening offers significant potential benefits to selected patients; however, many questions remain, including questions about the applicability of lung cancer screening in clinical practice.

L ung cancer remains the leading cause of cancer mortality worldwide, accounting for more deaths than colon cancer, breast cancer, and prostate cancer combined [1]; indeed, lung cancer is expected to result in more than 160,000 deaths in the United States this year alone [2]. Despite advances in clinical care and diagnostic imaging, most lung cancer patients present with advanced-stage disease, for which a cure remains elusive. The prognosis for patients with lung cancer is therefore generally poor, with an overall 5-year survival rate of approximately 16% [2]. However, early detection affords an opportunity to treat lung cancer at its earliest, most curable stage. Screening with low-dose computed tomography (LDCT) has recently been shown to result in the detection of earlier-stage lung cancers, as well as a significant reduction in cancer-specific mortality in high-risk patients.

LDCT Screening

The most informative study to have evaluated the effectiveness of imaging for lung cancer screening is the National Lung Screening Trial (NLST) [3]. Eligibility criteria for this randomized controlled trial are listed in Table 1. Patients were randomized to screening with either chest radiography or LDCT, and all patients received a total of 3 screening examinations: a baseline study followed by 2 annual screening examinations. A positive screen was defined as one that detected either a noncalcified pulmonary nodule measuring at least 4 mm in diameter or another finding possibly attributable to lung cancer. Among the 53,454 participants enrolled in this study, there were significantly fewer lung cancer deaths among those screened with LDCT than among those randomized to chest radiography (356 deaths versus 443 deaths), and there was a relative reduction in lung cancer–specific mortality of 20.3%

TABLE 1.
National Lung Screening Trial (NLST) Patient Eligibility Criteria

Inclusion criteria
Age 55–74 years
≥ 30 pack-years smoking history
If former smoker, quit ≤ 15 years ago
Exclusion criteria
History of lung cancer
Treatment for or evidence of any other cancer in the past 5 years, except for nonmelanoma skin cancer or carcinoma in situ
Prior lung resection
Signs or symptoms that could be attributable to malignancy (eg, weight loss, hemoptysis)
Acute respiratory infection treated with antibiotics within 12 weeks prior to eligibility assessment
Chest computed tomography examination in the past 18 months

over a median of 6.5 years of follow-up ($P = .004$) [3]. Of note, the NLST compares 2 screening modalities (LDCT and chest radiography) rather than comparing a cohort of patients who were screened with a second cohort who were not. Therefore the NLST may actually underestimate the benefit of computed tomography (CT) screening, and it is postulated that the reduction in mortality afforded by LDCT is likely greater than 20%.

Prior to implementation of widespread lung cancer screening, the potential benefits of screening must be weighed against the potential risks, the most commonly cited of which include overdiagnosis, complications associated with the management of false-positive results, and radiation exposure.

Overdiagnosis and False-Positive Results

Overdiagnosis occurs when screening identifies histologically confirmed lung cancer that would not have resulted in a patient's death if left untreated. Potential harmful effects

of overdiagnosis include the psychological stress that accompanies a diagnosis of cancer as well as the morbidity and mortality that may accompany unnecessary medical procedures. Overdiagnosis is inherent in any screening test; however, the extent of overdiagnosis with LDCT screening for lung cancer is currently unknown.

Another risk with all screening studies is the potential for both false-negative and false-positive results. The sensitivity of the screening test should be high enough to ensure that a cancer is not missed, while the specificity must be high enough to minimize the number of false-positive examinations. In the NLST, the sensitivity and specificity of LDCT screening were 93.8% and 73.4%, respectively [4]. Although 24.2% of LDCT screens were positive, the vast majority of these represented false-positive studies, because only 3.6% of patients with positive examinations actually had lung cancer [3].

With positive screening studies, additional testing is often required. Despite the high false-positive rate in the NLST, the majority of patients with a positive screening examination were managed noninvasively with follow-up imaging; only 11.4% of patients required invasive testing. Of those patients who underwent invasive testing, the rate of major complications was 0.06% for those without cancer and 11.2% for those with lung cancer. This suggests that, although LDCT screening has a higher rate of false-positive screens compared with other screening modalities, the number of invasive tests performed is low, complications from such procedures are rare, and the risks of additional testing are primarily incurred by patients who do have lung cancer [3].

Radiation Risks

Given the large number of people who would potentially be affected by widespread implementation of LDCT screening for lung cancer, it is important to minimize the amount of radiation exposure attributable to such screening. A standard diagnostic chest CT delivers approximately 8 millisieverts (mSv) of radiation [5]. LDCT can reduce the average effective dose to approximately 1.5 mSv, representing an 81% dose reduction; however, there may be considerable variation in the radiation dose delivered when LDCT is performed in clinical practice [3]. The level of radiation delivered can be reduced by reducing the tube current, increasing the pitch, or decreasing the tube voltage. Further dose reductions may be possible due to advances in CT technology and image reconstruction algorithms. By way of comparison, the radiation dose associated with LDCT screening for lung cancer is only slightly greater than that delivered during a standard 4-view mammogram.

Despite the use of a low-dose screening technique, the risk of radiation-induced malignancy is still a consideration. Unlike the tissue in solid organs, lung tissue becomes more susceptible to radiation-induced changes with increasing age. Furthermore, the risk of developing radiation-induced lung cancer may be increased in patients who smoke. To date, most of the data regarding radiation-induced malignancies comes from patients who received standard-dose imaging rather than LDCT. The mean latency period from radiation exposure to development of cancer is longer than 30 years for standard-dose screening examinations and is projected to be even longer for low-dose screening techniques. The average age of patients who underwent screening in the NLST was 62 years. Thus the risk of developing a radiation-induced cancer is extremely low when screening is performed in an appropriate population. Applying existing models to NLST data, estimates suggest that 1 cancer death per 2,500 patients screened may be attributable to radiation [6, 7]. Therefore, in the NLST population, the potential benefit of preventing lung cancer deaths was found to be greater than the potential radiation risk. However, modeling suggests that the risks associated with LDCT screening may outweigh the benefits in nonsmokers and in patients aged 50 years or younger [7].

Cost Effectiveness

Several factors influence the cost effectiveness of CT screening for lung cancer. The cost per quality-adjusted life-year (QALY) increases as the rate of overdiagnosis increases and as the prevalence of lung cancer decreases. The cost per QALY is likely to be highest during the first 2 years of screening due to costs associated with the evaluation of false-positive findings (eg, follow-up imaging to document 2-year stability of a low-suspicion nodule). Several studies have evaluated the cost effectiveness of lung cancer screening. A meta-analysis comparing the cost per life-year saved for various accepted screening modalities found that LDCT screening for lung cancer was as cost effective as colonoscopy screening for colon cancer and more cost effective than mammography screening for breast cancer [8].

The adoption of LDCT screening for lung cancer in the United States will depend largely on whether Medicare and private insurers are willing to underwrite the expense of implementing such a strategy. Estimates suggest that the total cost to screen the approximately 94 million Americans who fit the NLST high-risk criteria, at an average reimbursement rate of $300 [9], would approach $30 billion annually. However, the total cost of screening will likely be much higher, depending on negotiated reimbursement rates and the additional expenses incurred by the work-up of positive screening examinations. The cost of LDCT screening is currently not covered by Medicare and most private insurers. The Centers for Medicare & Medicaid Services will likely render a decision on CT lung cancer screening after careful review of the available peer-reviewed data, society recommendations, and cost-effectiveness analyses; private insurance providers will likely follow suit. The NLST cost-effectiveness data is expected to have a significant impact on these decisions.

Initial data from the NLST cost-effectiveness analysis was recently presented at a joint meeting of the National Cancer

Institute Board of Scientific Advisors and the National Cancer Advisory Board. The full analysis has not yet been published, but a news release dated June 24, 2013, from the American College of Radiology (ACR) stated that "CT lung cancer screening [is] appropriate when performed in the context of careful patient selection and follow-up, reducing lung cancer mortality by 20% . . . [and] is also cost effective" [10]. Another ACR press release published on the same day suggested that LDCT screening could be implemented on a large scale with acceptable population risks and costs [11].

Lung Cancer Screening Guidelines

Despite the promising results of the NLST and other studies that have evaluated LDCT lung screening, medical professional societies have been cautious in offering their endorsement of such screening, pending the final results of the NLST cost-effectiveness analysis that is currently under way. In the meantime, many professional societies have offered guidelines and recommendations based on the available data (see Table 2), including the American Cancer Society, the American College of Chest Physicians, the American Lung Association, the American Society of Clinical Oncology, the National Comprehensive Cancer Network (NCCN), and the US Preventive Services Task Force (USPSTF). The NCCN has given its highest recommendation (category 1) for LDCT screening for lung cancer, which is a stronger recommendation than the one given for screening mammography [12]. The USPSTF also recently endorsed LDCT screening for lung cancer, issuing a Grade B recommendation for high-risk patients similar to those included in the NLST; this recommendation is the same level as the USPSTF recommendation for screening mammography. The ACR is currently developing practice guidelines and appropriateness criteria for lung cancer screening to establish a national standard of care, which it plans to release in the spring of 2014. Until recommendations are formalized, the ACR refers patients and providers to the current NCCN guidelines.

Treatment Implications

One important criterion for a screening examination is the availability of an effective treatment that improves patient outcomes when it is provided in the preclinical phase (prior to the onset of symptoms) [13]. The efficacy of screening coupled with preclinical treatment (versus treatment once the patient becomes symptomatic) is difficult to definitively prove due to biases inherent in screening, which are beyond the scope of this discussion; however, with long-term follow-up, it may be possible to elucidate differences in survival between patients who were screened and those who were not [14, 15]. It is clear from outcomes data that early-stage lung cancers—those most often detected with LDCT screening—are more effectively treated than are advanced-stage cancers [2]. Early-stage lung cancer is most often treated with surgical resection (usually lobectomy) or with a combination of surgery and chemotherapy, whereas advanced disease is most often treated with chemotherapy (with or without radiation). Many surgeons have advocated video-assisted thoracoscopic (VATS) lobectomy, which is minimally invasive, as the new standard for lung resection. Compared with thoracotomy, the advantages of VATS lobectomy include shorter hospitalization, fewer overall complications, a higher rate of adjuvant chemotherapy completion, and improved long-term survival [16, 17].

Future Directions

Many questions remain and new questions arise as we seek to understand the implications of the NLST. Are the NLST results generalizable to other patient populations? At what age should screening begin, and for how many years should it continue? What is the most effective screening interval? Are there other criteria that should be considered to define a positive screen? Some of these questions may be answered by subanalysis of the NLST data or by ongoing European studies; other questions may require investigation with newly designed trials.

The NLST inclusion criteria are highly selective, and the trial does not provide evidence for or against screening in younger patients. Similarly, the results of the NLST should not be applied to individuals with a less extensive smoking history, including patients who have never smoked; however, individuals who have never smoked account for approximately 10% of all new lung cancer diagnoses [18]. In addition to age and personal smoking history, additional risk factors for lung cancer are recognized, including family history of lung cancer, personal history of malignancy, and carcinogen exposure other than tobacco. A recent study modeling LDCT screening results using inclusion criteria from the Prostate, Lung, Colon, and Ovarian Cancer (PLCO) trial, which included additional risk factors for lung cancer, found that the sensitivity of LDCT screening could increase from 71.1% to 83.0% (P<.001) without affecting specificity while detecting more lung cancers [19]. Current NCCN guidelines offer provisional recommendations for lung cancer screening in younger patients who have a less extensive or more remote smoking history and additional risk factors; these provisional recommendations are based on the findings of nonrandomized studies and on observational data [20-24].

Although the NLST was the first randomized trial to show a significant reduction in lung cancer mortality following CT screening, several other studies are ongoing. One of the largest is the Dutch-Belgian NELSON trial, which is expected to report final results in 2015. The NELSON study differs from the NLST in several ways. First, the NELSON trial is a true comparison of CT screening versus no screening, which should provide more definitive quantification both of lung cancer–specific mortality reduction in screened patients and of the risks associated with screening. Furthermore, the study is incorporating nodule volumetrics as one of the criteria for imaging follow-up, which may facilitate differentiation

TABLE 2.
Current Lung Cancer Screening Recommendations

Organization making the recommendations	Year	Recommendations
US Preventive Services Task Force (USPSTF)	2013	Screen with LDCT: age 55–79 years, ≥ 30 pack-years smoking history; if former smoker, quit within previous 15 years (Grade B)[a]
National Comprehensive Cancer Network (NCCN)	2012 (updated 2013)	Screen with LDCT per NLST eligibility criteria: age 55–74 years, ≥ 30 pack-years smoking history; if former smoker, quit within previous 15 years (Category 1)[b] Screen: age 50–74 years, ≥ 20 pack-years smoking history, and 1 additional risk factor other than secondhand smoke (Category 2B)[c]
American Association for Thoracic Surgery (AATS)	2012	Screen: age 55–79 years, ≥ 30 pack-years smoking history (Tier 1)[d] Screen: age ≥ 50 years, ≥ 20 pack-years smoking history, and ≥ 5% risk of developing lung cancer in 5 years (Tier 2)[e] Screen: Lung cancer survivors who have completed 4 years of recurrence-free surveillance and are still eligible for potential treatment (Tier 2)[e]
American Cancer Society	2012	Screen per NLST eligibility criteria. Screening linked to smoking cessation. Screening should be associated with expert multidisciplinary care. Shared decision making between patient and physician.
American College of Chest Physicians (ACCP)	2012	Screen per NLST eligibility criteria. Screening should be performed at centers that can provide expert multidisciplinary care, similar to that provided in the NLST (Grade 2B)[f].
American College of Radiology (ACR)	2012	Screening recommendations under development. Currently the ACR refers patients and providers to the NCCN guidelines.
American Lung Association	2012	Screen per NLST eligibility criteria. Do not screen with chest radiography. Screening linked to smoking cessation. Screening should be associated with expert multidisciplinary care. Advertising and promoting of screening should be ethical.
American Society of Clinical Oncology	2012	Screen per NLST eligibility criteria. Do not screen if patient has limited life expectancy.

Note. LDCT, low-dose computed tomography; NLST, National Lung Screening Trial.

[a]USPSTF Grade B: High certainty that the net benefit is moderate, or moderate certainty that the net benefit is moderate to substantial; recommend providing the service.

[b]NCCN Category 1: Based on high-level evidence, uniform NCCN consensus.

[c]NCCN Category 2A/B: Based on a lower level of evidence, uniform consensus that intervention is appropriate.

[d]AATS Tier 1: Patients determined to be at highest risk by Level 1 evidence (data from randomized prospective trials).

[e]AATS Tier 2: Patients determined to be at risk by Level 2 evidence (data from case control studies or nonrandomized trials) or Level 3 evidence (consensus opinion).

[f]ACCP Grade 2B: Weak recommendation based on moderate quality data.

between benign nodules and suspect nodules that require further evaluation. Preliminary data from the NELSON trial suggest a much lower false-positive rate with this strategy (7.9%); however, the factors contributing to this finding are not yet well understood; it is likely attributable, at least in part, to a lower prevalence of granulomatous disease in European populations [25]. The inclusion criteria for the NELSON trial also differ from those of the NLST. The NELSON study participants become eligible for screening at a younger age (50 years), and study participants include smokers with a shorter smoking history (the equivalent of approximately 15 or more pack-years) and former smokers with a shorter interval since quitting (10 years or less) [26]. The results from the NELSON study and other ongoing trials will be helpful in answering some of the questions raised by the NLST.

Summary

Results from the prospective, randomized NLST demonstrate that LDCT screening significantly reduces the rate of lung cancer deaths and is appropriate with careful patient selection and follow-up. Preliminary data from the NLST also suggest that LDCT screening is cost effective. Ongoing trials will aid in further refining screening guidelines. Although many questions remain, a growing quantity of data supports implementation of LDCT screening in routine clinical practice. Moving forward, it will be necessary to establish national, evidence-based screening and treatment guidelines to ensure that patients have access to care that is uniform in quality. To ensure that patients receive the benefits of screening and treatment that were demonstrated by the NLST, LDCT screening should ideally occur within a multidisciplinary program that includes experts in radiology, pulmonology, thoracic surgery, and oncology. NCMJ

Jared D. Christensen, MD assistant professor, Department of Radiology, and chief, Division of Cardiothoracic Imaging, Duke University Medical Center, Durham, North Carolina.
Betty C. Tong, MD, MHS assistant professor, Department of Surgery, Division of Cardiovascular and Thoracic Surgery, Duke University Medical Center, Durham, North Carolina.

References

1. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. CA Cancer J Clin. 2011;61(2):69-90.
2. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2013. CA Cancer J Clin. 2013;63(1):11-30.
3. National Lung Screening Trial Research Team; Aberle DR, Adams AM, Berg CD, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. N Engl J Med. 2011;365(5):395-409.
4. National Lung Screening Trial Research Team; Church TR, Black WC, Aberle DR, et al. Results of initial low-dose computed tomographic screening for lung cancer. N Engl J Med. 2013;368(21):1980-1991.
5. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology. 2008;248(1):254-263.
6. Einstein AJ, Henzlova MJ, Rajagopalan S. Estimating risk of cancer associated with radiation exposure from 64-slice computed tomography coronary angiography. JAMA. 2007;298(3):317-323.
7. Berrington de González A, Kim KP, Berg CD. Low-dose lung computed tomography screening before age 55: estimates of the mortality reduction required to outweigh the radiation-induced cancer risk. J Med Screen. 2008;15(3):153-158.
8. Pyenson BS, Sander MS, Jiang Y, Kahn H, Mulshine JL. An actuarial analysis shows that offering lung cancer screening as an insurance benefit would save lives at relatively low cost. Health Aff (Millwood). 2012;31(4):770-779.
9. National Lung Screening Trial (NLST) Initial Results: Fast Facts. National Cancer Institute Web site. http://www.cancer.gov/newscenter/newsfromnci/2011/NLSTFastFacts. Accessed July 12, 2013.
10. Guidance for ACR members on lung cancer screening with CT [press release]. American College of Radiology (ACR) Web site. http://www.acr.org/News-Publications/News/News-Articles/2013/Quality-Care/20130624-Guidance-for-ACR-Members-on-Lung-Cancer-Screening-with-CT. Published June 24, 2013. Accessed June 24, 2013.
11. ACR statement on CT lung cancer screening cost effectiveness: standards and infrastructure needed to support widespread screening [press release]. American College of Radiology (ACR) Web site. http://www.acr.org/About-Us/Media-Center/Press-Releases/2013-Press-Releases/20130624-ACR-Statement-on-CT-Lung-Cancer-Screening-Cost-Effectiveness. Published June 24, 2013. Accessed June 24, 2013.
12. NCCN Clinical Practice Guidelines in Oncology. Lung Cancer Screening. Version I.2014. http://www.nccn.org/professionals/physician_gls/pdf/lung_screening.pdf. Published June 12, 2013. Accessed June 27, 2013.
13. Obuchowski NA, Graham RJ, Baker ME, Powell KA. Ten criteria for effective screening: their application to multislice CT screening for pulmonary and colorectal cancers. AJR Am J Roentgenol. 2001;176(6):1357-1362.
14. Feinstein AR, Sosin DM, Wells CK. The Will Rogers phenomenon: stage migration and new diagnostic techniques as a source of misleading statistics for survival in cancer. N Engl J Med. 1985;312(25):1604-1608.
15. Black WC, Welch HG. Advances in diagnostic imaging and overestimation of disease prevalence and the benefits of therapy. N Engl J Med. 1993;328(17):1237-1243.
16. Whitson BA, Groth SS, Duval SJ, Swanson SJ, Maddaus MA. Surgery for early-stage non-small cell lung cancer: a systematic review of the video-assisted thoracoscopic surgery versus thoracotomy approaches to lobectomy. Ann Thorac Surg. 2008;86(6):2008-2018.
17. Petersen RP, Pham D, Burfeind WR, et al. Thoracoscopic lobectomy facilitates the delivery of chemotherapy after resection for lung cancer. Ann Thorac Surg. 2007;83(4):1245-1250.
18. Subramanian J, Govindan R. Lung cancer in never smokers: a review. J Clin Oncol. 2007;25(5):561-570.
19. Tammemägi MC, Katki HA, Hocking WG, et al. Selection criteria for lung-cancer screening. N Engl J Med. 2013;368(8):728-736.
20. International Early Lung Cancer Action Program Investigators; Henschke CI, Yankelevitz DF, Libby DM, Pasmantier MW, Smith JP, Miettinen OS. Survival of patients with stage I lung cancer detected on CT screening. N Engl J Med. 2006;355(17):1763-1771.
21. Hubbard R, Venn A, Lewis S, Britton J. Lung cancer and cryptogenic fibrosing alveolitis. A population-based cohort study. Am J Respir Crit Care Med. 2000;161(1):5-8.
22. Atabek U, Mohit-Tabatabai MA, Raina S, Rush BF Jr, Dasmahapatra KS. Lung cancer in patients with head and neck cancer. Incidence and long-term survival. Am J Surg. 1987;154(4):434-438.
23. Leuraud K, Schnelzer M, Tomasek L, et al. Radon, smoking and lung cancer risk: results of a joint analysis of three European case-control studies among uranium miners. Radiat Res. 2011;176(3):375-387.
24. Driscoll T, Nelson DI, Steenland K, et al. The global burden of disease due to occupational carcinogens. Am J Ind Med. 2005;48(6):419-431.
25. Pedersen JH, Ashraf H, Dirksen A, et al. The Danish randomized lung cancer CT screening trial—overall design and results of the prevalence round. J Thorac Oncol. 2009;4(5):608-614.
26. van Iersel CA, de Koning HJ, Draisma G, et al. Risk-based selection from the general population in a screening trial: selection criteria, recruitment and power for the Dutch-Belgian randomised lung cancer multi-slice CT screening trial (NELSON). Int J Cancer. 2007;120(4):868-874.

Chronic Obstructive Pulmonary Disease:
Epidemiology, Management, and Impact on North Carolina

Stephen Gegick, Hunter Allen Coore, Mark R. Bowling

Chronic obstructive pulmonary disease (COPD) affects millions of people worldwide, resulting in morbidity, mortality, and substantial utilization of health care resources. This review focuses on the epidemiology of COPD, management strategies, and the health and economic impact of this condition in North Carolina.

Chronic obstructive pulmonary disease (COPD) is a common respiratory disorder characterized by non-reversible airflow obstruction. When a susceptible individual is exposed to a noxious substance, pathophysiologic changes take place in the small airways, lung parenchyma, and pulmonary vasculature that cause airflow limitation. These changes result in the clinical manifestations of COPD: dyspnea, cough, hypoxemia, and mucous production. Acute exacerbations and comorbidities add to the overall severity and complications of the disease.

COPD is a major cause of morbidity and mortality worldwide [1]. The disease also uses a large portion of health care resources and is a significant social and economic burden. The Global Initiative for Chronic Obstructive Lung Diseases (GOLD), a program shaped by committees made up of international experts, seeks to raise awareness of COPD among health care professionals in order to improve prevention and management. The initiative has established evidence-based guidelines that are considered to be the standard of care [1]; these guidelines focus on the diagnosis, management, and prevention of COPD. This article reviews the epidemiology and basic management of COPD according to the GOLD guidelines and describes the effects of the disease in North Carolina.

Epidemiology

Recent data suggest that COPD is more prevalent among smokers (current and past), people over the age of 40 years, and men [1]. COPD is a major cause of chronic morbidity—including hospitalizations, dyspnea, and health care utilization—and in 2010 it was the third leading cause of death worldwide [2]. The social and economic ramifications of managing this disease are considerable and are increasing. In the United States, the direct and indirect costs of COPD are estimated to be $29.5 billion and $20.4 billion, respectively [1].

In North Carolina, COPD is common and has increased the utilization of health care resources. Analysis of data from the 2007 and 2009 Behavioral Risk Factor Surveillance System surveys showed that, in North Carolina, 5.7% of respondents (2,187 out of 26,227) reported having been diagnosed with COPD [3]. Although COPD is more common among men, COPD-related mortality among woman in North Carolina is increasing, with the death rate increasing from 12.9 to 59.1 per 100,000 population from 1980 through 2006. Mortality among men in North Carolina also increased during this period, but this increase was much smaller, from 72.9 to 83.7 per 100,000 population [4]. Additionally, from 2003 to 2007, there were 33,507 hospital discharges in North Carolina with a diagnosis of COPD, and the charges for these hospitalizations totaled $421.6 million; these numbers are greater than those for 1995–1999, when there were 28,496 hospital discharges with a diagnosis of COPD, with charges totaling $225.7 million [5].

Risk Factors

COPD results from the interaction of genetic and environmental factors. This interaction is best demonstrated by hereditary deficiency of alpha-1 antitrypsin (AAT), which is a well-documented risk factor for COPD [1]. Patients with COPD who are younger than 45 years of age or who live in an area with a high prevalence of AAT deficiency should undergo testing for this deficiency [1].

The main risk factor for developing COPD is cigarette smoking. Data clearly show that smokers have more symptoms, a higher rate of decline in lung function, and a higher rate of mortality than do nonsmokers [6]. Passive exposure to secondhand tobacco smoke can lead to respiratory symptoms and COPD [7].

In North Carolina, approximately 21% of adults and 11% of youth aged 12–17 years are current smokers [8]. During the period 2000–2004, the average annual smoking-attributable mortality rate among North Carolinians aged

35 years or older was 298.4 deaths per 100,000 population [8], which translates to about 12,000 deaths each year as a result of tobacco use. Most of these deaths are the result of COPD. In 2012, North Carolina Prevention Partners released a prevention report card [9] affirming that smoking is still the leading cause of preventable death in the state. According to the report, 60.5% of serious smokers in North Carolina are trying to quit, compared with 52% nationwide.

Although smoking is the most common risk factor for acquiring COPD, environmental or occupational exposure to organic or inorganic dust particles also places an individual at significant risk. Occupational exposures account for 10% to 20% of the symptoms and functional impairment associated with COPD [1]. The burning of substances such as wood, animal dung, or coal can lead to COPD. In particular, indoor pollution from biomass cooking in poorly ventilated areas is an important risk factor for the disease [10]. Exposure to outdoor pollutants appears to have some impact on the development of COPD, but the effect is small compared with that of cigarette smoking [1].

Diagnosis and Staging

The diagnosis of COPD is based on 3 considerations: a history of symptoms consistent with the disease (dyspnea, cough, and sputum production), a history of exposure to 1 or more noxious substances known to be a risk factor for COPD, and measurement of airflow obstruction. Treatment is based on the severity of symptoms and the degree of airflow limitation.

The most accurate method of demonstrating airflow limitation is spirometry, which involves measuring 2 respiratory variables. Forced expiratory volume in 1 second (FEV_1) is the amount of air that can be forcibly blown out during the first second of forced exhalation after complete inhalation. Forced vital capacity (FVC) is the total amount of air forcibly exhaled after a complete inhalation. The GOLD guidelines for diagnosis and management of COPD state that airflow obstruction is present when the FEV_1/FVC ratio is less than .70 when measured after administration of a short-acting inhaled bronchodilator [1]. However, using this fixed cutoff to define airflow limitation may result in overdiagnosis of COPD [1].

Depending on the degree of airflow obstruction, the severity of COPD is classified as stage I, 2, 3, or 4. (Spirometric cutpoints are listed in Table 1.) Staging of COPD helps to determine therapy. Also, a higher GOLD stage (indicating worsening of airflow limitation) correlates with increased risk of exacerbations of COPD, a higher number of hospitalizations, and a higher 3-year mortality rate [1].

Prevention and Management

Prevention of disease is the ultimate goal. Once COPD has been diagnosed, however, effective management should be aimed at reducing symptoms and reducing risk of exacerbations, disease progression, and death [1].

Prevention. COPD can be relatively easily prevented by not smoking cigarettes, avoiding secondhand smoke, and avoiding the inhalation of other noxious particles, such as chemical dust and fumes, both at home and in the workplace. The use of personal protective equipment and adherence to Occupational Safety and Health Administration standards as it pertains to workplace exposure are recommended and may help to decrease contact with noxious fumes and chemicals.

Public health policies and educational efforts are aiming to decrease North Carolinians' exposure to cigarette smoke and other noxious particles that are found indoors. North Carolina has taken measures to help control exposure to secondhand smoke among the general public. In 2009 the North Carolina General Assembly passed a law [11] banning smoking in almost all restaurants and bars.

It also may be appropriate to pursue legislation that minimizes occupational exposure to toxic particles by implementing engineering control and elimination of these particles—for example, by providing appropriate ventilation or finding substitutes for toxic substances. Such legislation could help to prevent work-related COPD.

Nonpharmacologic management. In patients for whom it is indicated, long-term oxygen therapy (more than 15 hours per day) has been shown to decrease mortality rates and hospitalization rates [12, 13]. To be an appropriate candidate for such therapy, the patient must have partial pressure of oxygen (Pao_2) at or below 55 mm Hg or oxygen saturation (Sao_2) at or below 88% on arterial blood gas analysis, when measured on room air. Either of these findings can occur with or without hypercapnia (increased carbon dioxide), and the measurement must be confirmed twice over a 3-week period. For patients who have pulmonary hypertension, peripheral edema, or polycythemia (hematocrit greater than 55%), long-term oxygen therapy is appropriate if Pao_2 is between 55 mm Hg and 60 mm Hg or Sao_2 is 88% [1].

Pulmonary rehabilitation has been shown to improve dyspnea, to enhance quality of life, to decrease hospitalizations, to decrease the number of days spent in the hospital, and to enhance exercise capacity; it may even improve survival [1]. Rehabilitation programs attempt to address the muscle wasting, deconditioning, depression, social isolation, and weight loss that often accompany COPD. Active smoking status is no longer an exclusion criterion, and pulmonary rehabilitation programs may include smoking cessation counseling.

Pharmacologic management. Smoking cessation remains the only intervention that can attenuate the age-related decline in FEV_1 experienced by patients with COPD [14]. Brief physician counseling alone is associated with a 5% to 10% smoking cessation rate [1]. Nicotine replacement products, varenicline, and bupropion are additional first-line options.

Bronchodilators include beta-agonists and muscarinic antagonists, both of which are available in short-acting and

long-acting formulations. Despite the myriad of broncho-dilators and inhaled corticosteroids available, none have been shown to modify the long-term decline in lung function that is associated with COPD, nor have any been shown to conclusively improve mortality. The role of these agents in COPD management is to decrease symptoms and exacerbations and to improve exercise tolerance and quality of life.

The GOLD 2013 guidelines recommend using bronchodilators and/or inhaled corticosteroids based on the patient's symptoms and his or her risk of exacerbations (Table 1). Symptoms are assessed using an instrument such as the Modified Medical Research Council Dyspnea Scale or the COPD Assessment Test; for example, if a patient walks slower than his or her peers because of dyspnea, that would be a symptom of COPD. A patient has a high risk of exacerbation if he or she has experienced 2 or more exacerbations in the past year or if his or her FEV_1 is less than 50% of the predicted value when measured with post-bronchodilator spirometry [1].

The recommended treatment for patients with less severe symptoms and a low risk of exacerbations is a short-acting muscarinic antagonist or a short-acting beta-agonist. In patients with moderate to severe disease, triple therapy with a long-acting beta-agonist, a long-acting muscarinic antagonist, and an inhaled corticosteroid improves lung function and may also improve quality of life and decrease exacerbations requiring hospitalization [15]. Long-term monotherapy with an inhaled corticosteroid is not recommended given the adverse effects of this drug, which include pneumonia, and the relatively decreased efficacy of such therapy. Likewise, the adverse effects of long-term oral corticosteroids—which include osteoporosis, cataracts, muscle wasting, and weight gain—make these agents unappealing. Strong evidence argues against their use as long-term monotherapy [1].

Roflumilast, the first phosphodiesterase-4 inhibitor to be approved for treatment of COPD, exerts an anti-inflammatory effect by inhibiting the breakdown of intracellular cyclic adenosine monophosphate. Multiple studies have shown that use of this agent decreases moderate exacerbations requiring steroids and decreases severe exacerbations requiring hospitalization [16]. The rate of discontinuation is higher with roflumilast than placebo (14% versus 11%), usually due to headache, diarrhea, or weight loss [16]. Given the long half-life of roflumilast (17 hours) and the even longer half-life of the active metabolite roflumilast N-oxide (30 hours), every-other-day dosing may be considered for patients who are experiencing side effects, although the drug's efficacy may be attenuated on such a schedule. Current guidelines recommend that clinicians consider adding roflumilast to the treatment regimen if patients have a high risk of exacerbations (that is, if patients have an FEV_1 less than 50% of the predicted value or they have experienced 2 or more exacerbations in the past year) [1].

Finally, influenza vaccination in patients with COPD has been shown to decrease exacerbations of the disease, although it does not decrease hospitalizations or mortality [17]. The GOLD 2013 guidelines recommend yearly administration of either killed viruses or live-inactivated viruses [1].

Surgical therapy. Lung volume-reduction surgery (LVRS) is a surgical procedure that removes parts of the patient's lungs in order to decrease hyperinflation. LVRS has been shown to decrease the mortality rate in patients whose exercise capacity after rehabilitation is poor and who have severe emphysema that predominantly affects the upper lobes; however, LVRS is costly compared with medical therapy [1]. Lung transplantation is an option for patients with severe COPD and has been shown to improve quality of life and to decrease mortality [1].

Conclusion

COPD is a debilitating disease that results in substantial morbidity and mortality as well as significant utilization of health care resources. The major risk factor for developing COPD is tobacco smoking. In North Carolina, much work remains to be done in terms of tobacco cessation, given the significant smoking rates among the state's adults and chil-

TABLE 1.
Recommended Therapy for Each Stage of Chronic Obstructive Pulmonary Disease[a]

GOLD stage	Recommended therapy according to GOLD guidelines					
	Influenza vaccine	Short-acting bronchodilator	Long-acting bronchodilator (1 or more)	Pulmonary rehabilitation	Inhaled corticosteroid if repeated exacerbations	Long-term oxygen therapy; consider surgical procedures
I. Mild FEV_1 > 80%	Yes	Yes	No	No	No	No
2. Moderate FEV_1 50%–80%	Yes	Yes	Yes	Yes	No	No
3. Severe FEV_1 30%–50%	Yes	Yes	Yes	Yes	Yes	No
4. Very severe FEV_1 < 30%	Yes	Yes	Yes	Yes	Yes	Yes

Note. GOLD, Global Initiative for Chronic Obstructive Lung Diseases.
[a]GOLD stage is based on the severity of airflow limitation measured in terms of forced expiratory volume in 1 second (FEV_1), as a percentage of the predicted value, after administration of a short-acting bronchodilator.

dren. Prevention is the key to success. This can be accomplished by aggressive education and through public health policy (eg, the banning of smoking in certain public areas). Emphasis needs to be placed not only on smoking cessation but also on the reduction of occupational exposure to noxious particles. Strategies to prevent work-related COPD include exposure controls such as elimination, engineering controls, diesel filters, administrative controls, and personal protective equipment.

For those who already have COPD, smoking cessation is essential and can reduce mortality. Long-term oxygen therapy also reduces mortality in patients for whom it is indicated. The goals of therapy are to reduce symptoms and to reduce the risk of disease progression, exacerbations, and death. Pharmacologic management of COPD should follow the GOLD guidelines, which recommend a stepwise addition of pharmacologic treatments based on the severity of the disease. NCMJ

Stephen Gegick, MD pulmonary and critical care fellow, Brody School of Medicine, East Carolina University, Greenville, North Carolina.
Hunter Allen Coore, MD chief resident, Internal Medicine Residency Program, Brody School of Medicine, East Carolina University, Greenville, North Carolina.
Mark R. Bowling, MD assistant professor of medicine, Department of Internal Medicine, Division of Pulmonary, Critical Care and Sleep Medicine, Brody School of Medicine, East Carolina University, Greenville, North Carolina.

References

1. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease (updated 2013). GOLD Web site. http://www.goldcopd.org/uploads/users/files/GOLD_Report_2013_Feb20.pdf. Published February 20, 2013. Accessed June 18, 2013.
2. Institute for Health Metrics and Evaluation (IHME). The Global Burden of Disease: Generating Evidence, Guiding Policy. Seattle, WA: IHME, 2013. http://www.healthmetricsandevaluation.org/sites/default/files/policy_report/2011/GBD_Generating%20Evidence_Guiding%20Policy%20FINAL.pdf. Accessed July 11, 2013.
3. Centers for Disease and Prevention (CDC). Chronic obstructive pulmonary disease and associated health-care resource use—North Carolina, 2007 and 2009. MMWR Morb Mortal Wkly Rep. 2012;61(8);143-146.
4. Brown DW, Pleasants RA. Mortality from chronic obstructive pulmonary disease among adults aged 25 years or older in North Carolina. South Med J. 2011;104(1):20-23.
5. Easley C, Petersen R, Holmes M. The health and economic burden of chronic diseases in North Carolina. N C Med J. 2010;71(1):92-95.
6. Kohansal R, Martinez-Camblor P, Agusti A, Buist AS, Mannino DM, Soriano JB. The natural history of chronic airflow obstruction revisited: an analysis of the Framingham offspring cohort. Am J Respir Crit Care Med. 2009;180(1):3-10.
7. Eisner MD, Balmes J, Katz PP, Trupin L, Yelin EH, Blanc PD. Lifetime environmental tobacco smoke exposure and the risk of chronic obstructive pulmonary disease. Environ Health. 2005;4(1):7-15.
8. Centers for Disease Control and Prevention (CDC). Smoking and tobaccouse.Statehighlights.NorthCarolina.2010.CDCWebsite.http://www.cdc.gov/tobacco/data_statistics/state_data/state_highlights/2010/states/north_carolina/index.htm. Accessed June 20, 2013.
9. North Carolina Prevention Report Card 2012. North Carolina Prevention Partners Web site. http://www.ncpreventionpartners.org/dnn/Publications/ReportCard/tabid/162/Default.aspx. Accessed June 22, 2013.
10. Torres-Duque C, Maldonado D, Perez-Padilla R, Ezzati M, Viegi G. Biomass fuels and respiratory diseases: a review of the evidence. Proc Am Thorac Soc. 2008;5:577-590.
11. NC Sess Law 2009-27.
12. Ringbaek TJ, Viskum K, Lange P. Does long-term oxygen therapy reduce hospitalisation in hypoxaemic chronic obstructive pulmonary disease? Eur Respir J. 2002;20(1):38-42.
13. Poole PJ, Chacko E, Wood-Baker RW, Cates CJ. Influenza vaccine for patients with chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2006;25(1):CD002733.
14. Anthonisen NR, Connett JE, Kiley JP, et al. Effects of smoking intervention and the use of an inhaled anticholinergic bronchodilator on the rate of decline of FEV_1: the Lung Health Study. JAMA. 1994;272(19):1497-1505.
15. Welte T, Miravitlles M, Hernandez P, et al. Efficacy and tolerability of budesonide/formoterol added to tiotropium in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2009;180:741-750.
16. Price D, Chisholm A, Ryan D, Crockett A, Jones R. The use of roflumilast in COPD: a primary care perspective. Prim Care Respir J. 2010;19(4):342-351.
17. Continuous or nocturnal oxygen therapy in hypoxemic chronic obstructive lung disease: a clinical trial. Nocturnal Oxygen Therapy Trial Group. Ann Intern Med. 1980;93(3):391-398.

The Race to Eliminate Tuberculosis

Jason E. Stout

Tuberculosis is a major cause of morbidity and mortality worldwide, but the number of cases is now lower than ever before, both in the United States and in North Carolina. Although case rates are declining, public health funding for tuberculosis is also declining; it remains to be seen whether tuberculosis will be successfully eliminated or whether it will reemerge in the United States.

Tuberculosis is the model of a disease that can only be successfully controlled through the integration of public health practice and individual health care. The responsible organism, *Mycobacterium tuberculosis*, is an obligate pathogen in humans—that is, it requires a host for growth and reproduction, and it must cause disease in order to be transmitted. It is transmitted from person to person via the respiratory route when an individual with pulmonary disease coughs, speaks, breathes, or sneezes. After transmission, disease occurs in a minority of infected persons, and progression to disease can be prevented with appropriate treatment. In theory, the cycle of transmission and progression to active disease can be broken by appropriately identifying and treating both ill individuals and those with latent infections, which would eventually result in disease elimination.

In the United States, vigorous public health efforts over the past 20 years have been directed toward breaking this cycle. Many states, including North Carolina, have eliminated barriers to appropriate tuberculosis treatment by providing free medications to all infected persons. In addition, local health departments routinely identify and test contacts of persons with infectious tuberculosis, thus identifying newly infected individuals (who have latent infections but are at relatively high risk to progress to active tuberculosis) and offering treatment to prevent future disease. These efforts require significant investment of resources; a large 2006 study estimated that in 2002 alone, between 291,000 and 433,000 persons were started on treatment for latent tuberculosis infection [1]. Investment of these resources seems to be paying off; the authors of the study estimated that 4,000 to 11,000 future cases of active tuberculosis were prevented because of this treatment. In fact, the number of tuberculosis cases reported in the United States in 2012 was at a historic low (9,951 cases; incidence rate, 3.2 cases per 100,000 population), representing the 20th consecutive year of decline [2]. Similarly, North Carolina had the lowest number of cases ever reported in

2012 (211 cases; incidence rate, 2.2 cases per 100,000 population), ranking North Carolina 29th among states in terms of incidence rate and 13th in terms of number of cases (Kitty Herrin, personal communication). In addition, the levels of drug-resistant tuberculosis have remained at relatively low levels. In 2011, the most recent year for which data were available, 127 cases of multidrug-resistant tuberculosis were reported in the United States [2], 2 of which were in North Carolina [3].

Although these statistics are encouraging, it is premature to declare victory in the war on tuberculosis—as has mistakenly been done before, with disastrous consequences. Tuberculosis is still being actively transmitted in North Carolina, particularly among disadvantaged minority populations. This disparity is most clearly seen in children with tuberculosis, many of whom have been recently infected. A study performed a decade ago found that, of children reported to be infected with tuberculosis in North Carolina during the period 1994–2002, 88.3% were nonwhite [4]; information in the North Carolina Electronic Disease Surveillance System database indicates that over the subsequent decade (2003–2012), that percentage remained essentially unchanged at about 89% [5]. Tuberculosis case rates are significantly higher among nonwhite populations than among whites both in North Carolina and in the United States as a whole. In 2012 the case rates among Asians, blacks, and Hispanics in the United States were 25.0, 7.3, and 6.6 times higher than the rate among whites, respectively [2].

Much of this health disparity is driven by the increasing proportion of tuberculosis cases attributable to foreign-born persons (imported tuberculosis). In 2012 a record 63% of all reported tuberculosis cases in the United States among individuals whose national origin was known occurred in persons who were foreign-born [2]. In North Carolina, foreign-born individuals accounted for 46% of all reported cases of tuberculosis [5]. These foreign-born cases usually represent infection in the country of origin, followed by reactivation after immigration to the United States. Given that more than 1 million immigrants enter the United States every

Treatment of Latent Tuberculosis Infection in North Carolina:
Strategies for Improving Adherence

Stephen R. Keener

Successful treatment of patients with latent tuberculosis infection is an important part of North Carolina's strategy for controlling this disease. Latent tuberculosis infection is defined as the presence of *Mycobacterium tuberculosis*, which might later cause disease, in a patient who currently has no symptoms [1]. By successfully treating persons with latent infection who are most at risk of developing active disease, new cases of tuberculosis can be prevented.

The North Carolina Division of Public Health sets goals for adherence to treatment of latent tuberculosis infection. These goals specify the target completion rates of prescribed treatment for patients in 3 categories: 83% of contacts to sputum acid-fast bacilli (AFB) smear-positive tuberculosis patients who start treatment for newly diagnosed latent tuberculosis infection; 73% of immigrants and refugees with abnormal chest radiographs read overseas as consistent with tuberculosis, and who are diagnosed with latent tuberculosis infection during evaluation in the United States and started on treatment; and 65% of all persons (non-contact) who begin treatment for latent tuberculosis infection [2].

Local health departments are challenged to meet these goals. With the world's population becoming more mobile, increasing numbers of people from countries with high rates of tuberculosis infection immigrate to North Carolina. New residents and visitors from other countries may have different cultural beliefs about health and illness, and many do not speak English. Transportation difficulties and coinfection with human immunodeficiency virus (HIV) and viral hepatitis are other obstacles to treatment adherence.

The traditional treatment of choice for latent tuberculosis infection is isoniazid—also known as isonicotinylhydrazine (INH)—taken daily for 9 months without observation. Given the long treatment course, reliance on self-administration, and occasional side effects, it is not unusual for patients to discontinue their medication without consulting a health care provider. When cultural, language, and transportation barriers are also present, there are even more reasons why treatment adherence may fall short of the desired goals.

How can local health departments improve patient compliance with treatment of latent tuberculosis infection? Strategies that increase treatment adherence include shorter treatment regimens with medications other than isoniazid, efficient utilization of human resources to facilitate directly observed treatment, and changes in the messages given to patients.

During the past year, the Centers for Disease Control and Prevention approved guidelines for new treatment regimens for latent tuberculosis infection, which have been adopted by the North Carolina Division of Public Health. Rifampin, one of the mainstays of antibiotic treatment for active tuberculosis, has been approved for unsupervised daily use to treat latent tuberculosis, which allows for a shorter course of therapy (currently 4 months for adults or 6 months for children). Another approved regimen calls for administration of isoniazid and rifapentine once weekly for 12 weeks, under direct observation by a health care professional [3]. Use of these regimens cuts the length of treatment by more than half and improves the chances that patients will complete treatment.

Efficient use of health care personnel can also increase treatment success. As the number of active cases of tu-

year [6], tuberculosis will never be eliminated in this country as long as the disease remains prevalent in the rest of the world.

Continued investment of resources will clearly be needed to prevent a resurgence of tuberculosis in the United States, but these resources may be in jeopardy. Funding provided by the Centers for Disease Control and Prevention (CDC) to state and local tuberculosis control programs has been reduced every year for the past several years. Many state and local government budgets have faced fiscal pressures that in turn put pressure on public health programs. In addition, some of the key tools of tuberculosis control have been limited in recent years. In the past year alone, shortages of key drugs such as isoniazid, amikacin, and intravenous rifampin have been reported [7, 8]. These shortages have resulted in rationing of therapy and delay in initiating treatment of latent tuberculosis [9]. Furthermore, a shortage of

the purified protein derivative (PPD) used for the tuberculin skin test has impaired clinicians' ability to screen exposed persons and identify those who are infected and would benefit from treatment of latent tuberculosis [10]. In the face of these shortages, a cynical observer might comment that tuberculosis statistics will continue to improve simply because we cannot detect the infection, due to the lack of PPD, and that we do not have the drugs to treat the disease if we do detect it.

In addition to resource constraints, tuberculosis control may fall victim to its own success. The decline in tuberculosis incidence translates to a decline in clinician experience with the disease, which may result in failure to recognize tuberculosis when it is encountered. Recent evidence supports a link between low levels of clinician experience with tuberculosis and delayed diagnosis. An examination of US surveillance data led to a 2009 report indicating that the

berculosis continues to decline in North Carolina, health departments are turning their attention to preventing new cases. A retrospective chart review of patients with latent tuberculosis infection who were seen in Mecklenburg County during the period 1996–2003 showed that, among patients with latent infection who were close contacts of a patient with active disease, direct observation of treatment resulted in an additional 30% of patients completing treatment (compared with self-administered treatment) [4]. Outreach nurses sometimes take tuberculosis medications to the homes of patients with active tuberculosis, and there are often others living in the same households who have been exposed and who need treatment for latent tuberculosis infection. The outreach nurse can directly observe treatment of these household members with latent infection at the same time that he or she visits the patient with active disease. Health departments have also engaged health care workers other than health department nurses to facilitate directly observed treatment. To minimize transportation barriers and increase convenience, pharmacists and nurses in physician practices have been utilized to observe patients with active disease as they swallow their medications, and these personnel could also observe treatment of those with latent infections. Some states have also been exploring the use of video technology for "direct" observation, which could increase a health department's capacity to observe treatment of latent tuberculosis infection.

Finally, tuberculosis control staff members in North Carolina have found that how they communicate with patients can make a difference in patient compliance. Because patients with latent tuberculosis infection are by definition asymptomatic, many do not understand the importance of treatment to prevent active disease. Spending a few extra minutes to explain how taking 1 or 2 medications for several months can prevent illness, loss of work time, disability, and even death can usually make an im-

pact on the patient's perspective.

All of these strategies can improve adherence to treatment of latent tuberculosis infection, particularly when they are employed in patients at highest risk: close contacts of patients with active disease, children, and those with HIV infection or another chronic illness. Successful treatment of latent tuberculosis can in turn contribute to the continuing decline in North Carolina's tuberculosis rate. NCMJ

Stephen R. Keener, MD, MPH medical director, Mecklenburg County Health Department, Charlotte, North Carolina.

References
1. Taylor Z, Nolan CM, Blumberg HM; Centers for Disease Control and Prevention (CDC); Infectious Diseases Society of America. Controlling tuberculosis in the United States. Recommendations from the American Thoracic Society, CDC, and the Infectious Diseases Society of America. MMWR Recomm Rep. 2005;54 (RR-12):1-81.
2. North Carolina Division of Public Health Agreement Addendum 552, Centers for Disease Control and Prevention. Tuberculosis Control, Fiscal Year 2013-2014.
3. North Carolina Department of Health and Human Services, Division of Public Health, Epidemiology Section. North Carolina Tuberculosis Policy Manual. Epidemiology Section Web site. http://epi.publichealth.nc.gov/cd/lhds/manuals/tb/toc.html. Updated February 20, 2013. Accessed July 14, 2013.
4. Smith DE, Cook ES, Keener SR. Directly observed preventive treatment of latent tuberculosis infection in close contacts: preliminary findings. Paper presented at: the 54th Annual Tuberculosis and Respiratory Disease Institute; July 24, 2004; Black Mountain, NC.

proportion of tuberculosis patients with advanced pulmonary disease (indicated by positive acid-fast smears with cavitation) steadily increased during the period 1993–2006 [11]. Furthermore, the proportion of tuberculosis patients with advanced disease in a given county was increasingly associated with a lower rate of tuberculosis disease in that county, which is particularly problematic because advanced disease is associated with greater infectiousness, and latent disease may be underreported or undetected. Delayed diagnosis of cases in low-incidence areas where providers and patients are less likely to be familiar with tuberculosis may easily lead to local outbreaks and a resurgence of the disease. Creative strategies, including targeted education of providers and high-risk populations, will be needed to prevent the erosion of previously achieved gains in tuberculosis control.

New technologies may help to facilitate continued progress toward tuberculosis elimination (Table 1). Rapid, sensitive, and specific techniques for diagnosing active tuberculosis are essential to reduce diagnostic delay and to increase the likelihood that appropriate treatment will be initiated in a timely fashion. Such techniques are particularly needed as clinical expertise declines and clinicians become less comfortable initiating empiric antituberculous treatment. Unfortunately, standard rapid diagnostic tests (nucleic acid amplification) are challenging to implement from a quality assurance and cost-effectiveness perspective when the number of tests performed is low. Referral laboratories may process enough specimens to make offering such tests feasible, but the delay inherent in sending specimens to referral laboratories and receiving results reduces some of the benefit of rapid testing.

TABLE 1.
Tests for Detecting *Mycobacterium tuberculosis* Infection

Type of test	Test name(s)	Advantages	Disadvantages
Molecular test for *M. tuberculosis* and rifampin resistance	Cepheid GeneXpert test (Xpert MTB-RIF)	• The test has excellent sensitivity and specificity. • Many laboratories already have the machine required to run the test. • The test requires minimal technician time and expertise. • The test provides simultaneous detection of *M. tuberculosis* and rifampin resistance.	• This assay is currently offered by only a few laboratories.
Tuberculin skin test		• The test is inexpensive to perform. • Providers are familiar with the test. • There are extensive data supporting a relationship between a positive test result and the patient's likelihood of developing active tuberculosis in the future.	• A second visit is required to read the test. • Inter-reader reliability is poor. • There is a potential for false-positive test results due to cross-reactivity with the BCG vaccine and environmental nontuberculous mycobacteria.
Interferon-gamma release assays	(1) QuantiFERON-TB Gold In-Tube test (2) T-SPOT.TB test	• Both tests are commercially available in the United States. • These tests require only a single blood draw to obtain a result. • These tests should have a lower likelihood of false-positive results compared with the tuberculin skin test. • These tests eliminate the need for personnel who are experience in reading tuberculin skin tests.	• These tests are significantly more expensive than the tuberculin skin test. • These tests are associated with significant biological and laboratory variability that may confound interpretation.

Note. BCG, bacille Calmette-Guerin.

The Cepheid GeneXpert test (Xpert MTB-RIF), an automated molecular test for *M. tuberculosis* and resistance to rifampin, may overcome some of these barriers. In international studies in tuberculosis-endemic areas, this test demonstrated excellent sensitivity and specificity [12]. This test is attractive in low-incidence settings where the volume of tests performed in laboratories is low. First, many laboratories already have the (expensive) machine required to run the test, as the same machine is used for other commonly ordered tests—such as rapid detection of methicillin-resistant *Staphylococcus aureus*, *Clostridium difficile*, and vancomycin-resistant *Enterococcus* species. Second, the test requires minimal technician time and expertise to perform. Third, the test provides simultaneous detection of *M. tuberculosis* and of rifampin resistance; the latter is a good marker for multidrug-resistant tuberculosis, which requires a different therapeutic approach.

A second relatively new technology that may help in domestic tuberculosis control is the interferon-gamma release assay. Two such assays are commercially available in the United States: the QuantiFERON-TB Gold In-Tube test and the T-SPOT.TB test. These assays, which measure an in vitro immune response to *M. tuberculosis*–specific antigens, have several advantages over the tuberculin skin test. First, they require only a single blood draw to obtain a result, compared with the 2 office visits needed to perform and interpret a tuberculin skin test. Second, the antigens used in these tests are not present in either the bacille Calmette-Guérin (BCG) vaccine or in most nontuberculous mycobacteria, which should reduce the likelihood of false-positive results compared with the tuberculin skin test. Third, these

assays eliminate the need for personnel who are experienced in reading tuberculin skin tests. However, the interferon-gamma release assays are not a panacea. They are significantly more expensive than the tuberculin skin test, do not discriminate between latent and active tuberculosis (neither does the skin test), and have significant associated biological and laboratory variability that may confound interpretation. The CDC recommends use of these tests instead of the tuberculin skin test [13], but the role of these tests in public health practice and tuberculosis elimination remains to be fully determined.

With carefully targeted provider education, new technologies, and sustained support for public health infrastructure, we will continue to make progress toward tuberculosis elimination. Complacency has the potential to undo the work of many decades, and we must remain focused on the core tasks of diagnosing, treating, and preventing tuberculosis, both in the United States and abroad. In 2011 there were an estimated 8.7 million new cases of active tuberculosis in the world, including nearly half a million cases of multidrug-resistant tuberculosis, and there were 1.4 million deaths from tuberculosis [14]. Eighty percent of new tuberculosis cases occur in just 22 high-incidence countries [14]. Given the number of immigrants who enter the United States every year, as well as the not-insignificant burden of tuberculosis among nonimmigrant visitors, our attention must be broader than the confines of our borders. A provocative cost-effectiveness analysis published in 2005 [15] suggested that investing resources in tuberculosis control abroad would provide a greater reduction in US tuberculosis cases than would investing similar resources to detect and treat latent

tuberculosis infections after immigrants enter the United States. As the saying goes, tuberculosis anywhere is tuberculosis everywhere, and we must remain vigilant if we are to see an end to this scourge. NCMJ

Jason E. Stout, MD, MHS associate professor of medicine, Division of Infectious Diseases and International Health, Duke University Medical Center, Durham, North Carolina, and tuberculosis medical director, North Carolina Department of Health and Human Services, Raleigh, North Carolina.
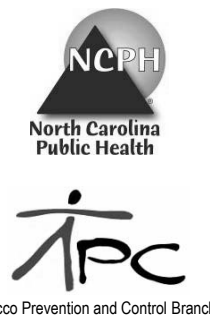
References

1. Sterling TR, Bethel J, Goldberg S, Weinfurter P, Yun L, Horsburgh CR; Tuberculosis Epidemiologic Studies Consortium. The scope and impact of treatment of latent tuberculosis infection in the United States and Canada. Am J Respir Crit Care Med. 2006;173(8):927-931.
2. Centers for Disease Control and Prevention (CDC). Trends in tuberculosis—United States, 2012. MMWR Morb Mortal Wkly Rep. 2013;62(11):201-205.
3. North Carolina Department of Health and Human Services, Division of Public Health, Communicable Disease Branch, Tuberculosis Control Program. 2011 Tuberculosis Statistics for North Carolina. http://epi.publichealth.nc.gov/cd/tb/figures/tbannual2011.pdf. Published April 2012. Accessed June 29, 2013.
4. Stout JE, Saharia KK, Nageswaran S, Ahmed A, Hamilton CD. Racial and ethnic disparities in pediatric tuberculosis in North Carolina. Arch Pediatr Adolesc Med. 2006;160(6):631-637.
5. North Carolina Department of Health and Human Services, Division of Public Health. North Carolina Electronic Disease Surveillance System (NC EDSS) database. NC EDSS Web site. https://ncedss.ncpublichealth.com. Accessed June 29, 2013.
6. US Department of Homeland Security. Yearbook of Immigration Statistics: 2011. Washington, DC: US Department of Homeland Security, Office of Immigration Statistics; 2012. http://www.dhs.gov/sites/default/files/publications/immigration-statistics/yearbook/2011/ois_yb_2011.pdf. Accessed July 13, 2013.
7. US Food and Drug Administration (FDA). Current Drug Shortages Index. FDA Web site. http://www.fda.gov/drugs/drugsafety/drugshortages/ucm050792.htm. Accessed June 29, 2013.
8. Centers for Disease Control and Prevention (CDC). Notes from the field: national shortage of isoniazid 300 mg tablets. MMWR Morb Mortal Wkly Rep. 2012;61(50):1029.
9. Centers for Disease Control and Prevention (CDC). Impact of a shortage of first-line antituberculosis medication on tuberculosis control—United States, 2012-2013. MMWR Morb Mortal Wkly Rep. 2013;62(20):398-400.
10. Centers for Disease Control and Prevention (CDC). National shortage of purified-protein derivative tuberculin products. MMWR Morb Mortal Wkly Rep. 2013;62(16):312.
11. Wallace RM, Kammerer JS, Iademarco MF, Althomsons SP, Winston CA, Navin TR. Increasing proportions of advanced pulmonary tuberculosis reported in the United States: are delays in diagnosis on the rise? Am J Respir Crit Care Med. 2009;180(10):1016-1022.
12. Boehme CC, Nabeta P, Hillemann D, et al. Rapid molecular detection of tuberculosis and rifampin resistance. N Engl J Med. 2010;363(11):1005-1015.
13. Mazurek GH, Jereb J, Vernon A, LoBue P, Goldberg S, Castro K; IGRA Expert Committee; Centers for Disease Control and Prevention (CDC). Updated guidelines for using Interferon Gamma Release Assays to detect *Mycobacterium tuberculosis* infection—United States, 2010. MMWR Recomm Rep. 2010;59(RR-5):1-25.
14. World Health Organization (WHO). Global Health Observatory (GHO): How many TB cases and deaths are there? WHO Web site. http://www.who.int/gho/tb/epidemic/cases_deaths/en/. Published 2013. Accessed June 29, 2013.
15. Schwartzman K, Oxlade O, Barr RG, et al. Domestic returns from investment in the control of tuberculosis in other countries. N Engl J Med. 2005;353(10):1008-1020.

Coughing Up Answers:
A Community's Response to Pertussis

Joseph B. Bass Jr., Stacie R. Turpin-Saunders

Pertussis is a highly contagious but vaccine-preventable disease. In spite of relatively high immunization rates, the number of cases continues to rise. A recent outbreak of pertussis in Alamance County, North Carolina, led to changes in response efforts and improved communication among partners, but it also left public health workers with many unanswered questions.

Pertussis, or whooping cough, was first recognized in France in 1414, and the first epidemic was recorded in Paris in 1578, but the organism responsible for infection, *Bordetella pertussis*, was not isolated until 1900 [1]. Known for the fits of coughing it causes and for the distinctive whooping sound patients make between coughs, pertussis remains one of the leading causes of deaths from vaccine-preventable disease worldwide, resulting in an estimated 300,000 deaths per year [2]. Until the late 20th century, pertussis was one of the most common childhood diseases in the United States.

Pertussis is typically described as having 3 stages [3]. The first stage is characterized by cold-like symptoms such as a runny nose, low-grade fever, and a mild cough; this stage may last up to 2 weeks. The next stage involves numerous coughing fits, and patients typically make a whooping sound between coughs—hence the common name "whooping cough." This second stage typically lasts 1–6 weeks but may last as long as 10 weeks. Coughing decreases during the final stage, but coughing fits may still occur; this convalescence stage may last a couple of weeks [3].

Antibiotic treatment is standard for pertussis infection, and early treatment is important for decreasing the severity of illness and for preventing the spread of disease. However, antibiotic treatment after 3 weeks of illness is unlikely to be effective; by that time, bacteria have left the body, although symptoms may still be present. Antibiotics may also be given to individuals who have been in contact with an infected individual in order to prevent further spread of the disease [4].

At its peak in the 1930s, pertussis affected approximately 265,000 individuals per year and killed thousands of American children every year. Use of vaccine began in the mid-1940s and eventually became widespread, after which the number of cases of pertussis declined dramatically, reaching an all-time low in the late 1970s [5]. Since the 1980s, the number of pertussis cases has gradually increased, however, with outbreaks occurring approximately every 3–5 years [5]. Alamance County experienced such an outbreak beginning in the winter of 2011.

In December 2011, a child attending a local Alamance County school was diagnosed with pertussis. Upon investigation of the child's contacts, many other children were found to be exhibiting symptoms of pertussis. Initially, staff members of the Alamance County Health Department followed existing guidelines from the Centers for Disease Control and Prevention (CDC), which stated that antibiotic prophylaxis should be administered to all close contacts of each case— that is, household contacts and others who had spent at least 15 minutes within 3 feet of the infected child [6]. Additionally, if 2 or more cases were found in the same classroom or on the same school bus, then all the children in that class or on that bus were considered contacts and received prophylaxis. Following these guidelines was a daunting task, and hundreds of courses of prophylactic antibiotics were administered in the first few weeks of the outbreak.

After weeks of administering prophylactic antibiotics, the health department saw that this strategy was having little effect in containing the spread of the disease, so they asked state partners and the CDC to review the response approach. After consultation with these groups, the health department moved from a strategy of providing prophylaxis for all close contacts to a more targeted strategy that focused on providing protection for contacts who had the highest risk of morbidity if they were to become infected with pertussis. These high-risk individuals included close contacts with a weakened immune system or chronic lung disease, pregnant women at more than 20 weeks of gestation, and infants younger than 12 months of age [6]. At the same time, the health department redoubled efforts to administer booster doses of the combination vaccine containing tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) to

Tdap Vaccination in Pregnancy:
New Guidance, New Challenges

Diana Curran

The incidence of pertussis outbreaks in the United States has increased over the past several years, and infants have been disproportionately affected. As a result, in October 2011 the Advisory Committee on Immunization Practices (ACIP) of the Centers for Disease Control and Prevention (CDC) recommended that pregnant women, and other individuals who come into close contact with infants, be vaccinated with a single booster dose of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (Tdap) to "cocoon" infants against exposure to pertussis [1]. Due to their immature immune system, infants cannot begin to receive the pertussis vaccine before age 6 weeks. To gradually build immunity, the ACIP recommends vaccinations at ages 2, 4, 6 and 15–18 months and 4–6 years [2]. In 2010 a total of 3,350 cases of pertussis occurred in infants younger than 6 months, resulting in 25 deaths; in 30% to 40% of cases in which the source of the infection was identified, the infant had acquired pertussis from his or her mother [3].

In 2012 the ACIP added the recommendation that every pregnant woman should be vaccinated between 27 and 36 weeks of gestation, during each pregnancy [4]. When Tdap is given during the final weeks of pregnancy, it boosts maternal antibodies and maximizes both the mother's protection and the infant's protection through passive immunity. The optimal timing of vaccination is at least 2 weeks prior to delivery and after 30 weeks gestation, when the active transport of maternal immunoglobulin G occurs [4].

Adopting this recommendation will be challenging, however, because of concerns about safety and fetal effects. The ACIP reviewed the best data available and considers administration of Tdap during pregnancy to be safe. The most common adverse events are fever (which occurs in 2.4% to 6.5% of patients) and pain at the site of the injection. The risk of serious adverse events is estimated to be very low, but that estimate is based on data from only a small number of patients. The ACIP has concluded that the benefits of vaccination—reducing the numbers of neonatal infections, hospitalizations, and deaths—are greater than the risks of vaccination. The committee plans to monitor safety through the Vaccine Adverse Event Reporting System (VAERS) and the Vaccine Safety Datalink, and it will assess both adverse events at the time of vaccination and pregnancy and birth outcomes.

Implementing routine Tdap vaccination in maternity care is another challenge. For example, we have yet to do a good job of administering influenza vaccine to pregnant women. In the 2011–2012 influenza season, an Internet panel survey conducted by the CDC found that only 47% of the 1,660 women surveyed received the influenza vaccine either before or during pregnancy [5]. This survey also found that only 43.7% of women had a health care provider recommend and offer the vaccine; however, women who were offered the vaccine had a higher vaccination rate (73.6%) compared with pregnant women whose provider did not offer or recommend the vaccine (11.1%).

all individuals meeting CDC criteria for vaccination.

From November 2011 through October 2012, 173 cases of pertussis were identified in Alamance County (Table 1). The number of cases began to return to baseline in August 2012 and has remained at or below baseline since that time. The number of cases peaked between December 2011 and February 2012, with the highest number of cases diagnosed in December (n = 42). The median age of infected individuals was 8 years, but infected individuals ranged in age from less than 12 months to 87 years. Of note, more than 17% of infected individuals were 18 years of age or older.

In approximately 88% of the laboratory-confirmed cases of pertussis and in 76% of probable cases, the patient was up-to-date on pertussis vaccine. In the cases involving school-age children, almost all (98%) of the patients were up-to-date on pertussis vaccine. In 2 cases, the patient was too young to have received the vaccine. No pertussis-related deaths occurred during this outbreak.

In addition to implementing revised guidelines for antibiotic prophylaxis and redoubling immunization efforts, the health department responded to the outbreak by initiating the Incident Command System—which is often used in preparedness work—to organize staff, community partners, and the overall effort. Under unified command, representatives from the health department, the Alamance-Burlington School System administration, the local hospital, and private practices—along with school principals, school nurses, and public information officers—developed initial action plans, set objectives, and assigned tasks. A 3-pronged approach was used to disseminate information to stakeholders: a letter was sent to all parents with children in the local school system; a communicable-disease bulletin was sent to local medical providers to increase their awareness of pertussis in the community; and press releases were prepared for the community at large. As more and more potential contacts were identified, the health department created a 24/7 communicable-disease phone line to answer questions from parents. Restrictions and cost barriers for booster doses of pertussis vaccine (Tdap) were lifted, allowing the health department to administer the vaccine to anyone meeting

Cost is another barrier that prevents some private maternity care providers from offering vaccines. There is a financial disincentive to stock vaccine, because reimbursement rates are low relative to the cost of purchasing and storing vaccine. Thus, some practices do not stock vaccine. When women must go elsewhere to get the recommended vaccine, their compliance is lower. Until cost and storage considerations can be addressed, practices may not be able to implement the new Tdap recommendations.

Participation in the North Carolina Pregnancy Medical Home program—which was developed by the North Carolina Division of Medical Assistance, the North Carolina Division of Public Health, and Community Care of North Carolina—may help facilitate adoption of Tdap vaccination during pregnancy. This Medicaid-sponsored program has promoted collaboration among maternity practices seeking to adopt evidence-based practices for pregnancy care. The program uses case management services to help expectant mothers achieve health goals. Workgroups meet regionally and regularly to educate prenatal providers statewide. Using this network to spread the word about the new Tdap vaccination recommendations may increase compliance within the Pregnancy Medical Home program. Partnering with local health departments may also help practices gain skills in purchasing and safely storing vaccine.

In my practice at a local health department, we assess the immunization status of pregnant women during their initial prenatal visit by reviewing their record in the North Carolina Immunization Registry and by testing them for immunity to rubella and varicella. If they require a vaccine, we put a note on the problem list. During influenza season, we offer influenza vaccine beginning in October, and we try to catch patients at their next routine visit. We then vaccinate new prenatal patients as they come in, until the end of March. We now also routinely discuss and offer Tdap vaccination at or after 30 weeks gestation. **NCMJ**

Diana Curran, MD medical director, Henderson County Department of Public Health, Hendersonville, North Carolina.

References
1. Centers for Disease Control and Prevention (CDC). Updated recommendations for use of tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccine (Tdap) in pregnant women and persons who have or anticipate having close contact with an infant aged <12 months—Advisory Committee on Immunization Practices (ACIP), 2011. MMWR Morb Mortal Wkly Rep. 2011;60(41):1424-1426.
2. Centers for Disease Control and Prevention (CDC). Pertussis vaccination: use of acellular pertussis vaccines among infants and young children. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 1997;46(RR-7):1-25.
3. Centers for Disease Control and Prevention (CDC). Vaccines and preventable diseases: Tdap for pregnant women: information for providers. CDC Web site. http://www.cdc.gov/vaccines/vpd-vac/pertussis/tdap-pregnancy-hcp.htm. Last updated on February 28, 2013. Accessed June 5, 2013.
4. Centers for Disease Control and Prevention (CDC). Updated recommendations for use of tetanus toxoid, reduced diphtheria, and acellular pertussis vaccine (Tdap) in pregnant women—Advisory Committee on Immunization Practices (ACIP), 2012. MMWR Morb Mortal Wkly Rep. 2013;62(7):131-135.
5. Centers for Disease Control and Prevention (CDC). Influenza vaccination coverage among pregnant women—2011-12 influenza season, United States. MMWR Morb Mortal Wkly Rep. 2012;61(38);758-763.

TABLE 1.
Demographics and Vaccine History of Pertussis Cases in Alamance County, North Carolina, November 2011–October 2012

Case status	No. (%)	Median age (range)	Infants No. (%)	Males No. (%)	Pertussis vaccination status			
					Up-to-date No. (%)	Not up-to-date No. (%)	Not old enough to receive vaccine[a] No. (%)	Unknown No. (%)
Confirmed	87 (50)	9 years (3 weeks–87 years)	5 (42)	40 (46)	76 (88)	—	2[b] (2)	9 (10)
Probable	86 (50)	8 years (2 weeks–75 years)	7 (58)	35 (41)	65 (76)	1 (1)	1 (1)	19 (22)
Total cases	**173 (100)**	**8 years (2 weeks–87 years)**	**12 (100)**	**75 (43)**	**141 (82)**	**1 (1)**	**3 (1)**	**28 (16)**

[a]Pertussis vaccination begins at 2 months of age.
[b]At onset of illness, 1 case was 3 weeks old and other was 5 weeks old.

CDC criteria, regardless of insurance eligibility or purchase constraints. Mass vaccination clinics were organized, and local health fairs and community events served as venues for administration of the vaccine. The health department also used off-site points of distribution for Tdap so that local providers could administer the vaccine at no cost, and the health department worked closely with staff members at the local hospital to vaccinate all new parents whose babies were delivered at the hospital, in order to create a cocoon of protection around infants who were too young to be eligible for the vaccine.

Although the outbreak dissipated, numerous challenges confronted those who were trying to prevent further disease in the community. Specific to this outbreak, timing was everything. Notification that the disease was present in the school system coincided with winter break and holiday celebrations, making it difficult to reach, isolate, and treat potential cases. In addition, because the local schools were the epicenter of cases, the initial approach of providing prophylaxis to all close contacts created a sizable challenge. The large number of individuals included in the initial approach meant that many public health workers were needed to track, notify, and monitor cases. The cost of prophylaxis for all close contacts was also significant. Hundreds of doses of antibiotics were administered in the initial response, and we still do not know the total cost to the public health system in Alamance County, as it includes not only the cost of the vaccine but also costs associated with staff hours at the health department, manpower hours at local schools, facility time at mass vaccinations, and miscellaneous supplies.

One of the challenges facing medical providers was differentiating pertussis from other respiratory infections during the advent of cold and influenza season. Since pertussis had seldom been seen in Alamance County, the outbreak served as a teaching moment, allowing public health workers to educate private providers about the epidemiology, identification, treatment, and containment of pertussis. Additionally, it provided an opportunity to collaborate in addressing a communitywide outbreak of vaccine-preventable communicable disease. The health department continually kept providers updated with the latest information by forwarding correspondences from the North Carolina Division of Public Health and the CDC regarding differentiation of pertussis from other respiratory infections and effective control measures. This was especially true when the outbreak response changed.

As a more complete picture of this outbreak developed, larger and more global challenges also emerged. As we have noted, the vast majority of individuals diagnosed with pertussis during this outbreak had been properly immunized, which raised questions regarding the efficacy of the acellular vaccine and the potential need for additional booster doses of pertussis vaccine in elementary school–aged children and in adults. Currently, the CDC recommends that children get 5 doses of the combination vaccine against diphtheria, teta-

nus, and pertussis (DTaP), to be administered at the ages of 2 months, 4 months, 6 months, 15–18 months, and 4–6 years (prior to entry into kindergarten); doses of the booster (Tdap) should then be administered at age 11–12 years and again at age 19 years, especially if individuals have close contact with infants [7]. The combined vaccine (DTaP) used to protect against pertussis was changed in the 1990s, with the whole-cell pertussis component being replaced by an acellular pertussis component. Recent research suggests that the acellular combined vaccine may not provide the same level of protection as the previously used whole-cell combined vaccine, leaving individuals with varying immune responses or waning immunity [8, 9]. The booster vaccine (Tdap) also contains an acellular pertussis component. Although the local health department is not charged with addressing these larger issues, staff members do have questions regarding the potential for waning immunity when the acellular vaccine is administered. That said, booster doses of Tdap vaccine at ages 11–12 and 19 years remain the best defense against widespread pertussis.

Although pertussis is a vaccine-preventable disease and there is evidence of a relatively high rate of immunization in North Carolina, pertussis continues to endure as an episodic epidemic disease. Early identification of pertussis is especially important in treating infants and those living in households with infants. One of the most effective ways of protecting infants is to introduce vaccine at 2 months of age and to comply with the vaccination schedule recommended by the CDC's Advisory Committee on Immunization Practices. It is also important to ensure that adults who have close contact with vulnerable infants and children are properly immunized against pertussis.

The pertussis outbreak in Alamance County led to changes in how public health workers respond to an outbreak in classroom and school situations; these changes were implemented following consultation with the CDC. The health department continues to educate caregivers, school staff, and the community at large about the importance of immunization for children and adults in order to prevent disease. Hopefully other communities and counties in the state will study the pertussis outbreak in Alamance County and reassess their own needs with regard to pertussis vaccine for their residents in order to better prevent future outbreaks. **NCMJ**

Joseph B. Bass Jr., MSW health director, Alamance County Health Department, Burlington, North Carolina.
Stacie R. Turpin-Saunders, MPH health education supervisor, Alamance County Health Department, Burlington, North Carolina.

References

1. Guiso N. *Bordetella pertussis* and pertussis vaccines. Clin Infect Dis. 2009;49(10):1565-1569.
2. Centers for Disease Control and Prevention (CDC). Pertussis (whooping cough). Pertussis in other countries. CDC Web site. http://www.cdc.gov/pertussis/countries.html. Last updated June 11, 2012. Accessed June 18, 2013.
3. Centers for Disease Control and Prevention (CDC). Pertussis signs and symptoms. CDC Web site. http://www.cdc.gov/pertussis/about/signs-symptoms.html. Last updated February 24, 2013. Accessed June 11, 2013.
4. Centers for Disease Control and Prevention (CDC). Pertussis (whooping cough). Diagnosis and treatment. CDC Web site. http://www.cdc.gov/pertussis/about/diagnosis-treatment.html. Last updated July 5, 2012. Accessed June 11, 2013.
5. Centers for Disease Control and Prevention (CDC). Pertussis—United States, January 1992-June 1995. MMWR Morb Mortal Wkly Rep. 1995;44(28):525-529. http://www.cdc.gov/mmwr/PDF/wk/mm4428.pdf. Accessed June 11, 2013.
6. Shapley-Quinn K. Coping with a pertussis outbreak in Alamance County, North Carolina. N C Med J. 2013;74(1):68-69.
7. Centers for Disease Control and Prevention (CDC). Vaccines and preventable diseases: pertussis (whooping cough) vaccination. CDC Web site. http://www.cdc.gov/vaccines/vpd-vac/pertussis/. Accessed July 15, 2013.
8. Klein NP, Barlett J, Fireman B, Rowhani-Rahbar A, Baxter R. Comparative effectiveness of acellular versus whole-cell pertussis vaccines in teenagers. Pediatrics. 2013;131(6):e1716-e1722.
9. Witt MA, Arias L, Katz PH, Truong ET, Witt DJ. Reduced risk of pertussis among persons ever vaccinated with whole cell pertussis vaccine compared to recipients of acellular pertussis vaccines in a large US Cohort. Clin Infect Dis. 2013;56(9):1248-1254.

Prevention and Control of Influenza:
No Easy Task

Kristina Simeonsson, Zack Moore

Every influenza season presents different challenges: Novel viruses emerge, new groups of people are identified as being at high risk for complications, vaccine effectiveness varies, and resistance to antiviral agents develops. Health care providers must partner with public health professionals to prevent influenza and to reduce the morbidity and mortality associated with this illness.

Influenza is a common respiratory illness responsible for many outpatient visits, hospitalizations, and deaths every year. During the influenza seasons spanning the decade 1990–1999, the disease resulted in an average of 36,000 deaths and more than 200,000 hospitalizations each year in the United States [1, 2]. A review of data from the 31 influenza seasons during the period 1976–2007 yielded estimates of the number of annual influenza-associated deaths during that time, which ranged from 3,349 deaths in the 1986–1987 influenza season to 48,614 deaths in the 2003–2004 season [3]. The vast majority of deaths occur in elderly individuals; however, rates of hospitalization for infants and young children are similar to those for elderly patients. A 2007 study by Molinari and colleagues estimated that the direct health care costs related to seasonal influenza total $10.4 billion annually; when indirect costs from missed days at work and premature death were included, using projected statistical life values, the total annual economic burden was estimated to be $87.1 billion (in 2003 dollars) [4].

Symptoms of influenza include sudden onset of fever, myalgias, and cough. Illness typically lasts 5 days; however, respiratory symptoms and malaise can persist for 2–3 weeks. Children may manifest gastrointestinal symptoms such as vomiting and diarrhea, and infants can present with a sepsis-like syndrome. Worsening of underlying chronic conditions is responsible for most of the severe complications and mortality associated with influenza. Secondary bacterial infections (eg, pneumonia) can occur in all age groups; in these cases, there is often a brief period of improvement followed by rapid deterioration.

Influenza is usually spread from person to person by inhalation of respiratory droplets produced by coughing and sneezing. Children are the major reservoir of influenza in community outbreaks, as they shed influenza virus longer and in larger quantities than do adults. Influenza activity in the United States usually peaks in January or February; however, some influenza seasons have peaked as late as May or as early as December. Because influenza circulates year-round, a diagnosis of influenza can be made at any time during the year, particularly in individuals who have traveled outside of the United States.

Two types of influenza virus are responsible for the vast majority of human disease: types A and B. Type A influenza viruses are further divided into subtypes based on 2 surface proteins: hemagglutinin and neuraminidase. More than one strain of influenza virus can circulate during each season, although a single strain usually predominates. From 1977 through 2008, circulating viruses included 1 of 2 strains of influenza B, and 2 subtypes of influenza A (H3N2 and H1N1). In 2009, a novel H1N1 virus emerged and resulted in a pandemic. Since then, the 2009 H1N1 virus has co-circulated with H3N2 and type B strains.

Surveillance

Influenza surveillance serves several functions, one of which is early detection of novel strains that have pandemic potential. The value of state and national influenza surveillance systems was demonstrated by the early detection of the pandemic H1N1 strain in California in 2009 and more recently by the detection of continued outbreaks of influenza A H3N2 variant (H3N2v) found to be associated with swine contact [5]. The continued occurrence of illness due to H5N1 and the recent emergence of H7N9 highlight the need for continued vigilance for novel viruses in the United States.

Accurate and timely surveillance data help clinicians by providing information about the timing and intensity of seasonal influenza activity in a given area, as well as yielding data on antiviral resistance, vaccine effectiveness, and predominant circulating strains. In North Carolina, influenza surveillance is coordinated by the Epidemiology Section of the Division of Public Health. This surveillance relies

Mandatory Influenza Vaccination Program Proves Successful in Its First Year

Brian Floyd

Vidant Health is a health care system comprising many physician practices, 9 hospitals, and an academic medical center affiliated with the Brody School of Medicine at East Carolina University. The system is headquartered in Greenville, North Carolina, and its network spreads throughout the 29 counties of Eastern North Carolina. Vidant Medical Center, a teaching hospital with 909 beds, serves as a health care resource throughout the region and delivers comprehensive tertiary care, education, and research. In 2012 Vidant Health joined a growing number of hospitals and health systems around the country in implementing a mandatory influenza vaccination program for its employees and physicians.

Every influenza season increases patients' risk of infection and possible complications, especially for vulnerable patients in a tertiary care setting. Exposure to influenza among Vidant Health's employees also threatens the operation of its clinics and hospitals and has the potential to reduce access to care. The leaders and employees of Vidant Health believe that the needs of the patient come first, and staff members accept their responsibility to model healthy behaviors. Thus, David Herman, chief executive officer of Vidant Health, proposed a mandatory vaccination program in the interest of patient safety, saying, "Patients trust that when they come to us for care, their health will improve and they will not be put at risk because we did not do everything possible to prevent harm" (written communication to employees, October 2012).

In previous years, Vidant Health had less than 75% compliance with influenza vaccination among its health care workers, despite efforts to promote vaccination. One reason for reduced participation was fear on the part of some staff members that vaccination would result in a more serious illness, such as Guillain-Barré syndrome. In addition, Vidant Health faced 2 other obstacles to making vaccination mandatory: the difficulty of confirming that an employee had received the vaccine, and concern that requiring vaccination would negatively affect the satisfaction of employees or affiliated physicians.

The decision to move forward with mandatory vaccination came after months of deliberation. Once the clinical governance committee of the health system achieved consensus, the decision became policy. Vidant Health followed the leadership of executive staff members and the physicians' medical executive committee to ensure that evidence of vaccination was provided by all medical, clinical, and administrative staff members; volunteers; students; and vendors. Individuals with certain medical conditions or religious beliefs, as defined in the policy, were exempt from the mandatory vaccination. Compliance became a condition of employment for all staff as well as a condition of medical privileges for physicians.

Vaccination was centrally coordinated and provided free of charge. Vaccination clinics were offered over a 3-month period to accommodate varying work shifts and to make vaccination available to employees and physicians who were working off site. A comprehensive communication strategy was used to educate individuals about the risk that influenza poses to patients, especially high-risk or immunocompromised patients, and the impact of illness on the workforce and the community.

Physicians and staff members were receptive to the mandatory vaccination initiative and quickly became ambassadors for its implementation. Influenza vaccination compliance ultimately reached 99.9%, demonstrating the commitment of Vidant Health's physicians and employees to patient safety. Despite concerns about a negative reaction or employee turnover among Vidant Health's teams, compliance with the policy was nearly universal. All physicians complied with the policy, as did all but 1 of more than 12,000 employees. Also, only 1 acute hospitalized influenza case was detected in the health system during the first year of mandatory vaccination (although we cannot prove any association with the vaccination program).

The leaders of Vidant Health are certain that the decision to require influenza vaccination served the purpose of protecting patients. The initiative has also had a positive impact on the culture of patient safety, resulting in a more engaged health care team that is working to put patients' needs first. NCMJ

Brian Floyd, MBA, RN executive vice president, Vidant Medical Center, Greenville, North Carolina.

on contributions from many partners, including physician practices, local health departments, student health centers, hospitals, and the national Centers for Disease Control and Prevention (CDC).

Unlike most communicable diseases that are under public health surveillance, influenza is not tracked by reporting of individual cases. Aside from the logistical challenges of such an undertaking, case-based reporting from physicians or laboratories would not be accurate because most persons who are infected with influenza never seek medical attention. Instead, influenza surveillance is conducted using a combination of data sources. These include monitoring of "influenza-like illness" (ILI), virologic surveillance, and reporting of influenza-associated deaths.

In North Carolina, ILI is primarily monitored through 2 systems: the North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) and the Influenza-Like Illness Surveillance Network (ILINet). NC DETECT is an electronic surveillance system that collects data twice daily from all emergency departments (EDs) in the state that are open 24 hours a day and 7 days a week; surveillance of data from NC DETECT allows for near real-time monitoring of ED visits for ILI and other syndromes. ILINet is a CDC-operated system coordinated by state health departments. Approximately 80 volunteer providers from across the state report weekly on the total num-

ber of patient visits and the number of visits for ILI (defined as a temperature of at least 100°F along with cough or sore throat), subdivided by age group. These data are used to monitor trends by comparing the current data with national and region-specific baselines. As shown in Figure 1, the timing and intensity of influenza activity varies from year to year. During the 2012–2013 influenza season, the peak occurred in late December, 2 months before the usual peak, and the proportion of all outpatient visits attributable to ILI reached the highest level since ILINet was introduced in North Carolina.

In addition to reporting data, ILINet providers collect nasopharyngeal swabs from selected patients and submit them to the North Carolina State Laboratory of Public Health. These specimens help public health officials to determine what proportion of ILI is caused by influenza, whether the current year's vaccine is a good match for circulating influenza strains, and whether resistance to antiviral medications is changing. Moreover, these specimens allow for timely recognition of new influenza strains that could have the potential to cause an influenza pandemic.

The third major component of influenza surveillance in North Carolina is tracking of influenza-associated deaths. The North Carolina Administrative Code requires physicians to report all influenza-associated deaths to their local public health departments within 24 hours. For reporting purposes,

FIGURE 1.
Percentage of All Outpatient Visits Attributable to Influenza-Like Illness, as Reported by Providers in the Influenza-Like Illness Surveillance Network (ILINet), 2007–2013
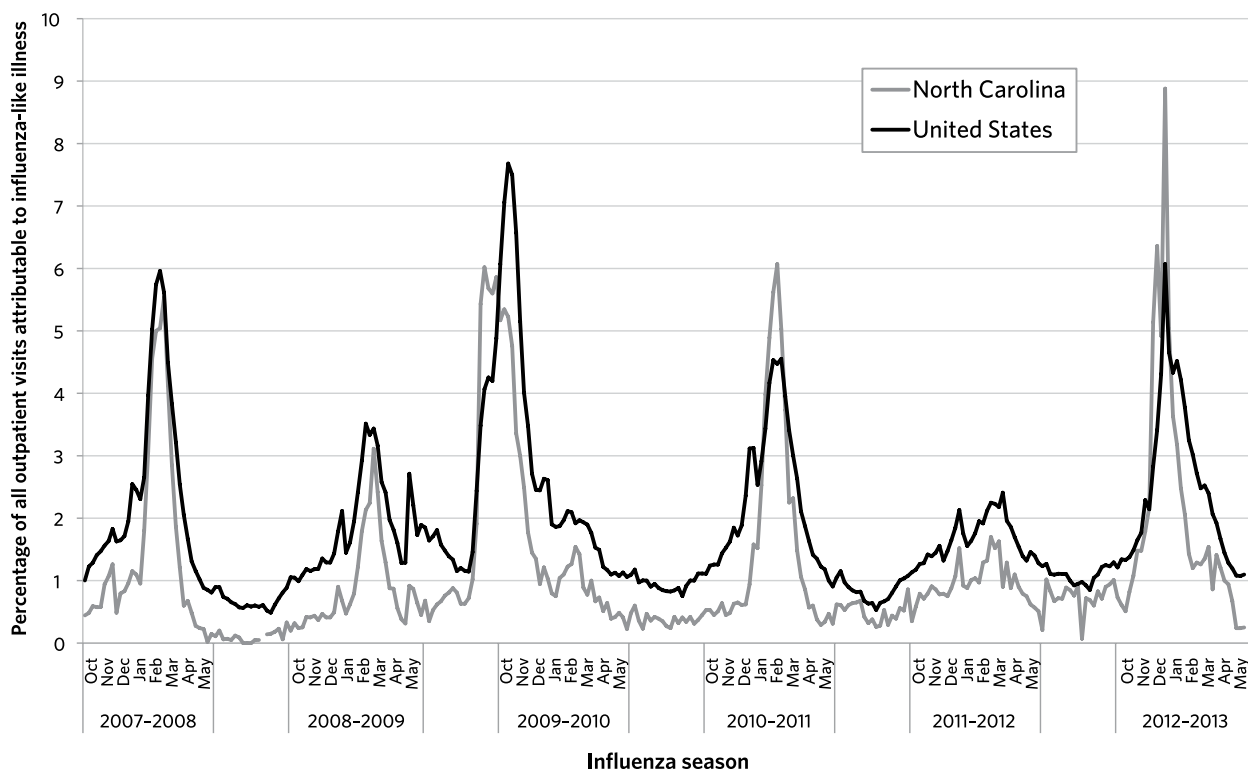
Pharmacists:
Medication Experts Who Help Prevent Disease

Ouita Davis Gatton

Vaccines help prevent disease and have significantly decreased morbidity and mortality due to influenza, pneumonia, and other bacteria and viruses. But vaccines are only beneficial if people are actually vaccinated. Influenza and pneumococcal disease are still among the leading preventable diseases in the United States, in part because vaccination rates for both diseases are well below the goals set in recent years. These low rates have led to an increase in preventable deaths, illnesses, and health care costs each year [1]. There are many reasons why someone may not be vaccinated, one of which is lack of access to vaccines. One strategy for addressing this need is to allow vaccination by pharmacists.

Pharmacists have been involved in immunization in some form since the middle of the 19th century, first serving to distribute vaccine and to educate physicians and the public. Small groups of pharmacists have also been involved in administering vaccines, but only recently has such involvement become coordinated within the profession [2].

States that allow pharmacists to administer a particular vaccine have higher vaccination rates for that vaccine than do states that do not allow vaccination by pharmacists [1-3]. Washington was the first state in which pharmacists made an organized effort to administer immunizations; their state association began training pharmacists in vaccine administration in 1994 [2]. Most initial efforts focused on having pharmacists administer influenza vaccine. It took nearly 17 years, but eventually pharmacists were granted the authority to immunize patients against influenza in all 50 states, the District of Columbia, and Puerto Rico; this was thanks to the determination and successful collaboration of pharmacists, state associations of pharmacists, state legislatures, supportive physicians, and other health care providers [4]. During the 2010–2011 influenza season, the Centers for Disease Control and Prevention (CDC) reported that pharmacists administered almost 20% of all adult influenza vaccinations [3]. Currently, more than 150,000 pharmacists are trained to provide immunizations in the United States, including more than 6,100 pharmacists in North Carolina [3].

Pharmacy-based immunization is not about removing patients from their medical home or denying patients access to physicians. Rather, it is about assisting in the prevention of disease by increasing the availability of vaccines to those who need them. The pharmacist is frequently the most accessible member of the health care team, as pharmacies often keep longer hours than do most physicians' offices and health care clinics [1, 4], and pharmacies are often located in areas where preventive care is needed but not readily accessible. Additionally, if pharmacists are legally able to vaccinate, they can screen patients who need vaccines—especially influenza and pneumococcal vaccines—and then immediately follow up on this screening to ensure that patients receive the vaccine without delay [4].

Laws governing pharmacy immunization practices vary from state to state. Until very recently, North Carolina had one of the most restrictive immunization practice mandates for pharmacists. Achieving change in pharmacists' immunizing authority has occurred slowly and has not been without misunderstanding and confusion on the part of physician groups [1]. Pharmacists have administered vaccines in North Carolina since 2003 and are governed by rules adopted by the Boards of Pharmacy, Nursing, and Medicine. The state's pharmacists must receive special

an influenza-associated death is defined as a death resulting from a clinically compatible illness that is confirmed to be influenza by an appropriate laboratory or rapid diagnostic test with no period of complete recovery between illness and death. Although the number of reported deaths is certainly an underestimate of all influenza-associated deaths, these reports allow for monitoring of trends within and across influenza seasons and provide important information about the groups that are at highest risk of death from influenza. For example, findings from reports of influenza-associated deaths helped identify the high risk of death from influenza among children with neurodevelopmental disorders and, during the H1N1 pandemic, the high risk of death among pregnant women. Data from this and all other influenza surveillance systems are posted weekly from October through May at www.flu.nc.gov.

Diagnosis

Definitive diagnosis of influenza infection is made by isolation of the virus from nasal or nasopharyngeal secretions. Confirming the presence of influenza virus by culture can take up to 7–10 days and therefore is not very useful in the clinical management of patients. Newer modalities to test for influenza are becoming more widely available—in particular, reverse transcriptase–polymerase chain reaction (RT-PCR) testing. Immunofluorescence assays are also available in many hospitals and can provide results within 2–4 hours.

For faster results, clinicians can use rapid influenza diagnostic tests (RIDTs); several of the commercially available RIDTs can provide results within 30 minutes. RIDTs are often used in outpatient settings when deciding whether to begin

vaccine training that is approved by the Board of Pharmacy. They must also follow a written protocol that is prepared, signed, and dated by both the pharmacist and a physician; they must hold current, provider-level certification in cardiopulmonary resuscitation (CPR); and they must maintain appropriate documentation as dictated by the Board of Pharmacy. Currently, pharmacists in North Carolina may administer influenza vaccine by written protocol to persons 14 years of age and older, and they may administer pneumococcal and zoster vaccines to those 18 years of age and older after contacting the patient's primary care provider. The H1N1 influenza public health crisis in 2009 prompted North Carolina to lower the minimum age for administration of influenza vaccine by pharmacists from 18 years to 14 years [5].

Adverse reactions to vaccines administered in a pharmacy are rare [1]. Pharmacists are trained to appropriately screen patients for allergies and other risks prior to administration of the vaccine. They are additionally mandated to explain the risks of the vaccine and any potential adverse reactions that could occur. If an adverse reaction does occur, pharmacists are trained in appropriate emergency protocols, including use of epinephrine and administration of CPR. Pharmacists must report any documented reaction to the patient's physician and to the Vaccine Adverse Event Reporting System. Appropriate Occupational Safety and Health Administration guidelines also apply to vaccination by pharmacists [5]. Current leaders in the pharmacy and medical communities are working on streamlining pharmacy best-practice models to make immunization protocols and documentation more uniform, despite the variation in state rules.

In July 2013, the North Carolina General Assembly passed House Bill 832, "An Act to Protect the Public's Health by Increasing Access to Immunizations and Vaccines through the Expanded Role of Immunizing Pharmacists" [6]. The legislation, which goes into effect on October 1, 2013, allows immunizing pharmacists who meet certain requirements to administer any CDC-recommended vaccination to any person at least 18 years of age who has a prescription. The new law also allows pharmacists to administer 6 vaccines under standing order or protocol. This will substantially increase pharmacy-based immunization practice in North Carolina, affording patients in the state increased access to vaccines and preventive care. The new law will provide North Carolina pharmacists with additional means by which to help decrease the number of deaths due to vaccine-preventable diseases. NCMJ

Ouita Davis Gatton, RPh clinical coordinator, Kroger Pharmacy, Raleigh, North Carolina.

References
1. Welch AC, Ferreri SP, Blalock SJ, Caiola SM. North Carolina family practice physicians' perceptions of pharmacists as vaccinators. J Am Pharm Assoc (2003). 2005;45(4):486-491.
2. Hogue MD, Grabenstein JD, Foster SL, Rothholz MC. Pharmacist involvement with immunizations: a decade of professional advancement. J Am Pharm Assoc (2003). 2006;46(2):168-179; quiz 179-182.
3. Skelton JB; American Pharmacists Association; Academy of Managed Care Pharmacy. Pharmacist-provided immunization compensation and recognition: white paper summarizing APhA/AMCP stakeholder meeting. J Am Pharm Assoc (2003). 2011;51(6):704-712.
4. Milenkovich N. The immunizing pharmacist. Modern Medicine Web site. http://drugtopics.modernmedicine.com/print/131323. Published September 15, 2011. Accessed May 23, 2013.
5. Work DR. Rule 21NCAC 46.2507 [memorandum]. http://www.ncbop.org/PDF/memoImmunization.pdf. Published May 19, 2004. Accessed September 17, 2013.
6. 2013-246 NC Sess Laws; House Bill 832. http://www.ncleg.net/Sessions/2013/Bills/House/PDF/H832v6.pdf. Accessed August 7, 2013.

treatment with antiviral medications. RIDTs differ in terms of the types of influenza they can detect and in their ability to distinguish between types of influenza. Results from RIDTs should be interpreted with caution, as these tests have a lower sensitivity (40%–70%) than that of viral culture; thus false-negative results are more likely with RIDTs. If confirmation of influenza is necessary, a negative RIDT should be confirmed with culture or RT-PCR testing.

The likelihood of obtaining a false-negative result with a RIDT can be minimized by obtaining an adequate specimen and by testing patients within the first few days of their illness. Given the inherent limitations of influenza diagnostic tests, treatment decisions are often based on clinical and epidemiologic information. If treatment is clinically indicated, it should not be delayed while awaiting laboratory confirmation, nor should it be withheld based on a negative RIDT result. False-positive results with RIDTs can also occur, especially when influenza activity in the community is low. If the RIDT is positive when the level of influenza activity in the community is low, confirmatory testing with viral culture or RT-PCR is recommended.

Management

Antiviral treatment for patients with severe infections has been associated with a decreased length of uncomplicated influenza illness and with reductions in deaths and other severe outcomes [6-9]. Prompt treatment can reduce the risk of severe illness or death among persons who are

at increased risk for influenza (Table 1). Only 2 classes of antiviral agents are currently licensed in the United States: adamantanes and neuraminidase inhibitors. The adamantanes, amantidine and rimantidine, are not effective against currently circulating strains of influenza. However, the neuraminidase inhibitors, oseltamivir and zanamivir, are effective against currently circulating strains of both influenza A and influenza B (Table 2) [12].

The CDC's Advisory Committee on Immunization Practice (ACIP) recommends that treatment with oseltamivir or zanamivir be initiated as early as possible for any patient with confirmed or suspected influenza who has severe, complicated, or progressive illness; for any patient who is hospitalized; or for any patient who is at higher risk for influenza complications [12]. Antiviral treatment also can be considered for previously healthy, symptomatic outpatients with confirmed or suspected influenza if treatment can be initiated within 48 hours of the onset of illness [12]. Antiviral treatment might also be effective in preventing serious outcomes in more severe cases even when treatment is started more than 48 hours after the onset of illness [8]. Patients who are hospitalized with influenza should be started on antiviral medications even if more than 48 hours have passed since the onset of symptoms.

Despite the clear clinical benefits of antiviral medications for treatment of influenza, use of these agents can lead to the development of antiviral resistance. Several different point mutations have been identified that confer low-level or high-level antiviral resistance. Most notably, the H275Y mutation in the H1N1 neuraminidase led to widespread resistance among H1N1 viruses circulating prior to the 2009 pandemic, and this mutation continues to occur in a smaller proportion of pandemic H1N1 viruses [13, 14]. Several clusters of antiviral-resistant influenza A and influenza B have been identified in North Carolina, sometimes in association with broad or prolonged use of antiviral medications [15-17].

Antiviral medications can be used to prevent influenza infection; however, they are not a substitute for vaccination. The benefits of antiviral chemoprophylaxis must be weighed against the risk of developing resistance. Antiviral chemoprophylaxis is particularly important in controlling the spread of influenza among high-risk patients in institutional settings, such as nursing homes, and for high-risk individuals for whom influenza vaccine is not indicated [18].

TABLE 1.
Antiviral Treatment and Influenza Vaccination Recommendations

Persons for whom antiviral *treatment* is recommended	Persons for whom influenza *vaccination* is recommended when vaccine supplies are limited
Hospitalized patients Patients with severe, complicated, or progressive illness	
Persons with the following types of chronic conditions:	Persons with the following types of chronic conditions:
Pulmonary (eg, asthma, COPD)	Pulmonary (eg, asthma, COPD)
Cardiovascular (except hypertension alone)	Cardiovascular (except hypertension alone)
Renal	Renal
Hepatic	Hepatic
Hematologic (eg, sickle cell disease)	Hematologic (eg, sickle cell disease)
Metabolic (eg, diabetes mellitus)	Metabolic (eg, diabetes mellitus)
Neurologic or neurodevelopmental (eg, epilepsy, cerebral palsy, stroke)	Neurologic or neurodevelopmental (eg, epilepsy, cerebral palsy, stroke)
Persons who are immunosuppressed, from HIV infection or from use of medications such as high-dose steroids or chemotherapy	Persons who are immunosuppressed, from HIV infection or from use of medications such as high-dose steroids or chemotherapy
Women who are pregnant or up to 2 weeks postpartum	Women who are pregnant or will be pregnant during the influenza season
Persons younger than 19 years of age who are receiving long-term aspirin therapy	Persons younger than 19 years of age who are receiving long-term aspirin therapy
American Indians	American Indians
Alaska Natives	Alaska Natives
Persons who are morbidly obese (body mass index $\geq$ 40 kg/m^2)	Persons who are morbidly obese (body mass index $\geq$ 40 kg/m^2)
Residents of nursing homes or other chronic care facilities	Residents of nursing homes or other chronic care facilities
Children younger than 2 years	Children aged 6 months to 4 years
Adults aged 65 years or older	Adults aged 50 years or older
	Health care personnel
	Household contacts and caregivers of children younger than 5 years or adults older than 50 years, with particular emphasis on contacts of infants younger than 6 months
	Household contacts and caregivers of persons with medical conditions that put them at high risk for severe complications

Note. COPD, chronic obstructive pulmonary disease.
Source: This table is adapted from Centers for Disease Control and Prevention [10] and Centers for Disease Control and Prevention [11].

TABLE 2.
Current Recommendations for Treatment and Prophylaxis of Influenza Using Antiviral Medications

Antiviral medication	Type of use	Age of patient	Dosing
Oseltamivir	Treatment[a]	Infants aged 2 weeks to 1 year	3 mg/kg twice daily
		Children older than 1 year	
		< 15 kg	30 mg twice daily
		15–23 kg	45 mg twice daily
		23–40 kg	60 mg twice daily
		> 40 kg	75 mg twice daily
		Adults	75 mg twice daily
	Prophylaxis[b]	Infants aged 3 months to 1 year[c]	3 mg/kg once daily
		Children older than 1 year	
		< 15 kg	30 mg once daily
		15–23 kg	45 mg once daily
		23–40 kg	60 mg once daily
		> 40 kg	75 mg once daily
		Adults	75 mg once daily
Zanamivir[d]	Treatment	Children 7 years and older	10 mg (2 inhalations) twice daily
		Adults	10 mg (2 inhalations) twice daily
	Prophylaxis	Children 5 years and older	10 mg (2 inhalations) once daily
		Adults	10 mg (2 inhalations) once daily

Source: This table is adapted from Centers for Disease Control and Prevention [10].
[a]Recommended duration of treatment with oseltamivir is 5 days; a longer course of treatment can be considered for patients who remain severely ill after 5 days. Treatment should ideally begin within 48 hours of symptom onset.
[b]Recommended duration of prophylaxis with oseltamivir is 7 days after last exposure. Duration of prophylaxis is longer for patients in long-term care facilities.
[c]Oseltamivir has not been approved by the US Food and Drug Administration for chemoprophylaxis in infants; however, oseltamivir was approved under Emergency Use Authorization for prophylaxis in infants aged 3 months to 1 year during the 2009 H1N1 pandemic.
[d]Zanamivir is not recommended for use in people with underlying respiratory disease.

Prevention

Vaccination is the best way to prevent influenza infection. In a 2013 study, Kostova and colleagues estimated that during the 6-year period 2005–2011, the number of cases of influenza averted each year by vaccination ranged from 1.1 million to 5 million, and the number of averted hospitalizations ranged from 7,700 to 40,400 [19]. Annual influenza vaccine is now recommended by the ACIP for everyone 6 months of age or older. During times of influenza vaccine shortage, the ACIP may tailor its recommendations to prioritize the vaccination of individuals in certain target groups (Table 1). The ACIP also recommends that health care workers and household contacts of high-risk individuals receive influenza vaccine, because they can spread influenza to high-risk people if they become infected. Similarly, vaccinating pregnant women is recommended because vaccination of the mother confers protection on the infant, thus reducing the infant's risk of laboratory-confirmed influenza virus infection and his or her risk of hospitalization for ILI during the first 6 months of life [20].

Vaccine effectiveness varies from year to year. A person's age, his or her immune status, and the strain of influenza can influence vaccine effectiveness. Adults aged 65 years or older mount less of an immune response to influenza vaccine than do younger adults and children. In the most recent influenza season, vaccination reduced the risk for medical visits resulting from influenza A (H3N2) by 44% in the population as a whole (95% confidence interval [CI], 35% to 52%); among those 65 years of age or older, however, vaccination reduced this risk by only 19% (95% CI, –36% to 52%) [21].

A wide variety of influenza vaccine formulations are available for the 2013–2014 influenza season. Quadrivalent vaccines that cover 4 strains of influenza—influenza A (H1N1), influenza A (H3N2), and 2 influenza B viruses—are available in both the inactivated (intramuscular) form and the live-attenuated (intranasal) form. In addition to the traditional egg-based trivalent inactivated vaccines, there will also be an inactivated trivalent vaccine that is made in cell culture—including influenza A (H1N1), influenza A (H3N2), and 1 strain of influenza B—and an inactivated trivalent vaccine made with recombinant technology; this is the first time non-egg-based vaccines are being offered. High-dose vaccine for persons 65 years of age or older will also still be available, as will the intradermal form of the inactivated vaccine. When more than one type or brand of influenza vaccine is appropriate and available for an individual, no preferential recommendation exists for the use of one product over another.

Even though the ACIP recommends influenza vaccine for all persons aged 6 months or older, there is still room for improvement in vaccination rates, both across the board

and in specific target groups. Vaccination of health care providers (HCPs) deserves special attention. The Healthy People 2020 goal for vaccination of HCPs is 90%. Despite long-standing recommendations that HCPs should receive influenza vaccine, vaccination rates are still well below this goal; during the 2010–2011 influenza season, only 63.5% of HCPs were vaccinated against influenza [22].

HCPs' reasons for refusing influenza vaccine are similar to those offered by the general population. A recent survey of 1,931 HCPs found that almost one-third did not think influenza vaccine worked, 27% were concerned about side effects, 23% did not think they needed to be vaccinated, and 18% were concerned they would get sick from the vaccine [22]. To remove some of the barriers to receiving influenza vaccine, health care institutions need to offer vaccine on site, free of charge, and on multiple days at various times. Education of HCPs needs to emphasize that receipt of influenza vaccine not only protects the HCP against influenza but also promotes patient safety.

The most effective way to improve vaccination rates among HCPs is for health care employers to require influenza vaccination. In a survey during the 2010–2011 influenza season, vaccination rates were 98% among HCPs whose employer required vaccination, compared with only 58% among those whose employers did not require vaccination [22]. Mandatory vaccination policies are supported by a variety of national organizations, including the Infectious Diseases Society of America, the American College of Physicians, and the Society for Healthcare Epidemiology of America. A majority of North Carolina hospitals now have policies that make annual influenza vaccination a condition of employment for HCPs; 20% of hospitals have a mask requirement for HCPs who decline vaccination (Stephanie Strickland, e-mail communication). [Editor's note: See the sidebar by Floyd on page 426 (in this issue) for details about the mandatory vaccination program implemented by Vidant Health.] The number of North Carolina hospitals with an influenza vaccination requirement is likely to increase. In January 2013, the Centers for Medicare & Medicaid Services began requiring hospitals to report their rate of influenza vaccination among HCPs as part of the Acute Care Hospital Inpatient Prospective Payment System. Thus hospitals now have a financial incentive to increase vaccine coverage among their employees.

Influenza is a common respiratory illness that is associated with significant morbidity and mortality. HCPs play a major role in the prevention of influenza and its complications, and they need to use available surveillance to recognize when influenza is circulating in their communities. Physicians also need to follow current recommendations on the appropriate use of antiviral medications, and they must report all influenza-associated deaths to the health department. Finally, HCPs need to encourage influenza vaccination in all patients, and they should set an example for their patients by being vaccinated themselves. *NCMJ*

Kristina Simeonsson, MD, MSPH associate professor, Department of Pediatrics and Public Health, Brody School of Medicine, East Carolina University, Greenville, North Carolina.
Zack Moore, MD, MPH medical epidemiologist, Epidemiology Section, North Carolina Division of Public Health, Department of Health and Human Services, Raleigh, North Carolina.

References
1. Thompson WW, Shay DK, Weintraub E, et al. Mortality associated with influenza and respiratory syncytial virus in the United States. JAMA. 2003;289(2):179-186.
2. Thompson WW, Shay DK, Weintraub E, et al. Influenza-associated hospitalizations in the United States. JAMA. 2004;292(11):1333-1340.
3. Centers for Disease Control and Prevention (CDC). Estimates of deaths associated with seasonal influenza—United States, 1976–2007. MMWR Morb Mortal Wkly Rep. 2010;59(33):1057-1062.
4. Molinari NA, Ortega-Sanchez IR, Messonnier ML, et al. The annual impact of seasonal influenza in the United States: measuring disease burden and costs. Vaccine. 2007;25(27):5086-5096.
5. Epperson S, Jhung M, Richard S, et al. Human infections with influenza A(H3N2) variant virus in the United States, 2011–2012. Clin Infect Dis. 2013;57(suppl 1):S4-S11.
6. Treanor JJ, Hayden FG, Vrooman PS, et al. Efficacy and safety of the oral neuraminidase inhibitor oseltamivir in treating acute influenza: a randomized controlled trial. US Oral Neuraminidase Study Group. JAMA. 2000;283(8):1016-1024.
7. Heinonen S, Silvennoinen H, Lehtinen P, et al. Early oseltamivir treatment of influenza in children 1–3 years of age: a randomized controlled trial. Clin Infect Dis. 2010;51(8):887-894.
8. McGeer A, Green KA, Plevneshi A, et al. Antiviral therapy and outcomes of influenza requiring hospitalization in Ontario, Canada. Clin Infect Dis. 2007;45(12):1568-1575.
9. Jain S, Kamimoto L, Bramley AM, et al. Hospitalized patients with 2009 H1N1 influenza in the United States, April–June 2009. N Engl J Med. 2009;361(20):1935-1944.
10. Centers for Disease Control and Prevention (CDC). Influenza antiviral medications: summary for clinicians. CDC Web site. http://www.cdc.gov/flu/pdf/professionals/antivirals/antiviral-summary-clinicians.pdf. Page last updated December 22, 2012. Accessed August 5, 2013.
11. Centers for Disease Control and Prevention (CDC). Seasonal influenza (flu). Persons for whom annual vaccination is recommended. CDC Web site. http://www.cdc.gov/flu/professionals/acip/persons.htm. Page last updated November 30, 2012. Accessed August 5, 2013.
12. Fiore AE, Fry A, Shay D, Gubareva L, Bresee JS, Uyeki TM; Centers for Disease Control and Prevention (CDC). Antiviral agents for the treatment and chemoprophylaxis of influenza—recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2011;60(1):1-24.
13. Dharan NJ, Gubareva LV, Meyer JJ, et al. Infections with oseltamivir-resistant influenza A(H1N1) virus in the United States. JAMA. 2009;301(10):1034-1041.
14. Graitcer SB, Gubareva L, Kamimoto L, et al. Characteristics of patients with oseltamivir-resistant pandemic (H1N1) 2009, United States. Emerg Infect Dis. 2011;17(2):255-257.
15. Garg S, Moore Z, Lee N, et al. A cluster of patients infected with I221V influenza B virus variants with reduced oseltamivir susceptibility—North Carolina and South Carolina, 2010-2011. J Infect Dis. 2013;207(6):966-973.
16. Chen LF, Dailey NJ, Rao AK, et al. Cluster of oseltamivir-resistant 2009 pandemic influenza A (H1N1) virus infections on a hospital ward among immunocompromised patients—North Carolina, 2009. J Infect Dis. 2011;203(6):838-846.
17. Centers for Disease Control and Prevention (CDC). Oseltamivir-

resistant 2009 pandemic influenza A (H1N1) virus infection in two summer campers receiving prophylaxis—North Carolina, 2009. MMWR Morb Mortal Wkly Rep. 2009;58(35):969-972.

18. Centers for Disease Control and Prevention (CDC). Seasonal influenza (flu): interim guidance for influenza outbreak management in long-term care facilities. CDC Web site. http://www.cdc.gov/flu/professionals/infectioncontrol/ltc-facility-guidance.htm. Page last updated December 19, 2011. Accessed June 6, 2013.

19. Kostova D, Reed C, Finelli L, et al. Influenza illness and hospitalizations averted by influenza vaccination in the United States, 2005-2011. PLoS One. 2013;8(6):e66312.

20. Eick AA, Uyeki TM, Klimov A, et al. Maternal influenza vaccination and effect on influenza virus infection in young infants. Arch Pediatr Adolesc Med. 2011;165(2):104-111.

21. National Immunization Vaccine Summit (NIVS). Key points: updated influenza vaccine effectiveness estimates for the 2012-13 flu season. NIVS Web site. http://www.preventinfluenza.org/newsletters/7-01-13_keypoints_effectiveness.pdf. Accessed September 16, 2013.

22. Centers for Disease Control and Prevention (CDC). Influenza vaccination coverage among health-care personnel—United States, 2010-11 influenza season. MMWR Morb Mortal Wkly Rep. 2011; 60(32):1073-1077.

The Impact of Pneumonia Guidelines and Core Measures on Patient-Oriented Outcomes

Bonzo Reddick, Kimberly Howe

Over the past decade, evidence-based guidelines have led to the development of national core measures for the management of pneumonia. Although it does not signify causation, implementation of these standards strongly correlates with a decrease in the incidence of pneumonia and with decreasing death rates from pneumonia.

Pneumonia, together with influenza, has caused a great burden of suffering throughout history. It ranked as the leading cause of death in the early 1900s and was still among the top 10 causes of death in 2011 [1-5]. Indeed, pneumonia remains the most common cause of infection-related mortality in the United States. More than 50,000 persons died of pneumonia or influenza in 2010, and 1,700 of those deaths occurred in North Carolina [2]. The age-adjusted death rate in the United States in 2010 for pneumonia and influenza combined was 15.1 deaths per 100,000 population [2].

The 1-year mortality rate for Medicare patients who have been hospitalized with community-acquired pneumonia is as high as 40% [6]. In the United States in 2010, pneumonia was listed as the first diagnosis on hospital discharge for nearly 1.3 million persons, for a rate of 36.6 discharges per 10,000 population [7]; in 2006, that rate was 41.3 per 10,000 population [5]. In 2006 the rate of discharge for patients with pneumonia as the first diagnosis was 189.0 per 10,000 population among patients older than 65 years, 33.4 per 10,000 population for those aged 45–64 years, and 8.5 per 10,000 population for those aged 15–44 years [5].

The estimated annual economic burden of pneumonia and influenza in the United States exceeded $40 billion in 2005, with more than $34 billion in direct costs and $6 billion in indirect costs [5]. The economic burden from community-acquired pneumonia alone is estimated to exceed $17 billion annually, including costs for approximately 4.2 million ambulatory visits [8].

Pneumonia Guidelines

The Infectious Diseases Society of America (IDSA) and the American Thoracic Society (ATS) issued consensus guidelines on the management of community-acquired pneumonia in 2007 [9]. These guidelines and previous updates have been the basis for the implementation of a number of core measures in health care systems around the country. For example, our institution—New Hanover Regional Medical Center in Wilmington, North Carolina—has the following goals: that antibiotics be administered to patients with pneumonia within 6 hours of their arrival at the hospital; that blood cultures be obtained prior to administration of the first dose of antibiotics; and that the initial antibiotic selection be based on current evidence and local epidemiology. Similar standards have been established by the Centers for Medicare & Medicaid Services and The Joint Commission, both of which accredit health care organizations and programs. In 2005 the IDSA and the ATS issued consensus guidelines on the management of health care–associated pneumonia, which includes hospital-acquired pneumonia and ventilator-associated pneumonia [10].

Both sets of guidelines make recommendations regarding treatment of patients after they acquire pneumonia and also recommend various measures to decrease the incidence of pneumonia. Frequently recognized standards from the health care–associated pneumonia guidelines include elevating the head of the bed for patients with pneumonia and giving mechanically ventilated patients daily "sedation vacations" in order to prevent pneumonia. The community-acquired pneumonia guidelines advocate counseling on smoking cessation for all smokers admitted to the hospital, and they encourage vaccination against influenza and pneumococcal disease in appropriate patients, per the recommendations of the Advisory Committee on Immunization Practices (ACIP) of the Centers for Disease Control and Prevention (CDC), with a goal of 90% adherence.

The IDSA goal is that the strongest recommendations be carried out for the majority of patients. Clinicians may reasonably decide to deviate from these guidelines, and it is not expected that every patient will receive the same exact care. Nevertheless, hospital guidelines and core measures provide a systematic approach to the management of pneumonia, and they may enhance reimbursement as pay-for-performance becomes a reality. An early review of

evidence-based algorithms for the treatment of pneumonia in other countries showed decreases in 30-day mortality, in-hospital mortality, and hospital length of stay [11]. As health care systems in the United States implement these types of guidelines, we do not yet know how adherence to the guidelines will impact long-term outcomes at the local and national levels.

Patient-Oriented Outcomes

Over the past decade, most measures of pneumonia morbidity and mortality have shown improvement, coinciding with the widespread use of clinical guidelines and the establishment of core measures for the treatment and prevention of pneumonia. Interestingly, the incidence of pneumonia among black individuals appears to be decreasing, despite the fact that this group has traditionally faced a number of health disparities.

In terms of hospitalizations, the total number of persons with pneumonia listed as the first diagnosis on hospital discharge actually increased slightly among white patients (from 786,000 to 787,000) between 1996 and 2006, but it decreased for black patients during that same period, from 149,000 to 116,000; the incidence of pneumonia among all other races also decreased, from 49,000 to 41,000 [5]. Between 1996 and 2006, the rate of pneumonia as the first-listed diagnosis at hospital discharge increased slightly for those aged 45–64 years—from 32.3 to 33.4 per 10,000 population—but this rate decreased for all other age groups. For those younger than 15 years, the rate decreased from 33.0 to 28.3 per 10,000 population; for those aged 15–44 years, it decreased from 11.8 to 8.5 per 10,000 population; and for those older than 65 years, it decreased from 206.3 to 189.0 per 10,000 population [5].

When comparing annual death rates for pneumonia and influenza for various years, it is important to keep in mind that the population standard for calculating age-adjusted death rates changed in 1999. The new standard places more weight on death rates at older ages and less weight on death rates at younger ages. Because the incidence of lung diseases increases with age, death rates for pneumonia and influenza are higher when calculated using the new standard [5]. Another important change, which also took place in 1999, occurred when the International Classification of Diseases, 10th Revision (ICD-10) implemented the direct sequel rule for selecting the underlying cause of death, which mandated that causes of death be listed beginning with the most proximate cause and working back to the condition initiating the chain of events that led to death. Therefore, the underlying disease is listed as the cause of death, not pneumonia. Because pneumonia is often a final consequence of another chronic or acute condition, such as chronic obstructive pulmonary disease, pneumonia mortality statistics are particularly affected by this rule. The result of this change is that the death rate appears to have decreased sharply between 1998 and 1999 (from 34.6 deaths to 23.5 per 100,000 population), but much of this drop is likely due to the shift from ICD-9 to ICD-10 [12]. Because of these changes, it is difficult to draw conclusions when comparing data from 1998 and prior years with data from subsequent years [11, 12]. However, tracking of pneumonia outcomes since 1999 has been consistent.

Beginning with death rates compiled under the new standard in 1999 and comparing those more recent mortality statistics, pneumonia death rates have decreased significantly. Between 1999 and 2010, age-adjusted death rates for pneumonia and influenza decreased 35%, from 23.4 deaths per 100,000 [5] to 15.1 per 100,000 population [2]. Between 1999 and 2006, the age-adjusted death rate for white men fell from 27.7 to 20.9 per 100,000 population, and for white women it fell from 20.8 to 15.5 per 100,000 population [5]. For black men, the rate decreased from 32.4 to 24.4 per 100,000 population, and for black women it decreased from 21.3 to 16.7 per 100,000 population [5].

Vaccinations

Adherence to guidelines for health care–associated and community-acquired pneumonia has improved, particularly with regard to influenza vaccination rates. In the last quarter of 2003, the percentage of adults aged 50–64 years who had received an influenza vaccination in the previous 12 months was 36.8%; by 2011 that rate had increased to 42.7% [13]. The vaccination rate also increased among persons aged 18–49 years, from 16.4% in 2003 to 27.2% in 2011. The vaccination rate among patients aged 65 years or older was relatively unchanged during this period, at 65.5% in 2003 and 67% in 2011. This is unfortunate, given that elderly individuals are at higher risk for complications from respiratory infections. Fortunately, influenza vaccination rates for some high-risk groups have improved; for example, the percentage of adults with asthma who received an influenza vaccination increased from 40.4% in 2003 to 45.6% in 2008 [5].

Although the percentage of elderly patients receiving influenza vaccine has remained consistent, the rate of pneumococcal vaccination in elderly individuals has increased dramatically over the past decade or so. The ACIP recommends the 23-valent pneumococcal polysaccharide vaccine (PPSV23, or Pneumovax) for all adults aged 65 years or older [14]. In 2004 the National Nursing Home Survey, which is conducted by the CDC, addressed compliance with pneumococcal vaccination recommendations. The CDC reported that only 45.4% of nursing home residents had been vaccinated, while 36.8% had not been vaccinated; the vaccination status of 17.7% of residents was unknown [15]. According to the National Health Interview Survey, persons age 65 year or older—including persons who were not nursing home residents—yielded a similar pneumococcal vaccination rate of 42.6% in 1997 [16]. Since this stagnant period (1997–2004), the percentage of elderly patients receiving PPSV23 has improved, reaching 62.7% in 2011 [13]. Even with this significant increase in vaccination rates, most pop-

ulation studies reveal that immunization rates still fall far short of the IDSA goal of 90% [17].

Discussion

Over the past decade, the overall incidence of pneumonia has decreased significantly, and the death rates from pneumonia are also decreasing. The total number of cases of pneumonia also decreased despite an increase in the size of the US population. Although racial and ethnic disparities still exist, pneumonia outcomes appear to be improving for most groups. While a small increase in the incidence of pneumonia was observed for white persons, the death rate from pneumonia decreased in all racial groups (including whites). Similarly, people aged 45–64 years experienced a slight increase in the incidence of pneumonia, but death rates dropped for all age groups.

As described above, rates of vaccination with PPSV23 have improved. Although there is conflicting evidence regarding the effectiveness of PPSV23 [14], the vaccine is generally believed to decrease the incidence and severity of invasive pneumococcal disease. The use of the 13-valent pneumococcal conjugate vaccine (PCV13) in children may also have indirect beneficial effects in the future. The encouraging news is that more patients for whom pneumococcal vaccine is appropriate are being vaccinated; however, many eligible patients are still being missed. Fortunately, North Carolina's immunization process has resulted in vaccination rates for most diseases that are consistently above the national average [18].

Over the past 15 years, guidelines for the management and prevention of pneumonia in the community and in health care settings have been developed and subsequently updated. Core measures have also been developed by health care organizations, and both the incidence of pneumonia and death rates from pneumonia have decreased. It is extremely important to remember that correlation does not imply causation and that the improvement in pneumonia outcomes is likely due to multiple factors. Indeed, there are myriad factors other than the practice guidelines and core measures for pneumonia that could explain these improved outcomes.

Past studies of the epidemiology of pneumonia have not distinguished between community-acquired pneumonia and health care–associated pneumonia; hypothetically, if it were determined that most of the improvement in pneumonia outcomes was related to the latter rather than the former, then advances in technology and critical care medicine might deserved the credit. However, comparing current hospital data with outpatient data is not sufficient to distinguish between health care–acquired and community-acquired pneumonia, because some patients with community-acquired pneumonia are hospitalized. However, future assessments might be able to use billing and coding data to allow the 2 different types of pneumonia to be tracked separately or together.

Regardless of what we discover or what we may never know about pneumonia, a health care system that is seeing an increase in chronic diseases should welcome guidelines that seem to be correlated with improved outcomes for a disease that is a major cause of morbidity and mortality, both in North Carolina and in the rest of the nation. NCMJ

Bonzo Reddick, MD faculty physician, Family Medicine Residency, New Hanover Regional Medical Center, Wilmington, North Carolina.
Kimberly Howe, MD resident physician, Family Medicine Residency, New Hanover Regional Medical Center, Wilmington, North Carolina.

References

1. National Center for Health Statistics, Centers for Disease Control and Prevention (CDC). Leading Causes of Death, 1900-1998. CDC Web site. http://www.cdc.gov/nchs/data/dvs/lead1900_98.pdf. Accessed July 2, 2012.
2. Murphy SL, Xu J, Kochanek KD. Deaths: final data for 2010. Natl Vital Stat Rep. 2013;61(4):1-167. Hyattsville, MD: National Center for Health Statistics; 2013. http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_04.pdf. Accessed August 8, 2013.
3. Hoyert DL, Xu J. Deaths: preliminary data for 2011. Natl Vital Stat Rep. 2012;61(6):1-51. Hyattsville, MD: National Center for Health Statistics; 2012. http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_06.pdf. Accessed August 9, 2013.
4. Centers for Disease Control and Prevention (CDC). FastStats. Pneumonia. CDC Web site. http://www.cdc.gov/nchs/fastats/pneumonia.htm. Last updated April 5, 2013. Accessed July 1, 2013.
5. American Lung Association, Research and Program Services, Epidemiology and Statistics Unit. Trends in pneumonia and influenza morbidity and mortality. April 2010. http://www.lung.org/finding-cures/our-research/trend-reports/pi-trend-report.pdf. Accessed July 1, 2013.
6. Watkins RR, Lemonovich TL. Diagnosis and management of community-acquired pneumonia in adults. Am Fam Physician. 2011;83(11):1299-1306.
7. Mandell LA, Wunderink RG, Anzueto A, et al. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis. 2007;44(suppl 2):S27-S72.
8. American Thoracic Society; Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005;171(4):388-416.
9. Capelastegui A, España PP, Quintana JM, et al. Improvement of process-of-care and outcomes after implementing a guideline for the management of community-acquired pneumonia: a controlled before-and-after design study. Clin Infec Dis. 2004;39(7):955-963.
10. Kaplan V, Clermont G, Griffin MF, et al. Pneumonia: still the old man's friend? Arch Intern Med. 2003;163(3):317-323.
11. Centers for Disease Control and Prevention (CDC). CDC/NCHS National Hospital Discharge Survey, 2010. Number and rate of discharges from short-stay hospitals and days of care, with average length of stay and standard error, by selected first-listed diagnostic categories: United States, 2010. CDC Web site. http://www.cdc.gov/nchs/data/nhds/2average/2010ave2_firstlist.pdf. Accessed July 1, 2013.
12. Anderson RN, Miniño AM, Hoyert DL, Rosenberg HM. Comparability of cause of death between ICD-9 and ICD-10: preliminary estimates. Natl Vital Stat Rep. 2001;49(2):1-32. Hyattsville, MD: National Center for Health Statistics; 2001. http://www.cdc.gov/nchs/data/nvsr/nvsr49/nvsr49_02.pdf. Accessed July 4, 2013.
13. Centers for Disease Control and Prevention. Early Release of Selected Estimates Based on Data from the 2011 National Health Interview Survey. http://www.cdc.gov/nchs/data/nhis/earlyrelease/earlyrelease201206.pdf. Published June 19, 2012. Accessed September 18, 2013.
14. Centers for Disease Control and Prevention (CDC); Advisory Committee on Immunization Practices. Updated recommendations for prevention of invasive pneumococcal disease among adults using

the 23-valent pneumococcal polysaccharide vaccine (PPSV23). MMWR Morb Mortal Wkly Rep. 2010;59(34):1102-1106.

15. Centers for Disease Control and Prevention. Nursing Home Current Residents. June 2008. http://www.cdc.gov/nchs/data/nnhsd/Estimates/nnhs/Estimates_Diagnoses_Tables.pdf. Accessed September 18, 2013.

16. Centers for Disease Control and Prevention. Influenza and pneumococcal vaccination coverage among persons aged ≥65 years—United States, 2004–2005. MMWR Morb Mortal Wkly Rep. 2006;55(39):1065-1068. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5539a2.htm. Accessed September 18, 2013.

17. Adams PF, Kirzinger WK, Martinez ME. Summary health statistics for the US population: National Health Interview Survey, 2011. Data from the National Health Interview Survey. Vital Health Stat 10(255). Hyattsville, MD: National Center for Health Statistics; 2012. http://www.cdc.gov/nchs/data/series/sr_10/sr10_255.pdf. Accessed August 8, 2013.

18. North Carolina Immunization Branch. The North Carolina Immunization Registry (NCIR). North Carolina Department of Health and Human Services Web site. http://www.immunize.nc.gov/providers/ncir.htm. Accessed August 8, 2013.

Spread fun. Not Flu.

Even healthy kids of any age can get seriously sick from the flu, and they can spread it to family, friends, and others.

Everyone 6 months of age and older should get a flu vaccine every year.

Get Your Flu Vaccine. Not the Flu.
The flu benefit is a covered service for Medicare
and for children enrolled in Medicaid and CHIP.

For more information, visit http://www.flu.gov

Running the Numbers

A Periodic Feature to Inform North Carolina Health Care Professionals
About Current Topics in Health Statistics

Pneumococcal Vaccination Status of North Carolina Adults in 2011

Strains of *Streptococcus pneumoniae* (strep) bacteria are a known cause of serious bacterial infections, including meningitis, blood infections, ear infections, sinus infections, and most cases of pneumonia (pneumococcal pneumonia) [1]. Among North Carolina adults aged 18 years or older, there were 18 deaths with an International Classification of Diseases, 10th Revision (ICD-10) mortality code of J13 in 2011, and there were 1,285 inpatient hospitalizations with an International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis code of 481, meaning that those deaths and hospitalizations were attributable to *S. pneumoniae* pneumonia [2, 3]. In 2011 North Carolina's inpatient hospitalization charges related to pneumococcal pneumonia exceeded $62 million, with an average hospital length of stay of 8.7 days and an average charge of $48,584 per case [3].

The pneumococcal vaccine can prevent certain serotypes of pneumococcal infection [4], and vaccination of at-risk adults could reduce hospitalizations and deaths due to pneumococcal pneumonia among North Carolina residents. The Advisory Committee on Immunization Practices (ACIP) of the Centers for Disease Control and Prevention (CDC) recommends that all adults aged 65 years or older receive the pneumococcal vaccine. Additionally, the ACIP recently began recommending pneumococcal vaccine for adults aged 19–64 years who have certain chronic conditions or risk factors, including chronic obstructive pulmonary disease (COPD), asthma, cardiovascular disease, diabetes, kidney disease, and cigarette smoking [5]. Increasing the percentage of adults who are vaccinated against pneumococcal disease is an objective of the national Healthy People 2020 program; the goal is that 90% of noninstitutionalized US adults aged 65 years or older and 60% of high-risk adults aged 18–64 years will have received the pneumococcal vaccine by 2020 [6]. This report examines the prevalence of pneumococcal vaccination among North Carolina adults and the state's progress toward achieving these Healthy People 2020 targets.

Prevalence data for this report were derived from the 2011 Behavioral Risk Factor Surveillance System (BRFSS) survey of North Carolina adults [7]. The BRFSS survey is a random-digit-dial telephone survey of noninstitutionalized adults aged 18 years or older. The survey is conducted annually by state health departments in collaboration with the CDC. The BRFSS survey collects information on health behaviors, chronic conditions, and use of preventive care. The 2011 BRFSS survey included the following question regarding pneumococcal vaccination: "A pneumonia shot or pneumococcal vaccine is usually given only once or twice in a person's lifetime and is different from the flu shot. Have you EVER had a pneumonia shot?" [8]. Those who responded *yes* to this question comprised the pneumococcal vaccination group; those who responded *no* comprised the nonvaccinated group. Respondent groups targeted by Healthy People 2020 for pneumococcal vaccination were identified, including respondents aged 65 years or older, as well as respondents aged 18–64 years who reported the following chronic conditions or behaviors that place them at increased risk for pneumococcal infection: COPD, asthma, cardiovascular disease, kidney disease, or cigarette smoking.

A total of 3,525 North Carolinians aged 65 years

TABLE 1.

Pneumococcal Vaccination Rates for Respondents Aged 65 Years or Older, North Carolina Behavioral Risk Factor Surveillance System Survey, 2011

Respondent characteristic	Total no. of respondents with characteristic	Reported having received the pneumococcal vaccine		Reported not having ever received the pneumococcal vaccine	
		No. (%)[a]	95% CI	No. (%)[a]	95% CI
Total	**3,525**	**2,566 (72.1)**	**69.6–74.4**	**959 (27.9)**	**25.6–30.4**
Sex					
Male	1,230	881 (71.8)	67.5–75.8	349 (28.2)	24.2–32.5
Female	2,295	1,685 (72.2)	69.3–74.9	610 (27.8)	25.1–30.7
Race					
White	2,990	2,227 (74.5)	71.9–76.9	763 (25.5)	23.1–28.1
African American	420	274 (62.6)	54.9–69.8	146 (37.4)	30.2–45.1
Native American	54	—	—	—	—
Other minorities	44	—	—	—	—
Ethnicity					
Hispanic	55	—	—	—	—
Non-Hispanic	3,457	2,526 (72.2)	69.8–74.6	931 (27.8)	25.4–30.2
Age in years					
65–74	1,965	1,341 (66.9)	63.5–70.1	624 (33.1)	29.9–36.5
≥75	1,560	1,225 (78.6)	75.0–81.8	335 (21.4)	18.2–25.0
Education					
Less than high school	642	447 (68.6)	62.1–74.5	195 (31.4)	25.5–37.9
High school or GED	1,140	795 (69.5)	65.4–73.4	345 (30.5)	26.6–34.6
Some post–high school	820	634 (76.3)	71.6–80.4	186 (23.7)	19.6–28.4
College graduate	911	684 (75.0)	70.9–78.7	227 (25.0)	21.3–29.1
Household income					
Less than $15,000	448	314 (71.1)	64.4–77.0	134 (28.9)	23.0–35.6
$15,000–$24,999	758	548 (69.5)	63.3–75.0	210 (30.5)	25.0–36.7
$25,000–$34,999	426	316 (71.0)	63.3–77.7	110 (29.0)	22.3–36.7
$35,000–$49,999	407	316 (78.9)	72.3–84.3	91 (21.1)	15.7–27.7
$50,000–$74,999	306	220 (75.9)	67.3–82.8	86 (24.1)	17.2–32.7
$75,000 or more	320	237 (70.8)	62.4–78.0	83 (29.2)	22.0–37.6
Disability status					
Yes	1,405	1,094 (76.5)	72.5–80.0	311 (23.5)	20.0–27.5
No	2,103	1,461 (69.2)	66.0–72.3	642 (30.8)	27.7–34.0
Veteran status					
Veteran	746	555 (75.9)	70.7–80.4	191 (24.1)	19.6–29.3
Nonveteran	2,779	2,011 (70.9)	68.0–73.5	768 (29.1)	26.5–32.0

Note. CI, confidence interval; GED, Certificate of High School Equivalency obtained by passing General Educational Development tests. Column totals may not add up to the overall total because some values for demographic characteristics are missing. Estimates based on a small number of respondents have been suppressed because they do not meet statistical reliability standards.
[a]Percentages shown are weighted percentages, designed to reflect the adult population of North Carolina.

or older responded to the BRFSS pneumonia vaccine question in 2011 (Table 1). Overall, 72.1% of elderly respondents reported having received the pneumococcal vaccine (95% confidence interval [CI], 69.6–74.4). This figure falls well below the Healthy People 2020 target vaccination rate of 90% for elderly individuals. Within this group, the vaccination rate was higher among respondents aged 75 years or older; this group had a vaccination rate of 78.6% (95% CI, 75.0–81.8), compared with a vaccination rate of 66.9% (95% CI, 63.5–70.1) for respondents aged 65–74 years. Elderly respondents with a disability were slightly more likely to report having received the pneumonia vaccine; in this

group, the vaccination rate was 76.5% (95% CI, 72.5–80.0), compared with a vaccination rate of 69.2% (95% CI, 66.0–72.3) for those who did not report having a disability. The vaccination rate was also higher among elderly respondents who were white; 74.5% of respondents in this group had been vaccinated (95% CI, 71.9–76.9), compared with 62.6% of elderly African American respondents (95% CI, 54.9–69.8). Rates for other racial groups and Hispanic individuals were not calculated because the number of elderly respondents in those demographic categories was too small to meet standards of statistical reliability. Pneumococcal vaccination rates among elderly individuals did not vary significantly by sex, education level, household income, or veteran status.

More than 2,600 North Carolinians (N = 2,624) aged 18–64 years who had chronic conditions or risk factors responded to the BRFSS question on pneumonia vaccination (Table 2). The pneumococcal vaccination rate for nonelderly adults with chronic conditions or risk factors was 27.7% (95% CI, 25.2–30.3); this rate was significantly lower than the 72.1% vaccination rate for elderly adults (95% CI, 69.6–74.4). Additionally, North Carolina's pneumonia vaccination rate for nonelderly adults with chronic health conditions or risk factors was less than half the Healthy People 2020 target of 60% for that group. Respondents aged 18–64 years who were current smokers had the lowest vaccination rates; only about 1 in 5 people in this group—19.9% (95% CI, 17.0–23.1)—reported that they had received the pneumonia vaccine. Vaccination rates were higher for those with chronic health conditions (ranging from 42.4% to 53.8%), but none of the chronic condition groups achieved the Healthy People 2020 target rate of 60%.

Based on North Carolina BRFSS survey data for 2011, North Carolinians aged 65 years or older and those aged 18–64 years with chronic conditions or other risk factors have pneumococcal vaccination rates that fall well below national targets estab-

TABLE 2.

Pneumococcal Vaccination Rates for Respondents Aged 18-64 Years with Selected Chronic Conditions or Risk Factors, North Carolina Behavioral Risk Factor Surveillance System Survey, 2011

Chronic condition or risk factor	Total no. of respondents with characteristic	Reported having received the pneumococcal vaccine		Reported not having ever received the pneumococcal vaccine	
		No. (%)[a]	95% CI	No. (%)[a]	95% CI
Total	**2,624**	**910 (27.7)**	**25.2-30.3**	**1,714 (72.3)**	**69.7-74.8**
Current smoker					
Yes	1,404	348 (19.9)	17.0-23.1	1,056 (80.1)	76.9-83.0
No	1,215	559 (39.7)	35.5-44.2	656 (60.3)	55.8-64.5
History of CVD					
Yes	510	267 (45.4)	38.9-52.0	243 (54.6)	48.0-61.1
No	2,084	631 (24.6)	21.9-27.5	1,453 (75.4)	72.5-78.1
COPD					
Yes	478	265 (53.0)	46.3-59.7	213 (47.0)	40.3-53.7
No	2,133	639 (23.5)	20.9-26.3	1,494 (76.5)	73.7-79.1
Current asthma					
Yes	590	289 (42.4)	36.2-48.9	301 (57.6)	51.1-63.8
No	2,020	617 (23.5)	21.0-26.3	1,403 (76.5)	73.7-79.0
Diabetes					
Yes	708	367 (44.3)	39.0-49.8	341 (55.7)	50.2-61.0
No	1,910	543 (23.1)	20.3-26.1	1,367 (76.9)	73.9-79.7
Kidney disease					
Yes	154	79 (53.8)	42.3-64.9	75 (46.2)	35.1-57.7
No	2,459	824 (26.5)	23.9-29.2	1,635 (73.5)	70.8-76.1

Note. CI, confidence interval; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease.
Column totals may not add up to the overall total because some values for demographic characteristics are missing.
[a]Percentages shown are weighted percentages, designed to reflect the adult population of North Carolina.

lished by the Healthy People 2020 program. These results suggest that the state should increase its efforts to identify and inform vulnerable adults about the importance of the pneumococcal vaccine in preventing hospitalizations and deaths related to pneumococcal pneumonia. NCMJ

Kathleen Jones-Vessey, MS statistical services unit manager, State Center for Health Statistics, Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.
**Donald Akin, MS** statistician, State Center for Health Statistics, Division of Public Health, North Carolina Department of Health and Human Services, Raleigh, North Carolina.

References
1. Ortqvist A, Hedlund J, Kalin M. Streptococcus pneumoniae: epidemiology, risk factors, and clinical features. Semin Respir Crit Care Med. 2005;26(6):563-574.
2. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. 2011 North Carolina Resident Mortality [data file].
3. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. 2011 North Carolina Inpatient Hospital Discharges [data file].
4. Lynch JP 3rd, Zhanel GG. *Streptococcus pneumoniae*: epidemiology and risk factors, evolution of antimicrobial resistance, and impact of vaccines. Curr Opin Pulm Med. 2010;16(3):217-225.
5. Centers for Disease Control and Prevention (CDC). Advisory Committee on Immunization Practices. Updated recommendations for prevention of invasive pneumococcal disease among adults using the 23-valent pneumococcal polysaccharide vaccine (PPSV23). MMWR Morb Mortal Wkly Rep. 2010;59(34):1102-1106.
6. US Department of Health & Human Services. Office of Disease Prevention and Health Promotion. Healthy People 2020. Immunization and infectious diseases objectives, IID-13. HealthyPeople.gov Web site. http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicid=23. Page last updated July 30, 2013. Accessed August 12, 2013.
7. North Carolina State Center for Health Statistics (NCSCHS). Behavioral Risk Factor Surveillance System (BRFSS). NCSCHS Web site. http://www.schs.state.nc.us/units/stat/brfss/. Page last updated July 15, 2013. Accessed September 17, 2013.
8. North Carolina State Center for Health Statistics (NCSCHS). BRFSS – Annual Questionnaires. NCSCHS Web site. http://www.schs.state.nc.us/units/stat/brfss/questions.htm. Page last updated June 20, 2013. Accessed September 17, 2013.
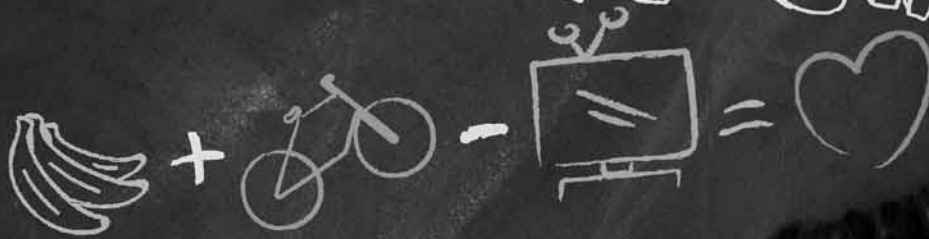
Issue Brief

Promoting Healthy Weight for Young Children
A Blueprint for Preventing Early Childhood Obesity in North Carolina
September 2013

Obesity has become a leading health issue over recent decades. Obesity complicates existing health problems, creates increased risks for disease and other health conditions, and can substantially reduce length and quality of life. The adverse outcomes of obesity can occur throughout a person's lifetime—from childhood to adulthood. Despite this, there is often little focus on obesity among very young children, ages 0-5 years. Focusing on early childhood obesity prevention can help promote child health and can reduce risk factors that contribute to chronic illnesses among adults. Young children who are obese are more likely to become obese adults. Therefore, reaching this population is not only an opportunity for obesity prevention, but also an opportunity to prevent obesity-associated health problems from occurring in the adult population.

Obesity often starts in very young children. One in every 10 preschool-aged children in the United States was considered obese in 2010.[1] The North Carolina Pediatric Nutrition Surveillance System, which collects data on low-income children ages 0-4 years, shows that the obesity epidemic affects even the youngest individuals in the state. Roughly 3 out of every 10 (28.5%) low-income young children ages 2-4 years are either overweight or obese in North Carolina. Over the past 30 years, the obesity rate has more than doubled among young children ages 2-4 years in North Carolina, increasing from 6.9% in 1981 to 15.4% in 2011. The percentage of overweight children in this age group also increased during this time from 11.7% in 1981 to 16.2% in 2011.[2]

Evidence shows that being overweight or obese in very early childhood is associated with an individual's future body weight. According to a longitudinal study of approximately 1,000 children, children who were overweight at ages 24,

> *Roughly 3 out of every 10 (28.5%) low-income young children ages 2-4 years are either overweight or obese in North Carolina.*

36, or 54 months were 5 times more likely to be overweight at age 12 years than those children who were not overweight at those ages.[3] Further, a study of about 800 individuals found that obese children over the age of 6 have more than a 50% probability of becoming obese adults compared to a 10% probability for non-obese children.[4]

The potential health impacts caused by being overweight or obese are extensive. Excess weight can negatively affect most organ systems including the circulatory, cardiovascular, skeletal, respiratory, reproductive, and digestive systems. People who are overweight or obese are more likely to develop type 2 diabetes, high blood pressure, heart disease, certain cancers, and stroke.[5] Other complications stemming from being overweight or obese include high cholesterol, sleep apnea, osteoarthritis, liver and gall bladder disease, and gynecological problems.[6]

The majority of studies about the adverse health impacts of obesity among children are from studies with older children; however, there are some studies that show the health impacts of obesity in children ages 0-5 years.[7,8] While some of these adverse health consequences can take years to develop (such as cancer), others are evident in the shorter-term (such as type 2 diabetes), cardiovascular disease risk factors (such as elevated cholesterol, insulin, or blood pressure),[9] sleep apnea, bone and joint problems, and social and psychological problems.[10] Obesity is a multifactorial health outcome influenced by factors such as lifestyle, family history, community and environment, and genetics. As such, there is no one way to prevent obesity. However, there are many interventions that have been proven effective. Increasing physical activity, improving nutrition practices, reducing screen time, and improving sleep duration are ways to reduce a young child's risk for obesity. At the request of the Blue Cross and Blue Shield of North Carolina Foundation (BCBSNC Foundation), the North Carolina Institute of Medicine (NCIOM) convened a task force to develop a blueprint to promote healthy weight and to prevent and reduce early childhood obesity. The NCIOM Task Force on Early Childhood Obesity Prevention (ECOP) was a collaborative effort between the BCBSNC Foundation, the North Carolina Partnership for Children (NCPC), and the NCIOM.

North Carolina Institute of Medicine
In collaboration with the Blue Cross Blue Shield of North Carolina Foundation and the North Carolina Partnership for Children

The ECOP Task Force was charged with examining recommendations of evidence-based and evidence-informed strategies from prior North Carolina and national task forces that focused on reducing childhood obesity, and developing a blueprint to prevent or reduce early childhood obesity in North Carolina. In essence, the blueprint for action includes the strategies needed to implement these recommendations. It includes the lead organizations and partners needed to implement the strategies, necessary funding and resources, and performance measures for evaluation. The blueprint is intended to serve as a common guide to focus the work of child care professionals, health professionals, public health professionals, state and local policymakers, nonprofits, and funders at the state, local, and, when appropriate, national level, who are interested in promoting healthy weight among young children in North Carolina.

The Task Force was co-chaired by Kathy Higgins, president, Blue Cross and Blue Shield of North Carolina Foundation, and Olson Huff, MD, former chair, North Carolina Partnership for Children, Inc, and chair, North Carolina Early Childhood Foundation. They were joined by more than 70 other ECOP Task Force members including state and local policymakers, health professionals, public health professionals, child care providers, nutrition experts, faith community representatives, nonprofit community organizations, and philanthropic organizations. The ECOP Task Force met 14 times between September 2011 and May 2013 and developed a total of 15 strategies in the clinical, community/environment, and policy areas.

Focusing on early childhood obesity prevention can help promote child health and can reduce risk factors that contribute to chronic illnesses among adults.

Clinical Strategies

Studies have shown that health professionals play an important role in promoting healthy behaviors. Health professionals should assess the weight status of young children; provide valuable information to parents and other caregivers about healthy weight, nutrition, physical activity, and community resources; and refer patients for additional treatment when appropriate. The academic preparation of health professionals is important in ensuring they have the knowledge, skills, and self-efficacy to perform these tasks. Thus, the ECOP Task Force developed a strategy to **increase and enhance the education of health professionals while in training (pre-service) or in residency programs**. In

addition, to ensure that new health professionals are adequately trained in this area, a strategy was developed to **expand education for practicing health professionals, which could be met through enhanced continuing education opportunities**.

The Affordable Care Act requires coverage for services related to the prevention or treatment of early childhood obesity and includes assessment of weight for height and BMI percentile and obesity counseling.[11] However, it does not mandate how insurers pay for these services. Many insurers may be covering this as part of the well-child check-up and may not be providing additional reimbursement to encourage health professionals to spend the time necessary for obesity counseling. Thus, a strategy of the ECOP Task Force is to **ensure adherence of insurers/payers to the Affordable Care Act requirements for coverage of the prevention, diagnosis, and treatment of obesity (and as outlined in the American Academy of Pediatrics' Bright Futures guidelines), and to ensure payment for these services**.

One of the barriers identified during ECOP Task Force meetings was the lack of community referral resources for health professionals to use with their patients and families. Therefore the ECOP Task Force developed a strategy that local health departments work with appropriate partners to **convene a group to identify and catalog core statewide and local services, resources, and supports for health professionals to refer families and children for additional support or intervention to enhance clinical recommendations**.

Community and Environment Strategies

In North Carolina, there are a few community and environment obesity prevention initiatives that focus on promoting healthy weight among very young children ages 0-5 years. The ECOP Task Force built on existing efforts and identified other strategies to reach these young children. Three of the five priority community/environment strategies focus on child care programs since most children ages 0-5 years spend part of their early childhood in child care programs. In fact, at any point in time, one in four children in this age group are in licensed, regulated child care programs. Throughout the year, many more children spend time in child care programs, as many families enroll and disenroll.

There has already been considerable effort to implement evidence-based and evidence-informed physical activity and nutrition strategies in child care programs through existing programs like Shape NC, Nutrition and Physical Activity Self Assessment in Child Care (NAP SACC), Preventing Obesity by Design (POD), and Be Active Kids®. The ECOP Task Force members believed it was both important and practical to support the progress made in improving health and wellness in pilot child care centers, and to then spread the innovations to other child care programs across the

2

state. To build on the existing efforts, the ECOP Task Force developed a strategy to **expand the use of evidence-based and evidence-informed strategies for physical activity and nutrition in pilot child care centers**.

Just as there is a need to enhance training for health professionals about strategies to promote healthy weight and reduce early childhood overweight and obesity, there is also a need to provide enhanced training for child care professionals. Therefore, a strategy was developed to **provide pre-service and in-service education for child care providers on evidence-based and evidence-informed strategies for physical activity and nutrition**. In-service training is also important for the consultants or technical assistance staff who are in frequent contact with the staff in child care programs. If trained, these consultants can provide child care professionals with consistent health information about childhood overweight and obesity and can help provide technical assistance about appropriate prevention strategies. Therefore, a strategy was developed to **cross-train all child care consultants and other support personnel on evidence-based and evidence-informed strategies for physical activity and nutrition**.

Not all children ages 0-5 years can be reached through child care or early education settings. Thus, the ECOP Task Force developed other strategies to reach young children and their families. The first is to **increase Eat Smart, Move More North Carolina's focus on young children and their families**. Eat Smart, Move More North Carolina is a coalition of more than 80 organizations working to promote opportunities for healthy eating and physical activity in the community in order to help people achieve a healthy weight.[12] The second is to **form an ECOP Communications Committee to develop a communications campaign to support policy and behavior change to reduce early childhood obesity**.

Policy Strategies

The ECOP Task Force's policy strategies focus primarily on voluntary efforts that the state can take to improve early childhood nutrition, expand physical activity, enhance the outdoor learning environment, and support breastfeeding. In addition, the ECOP Task Force included strategies aimed at changing Medicaid payment policies.

The ECOP Task Force recommended the **creation of a voluntary recognition program for child care programs and early education programs that meet enhanced physical activity and nutrition standards**. These standards may include new nutrition standards for licensed child care facilities, a requirement for increased time in active play, and/or more limted screen time. This recognition system would be voluntary, not mandatory, (more like a "Good Housekeeping Seal of Approval") and could help lead to system change over time.

Home visiting programs like the Nurse Family Partnership and Healthy Families America rely on trained professionals who work directly with at-risk families, and thus have an opportunity to provide valuable information on healthy weight and obesity directly to the families. Interventions that include parental involvement and the home setting are more likely to result in better weight outcomes than programs provided only in the school environment or other non-home settings.[13] Therefore, the ECOP Task Force recommended **enhancing family education about early childhood healthy weight and obesity prevention strategies through existing maternal, infant, and early childhood home visiting and family strengthening programs**.

The concept of healthy community design is based on the tenet that both the physical built environment and the food environment are important ways to respond to the obesity epidemic and related chronic diseases. Increasing access to healthy foods and places to be active is an integral part of a larger strategic plan to help individuals maintain healthy weight and reduce chronic diseases. All North Carolina agencies that make decisions affecting the built environment and food environment should consider the impact their decisions have on the health and well-being of younger North Carolinians. Ensuring equitable access to opportunities for physical activity, as well as to healthy and affordable food, should also be part of the planning process. Therefore, the ECOP Task Force included a strategy to **expand the focus of state agencies to include early childhood health, physical activity, and nutrition through healthy community design**.

Having data to create an understanding of the current health status and behaviors of very young children and their environments is necessary to know how best to target interventions and to measure collective success in preventing obesity within this age group. Currently there is no source of information on the BMI of all young children in the state—only for low-income children. North Carolina needs consistent, reliable data on the BMI of a cross-section of all young children to be able to assess whether interventions are helping improve healthy weight among young children. Two strategies in the blueprint address the issue of gathering useful, reliable data. The first strategy is to **improve the collection and reporting of physical activity and nutrition data in multiple settings to more fully promote healthy weight among young children**. The second is to **improve the collection of BMI data for young children and make the information available to policymakers, health professionals, and the public to evaluate existing programmatic and policy initiatives and to inform future ones**.

The last policy strategy of the ECOP Task Force is to **promote breastfeeding for more North Carolina infants through Medicaid**. Children who have been breastfed are less likely to develop acute disease in childhood or chronic illness such diabetes and heart disease later in life.[14] In addition, breastfeeding may offer modest protection against

3

obesity. Although private insurers are required to provide coverage of lactation support and counseling, and help pay for breastfeeding equipment, this same mandate does not apply to Medicaid. Current data suggests that Medicaid-eligible women are less likely to breastfeed than are women with other insurance coverage.

Conclusion

A young child's weight is influenced by his or her family, the community or environment in which he or she lives, public policies, and clinical interventions. Because the underlying factors that contribute to early childhood overweight or obesity are multifaceted, the interventions must be similarly targeted to those different levels of influence. Multifaceted interventions have a far greater likelihood of improving population health than any single intervention.[15]

Progress in early childhood obesity prevention cannot be accomplished through one method, one policy, one funder, or any one type of intervention; and it can certainly not be done alone. The ECOP Task Force's blueprint builds on resources and partners already dedicated to improving child health, and it depends heavily on those settings where very young children can best be reached. This blueprint is an invitation to any stakeholder interested in the health and well-being of young children to work collectively to address this critical problem. There is a role for everyone to play in ensuring a healthy start for our youngest children.

References

1. Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion. Overweight and Obesity. http://www.cdc.gov/obesity/index.html. Published December 21, 2012. Accessed April 5, 2013.
2. Centers for Disease Control and Prevention. Nutrition Services Branch, Women's and Children's Health, NC Division of Public Health, NC Department of Health and Human Services. 2011 Pediatric Nutrition Surveillance: North Carolina Summary of Demographic Indicators Children Aged < 5 Years. http://www.nutritionnc.com/pdfPregPed/PNSS/PedNSS2011StateTables.pdf. Published March 13, 2012. Accessed April 5, 2013.
3. Nader PR, O'Brien M, Houts R, et al. Identifying risk for obesity in early childhood. *Pediatrics.* 2006;118(3):e594-601.
4. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med.* 1997;337(13):869-873.
5. Division of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. Overweight and Obesity: Causes and Consequences. http://www.cdc.gov/obesity/adult/causes/index.html. Published April 27, 2012. Accessed April 5, 2013.
6. Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. About BMI for Adults. http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html. Published September 13, 2011. Accessed April 5, 2013.
7. Skinner AC, Steiner MJ, Perrin EM. Healthy for now? A cross-sectional study of the co-morbidities in obese preschool children in the united states. *Clin Pediatr.* 2010;49(7):648.
8. Skinner AC, Steiner MJ, Henderson FW, Perrin EM. Multiple markers of inflammation and weight status: Cross-sectional analyses throughout childhood. *Pediatrics.* 2010;125(4):1.
9. Freedman DS, Mei Z, Srinivasan SR, Berenson GS, Dietz WH. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: The bogalusa heart study. *J Pediatr.* 2007;150(1):12-17.e2.
10. Centers for Disease Control and Prevention. Childhood Obesity Facts. http://www.cdc.gov/healthyyouth/obesity/facts.htm. Published February 19, 2013. Accessed April 5, 2013.
11. HealthCare.gov Website. 27 Covered Preventive Services for Children. US Department of Health & Human Services website. http://www.healthcare.gov/news/factsheets/2010/07/preventive-services-list.html#CoveredPreventiveServicesforChildren. Published September 23, 2010. Published September 27, 2012. Accessed April 5, 2013.
12. Eat Smart, Move More NC. Leadership Team. http://www.eatsmartmovemorenc.com/ESMMLeadership/ESMMLeadership.html. Published April 15, 2013.
13. Casazza K, Fontaine KR, Astrup A, et al. Myths, presumptions, and facts about obesity. *N Engl J Med.* 2013;368(5):446-454.
14. Mims SR, Lisenbee JH. Maternal care practices and breastfeeding in north carolina: Becoming baby-friendly. *N C Med J.* 2013;74(1):44-47.
15. Bernstein R. *Praxis and Action.* Ed. Anonymous Philadelphia: University of Pennsylvania Press; 1971.

North Carolina Institute of Medicine
shaping policy for a healthier state

630 Davis Drive, Suite 100 • Morrisville, NC 27560 • 919.401.6599 • www.nciom.org • www.ncmedicaljournal.com

I WILL MOVE MORE!

EMPOWER YOURSELF.

Don't sweat it – you can do it!

Walk, jog or go for a bike ride with the kids – just get your heart pumping at least 30 minutes a day. Can't squeeze in 30 minutes? Break it up into 10 minute intervals, 3 times a day to fit your schedule better. It all adds up. Get moving and make small changes that can have a big effect on your life.

Remember: 30 minutes a day is all it takes. So start today!

For more ways to get and stay active, visit:

www.MyEatSmartMoveMore.com

Eat Smart Move More
NORTH CAROLINA ™

| RIGHT SIZE YOUR PORTIONS | MOVE MORE | WATCH LESS TV | EAT MORE FRUITS & VEGGIES | PREPARE MORE MEALS AT HOME | DRINK MORE WATER |

Translating Tuberculosis Research into Practice:
Collaboration Between Academic Researchers and Public Health Departments in North Carolina

David P. Holland, Emily J. Hecker, Ann W. Mosher, Jason E. Stout

Successful collaborations between academic researchers and local health departments are vital for public health research, but developing and maintaining such partnerships is often difficult. However, in the North Carolina Tuberculosis Control Program, such partnerships have flourished and have led to notable improvements in patient care.

Between 1995 and 2010, medical consultants for the North Carolina Tuberculosis Control Program initiated and conducted 7 different studies, which were published in 6 papers [1-6]. During that same period, other researchers published the results of 2 multicenter clinical trials of tuberculosis treatment, both of which included sites in North Carolina [7, 8]. All 9 studies had a direct impact on clinical practice, with rapid movement from study results to policy changes and improved patient care. We describe these studies and discuss how close ties between academic researchers and public health professionals in North Carolina have promoted rapid implementation of evidence-based tuberculosis treatment.

Background

Collaborations between academic institutions and local health departments have long been critically important to the success of public health research; indeed, without the combined resources of both entities, some questions would be impossible to answer. In tackling such problems, the university brings expertise, funding, and occasionally additional staff members, while the health department brings practical knowledge of the target community and, most importantly, access to patients.

Although academic researchers often design studies and then seek to collaborate with public health departments, the cooperation between academic centers and local health departments does not (and should not) always begin with a study protocol. Researchers often get their ideas for studies through contact with local public health providers and patients. Such contact can (and should) lead to collaborative research projects that fully and equitably call on the strengths of both the academic researchers and the public health providers. Such cooperation is a component of what

is now called *community-based participatory research*, which has been identified as an area of focus for future public health education by the Institute of Medicine of the National Academies [9].

Despite these advantages, collaborations between academic researchers and public health departments are often difficult to establish and maintain. Barriers to research at local health departments include limited capacity, the perception that research has little relevance to the functions of the health department, uncertainty regarding how research fits into the professional roles of health department staff members, and the perception that university researchers are out of touch with the needs of the community [10]. That said, health department staff members believe that research contributes to their knowledge, their professional growth, and improvements in clinical practice [10].

Of course, there are many examples of successful partnerships. In this paper, we describe one such partnership and show how collaboration between an academic medical center and a local tuberculosis control program led directly to changes in public health policy that benefited both staff members and patients.

Translating Study Results into Improved Patient Care

In 2011 North Carolina had 244 cases of active tuberculosis [11]. By law, all patients in the state who are receiving treatment for active tuberculosis must have each dose directly observed by a health care worker [12]. Thus, virtually all individuals with tuberculosis are treated through local health departments, in most cases using standardized protocols. For complicated cases, medical consultative services are provided by 2 faculty members in the Division of Infectious Diseases at Duke University Medical Center (D.P.H. and J.E.S.). Within North Carolina, Wake County is

the second most populous county, but it has the highest case rate for tuberculosis. J.E.S. serves at the staff physician for Wake County's tuberculosis clinic.

In this section, we describe and discuss several tuberculosis research projects that were conducted at sites in North Carolina. These 9 studies are summarized in Table 1.

Human immunodeficiency virus (HIV) testing in tuberculosis patients. One of the first studies we performed was a retrospective review of all patients treated for tuberculosis in North Carolina during the period 1993–1999 [1]. Of the 3,119 tuberculosis patients for whom information about HIV testing was reported, more than 34% had not received HIV testing; 604 (19%) of these 3,119 patients had never been offered the test, and 465 (15%) had refused HIV testing. HIV testing appeared to be targeted to those individuals thought to be at high risk of infection, but many patients with epidemiologic risk factors for HIV infection were not offered testing.

In 2007 North Carolina discontinued its policy of requiring HIV pretest counseling. Immediately afterward, the North Carolina Tuberculosis Control Program instituted a policy of offering opt-out HIV testing to all tuberculosis patients, regardless of their perceived risk for HIV infection. As a result of this change, HIV testing of tuberculosis patients dramatically increased. In 2008 only 3 (0.9%) of 335 tuberculosis patients were not offered HIV testing [13], and in 2010 only 1 patient was not offered HIV testing [14]. In the latter case, the patient died just 2 days after beginning tuberculosis treatment, before HIV testing could be offered.

Isoniazid (INH) and rifapentine in the continuation phase of tuberculosis treatment. The Tuberculosis Trials Consortium (TBTC) is a multisite clinical trials group funded by the Centers for Disease Control and Prevention (CDC) and tasked with conducting "programmatically relevant" research regarding tuberculosis diagnostics and therapeutics. One such project was TBTC Study 22 [7], which demonstrated the efficacy of once-weekly administration of INH and rifapentine in the continuation phase of tuberculosis treatment for HIV-negative patients with no cavitary lesions on initial chest radiograph. Several North Carolina sites participated in this study. Study 22 also showed that individuals with cavitary disease and positive mycobacterial sputum cultures at 8 weeks had a probability of relapse greater than 20%, even when they were treated with standard therapy of INH, rifampin, ethambutol, and pyrazinamide for 2 months followed by INH and rifampin for 4 months. This latter finding was later supported by the results of a retrospective systematic review that assessed clinical trials of rifamycin-containing treatment regimens [15].

As a result of these findings, the North Carolina Tuberculosis Control Program added once-weekly combination therapy with INH and rifapentine to its list of approved treatment regimens. Additionally, anticipating CDC recommendations in advance of published guidelines, we extended treatment duration to 9 months for all patients with cavitary disease and for those whose sputum cultures were positive after 2 months of treatment.

Rifampin plus pyrazinamide for treatment of latent tuberculosis infection. Rifampin plus pyrazinamide has been used in selected patients for the treatment of latent tuberculosis infection since 1999. After reports of fatal hepatotoxicity related to this regimen began to emerge [16], we conducted a retrospective review of 114 patients who had received this regimen at Wake County Human Services between December 1999 and May 2002 [2]. In this cohort, 67.5% of individuals completed the full course of therapy, which is a good rate of completion, considering that 60.5% of the study population was homeless. Of the 114 patients who did not complete therapy, 8 patients (7%) stopped therapy due to toxicity, and 106 patients (93%) were lost to follow-up. Unfortunately, 5.3% of patients taking the regimen acquired confirmed or suspected hepatitis during treatment.

In response to these data, we decided to place stringent controls on use of combination therapy with rifampin and pyrazinamide, although we did not go so far as to completely discontinue use of this treatment regimen. The regimen can now be prescribed only with the approval of the medical director of the North Carolina Tuberculosis Control Program and must be given according to a strict clinical protocol under the direct supervision of a physician (ie, there are no nursing protocols). We have had no deaths or hospitalizations from this regimen.

Epidemiology of pediatric tuberculosis. To learn more about the epidemiology of pediatric tuberculosis in North Carolina, we reviewed all 180 tuberculosis cases that occurred among children in the state from January 1, 1994, to December 31, 2002 [3]. We found that pediatric tuberculosis in North Carolina is limited almost entirely to African American and Hispanic children; specifically, 88.3% of the pediatric patients with tuberculosis in our study were non-white. Furthermore, one-third of these pediatric tuberculosis cases were "foreign-associated" (either the child was foreign-born, or the parents of the child were foreign-born); half of these foreign-associated cases were in US-born children of foreign-born parents [3].

Pilot screening program for pediatric tuberculosis. As a result of our epidemiologic study of pediatric tuberculosis in North Carolina, we designed a pilot screening program for US-born children of foreign-born parents who had emigrated from tuberculosis-endemic regions; this program was carried out in the Wake County Human Services pediatric clinic [3]. Beginning in July 2004, all children who met the aforementioned screening criteria were administered a tuberculin skin test; if the test result was positive, they were treated for latent tuberculosis infection. Unfortunately, the yield of this screening program was quite low, with only 0.32% of US-born children of foreign-born parents having a positive tuberculin skin test result. Thus the project was discontinued after about 5 months. (Sometimes, our projects show us what does *not* work.)

TABLE 1.
Research Projects Conducted from 2002 to 2010 that Impacted Policy and Patient Care in the North Carolina Tuberculosis Control Program

Project	Description	Findings	Policy impact
HIV testing in tuberculosis patients [1]	This study assessed HIV testing practices for tuberculosis patients in North Carolina from 1993 to 1999.	• At least 34% of tuberculosis cases had not been tested for HIV. • HIV testing seemed to be targeted at groups believed to be at high risk. • Although HIV testing rates had improved over time, many persons had not been offered HIV testing.	• North Carolina now provides opt-out HIV testing to all tuberculosis patients regardless of age or perceived risk. • In 2008 only 3 (0.9%) of 335 patients were not offered HIV testing, and only 11 (3.3%) refused testing.
Rifapentine and INH in the continuation phase of tuberculosis treatment (TBTC Study 22) [7]	This study compared the safety and efficacy of once-weekly rifapentine and INH to twice-weekly rifampin and INH in the continuation phase of treatment for pulmonary tuberculosis. Several North Carolina sites participated.	• Once-weekly INH and rifapentine is safe and effective in the continuation phase of treatment for HIV-negative patients without cavitary disease. • Relapse was associated with acquired rifamycin resistance in HIV-positive patients with lower CD4+ cell counts. • Failure/relapse in HIV-negative patients was associated with cavitation on chest radiograph and a positive sputum culture at 2 months.	• INH and rifapentine can be used in the continuation phase of treatment if the patient is HIV-negative, has no cavitary disease, and has negative sputum cultures at 8 weeks. • All patients with cavitary disease and positive sputum cultures at 8 weeks must have 9 months of treatment.
Rifampin plus pyrazinamide for treatment of latent tuberculosis infection [2]	This study evaluated the safety and tolerability of 2 months of rifampin plus pyrazinamide for treatment of latent tuberculosis infection in 114 patients in Wake County, North Carolina, 60.5% of whom were homeless.	• 67.5% completed therapy. • 5.3% developed confirmed or suspected hepatitis. • There were no hospitalizations or deaths.	• Rifampin plus pyrazinamide may only be used when a strict clinical protocol is being followed under the direction of a physician. • Use of rifampin plus pyrazinamide must be approved by the medical director of the North Carolina Tuberculosis Control Program.
Epidemiology of pediatric tuberculosis [3]	This study examined the epidemiology of tuberculosis in children in North Carolina from 1994 to 2002 (180 cases).	• Most cases of pediatric tuberculosis in North Carolina occurred in children who were African American or Hispanic. • 1/3 of pediatric tuberculosis cases were "foreign-associated." • Half of foreign-associated cases were US-born children of foreign-born parents.	• A pilot screening program of US-born children of foreign-born parents was initiated at the pediatric clinic at Wake County Human Services, but yield for latent tuberculosis infection was low. • The project was discontinued, and such screening is not recommended.
Twice-weekly treatment of HIV-related tuberculosis (TBTC Study 23) [8]	This study evaluated the rate of confirmed treatment failure and relapse with an intermittent rifabutin-based regimen for the treatment of HIV-related tuberculosis. Several North Carolina sites participated.	• 5.3% of subjects had treatment failure or relapse. • Failure or relapse was associated with low CD4+ cell count (<100 cells/μL) at baseline. • 89% of subjects with treatment failure or relapse had acquired rifamycin resistance.	• Recent CD4+ cell count (within 3 months) is required for patients coinfected with HIV and tuberculosis. • Those with a low CD4+ cell count (<100 cells/μL) at the initiation of tuberculosis therapy receive a daily regimen for the entire course of therapy.
Therapeutic drug monitoring in patients coinfected with HIV and tuberculosis [4]	Conducted between March 2002 and September 2007, this study analyzed INH and rifampin concentrations for 21 patients coinfected with HIV and tuberculosis who had a low CD4+ cell count (<100 cells/μL). Levels were compared with reference ranges, and drug doses were adjusted to achieve desired serum concentrations.	• 86% had low serum concentrations of at least 1 drug. • All patients successfully achieved desired serum concentrations with higher doses. • No patient demonstrated any adverse effects attributed to higher doses of tuberculosis drugs.	• Measurement of serum drug levels should be considered for all patients coinfected with HIV and tuberculosis who have a low CD4+ cell count (<100 cells/μL) and are taking INH or rifampin as part of therapy. • Therapeutic drug monitoring is also recommended for patients experiencing treatment failure or early relapse.
HIV care and mortality in patients coinfected with HIV and tuberculosis [5]	This study analyzed HIV-associated health care utilization and mortality in North Carolina patients coinfected with HIV and tuberculosis from 1993 to 2003.	• Patients with known HIV infection had a high risk of dying before tuberculosis diagnosis or during tuberculosis treatment. • Only one-third of patients with known HIV infection had seen a physician for their HIV in the previous 6 months. • Having a higher baseline CD4+ cell count and starting HAART during tuberculosis treatment were associated with reduced mortality.	• The North Carolina Tuberculosis Control Program routinely records HIV care data for all patients coinfected with HIV and tuberculosis. • One of the state's tuberculosis medical consultants (all of whom are experienced HIV providers) reviews each of these coinfection cases in real time to look for problematic drug interactions and to advocate for the best HIV care.
Pairing tuberculosis testing with opt-out HIV testing [6]	This was a large-scale contact investigation at a meat packing facility that combined IGRA testing for tuberculosis with opt-out HIV testing (326 contacts tested).	• 88% of patients accepted HIV testing. • 2 patients tested positive for HIV; both already knew their HIV status but had not disclosed it to health department staff. • 95.7% of patients had adequate IGRA specimens. • 10% of patients had IGRA results but no tuberculin skin test results.	• Opt-out HIV testing is routinely performed in all contact investigations in which IGRA testing is used to screen for tuberculosis.

Note. HAART, highly active antiretroviral therapy; HIV, human immunodeficiency virus; IGRA, interferon gamma release assay; INH, isoniazid; TBTC, Tuberculosis Trials Consortium.

Twice-weekly treatment of HIV-related tuberculosis with rifabutin. TBTC Study 23, which was performed at sites in North Carolina, evaluated the safety and efficacy of twice-weekly regimens containing rifabutin for treatment of HIV-positive patients who are also being treated for active tuberculosis [8]. The overall rate of culture-positive treatment failure or relapse in this study was 5.3%; more importantly, 8 (89%) of the 9 individuals who relapsed showed newly acquired resistance to rifamycin. Relapse was associated with low baseline CD4+ lymphocyte counts (less than 100 cells/μL), low levels of INH, and low levels of rifabutin (although the latter was found in only 1 study) [17-20].

Because rifamycin resistance greatly increases the length and cost of tuberculosis treatment [21], the North Carolina Tuberculosis Control Program instituted a policy of requiring CD4+ cell counts for all HIV-positive patients being started on treatment for active tuberculosis; any HIV-positive patient with a CD4+ cell count less than 100 cells/μL is now required to receive medications daily throughout the course of tuberculosis treatment. Again, participating in this project allowed us to anticipate CDC recommendations and to institute them in advance of official guidelines. Since our policy was put into place, we have had no occurrences of acquired rifamycin resistance in patients who are coinfected with tuberculosis and HIV.

Therapeutic drug monitoring for patients coinfected with tuberculosis and HIV. Because of the association between relapse and low drug serum levels, Wake County Human Services instituted a therapeutic drug monitoring program for all patients coinfected with HIV and tuberculosis. After being started on tuberculosis therapy, patients came to the clinic and were administered a dose of their medications, after which blood was drawn at 2 hours to determine levels of INH and rifampin, at 3 hours to determine levels of rifabutin, and at 6 hours to determine levels of all 3 drugs.

In 2009 we published the results of a retrospective analysis of the 21 patients treated under this protocol from its inception in March 2002 through September 2007 [4]. We found that 86% of these coinfected patients had low serum levels of at least 1 drug when blood was drawn after 2 or 3 hours, but that therapeutic drug levels could be achieved with higher doses. No adverse events were associated with higher drug doses. Although our study was not designed to detect a clinical benefit from therapeutic drug monitoring, our findings suggest that low serum drug levels are common and that a therapeutic drug monitoring program can be successfully implemented in a local health department. Therefore, we suggest that therapeutic drug monitoring be performed for all HIV-positive tuberculosis patients with a CD4+ lymphocyte count less than 100 cells/μL (as well as for any patient experiencing treatment failure or early relapse).

HIV care and mortality in patients coinfected with tuberculosis and HIV. To better understand those patients who are coinfected with tuberculosis and HIV, we performed a retrospective review of all HIV-positive tuberculosis cases reported in North Carolina from 1993 to 2003 [5]. We found that patients with known HIV infection had a high rate of death; 27 (5%) of the 542 patients in this cohort died prior to tuberculosis diagnosis, and 70 (13.6%) of the remaining 515 patients died during tuberculosis treatment. We also found that a higher baseline CD4+ lymphocyte count and use of highly active antiretroviral therapy (HAART) during tuberculosis treatment were associated with reduced mortality. In addition, only one-third of patients whose HIV status was known before they were diagnosed with tuberculosis had seen a physician for HIV treatment during the 6 months preceding their tuberculosis diagnosis.

These data were worrisome and clearly merited a response on the part of the tuberculosis control program. Ideally, each of these patients would be managed by an expert in the treatment of HIV and tuberculosis coinfection, but unfortunately many of these coinfected patients live in rural or semirural areas far from major medical centers. To compensate for this lack of local expertise, local health departments have been asked to collect data on HIV care for all patients who are coinfected with HIV and tuberculosis. One of the tuberculosis medical consultants then reviews this information in real time to look for potential drug interactions and to ensure optimal tuberculosis care. The consultants also assist with obtaining the best possible HIV care for tuberculosis patients and recommend therapy when appropriate.

Since this policy was implemented, the state nurse consultants have become more attuned to the specialized needs of patients coinfected with HIV and tuberculosis, and they have developed strategies for getting these patients into HIV care. HIV care data have also been incorporated into the state's tuberculosis cohort review so that we can continue to monitor the effect our intervention is having on HIV-related mortality.

Pairing tuberculosis testing with opt-out HIV testing. Per CDC guidelines, HIV-positive individuals who are exposed to tuberculosis should receive treatment for latent tuberculosis infection regardless of their tuberculin skin test results [22]. However, many HIV-infected patients are unaware of their HIV status. Incorporating HIV testing into tuberculosis contact investigations would be an ideal way of identifying these high-risk patients and would perhaps prevent incident tuberculosis, but implementing such a strategy as a regular policy has proven challenging.

One barrier to routine HIV testing of tuberculosis contacts was removed when North Carolina lifted its requirement for pretest HIV counseling. Shortly thereafter, we conducted a large-scale single-site investigation of the contacts of a person with highly infectious tuberculosis who worked at a meat packing factory. We used that opportunity to test the feasibility of interferon-gamma release assay testing for tuberculosis combined with opt-out HIV testing [6]. Each contact received a tuberculin skin test and had blood drawn for interferon-gamma release assay testing; HIV testing was

offered on an opt-out basis. Of the 326 contacts screened, 88% accepted HIV testing; 2 of these individuals were HIV seropositive. Although both of these individuals knew their HIV status prior to testing, neither had revealed this fact to health department staff members. Also, neither of them tested positive for tuberculosis with either the tuberculin skin test or the interferon-gamma release assay; thus, without knowledge of their HIV status, the health department would not have offered them treatment for latent tuberculosis infection. We now routinely perform opt-out HIV testing during any investigation in which an interferon-gamma release assay is used for tuberculosis screening.

Summary

Incorporating the results of research into clinical practice is often a slow and inconsistent process, with uptake of proven interventions often occuring years after publication of the study that showed the intervention to be effective. Effective alliances between researchers and policymakers have been cited as potent tools to accelerate implementation of research results [23].

All of our projects were made possible by a close collaboration between researchers at Duke University School of Medicine, staff members of the North Carolina Tuberculosis Control Program, and local health departments. When health department staff members help generate research questions, they can easily see how the project will have a direct impact on their ability to care for patients. In fact, many of the aforementioned studies began as quality improvement activities. Other studies of tuberculosis-related interventions have demonstrated that early involvement of clinical and administrative staff members in research facilitates uptake of the research results [24]. Of course, such collaborations do not materialize overnight; we have been involved with the North Carolina Tuberculosis Control Program for more than 10 years.

One important point is that large-scale, multisite studies such as those performed by the TBTC have also directly benefited our patients. The primary benefit has been our ability to institute new recommendations quickly, as data become available, but there are additional benefits as well. Because the treatment regimens evaluated in such studies may eventually make it into CDC guidelines, study cohorts should be representative of the patients seen in clinical practice; by participating in research, we can ensure that our patients are represented in these groups. Furthermore, by having participated in the research projects, health department nurses are already familiar with the new drugs and regimens when they are released. We have also seen that a health department's participation in clinical research improves patient care throughout the department's clinics.

In summary, the North Carolina Tuberculosis Control Program maintains an active research agenda focused on patients. The results of the research studies we have conducted at local health departments have had a direct, rel-evant impact on tuberculosis treatment policies and have improved patient care. In other words, our research benefits our patients. NCMJ

David P. Holland, MD, MHS assistant professor, Department of Medicine, School of Medicine, Duke University Medical Center, Durham, North Carolina, and medical consultant, North Carolina Tuberculosis Control Program, Raleigh, North Carolina.
Emily J. Hecker RN, MSN clinical research nurse, Duke University Medical Center, Durham, North Carolina.
Ann W. Mosher, MPH, FNP-BC nurse practitioner, Duke University Medical Center, Durham, North Carolina.
Jason E. Stout, MD, MHS assistant professor, Department of Medicine, School of Medicine, Duke University Medical Center, Durham, North Carolina, and medical director, North Carolina Tuberculosis Control Program, Raleigh, North Carolina.

References
1. Stout JE, Ratard R, Southwick KL, Hamilton CD. Epidemiology of human immunodeficiency virus testing among patients with tuberculosis in North Carolina. South Med J. 2002;95(2):231-238.
2. Stout JE, Engemann JJ, Cheng AC, Fortenberry ER, Hamilton CD. Safety of 2 months of rifampin and pyrazinamide for treatment of latent tuberculosis. Am J Respir Crit Care Med. 2003;167(6):824-827.
3. Stout JE, Saharia KK, Nageswaran S, Ahmed A, Hamilton CD. Racial and ethnic disparities in pediatric tuberculosis in North Carolina. Arch Pediatr Adolesc Med. 2006;160(6):631-637.
4. Holland DP, Hamilton CD, Weintrob AC, et al. Therapeutic drug monitoring of antimycobacterial drugs in patients with both tuberculosis and advanced human immunodeficiency virus infection. Pharmacotherapy. 2009;29(5):503-510.
5. Gadkowski LB, Hamilton CD, Allen M, et al. HIV-specific health care utilization and mortality among tuberculosis/HIV coinfected persons. AIDS Patient Care STDS. 2009;23(10):845-851.
6. Person AK, Goswami ND, Bissette DJ, et al. Pairing QuantiFERON gold in-tube with opt-out HIV testing in a tuberculosis contact investigation in the Southeastern United States. AIDS Patient Care STDS. 2010;24(9):539-543.
7. Benator D, Bhattacharya M, Bozeman L, et al. Rifapentine and isoniazid once a week versus rifampicin and isoniazid twice a week for treatment of drug-susceptible pulmonary tuberculosis in HIV-negative patients: a randomised clinical trial. Lancet. 2002;360(9332):528-534.
8. Burman W, Benator D, Vernon A, et al. Acquired rifamycin resistance with twice-weekly treatment of HIV-related tuberculosis. Am J Respir Crit Care Med. 2006;173(3):350-356.
9. Gebbie K, Rosenstock L, Hernandez LM, eds. Who Will Keep the Public Healthy?: Educating Public Health Professionals for the 21st Century. Washington, DC: The National Academies Press; 2003.
10. Befort CA, Orr S, Davis A, Ely A, Steiger K. Perspectives on research among Kansas County health department administrators. J Public Health Manag Pract. 2009;15(3):E9-E15.
11. North Carolina Department of Health and Human Services, Division of Public Health, Communicable Disease Branch, Tuberculosis Control Program. 2011 Tuberculosis Statistics for North Carolina. Raleigh, NC: North Carolina Department of Health and Human Services; 2012. http://epi.publichealth.nc.gov/cd/tb/figures/tbannual2011.pdf. Accessed September 17, 2013.
12. North Carolina Administrative Code. Control Measures—Tuberculosis. 10A NCAC 41A.0205. http://reports.oah.state.nc.us/ncac/title%2010a%20-%20health%20and%20human%20services/chapter%2041%20-%20epidemiology%20health/subchapter%20a/10a%20ncac%2041a%20.0205.pdf. Accessed September 18, 2013.

13. North Carolina Department of Health and Human Services, Division of Public Health, Communicable Disease Branch, Tuberculosis Control Program. 2008 Tuberculosis Statistics for North Carolina. Raleigh, NC: North Carolina Department of Health and Human Services; 2009. http://epi.publichealth.nc.gov/cd/tb/figures/tbannual2008.pdf. Accessed August 16, 2013.

14. North Carolina Department of Health and Human Services, Division of Public Health, Communicable Disease Branch, Tuberculosis Control Program. 2010 Tuberculosis Statistics for North Carolina. Raleigh, NC: North Carolina Department of Health and Human Services; 2011. http://epi.publichealth.nc.gov/cd/tb/figures/tbannual2010.pdf. Accessed September 17, 2013.

15. Chang KC, Leung CC, Yew WW, Chan SL, Tam CM. Dosing schedules of 6-month regimens and relapse for pulmonary tuberculosis. Am J Respir Crit Care Med. 2006;174(10):1153-1158.

16. Centers for Disease Control and Prevention (CDC). Update: Fatal and severe liver injuries associated with rifampin and pyrazinamide treatment for latent tuberculosis infection. MMWR Morb Mortal Wkly Rep. 2002;51(44):998-999.

17. Sandman L, Schluger NW, Davidow AL, Bonk S. Risk factors for rifampin-monoresistant tuberculosis: a case-control study. Am J Respir Crit Care Med. 1999;159(2):468-472.

18. Peloquin CA, Berning SE, Huitt GA, Iseman MD. AIDS and TB drug absorption. Int J Tuberc Lung Dis. 1999;3(12):1143-1144.

19. Weiner M, Burman W, Vernon A, et al. Low isoniazid concentrations and outcome of tuberculosis treatment with once-weekly isoniazid and rifapentine. Am J Respir Crit Care Med. 2003;167(10):1341-1347.

20. Weiner M, Benator D, Burman W, et al; Tuberculosis Trials Consortium. Association between acquired rifamycin resistance and the pharmacokinetics of rifabutin and isoniazid among patients with HIV and tuberculosis. Clin Infect Dis. 2005;40(10):1481-1491.

21. Blumberg HM, Burman WJ, Chaisson RE, et al. American Thoracic Society/Centers for Disease Control and Prevention/Infectious Diseases Society of America: treatment of tuberculosis. Am J Respir Crit Care Med. 2003;167(4):603-662.

22. Targeted tuberculin testing and treatment of latent tuberculosis infection. American Thoracic Society. MMWR Recomm Rep. 2000;49(RR-6):1-51.

23. Philpott A, Maher D, Grosskurth H. Translating HIV/AIDS research findings into policy: lessons from a case study of "the Mwanza trial." Health Policy Plan. 2002;17(2):196-201.

24. White MC, Tulsky JP, Menendez E, Arai S, Goldenson J, Kawamura LM. Improving tuberculosis therapy completion after jail: translation of research to practice. Health Educ Res. 2005;20(2):163-174.

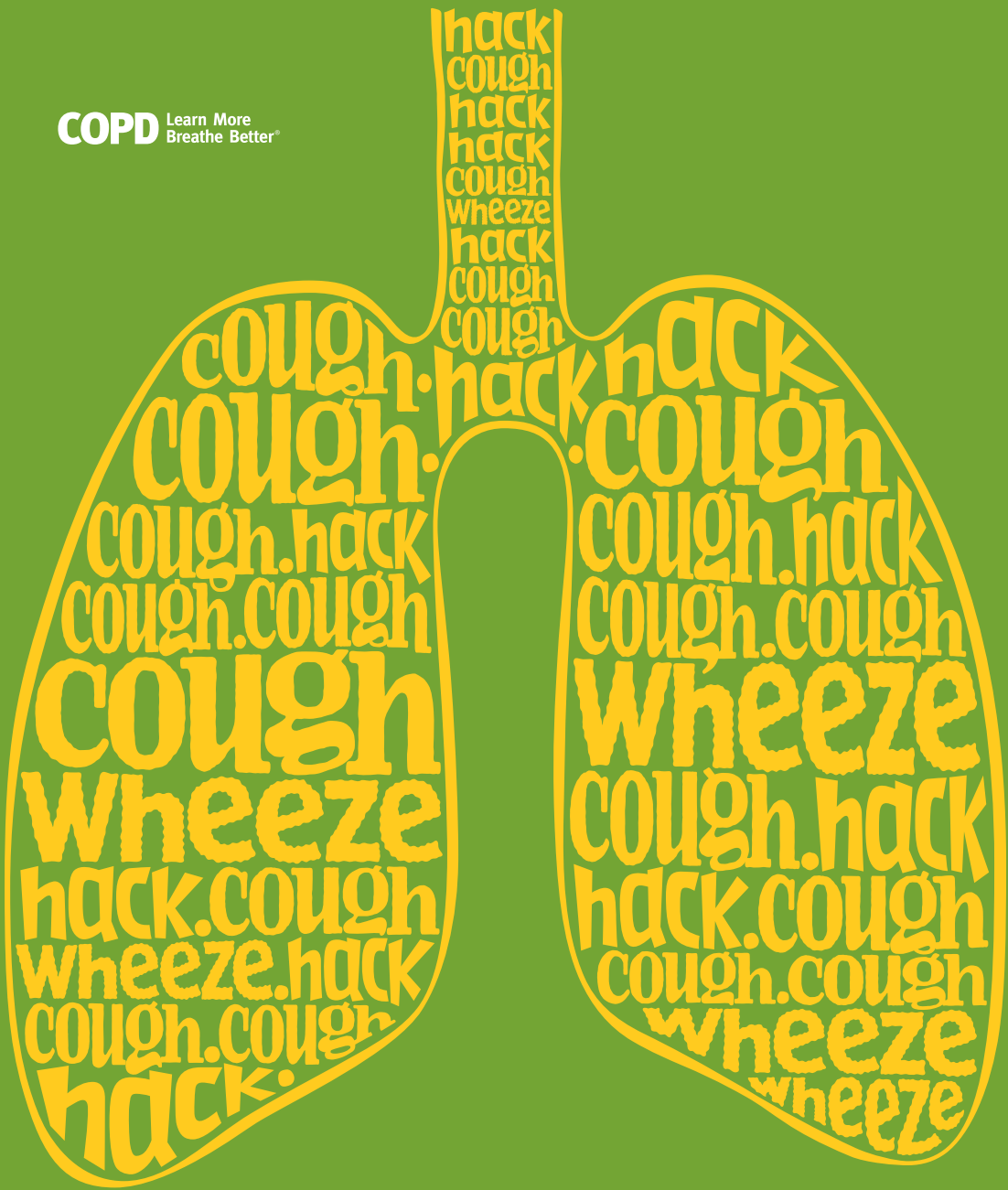# Classified Advertisements

---

Advertiser Index

LEARN TO RECOGNIZE WILDFIRE HAZARDS IN YOUR COMMUNITY

A single ember from a wildfire can travel over a mile to your home or community. Learn how to reduce wildfire damage by spotting potential hazards at fireadapted.org.

FIREADAPTED.ORG

COPD Learn More Breathe Better®

hack cough hack hack cough wheeze hack cough cough

cough cough cough.hack cough.cough cough wheeze hack.cough wheeze.hack cough.cough hack.

hack hack cough cough.hack cough.cough wheeze cough.hack hack.cough cough.cough wheeze wheeze

Are your lungs trying to tell you something?

If you're struggling for air, listen to your lungs—it could be COPD. See your doctor right away. With early diagnosis and treatment, this serious lung disease can be managed so you can breathe better and enjoy life more.

COPD.nhlbi.nih.gov

U.S. Department of Health and Human Services
National Institutes of Health

National **Heart**
Lung and Blood Institute
People Science Health