The EpiLink

A public health news bulletin from the Texas Department of State Health Services
Infectious Disease Control Unit

Volume 64/Number 5/May 29, 2007

Health Focus: Health Care-associated Infections

Editorial: Healthcare-associated Infections

The focus for this issue of *EpiLink* is health care-associated infections. Based on Centers for Disease Control and Prevention (CDC) statistics for 2002, the 1.74 million health care-associated infections that occurred in United States hospitals caused 98,987 deaths. This number represents a rate of 9.3 infections per 1000 patient-days or 4.5 infections per 100 admissions in 2002. Hospital-acquired infections add an additional $27.5 billion to the cost of hospital care. Averaged out over all hospital admissions, hospital-acquired infections add $16,000 to the cost of every hospital admission. Since these are infections that patients do not have when they enter the health care system, they should be largely preventable through measures that keep patients from becoming infected after they arrive at those facilities. Page 2.

Estimating Health Care-associated Infections and Deaths in U.S. Hospitals, 2002

Public Health Reports. The purpose of this study was to provide a national estimate of the number of health care-associated infections (HAI) and deaths in United States hospitals. No single source of nationally representative data on HAIs is currently available. The authors used a multi-step approach and three data sources. The main source of data was the National Nosocomial Infections Surveillance (NNIS) system, data from 1990–2002, conducted by the Centers for Disease Control and Prevention. Data from the National Hospital Discharge Survey (for 2002) and the American Hospital Association Survey (for 2000) were used to supplement NNIS data. The percentage of patients with an HAI whose death was determined to be caused or associated with the HAI from NNIS data was used to estimate the number of deaths. In 2002, the estimated number of HAIs in U.S. hospitals, adjusted to include federal facilities, was approximately 1.7 million. The estimated deaths associated with HAIs in U.S. hospitals were 98,987. Read complete report.

Texas Department of State Health Services Report of the Texas Legionnaires' Disease Task Force

A task force was assembled in December 1999 to develop a Texas Legionnaires' disease control plan to help local health officials respond to reports of legionellosis in hospitals, long-term care facilities, and the community. This article provides the latest statistics on legionellosis in Texas and a link to the full recommendations. Page 4.

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Editorial:

Health Care-associated Infections

Tom Betz, MD, MPH, Manager, Infectious Disease Surveillance and Epidemiology Branch, Department of State Health Services

The focus for this issue of *EpiLink* is health care-associated infections. Based on Centers for Disease Control and Prevention (CDC) statistics for 2002, the 1.74 million health care-associated infections that occurred in United States hospitals caused 98,987 deaths. This number represents a rate of 9.3 infections per 1000 patient-days or 4.5 infections per 100 admissions in 2002 (Klevins RM, et al. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. *Public Health Reports* 2007; 122: 160-6). Hospital-acquired infections add an additional $27.5 billion to the cost of hospital care. Averaged out over all hospital admissions, hospital-acquired infections add $16,000 to the cost of every hospital admission (*Emerging*: The MRSA issue. Plexus Institute 2006: page 4). Since these are infections that patients do not have when they enter the health care system, they should be largely preventable through measures that keep patients from becoming infected after they arrive at those facilities.

The methodologies applied by the CDC for calculating the national statistics for health care-associated infections in 2002 have not yet been applied to Texas data. Based on a pro-rata extrapolation of national data using population estimates, the annual burden of health care infections in Texas is estimated at 136,000 infections, causing 7,770 deaths, at a cost of $2.16 billion health care dollars. From a public health perspective, health care-associated infections are the leading category of infectious disease mortality in Texas. For comparison, there were 3,739 motor vehicle traffic fatalities reported in Texas in 2001 (Texas Department of Public Safety [DPS] statistics) and 1,385 homicides reported in Texas in 2006 (*Houston Chronicle* May 10, 2007/DPS statistics).

Health care-associated infections involve a constellation of risk factors that contribute to their origin, host factors including patients with underlying medical conditions that make them relatively immunocompromised, stress and wound sites related to surgical procedures, and environments in which the use of antibiotics creates a pressure to select out antibiotic-resistant strains of pathogens.

Those involved in infection control activities have long been aware of the importance of health care-associated infections. Increasingly this awareness has spread to consumer advocacy groups such as Consumers Union as well as citizen action groups whose lives have been changed dramatically by family and friends who have acquired health care-associated infections. The collective response for action has now resulted in 15 states (Colorado, Connecticut, Florida, Illinois, Maryland, Missouri, New York, New Hampshire, Ohio, Pennsylvania, South Carolina, Tennessee, Texas*, Virginia, Vermont) passing legislation requiring public reporting of health care-associated infection rates, an additional 2 states that have laws that require the public reporting of infection information, but not specifically rates (California, Rhode Island), and 2 states that have laws requiring confidential reporting of infection rates (Nebraska, Nevada). All other states except Wyoming,

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Arizona, Montana, and North Dakota have considered hospital infection reporting laws, but have not yet passed legislation (www.stophospitalinfections.com). The objective of that reporting is to have individual facility infection rates available for public review so that patients may compare rates and make informed decisions concerning the facilities they choose for their health care.

During the 79th Legislative session in 2005, Senate Bill 872 (Nelson) was passed that established a 14-member advisory panel, consisting of 4 infection control practitioners; 3 physicians, hospital and ambulatory surgery center administrators; 2 consumer representatives; and 3 Department of State Health Services (DSHS) non-voting staff with expertise in epidemiology and regulatory activities. The charge to the panel was to recommend how hospitals and ambulatory surgical centers (ASCs) should report health care-associated infections to DSHS. The Panel met 9 times between November 2005 and October 2006, filing its report to the Commissioner of Health on October 24, 2006. Key recommendations were that:

Texas should implement a system for Texas general hospitals and ambulatory surgery centers to publicly report health care-associated infection rates with the following 3 objectives:

- To allow consumers to make informed choices about hospitals for their own care based on consideration of health care-associated infection rate comparisons;
- To provide incentives to facilities to reduce their infection rates by doing high yield outcome measurement; and
- To improve patient safety and reduce health care costs by reducing prolongation of stay and utilization of resources due to health care-associated infections.

Texas facility-specific reports should be available on a Web site and other formats accessible to the public.

After internal review and approval, the report was formally submitted to the Governor on October 26, 2006. The complete report and supporting documentation is available online through the following website:

http://www.dshs.state.tx.us/legislative/HAIPanelReport.pdf

The recommendations of the Advisory Panel were used as templates for legislation during the current 80th legislative session. Senate Bill 288 (Nelson), relating to the reporting of health care-associated infections at certain health care facilities and the creation of an advisory panel, was introduced and passed by a vote of 141 yeas/1 Present, not voting in the House on May 3, 31 yeas/ 0 nays/ in the Senate on May 15, and sent to the Governor for signature on May 17th.

Report of the Texas Legionnaire's Disease Task Force

A task force was assembled in December 1999 to develop a Texas Legionnaires' disease control plan to help local health officials respond to reports of legionellosis in hospitals, long-term care facilities, and the community. The recommendations of the Legionnaires' disease task force were completed and published on the Texas Department of State Health Services website http://www.dshs.state.tx.us/idcu/disease/legionnaires/taskforce/) in April 2002. These recommendations include comparisons to plans in place for Allegheny County, PA, the state of Maryland, and the Centers for Disease Control and Prevention (CDC).

Diagnostic Capacity
The Texas Legionnaires' Disease Task Force recommends that all acute care hospitals and all long-term care facilities either provide *Legionella* urine antigen testing in-house or contract with a laboratory that can report test results within 48 hours. These facilities should have a similar mechanism in place for *Legionella* culturing. Single serum antibody test results, which are commonly reported, can not be used to confirm a diagnosis of Legionnaires' disease.

Surveillance
Legionellosis surveillance should be conducted by all acute care and long-term care facilities, and detected cases should be reported to the appropriate local health department or to the Texas Department of State Health Services. Active surveillance, including urine antigen testing of other pneumonia patients and daily evaluation of all sputa and x-rays, should be implemented whenever an investigation of a suspected nosocomial case is initiated. Community-acquired cases must also be reported, but active surveillance and a thorough epidemiologic investigation are recommended only if 2 or more cases of legionellosis are confirmed in a small community within a 6-month period or if the rate in a large community seems to be above the state's 10-year average of 0.2 cases per 100,000 population.

Environmental Testing
Routine culturing of acute care hospital water distribution systems (i.e., environmental testing) for *Legionella* is not recommended by the Texas Legionnaires' disease Task Force. On the other hand, environmental testing may be appropriate if it is determined that there is a significant risk of nosocomial Legionnaires' disease transmission. The Task Force provides guidelines for assessing this risk. In long-term care facilities, the Task Force recommends environmental culturing only if there are 1 or more definite or 2 or more possible nosocomial cases. The Texas guidelines generally recommend environmental testing in a community setting only in the event of an outbreak and an epidemiologically implicated source. The Task Force also provides detailed guidelines for water distribution system testing when implemented.

Prevention
The Texas Legionnaires' disease Task Force recommendations for legionellosis prevention include education of physicians and other hospital/facility personnel, equipment maintenance, and general facility control measures in acute care and long-term care facilities that do not have identified Legionnaires' disease

cases. Facilities with cases or with a substantial number (>30%) of water distribution system sites that are culture-positive for *Legionella* upon background testing should further implement enhanced surveillance, immediate remediation, and protection of high risk patients.

Editorial Note:

Legionnaires' disease typically presents as a severe form of pneumonia, which is most common in the elderly, smokers, and those with underlying medical conditions, such as chronic lung disease, cancer, diabetes, end-stage renal disease, or immunosuppression. The causative agent is a gram-negative bacilli that can be difficult to recover and isolate. Transmission occurs when water containing the bacteria is aerosolized and inhaled. Human-to-human transmission does not occur. The incubation period for Legionnaires' disease can be anywhere between 2-10 days. Symptoms may include fever, non-productive cough, myalgia, malaise, and headache. Diarrhea is often present. The case fatality rate in hospitalized patients can be as high as 40%.

The true incidence of Legionnaires' disease is unknown. While it is a notifiable disease both in Texas and the United States, Legionnaires' disease often goes undiagnosed and under-reported. It is estimated that 8,000 to 18,000 cases occur in the United States every year; however, in 2005, only 2,301 cases were reported to the Centers for Disease Control and Prevention. The majority of cases are sporadic, but a significant number occur as part of an outbreak. Both nosocomial and travel-associated Legionnaires' disease are thought to represent a significant percentage of cases; however, the true nature of the problem is ill defined and difficult to measure.

Reported Cases of Legionellosis in Texas, 1997-2006

1997	32
1998	17
1999	22
2000	15
2001	17
2002	28
2003	71
2004	137
2005	55
2006	69
Average	46

Although many species of *Legionella* have been documented, it is believed that approximately 90% of reported cases of Legionellosis are caused by *Legionella pneumophila*, with 79% of those caused by serogroup 1. It should be noted that the currently available urine antigen tests detect only serogroup 1. Both a urine antigen and a culture utilizing media designed specifically to grow *Legionella* should be performed on all patients suspected of having Legionnaires' disease. Complete reliance on either the urine antigen test or culture alone may result in missing up to half of all cases.

A hospital-associated outbreak of Legionnaires' disease occurred in San Antonio during the spring and summer of 2006. A total of 10 cases were identified with 3 deaths. All cases had either been patients or visitors to the hospital during their incubation period. No other common source of exposure was identified. The potable water

system of the hospital was found to be contaminated by a variety of different species of *Legionella*, including *Legionella pneumophila* serogroup 1, the most common outbreak strain. An isolate obtained from one of the cases was found to be identical to 3 of the 12 isolates recovered from environmental sources within the hospital.

Prepared by Linda Gaul, PhD, MPH, and Stacy Davlin, MPH, Infectious Disease Control Unit, Texas Department of State Health Services.

Public Health in Action:
The Texas Child Care Immunization Assessment Survey

Abstract

Children attending child care facilities in Texas are required to have age appropriate vaccination against diphtheria, tetanus, pertussis, Haemophilus influenzae *type b (Hib), polio, measles, mumps, rubella, varicella, pneumococcal disease, hepatitis B, and hepatitis A. In 2005, a new methodology was developed to assess vaccination coverage levels among Texas child care attendees 19 - 59 months of age. The sampling design consisted of a stratified cluster sample, with 100 child care facilities randomly selected from the 8 administrative health service regions (HSRs) in Texas. From each selected facility, 20 child immunization records were randomly selected. Statewide estimates ranged from 95% for 3 doses of polio vaccine to nearly 25% for 2 doses of hepatitis A vaccine. Among the HSRs, estimates ranged from a high of 97% for 3 doses of polio vaccine in HSR 2/3 to nearly 11% for 2 doses of hepatitis A vaccine in HSR 4/5N and HSR 7.*

Introduction

Children attending child care facilities in Texas are required to have age appropriate vaccination against diphtheria, tetanus, pertussis, *Haemophilus influenzae* type b (Hib), polio, measles, mumps, rubella, varicella, pneumococcal disease, hepatitis B, and hepatitis A.[1] Child care immunization requirements are in place to prevent the transmission of vaccine-preventable diseases and to bring children up to date on the childhood vaccinations required for attendance. Ideally, most primary vaccination series are completed by 19 months of age, in accordance with the Recommended Childhood and Adolescent Immunization Schedule.[2]

While public school districts and accredited private schools are required to report the immunization status of their students on an annual basis, no such requirement exists for child care facilities. Although these facilities are subject to routine audits, biases may exist in the way audit data are captured. In 2005, the Texas Department of State Health Services (DSHS) developed a new survey to assess vaccination coverage levels among children attending licensed child care centers and registered child care homes.

Methods

A data file of all licensed child care centers and registered child care homes was obtained from Child Care Licensing at the Texas Department of Family and Protective Services.Since enrollment data were not available on each facility, maximum capacity data were requested.

Descriptive statistics were calculated using SAS® version 9 on the capacity data to determine mean and median capacity size. Based on the analysis of capacity data, around 90% or more of children were expected to attend licensed child care centers.

Since all registered child care homes had a maximum capacity of 12, it was decided that all children 19 – 59 months of age would be included in the survey at selected registered child care homes, and that 20 immunization records of children 19 – 59 months of age would be randomly selected from the selected licensed child care centers.

Since regional Texas vaccination coverage levels among child care attendees were needed, a stratified cluster sample methodology was proposed for the survey, with strata consisting of the 8 health service regions (HSRs), and clusters consisting of randomly selected child care facilities using probability proportional to size (pps) sampling based on capacity size.

A sample size of 1,708 children was determined for each HSR of Texas, with a sample of 100 child care facilities from each HSR. Sampling of child care facilities was completed using the SURVEY SELECT procedure in SAS®. First stage sampling weights were retained for the analysis.

Regional and local health department audit staff contacted the child care facilities selected for the survey and arranged a date to visit the facility or arranged data collection through the mail. The survey was conducted from December 2005 through March 2006. Audit staff were instructed to randomly select 20 children from a roster of children 19 – 59 months of age if there were more than 20 children enrolled at the facility. In registered child care homes, all children in the target age range were selected. Immunization records were entered into the Clinic Assessment Software Application (CASA) and included the child's date of birth and month/day/year of each vaccination. Audit staff were instructed to enter all vaccination dates. A worksheet was also completed on each facility to collect enrollment and exemption totals. After the surveys were completed, the worksheets and electronic data extracts were mailed to DSHS central office in Austin.

DSHS Austin staff reviewed the data submitted in CASA for completeness and data errors. Data from the facility worksheets were entered into a Microsoft® Access database. SAS® version 9 was used for the analysis. Child immunization records outside of the 19 – 59 month of age range were excluded. If the survey date was not available, the child's age on January 1, 2006 was calculated instead. For facilities in which enrollment data for children 19 – 59 months of age were not collected, total enrollment was used to calculate weights. Final weights were calculated using enrollment data and the number of children selected for the survey (inverse of the probability of the child being selected for the survey at the facility) and the first stage sampling weights retained from SAS®.

Children were considered in compliance with the child care immunization requirements if they had received each of the following vaccines and doses at the time of the survey: 4 doses of diphtheria, tetanus, and acellular pertussis vaccine (DTaP); 3 doses of poliovirus vaccine; 1 dose measles, mumps, and rubella vaccine (MMR) received on or after the first birthday; 3 doses of hepatitis B vaccine; 3 - 4 doses of Hib vaccine (fewer required if series was delayed); 1 dose of varicella vaccine received on or after the first birthday (unadjusted for disease history); 3 – 4 doses of pneumococcal vaccine (fewer required if series was delayed); and 2 doses of hepatitis A vaccine received on or after the first birthday. Since the hepatitis A vaccine was only recently licensed for children as young as 12 months of age, the analysis was restricted to children 24 – 59 months of age (previously hepatitis A vaccine was licensed for children 24 months of age and older).

Coverage level estimates were calculated individually for each vaccine requirement, and for the 4:3:1 (4 or more doses of DTaP vaccine, 3 or more doses poliovirus vaccine, 1 or more doses MMR vaccine), 4:3:1:3:3 (4:3:1 series plus 3 or more doses Hib vaccine and 3 or more doses hepatitis B vaccine), and 4:3:1:3:3:1 (4:3:1:3:3 plus 1 or more doses varicella vaccine) vaccine series. In addition, up-to-date status for each vaccine series at 19 – 35 months of age, receipt of DTaP by 19 months of age, receipt of 3 doses of Hib vaccine, and receipt of 3 doses of pneumococcal vaccine were calculated. Weighted coverage level estimates with 95% confidence intervals were generated using SUDAAN and the SURVEYFREQ procedure in SAS®.

Results

Data were received from 688 child care facilities (86% selected for the survey) in Texas on 11,764 children 19 – 59 months of age. Of children included in the survey sample, 0.5% either had no immunization record on file or had received no vaccinations. The following are select results from the Texas Child Care Immunization Assessment Survey.

Table 1 presents vaccination coverage level estimates for each individual vaccine requirement by HSR and statewide. Statewide coverage level estimates for child care attendees 19 – 59 months of age ranged from 95% for 3 doses of polio vaccine to nearly 25% for 2 doses of hepatitis A vaccine. Among the HSRs, coverage level estimates ranged from a high of 97% for 3 doses of polio vaccine in HSR 2/3 (Dallas-Ft. Worth/North Central Texas) to nearly 11% for 2 doses of hepatitis A vaccine in HSR 4/5N (East Texas) and HSR 7 (Austin/Central Texas).

There were no statistically significant differences in vaccination coverage with DTaP, polio, MMR, and varicella among HSRs. Statewide coverage with 4 doses of DTaP vaccine was 89.4%. DTaP coverage level estimates ranged from 85.4% in HSR 7 to 92.1% in HSR 9/10. Coverage with 3 doses of polio vaccine was 95.1% statewide and ranged from 91.4% in HSR 7 to 97.1% in HSR 2/3. Coverage with 1 dose of MMR vaccine was at 94.7%, and ranged from 91.9% in HSR 7 to 96.6% in HSR 2/3. For 1 dose of varicella vaccine (unadjusted for disease history), the statewide estimate was 93.2%, ranging from 90.4% in HSR 7 to 95.0% in HSR 2/3.

Coverage with 3 doses of hepatitis B vaccine varied significantly among HSRs, from 87.4% in HSR 7 to 95.5% in HSR 4/5N, with statewide coverage at 91.8%. Estimates from HSRs 4/5N, 8, and 9/10 were all statistically significantly higher than the estimate for HSR 7. The state estimate was statistically significantly higher than the estimate for HSR 1, and the estimates for HSRs 4/5N and 8 were statistically significantly higher than the state estimate.

Hib vaccination coverage levels in accordance with the Advisory Committee on Immunization Practices (ACIP) recommendations varied among HSRs. Statewide coverage with Hib was only 83.2% and ranged from 73.0% in HSR 11 to 93.1% in HSR 1. Coverage in HSR 11 was statistically significantly lower than coverage level estimates in HSRs 1, 4/5N, 6/5S, 8, and 9/10. HSRs 1, 4/5N, 8, and 9/10 had estimates statistically significantly higher than the state estimate.

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Table 1. Vaccination Coverage Level Estimates of Child Care Attendees 19 - 59 Months of Age by Vaccine Requirement, Texas 2005/2006

HSR	4+ DTaP	95% CI	3+ Polio	95% CI	1+ MMR	95% CI	1+ Var	95% CI	3+ HepB	95% CI	3-4 Hib*	95% CI	4 PCV *	95% CI	2 HepA ^^	95% CI
1	89.3	85.7 - 92.1	95.9	94.2 - 97.1	96.4	94.9 - 97.5	93.4	91.9 - 94.6	88.3	85.7 - 90.4	93.1	91.6 - 94.3	70.6	65.3 - 75.3	18.0	14.0 - 23.0
2/3	91.6	88.6 - 93.9	97.1	95.6 - 98.0	96.6	95.0 - 97.8	95.0	93.0 - 96.5	92.8	91.0 - 94.3	78.9	70.3 - 85.5	74.0	69.4 - 78.0	21.8	17.3 - 27.2
4/5	92.0	89.7 - 93.9	96.8	95.3 - 97.9	95.7	94.3 - 96.8	93.8	92.1 - 95.2	95.5	93.4 - 96.9	89.0	86.5 - 91.1	73.7	68.3 - 78.6	10.5	7.9 - 13.8
6/5	87.5	83.3 - 90.8	93.8	91.2 - 95.7	93.2	90.4 - 95.3	91.7	88.8 - 93.9	90.8	87.4 - 93.3	85.0	81.7 - 87.8	60.3	52.9 - 67.3	21.4	14.8 - 29.8
7	85.4	78.9 - 90.1	91.4	84.2 - 95.5	91.9	84.7 - 95.9	90.4	83.5 - 94.6	87.4	81.2 - 91.8	82.4	75.6 - 87.6	NC**		10.6	7.9 - 14.1
8	91.1	88.3 - 93.2	95.7	93.9 - 97.0	95.3	93.8 - 96.5	94.6	92.8 - 95.9	95.3	93.7 - 96.5	91.7	89.4 - 93.6	67.3	62.5 - 71.7	46.3	39.4 - 53.3
9/10	92.1	89.7 - 94.0	96.1	94.6 - 97.2	96.2	94.6 - 97.4	94.9	93.2 - 96.2	94.0	92.1 - 95.5	90.7	88.1 - 92.8	76.0	72.1 - 79.6	46.9	38.9 - 55.0
11	90.8	87.1 - 93.5	96.5	93.0 - 98.3	95.5	92.3 - 97.4	94.4	91.2 - 96.5	94.6	91.1 - 96.8	73.0	62.5 - 81.5	63.9	56.5 - 70.7	47.2	38.4 - 56.3
State	89.4	87.7 - 90.9	95.1	93.8 - 96.1	94.7	93.4 - 95.8	93.2	91.9 - 94.4	91.8	90.5 - 93.0	83.2	80.4 - 85.7	68.0 ^	65.0 - 71.0	24.6	21.9 - 27.5

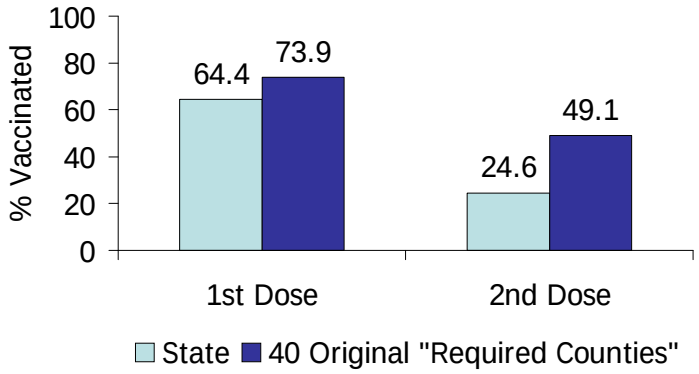
*Age appropriate vaccination according to the Advisory Committee on Immunization Practices (ACIP). Children beginning the series late may not require all doses

**Not collected (NC) from most child care facilities

^excluding HSR 7

^^Analysis restricted to children 24 - 59 months of age

Chart 1. Vaccination Coverage Level Estimates for Hepatitis A Vaccine Among Children 24 – 59 Months of Age Attending Child Care, State vs. the 40 Original Required Counties



Pneumococcal vaccination history dates were not collected in HSR 7; therefore, a coverage level estimate could not be calculated for this HSR. Coverage for the pneumococcal vaccination ranged from 60.3% in HSR 6/5S to 76.0% in HSR 9/10. The coverage level estimate for HSR 9/10 was statistically significantly higher than estimates for HSRs 6/5S, 8, 11, and the state. The statewide coverage level estimate was 68.0% (excluding HSR 7) for pneumococcal vaccination in accordance with ACIP requirements.

Along with pneumococcal vaccine, hepatitis A is a new vaccine requirement. Statewide coverage was at 24.6% for children 24 – 59 months of age. Coverage level estimates ranged from 10.5% in HSR 4/5N to 47.2% in HSR 11. Coverage estimates in HSRs 8, 9/10, and 11 were statistically significantly higher than estimates from HSRs 1, 2/3, 4/5N, 6/5S, 7, and the state as a whole.

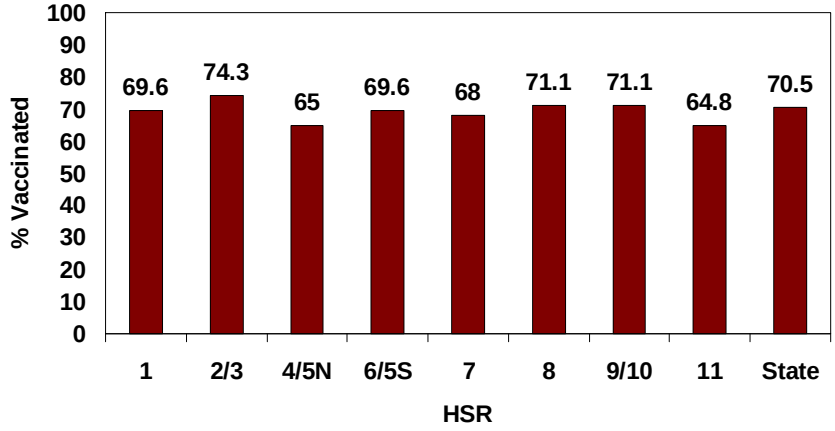
Chart 1 compares vaccination coverage with 1 and 2 doses of hepatitis A vaccine for the state as a whole versus the 40 counties in which hepatitis A vaccine was originally mandated for children attending child care facilities and for children in kindergarten through third grade.[1] Most of these counties are either along the Texas – Mexico border or in the past had consistently elevated incidence rates of hepatitis A disease. Coverage in the 40 counties with 1 dose of hepatitis A vaccine was at 73.9%, and 49.1% of children 24 – 59 months of age in child care facilities had completed the series. In comparison, 64.4% of children attending child care facilities statewide had received one dose, but only 24.6% had completed the series.

Chart 2 compares vaccination coverage with 4 doses of DTaP vaccine by 19 months of age for children attending child care by HSR and the state as a whole. Estimated vaccination coverage levels ranged from 64.8% in HSR 11 to 74.3% in HSR 2/3. The state estimate was 70.5%.

Discussion

For most vaccine antigens, coverage did not meet or exceed the Healthy People 2010 goal of 95% vaccination coverage among child care attendees.[3] Coverage level estimates were generally lower than those collected

Chart 2. Vaccination Coverage Level Estimates for 4 Doses of DTaP Vaccine by 19 Months of Age Among Child Care Attendees, by Health Service Region (HSR) and Texas



through audit data, which may be subject to bias through differences in interpreting child care immunization requirements or by using follow-up, rather than initial, visit data. Children who were in compliance with the child care immunization requirements due to a medical or conscientious exemption on file with the facility were not counted as vaccinated if they did not receive the specified vaccine. For varicella, coverage level estimates were not adjusted for history of the disease. Thus, all coverage level estimates represent vaccination rates.

Hib vaccination coverage levels were low compared to estimates for other routinely recommended vaccines. Some auditors may have not realized child care attendees were subject to a vaccine requirement for Hib since this vaccine is not required for kindergarten attendance. Hib vaccination dates were not collected consistently in HSRs 2/3 and 11. Some children who started the Hib vaccine series on time as infants were missing the booster dose typically received between 12 – 15 months of age and were not considered to be up to date with the series.

New immunization requirements for hepatitis A and pneumococcal vaccine for all child care attendees were passed by the Texas Legislature in the spring of 2005 and went into effect in September 2005. At the time of the survey, some auditors may have not realized that these vaccination requirements were already in effect or that the survey would be collecting these data.

Most children routinely receive pneumococcal vaccine as part of the Recommended Childhood and Adolescent Immunization Schedule.[2] However, prior to January 2006, when hepatitis A vaccine was incorporated into the 2006 Recommended Childhood and Adolescent Immunization Schedule for children 12 – 23 months of age, the Centers for Disease Control and Prevention (CDC) had recommended that only children living in communities with high hepatitis A disease incidence rates receive the hepatitis A vaccine.[4] In Texas, children living in counties with high hepatitis A disease incidence rates were required to have hepatitis A vaccine in order to attend child care facilities or kindergarten through third grade. Hepatitis A vaccine is currently

mandated for 40 Texas counties for children in kindergarten through third grade. Vaccination coverage level estimates for 2 doses of hepatitis A vaccine were highest in the HSRs where the majority of counties mandated for hepatitis A vaccine for child care attendance prior to September 2005 are located. HSRs 8, 9/10, and 11, which are near the Texas – Mexico border, had the highest hepatitis A vaccination coverage level estimates, ranging from 46.3% to 47.2% for 2 doses. However, a number of children living in other parts of Texas had received the first dose of the hepatitis A vaccine series. Some of these children may be either missing documentation of the second dose or insufficient time has passed to be medically eligible to receive the second dose (a 6-month time period).

Record keeping by child care facilities may have also contributed to the low vaccination coverage level estimates for certain vaccine antigens. Some facilities may not have been aware of the new requirements for hepatitis A and pneumococcal vaccines. There may also have been delays in receiving documentation after the receipt of a vaccine.

A pneumococcal conjugate vaccine shortage from 2001 – 2004 may have also influenced coverage levels for this vaccine. Third and fourth doses of this vaccine were deferred for healthy children in response to the shortage.[5] Some children may not have been recalled by their health care provider once the shortage was resolved.

Among HSRs, coverage level estimates varied and, for some vaccine antigens, the estimates reached statistical significance. In most HSRs the target sample size was not met, thus limiting the precision of some estimates. HSR 7 had the lowest response rate among child care facilities (77%) and its 95% confidence interval range tended to be wider compared to other HSRs.

Statewide, around 30% of child care attendees 19 – 59 months of age had not received the fourth dose of DTaP by 19 months of age. This is consistent with results from the 2004 National Immunization Survey for Texas on receipt of 4 doses of DTaP by 19 months of age.[6] Due to the elevated incidence rates of pertussis in Texas and an increase in infant deaths from pertussis over the last several years, completion of the DTaP primary series by 19 months of age, along with Tdap (adolescent and adult tetanus, reduced diphtheria, and acellular pertussis vaccines) vaccination for adolescents and adults, need to be emphasized.

While for most vaccine antigens coverage level estimates were 90% or higher among child care attendees at the time of the survey, improvement is needed with regards to DTaP, Hib, pneumococcal, and hepatitis A vaccination coverage levels. Some geographical areas of the state had vaccination coverage level estimates consistently lower than the overall state estimates, and interventions may be needed in these areas. Although child care immunization requirements may function to bring preschool children not otherwise up to date with a vaccine series up to date, age appropriate vaccination of infants should be emphasized.

Acknowledgements

We would like to thank the DSHS regional offices and local health department staff who collected the data for this survey.

Prepared by: Julie Townsend, MS, and Tony Aragon, MS, Disease Prevention and Intervention Section, and by Monica Gamez, Immunization Branch, Texas Department of State Health Services.

References

1. Texas Administrative Code. Title 25 Health Services. Part 1 Department of State Health Services. Chapter 97 Communicable Diseases. Subchapter B Immunization Requirements in Texas Elementary and Secondary Schools and Institutions for Higher Education. δ97.63. Available at: http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=25&pt=1&ch=97&rl=63 . Accessed November 29, 2006.
2. Centers for Disease Control and Prevention. Recommended Childhood and Adolescent Immunization Schedule – United States, 2006. MMWR. 2005; 54(Nos. 51&52): Q1-Q4.
3. U.S. Department of Health and Human Services. Healthy People 2010. Washington, D.C: U.S. Department of Health and Human Services; 2000. Available at: http://www.healthypeople.gov/Document/HTML/Volume1/14Immunization.htm#_Toc494510242 . Accessed December 18, 2006.
4. Centers for Disease Control and Prevention. Prevention of Hepatitis A Through Active or Passive Immunization. MMWR. 2006; 55(RR07): 1-23.
5. Centers for Disease Control and Prevention. Notice to Readers: Updated Recommendations on the Use of Pneumococcal Conjugate Vaccine in a Setting of Vaccine – Shortage – Advisory Committee on Immunization Practices. MMWR 2001; 50(50): 1140 - 1142.
6. Centers for Disease Control and Prevention. 2004 National Immunization Survey. Available at: http://www.cdc.gov/nip/coverage/NIS/04/toc-04.htm . Accessed November, 29, 2006.

DSHS Enrolling Providers for the Influenza Sentinel Surveillance Network

For decades, the Department of State Health Services (DSHS) has had an active influenza surveillance system in place to obtain specimens for laboratory analysis from sites throughout Texas. The purpose of this culture surveillance system is to identify what types of influenza are circulating, where flu activity is occurring, and what population is being infected, and, to a certain extent, to determine the degree of activity. This information can be used to confirm influenza diagnoses, collect data that enable public health officials to assess the severity of the annual epidemic, and to assist with national influenza surveillance activities. Identification of viral strain is important to ascertain whether the current season's flu vaccine will protect against the circulating influenza strains.

Each surveillance site is provided with culture media and guidelines for utilization. These sites set up the active surveillance protocols for their jurisdiction. Physicians and public health clinics are encouraged to report all suspected influenza cases, obtain the culture media and guidelines from the main surveillance site, and submit cultures to the DSHS Laboratories Services Section at no charge. Some isolates identified by the DSHS Lab are then sent to the Centers for Disease Control and Prevention for further typing.

The Sentinel Provider Surveillance Network

The Sentinel Provider Surveillance Network (SPSN) is a program sponsored by the Centers for Disease Control and Prevention (CDC), which collects data on Influenza-like Illness (ILI) from clinicians around the country. In collaboration with the CDC, the DSHS Infectious Disease Control Unit is currently recruiting health care providers in family practice, pediatrics, general practice, internal medicine, and hospital emergency rooms to participate in the Influenza SPSN program. Nurse practitioners, physician assistants, and others may also enroll.

Participating sentinel sites report influenza-like illness (ILI) to CDC on a weekly basis. The reports include the number of patients with ILI in the 0-4, 5-24, 25-64, and>65 years of age groups, as well as the total number of patients seen for any reason that week. The reporting process takes about 10-20 minutes a week and reports are entered at the website or faxed to CDC.

SPSN providers may also submit specimens to the state lab as a part of culture surveillance at no cost to the provider. The state of Texas currently has 114 health care providers enrolled in the network. Specific areas of the state needing additional providers are Bell, Bexar, Brazos, Denton, Ellis, Galveston, Hays, Hidalgo, Johnson, McLennan, Montgomery, Tarrant, Taylor, Webb, and Williamson counties.

While there is no financial compensation for contributing valuable public health information, the advantages for SPSN providers for participating are as follows:

• Recognition in IDCU's *EpiLink Online Bulletin*

• A complimentary subscription to CDC's *Morbidity and Mortality Weekly Report* and *Emerging Infectious Disease Journa*l for participating physicians

• A CDC certificate of participation for sites submitting at least 50% of the weekly reports for the current influenza reporting period

Those interested in participating in this important public health activity should contact Irene Brown at (512) 456-7111, ext. 6878, irene.brown@dshs.state.tx.us. IDCU will provide participants with a CDC instruction packet and a CDC-issued identification code required for entering ILI data. In addition to entering and viewing their own data, participating surveillance sites will also have access to the most recent national and regional CDC influenza surveillance data provided online.

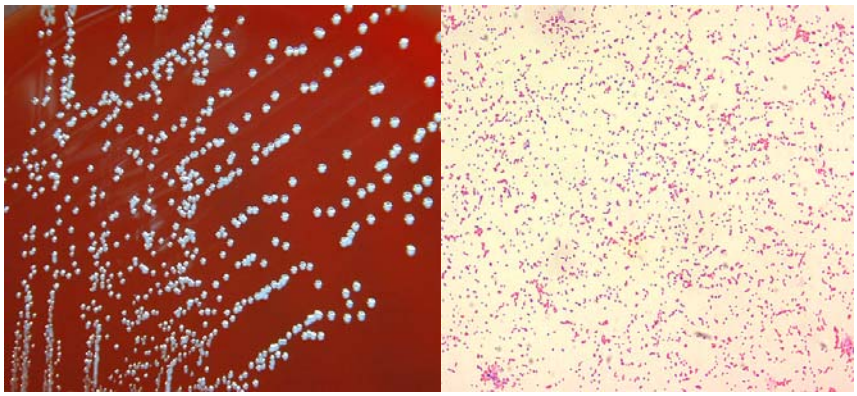
Prepared by Irene Brown, Infectious Disease Control Unit, Texas Department of State Health Services

Public Health in Action:
EpiSleuth!

Case Study: Flu-Like Illness in Moo County

You are an epidemiologist at the Texas Department of State Health Services. One day, you receive a call from your counterparts in Moo County. Over the past four days, nine patients have been admitted to the local hospital with what looks like influenza and debilitating joint and back pain. One patient is in the intensive care unit requiring mechanical ventilation. The rapid tests for influenza are negative, and while cultures are underway, no virus has been isolated yet. Three patients are dairy farmers, one patient is a local veterinary technician, and one patient works in the county public health laboratory. Of interest, all patients (except the lab worker) report attending the annual Moo County Dairy Fair two weeks ago.

Blood cultures have grown a gram-negative coccobacillus from 5 patients. The laboratory manager sends you digital images of a representative culture plate and gram stain of these clinical isolates. She notes that the colonies are pin-point in size and the lab tech really needed to zoom in to get the picture you see.



(images courtesy of Public Health Information Library: http://phil.cdc.gov/phil/home.asp)

Question 1: Based upon this information, what would be one of the most likely infectious agents this microorganism represents?

You decide that a visit to Moo County would be a good idea. Before you get to the parking lot, however, you are stopped by a man in a dark suit with sunglasses. He identifies himself (with proper credentials) as the FBI Special Agent in Charge who is investigating the most recent bioterror attack on Moo County.

“Bioterror attack?” you ask.

“Absolutely,” he answers. “We have highly credible intelligence indicating that Moo County was the target of a recent biological agent attack by the Delusional Liberation Front for Poor Exploited Dairy Animals.”

Question 2: Why would the FBI think that these patients are victims of a bioterror attack? (Hint: could this microorganism be used as a biological weapon?)

(The FBI later learns that their “highly credible” source was a tabloid columnist who got his sources crossed between the Moo County outbreak and a leak for the plotline of an upcoming season of a TV action-thriller series.)

(continued ☞)

EPISLEUTH! ANSWERS:

Question 1

The clinical description falls under the category of “influenza-like illness” (ILI). Unfortunately, there are many illnesses that begin as an ILI, including both viral and bacterial causes. The negative results for influenza (and other) viruses hopefully discourages further consideration of viral causes. However, there is a connection with dairy products and/or dairy-producing animals, which hopefully hints in a certain direction…

The bacterial cultures show gram-negative coccobacilli that form pinpoint colonies. Coupled with the clinical history of ILI, the reader is hopefully thinking of *Brucella* spp. and *Francisella* spp., both of which are notorious for their ability to cause laboratory-acquired infections [Koneman]. The illness in the laboratory worker hopefully reinforces this point. *Brucella* spp., however, are typically related to dairy products and animals [Mandell, CDC] and is therefore the intended answer here.

Brucellosis is almost always a result of exposure to animals, directly or indirectly [Mandell]. Brucella spp. are found worldwide, including Mexico and Central and South America. The disease has largely been eradicated from the United States, although in Texas brucellosis is typically associated with eating unpasteurized dairy products.

Symptoms of human brucellosis generally occur 2 to 4 weeks after exposure to the microorganism. Onset of symptoms can be abrupt and dramatic, or insidious and slow. These symptoms are also vague: fever, sweats, headache, and back pain are but a few of them. As mentioned, ILI is one presentation of the disease. If untreated for long periods of time, a pattern of fevers that come and go (“undulant” fever pattern) can occur.

On physical exam, findings can be sparse. About 20% of cases show mild enlargement of the lymph nodes, liver and spleen. Any organ can be involved, however [Mandell]. Diagnosis usually involves either isolating the infectious agent by culture (typically from blood or bone marrow, but other tissues can be used) or by showing rising titers of anti-Brucella antibodies.

Treatment usually involves combinations of antibiotics, as single agents have a high rate of relapse [Mandell]. Such combinations include doxycycline and rifampin, doxycycline and streptomycin (or another aminoglycoside, like gentamicin), and cotrimoxazole plus another agent (rifampin, quinolones, or an aminoglycoside). Treatment usually lasts for six weeks.

Question 2

While brucellosis typically occurs in the context of animal (or animal product) exposure, *Brucella* spp. has a shadier history. Because of its ability to cause debilitating human illness and its contagiousness, the U.S. and former Soviet Union (and other countries) developed versions of *Brucella* spp. as biological weapons [Alibek, Peters].

In 2002, the U.S. government developed a “select agent” list containing microorganisms “that could pose a severe threat to public health and safety”, partly in

(continued ☞)

an effort to improve the physical security of laboratories containing such agents [CDC]. Because of its history as a biological weapon, *Brucella* spp. are on that list. While the circumstances here don't really raise the suspicion of a terrorist attack, any situation that involves a select agent should – if only briefly – lead a person to raise an eyebrow and ask, "Could this have been intentional?"

References

1.Alibek, K W, Stephen Handelman S. Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World Told. Dell Publishing (1999).
2.CDC link: http://www.cdc.gov/od/sap/ (last accessed 5/18/07)
3.Koneman EW, Allen SD, et al. Color Atlas of Diagnostic Microbiology (6th ed). Lippincott Williams & Wilkins (2005).
4.Mandell GL, Bennett JE, Dolin R. Principles and Practice of Infectious Diseases (6th ed). Elsevier Science (2004).
5.Peters, CJ, Olshaker M. Virus Hunter: Thirty Years of Battling Hot Viruses Around the World. Knopf Publishing Group (1997).

Prepared by John Su, MD, PhD, MPH, LCDR, US Public Health Service, Epidemic Intelligence Service Officer, Texas Department of State Health Services

Become an Epi*Sleuth*! Does you health facility or department have an interesting case to submit for this new feature? Submit it to epilink@dshs.state.tx.us, and, if printed, you will receive an Epi*Sleuth* certificate!

Public Health in Action:

Recommendations for Preventing Foodborne Illness

Keep hands and surfaces clean.

Wash hands with hot, soapy water for at least 20 seconds before handling food and after using the bathroom, changing diapers, and handling pets.

Wash cutting boards, dishes, utensils, and counter tops with hot, soapy water after preparing each food item and before preparing another food item.

Prevent cross-contamination.

Keep raw meat, poultry, and seafood separate from other foods.

Use a different cutting board for meat, poultry, and seafood items, if possible.

Wash hands, cutting boards, dishes, utensils, and counter tops with hot, soapy water after contact with raw meat, poultry, or seafood.

Do not place cooked food on a plant that held raw meat, poultry, or seafood.

Cook food to proper temperatures.

Check internal temperatures of food to make sure they are fully cooked.

- Whole cuts of beef: 145°F
- Ground beef: 160°F
- Whole poultry: 180°F
- Poultry breasts and roasts: 170°F
- All cuts of pork: 160°F

Do not eat meat that is pink inside unless the internal temperature has been checked.

Fish should be cooked until it is opaque and flakes easily.

Refrigerate food promptly.

Refrigerate or freeze perishable foods, prepared foods, and leftovers within 2 hours of preparation.

Do not defrost food at room temperature—thaw it in the refrigerator, under running water, or in the microwave.

Refrigerator temperature should be no higher than 40°F, and freezer temperature should be no higher than 0°F.

Proper hand washing is the single most effective measure for preventing the spread of foodborne illnesses.

Epstein Barr Viral Infections in Johnson County

A call from a general practitioner in Burleson, Texas, prompted an investigation of an illness cluster in Johnson County of over 50 cases of an extended flu-like illness with recurrent fatigue. All occurred between December 2006 and early April 2007. Patients with such complaints were seen several times a week between December and February, but in March the physician saw up to 10 patients daily with such complaints. The private practitioner, who has served the community for over 3 decades, contacted the Health Service Region 2/3 office in Arlington in early April, requesting assistance.

The investigation consisted of interviews with the physician, a review of patient charts over a 5-month period, and examination of lab reports. Patients seen in the physician's office complained of a flu-like illness that began with pharyngitis, cervical adenopathy, rash, and fever. The patients were mostly middle aged, with a range of 8-63 years of age. Most were women and about 20% were Hispanic. During the week or 2 following the initial visits, many patients revisited the physician with further complaints that their illnesses were complicated by extreme myalgias, fatigue, loss of appetite and heightened irritability. Patients remained fatigued for 3-4 weeks with a clinical picture compatible with infection by Epstein Barr virus (EBV), the herpes virus that causes mononucleosis.

Fifteen had laboratory testing confirming recent EBV infection. The EBV laboratory test ordered looked for antibodies to multiple virus associated antigens; capsid, early antigen, and nuclear antigen. The predictive value of this test is greater than the heterophile antibody test, also called the Monospot test.

Visits by patients with a diagnosis of an extended flu-like illness declined by mid-April. The physician did not conduct influenza testing.

Review of absentee reports in Parker County Schools associated with influenza-like illness did not show a similar March peak to those reported by the physician's office (Figure 1). School absenteeism is monitored as part of the Department of State Health Services syndromic surveillance efforts.

Editorial note:

The Epstein-Barr virus is a member of the herpes virus family and one of the most common human viruses. In the United States, as many as 95% of adults between 35 and 40 years of age have been infected. Childhood infections usually cause no symptoms, or are indistinguishable from other mild, brief viral illnesses. Infection during adolescence or young adulthood causes infectious mononucleosis 35% to 50% of the time.

Acute infectious mononucleosis presents with a history of 1-2 weeks of fatigue and malaise; however, onset may be abrupt. Infectious mononucleosis is characterized by fever, pharyngitis (often with exudative tonsillitis), generalized lymphadenopathy (particularly cervical nodes), and, commonly, splenomegaly. Most clinical symptoms are a consequence of B-cell proliferation and organ infiltration. The incubation period is 30-50 days. Symptoms usually persist for 2-3 weeks. Fatigue may be prolonged, though seldom lasting longer than 4 months.

EBV remains dormant in some lymphocytes and cells of the orophyrangeal mucosa for the rest of the person's life. Periodically, the virus can reactivate and be found in the saliva, potentially spreading. This reactivation usually occurs without symptoms of illness. There are no known associations between active EBV infection and problems during pregnancy, such as miscarriages, or birth defects.

Because the antibody response to primary EBV infection is quite rapid, testing paired acute- and convalescent-phase serum samples often will not demonstrate a significant change in titers. Diagnosis can be made on a single acute-phase serum sample by testing for antibodies to several EBV-associated antigens simultaneously as was done here. A positive Paul-Bunnell heterophile antibody test result in a person with a classical presentation, fever, pharyngitis, and lymphadenopathy, is also diagnostic. Infants and children may give false negative results. Infection with cytomegalovirus or toxoplasmosis is known to produce false positives. At this time, the Texas Department of State Health Services laboratory does not offer heterophile antibody or other EBV diagnostic testing.

Prepared by Joann Schulte, DO, MPH, and Thi Nguyen, MPH, Health Service Region 2/3, Texas Department of State Health Services, and Gary Heseltine, MD, MPH, Central Office, Texas Department of State Health Services.

References

1. Epstein-Barr Virus and Infectious Mononucleosis, National Center for Infectious Diseases. Available at: http://www.cdc.gov/ncidod/diseases/ebv.htm

Statistical Summaries:

Vaccine Preventable Diseases and Rabies Monthly Updates

VACCINE PREVENTABLE DISEASES- CUMULATIVE CASES

Disease	2001	2002	2003	2004	2005	2006[4]	2007[4]
Congenital Rubella Syndrome	0	0	0	0	0	0	0
Hepatitis A	1,154	960	613	624	461	330	54
Hepatitis B	714	1,110	965	687	742	820	220
Hepatitis B, Perinatal[3]	11	3	1	0	8	1	0
Hib[1]	3	7	5	2	8	11	3
Measles	1	1	0	0	3	0	4
Mumps	14	15	18	23	25	54	10
Pertussis	615 (5)	1,240 (4)	670 (6)	1,184 (2)	2,224 (9)	936 (1)	196 (0)
Rubella	2	2	0	1	0	0	0
Tetanus	3 (1)	2 (1)	1	2	0	1	0
Varicella (Chickenpox)[2]	5,741(1)	6,047 (1)	5,465 (0)	8,544 (0)	8,336 (0)	11,785 (0)	5,209 (0)

[1]Beginning in 1997, invasive *Haemophilus influenzae* type b infections were counted regardless of age. In 1996, all invasive infections in children 5 years of age and younger, due to any type of Haemophilus influenzae were counted. Prior to 1996, all invasive infections due to any type of Haemophilus influenzae were counted regardless of age.
( ) deaths
[2]Vaccine to prevent varicella (chickenpox) was licensed in 1995.
[3]Beginning in 2001, Perinatal Hepatitis B were counted in children less than 2 years of age.
[4] Provisional as of May 16, 2007.

(continued ☞)

RABIES MONTHLY UPDATE – FEBRUARY 2007

During February, there were no cases of canine rabies in South Texas. To date, no cases of canine rabies have been reported north of the South Texas Oral Rabies Vaccination Program (ORVP) drop-zone for coyotes.

In West-Central Texas, there were 9 cases of gray fox rabies from the following counties: Edwards (1 dog, 1 fox, 1 raccoon), Menard (1 bobcat), Sutton (1 bobcat), Tom Green (1 bobcat), Upton (1 cat), Val Verde (1 fox), and Ward (1 dog). This is the first year in which there has been a reported case of gray fox rabies in Ward County. To date, no cases of gray fox rabies have been reported beyond the boundaries of the original ORVP drop-zone for gray foxes.

There were 69 reported cases of rabies in animals, including:

46 skunks	2 foxes
11 bats	2 raccoons
3 dogs	1 cat
3 bobcats	1 cow

These cases were reported from the following counties:

Bexar (1 skunk)
Brazoria (1 bat)
Brazos (3 skunks)
Burleson (2 skunks)
Burnet (1 skunk)
Childress (1 cow)
Clay (1 skunk)
Coleman (1 skunk)
Coryell (1 bat)
Denton (1 skunk)
Edwards (1 dog, 1 fox, 1 raccoon)
El Paso (1 bat)
Ellis (3 skunks)
Galveston (1 bat)
Grayson (1 skunk)
Grimes (1 skunk)
Harris (3 bats)
Henderson (2 skunks)
Hidalgo (1 bat)
Hopkins (2 skunk)
Houston (1 skunk)
Kendall (1 raccoon)
Leon (1 dog)
Menard (1 bobcat)
Navarro (2 skunks)
Nueces (2 bats)
Parker (2 skunks)
Rockwall (1 skunk)
Runnels (1 skunk)
Sutton (1 bobcat)
Tom Green (1 bobcat)
Upton (1 cat)
Val Verde (1 fox)
Victoria (1 skunk)
Ward (1 dog)
Webb (1 bat)
Wharton (15 skunks)
Wichita (1 skunk)
Wise (3 skunks)

View yearly rabies summary reports.
[http://www.dshs.state.tx.us/idcu/disease/rabies/cases/statistics/]

FDA Clears First Respirators for Use in Public Health Medical Emergencies

FDA News. May 8, 2007

The U.S. Food and Drug Administration (FDA) today cleared for marketing the first respirators that can help reduce the user's exposure to airborne germs during a public health medical emergency, such as an influenza pandemic.

These two filtering facepiece respirators, manufactured by St. Paul, Minn.-based 3M Company (and called the 3M Respirator 8612F and 8670F), will be available to the general public without a prescription.

The devices are also certified as N95 filtering facepiece respirators by the National Institute for Occupational Safety and Health (NIOSH). NIOSH certifies respirators for use in occupational settings in accordance with an appropriate respiratory protection program.

An N95 filtering facepiece respirator is a type of face mask that fits tightly over the nose and mouth. It is made of fibrous material that is designed to filter out at least 95 percent of very small airborne particles. The filter and a proper fit determine the effectiveness of the product.

"While the exact nature and concentration of the biological agent or germ may not be known in a public health medical emergency, we believe that minimizing exposure will help reduce risk," said Daniel Schultz, M.D., director, FDA's Center for Devices and Radiological Health. "These respirators are only one part of a combination of approaches that can be used to help reduce the spread of infection between individuals during such events."

Many companies make N95 respirators for workplaces, including health care settings. However, the 3M respirators are the first devices to receive FDA clearance for use by the public during public health medical emergencies to reduce exposure to airborne germs.

Under Occupational Safety and Health Administration and other occupational health regulations, respirators used in the workplace must be individually selected for each worker and tested to ensure a proper fit. This kind of fit testing is not generally employed outside the workplace now and would probably not be feasible during a public health medical emergency.

FDA is requiring those who want to market respirators for use during public health medical emergencies to assure that they are certified by NIOSH to provide adequate filtration without hampering people's ability to breathe. In addition, companies must conduct fit assessment testing, conduct biocompatibility testing to reduce the chance for allergic skin reaction, and provide instructions that will enable wearers to achieve a protective fit and use the devices properly.

3M evaluated fit characteristics in healthy adults to determine that a user could achieve a protective fit following the instructions on the label. They measured how many airborne test particles were able to get inside the respirator through small leaks between the edges of the respirator and the wearer's face. While individual results varied, all participants tested achieved some reduction in exposure to airborne test particles.

The 3M respirators are sized for adults and may not form a proper fit on children. Anything that comes between the respirator and the face, such as facial hair, may interfere with its fit. Persons with pre-existing heart or lung disease or other health conditions may have difficulty breathing through a respirator. The devices are for single use. Wearers should not wash, disinfect, reuse or share their respirator with others. The respirators should be discarded after use.

FDA will soon issue a guidance document outlining its regulatory approach to this new type of device.

Inhaling particles is just one route of exposure to disease-causing organisms. Others include touching contaminated surfaces and coming into close contact with those who have infectious diseases. A total approach to personal protection includes hand hygiene, cough etiquette and other protection practices such as avoiding crowded settings.

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DSHS Publication Number E59-12544

How to submit manuscripts for publication

The *EpiLink* welcomes the submission of articles on a variety of public health and medical topics for publication. In addition, the newsletter will focus on a different health topic each month, such as maternal and child health and border health issues. If you are interested in contributing articles for the monthly health focus, please read the chart for topics and deadlines.

Issue	Topic	Articles due by
July	Maternal and Child Health	July 2, 2007
August	Chronic Diseases	July 30, 2007
September	Mental Health	August 28, 2007
October	Influenza	October 1, 2007
November	Border Health Issues	October 29, 2007
December	Communication and Information Technology in Public Health	December 3, 2007
January	Environmental Issues and Occupational Diseases	January 2, 2008
February	Social Marketing in Public Health	January 25, 2008

TEXAS Department of State Health Services

Estimating Health Care-Associated Infections and Deaths in U.S. Hospitals, 2002

R. Monina Klevens, DDS, MPH[a]
Jonathan R. Edwards, MS[a]
Chesley L. Richards, Jr., MD, MPH[a,b,c,d]
Teresa C. Horan, MPH[a]
Robert P. Gaynes, MD[a,e]
Daniel A. Pollock, MD[a]
Denise M. Cardo, MD[a]

SYNOPSIS

Objective. The purpose of this study was to provide a national estimate of the number of healthcare-associated infections (HAI) and deaths in United States hospitals.

Methods. No single source of nationally representative data on HAIs is currently available. The authors used a multi-step approach and three data sources. The main source of data was the National Nosocomial Infections Surveillance (NNIS) system, data from 1990–2002, conducted by the Centers for Disease Control and Prevention. Data from the National Hospital Discharge Survey (for 2002) and the American Hospital Association Survey (for 2000) were used to supplement NNIS data. The percentage of patients with an HAI whose death was determined to be caused or associated with the HAI from NNIS data was used to estimate the number of deaths.

Results. In 2002, the estimated number of HAIs in U.S. hospitals, adjusted to include federal facilities, was approximately 1.7 million: 33,269 HAIs among newborns in high-risk nurseries, 19,059 among newborns in well-baby nurseries, 417,946 among adults and children in ICUs, and 1,266,851 among adults and children outside of ICUs. The estimated deaths associated with HAIs in U.S. hospitals were 98,987: of these, 35,967 were for pneumonia, 30,665 for bloodstream infections, 13,088 for urinary tract infections, 8,205 for surgical site infections, and 11,062 for infections of other sites.

Conclusion. HAIs in hospitals are a significant cause of morbidity and mortality in the United States. The method described for estimating the number of HAIs makes the best use of existing data at the national level.

[a]Division of Healthcare Quality Promotion, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, GA

[b]Atlanta VA Medical Center/Geriatric Research, Education, and Clinical Center, Atlanta, GA

[c]Division of Geriatric Medicine and Gerontology, Department of Medicine, Emory University School of Medicine, Atlanta, GA

[d]Atlanta VA Health Services Research and Development Center, Atlanta, GA

[e]Division of Infectious Diseases, Department of Medicine, Emory University School of Medicine, Atlanta, GA

Address correspondence to: R. Monina Klevens, Centers for Disease Control and Prevention, 1600 Clifton Rd., MS A-24, Atlanta, GA 30333; tel. 404-639-4174; fax 404-639-4045.

Healthcare-associated infections (HAIs) are a common cause of morbidity and mortality in the United States and are among the most common adverse events in healthcare.[1] Recently, new emphasis on HAIs as a patient safety and public health problem has underscored the need for systematic HAI surveillance as part of a broad-based prevention and control strategy.[2–4]

As of March 2006, seven states have implemented mandatory reporting of HAIs by hospitals and other states are considering similar legislative mandates.[5] At the national level, the Centers for Disease Control and Prevention's (CDC) National Nosocomial Infections Surveillance (NNIS) system, which was started in 1970 with 62 participating hospitals, expanded to over 300 acute care hospitals in 42 states by 2000. The NNIS system provided data on HAIs and was voluntary and confidential;[6] benchmark rates were published for inter-hospital comparison.[7] CDC's successor system to NNIS, the National Healthcare Safety Network (NHSN), is designed to facilitate participation by a larger number of hospitals and expand enrollment to other types of healthcare settings.[8]

Ideally, one source of HAI information would meet different needs for surveillance data. In practice, however, resource requirements and evolving needs and priorities have prompted more selective goal setting and surveillance efforts. The NNIS system reflects these changes. Comprehensive or "hospital-wide" surveillance was performed by at least half of NNIS hospitals through 1991. This enabled national estimates of all HAIs in hospitals to be made directly from NNIS data. However, interest in hospital-wide surveillance waned as more efficient, targeted surveillance emerged and new emphasis was placed on surveillance of high-risk, high-volume areas of hospital practice.[9] NNIS added more specific components (e.g., intensive care units) and discontinued hospital-wide surveillance in 1998. While more targeted surveillance yielded many benefits for HAI prevention and control, the cessation of hospital-wide surveillance has complicated the task of estimating all HAIs in hospitals. Still, with the aid of historical NNIS data and data from other sources, we developed a multi-step approach to estimate the magnitude of HAIs and associated deaths in U.S. hospitals in 2002. The purposes of this article are to present national estimates of HAIs and to discuss the challenges and opportunities for improving national public health surveillance of HAIs.

METHODS

Definitions

An HAI was defined as a localized or systemic condition that (*1*) results from an adverse reaction to the presence of an infectious agent(s) or its toxin(s), (*2*) that occurs during a hospital admission, (*3*) for which there is no evidence the infection was present or incubating at admission, and (*4*) meets body site-specific criteria.[6] Patient-days were defined as the total number of days that patients were in the hospital.

Data sources

The National Nosocomial Infections Surveillance (NNIS) system. The NNIS system was a voluntary network of U.S. hospitals collaborating with CDC to monitor HAIs from 1970–2005. Hospitals participating in NNIS provided acute care, had 100 or more beds, and a minimum of one full-time equivalent infection control practitioner for the first 100 occupied beds. Detailed methods of the NNIS system are described elsewhere.[6] Hospitals participating in NNIS were not selected randomly and might not represent all acute care hospitals in the United States. We used data from 283 participating NNIS hospitals in 2002; these contributed 2.3 million patient-days of information from 678 intensive care units (ICUs).

National Hospital Discharge Survey (NHDS). The NHDS is an annual CDC probability survey of characteristics of inpatients discharged from nonfederal short-stay hospitals in the United States. Methods for NHDS have been described extensively.[10,11] Briefly, survey sampling is conducted in three stages. First, the geographic area (e.g., counties) is sampled; second, hospitals are selected within those geographic areas; and third, patient discharges are sampled within selected hospitals. Patient records are reviewed to collect information on characteristics of the patient (e.g., age, gender), procedures performed, diagnoses, and dates of admission and discharge. Patient-days are calculated by counting days from admission to discharge and summing the days for all patients during the year. In 2002, 445 hospitals participated in the survey and provided data on a weighted 37.5 million discharges. Of these discharges, 90% (33,726,611) were among adults and children and 10% (3,789,310) were among newborns.

American Hospital Association (AHA) Survey. The AHA conducts an annual survey of hospitals and their characteristics (e.g., number of beds, discharges, services, occupancy).[12] Participation in the AHA survey does not require membership in the AHA. Admissions and

patient-day data are available for federal and nonfederal hospitals. In 2000, there were 5,800 hospitals in the AHA survey representing 34.9 million admissions and 236.4 million patient-days. Federal hospitals accounted for 13.2 million (5.6%) patient-days.

Estimate of HAIs in hospitals

To estimate infections, we created four subpopulations (newborns in high-risk nurseries, newborns in well-baby nurseries, adults and children in ICUs, and adults and children outside of ICUs) and grouped HAIs into five major sites (surgical site infections, bloodstream infections, pneumonia, urinary tract infections, and other sites combined).

Step 1. Estimate of HAI among newborns. We stratified patient-days from NHDS among newborns into days spent in the high-risk nursery or the well-baby nursery according to the distribution of patient-days for these two subpopulations in NNIS hospital-wide surveillance. Then we calculated infection rates by major site of infection for the high-risk nursery using 2002 NNIS data from the high-risk nursery component, and in the well-baby nursery by major site of infection from 1990–1995 using NNIS hospital-wide surveillance data. Total infections were estimated by multiplying the number of NHDS patient-days by the corresponding NNIS infection rates for the high-risk nursery and well-baby nursery (number of patient-days × infection rate/patient-days = number of infections).

Step 2. Estimate of HAI among adults and children in ICUs. From NHDS, we obtained total patient-days nationally for adults and children and stratified these into ICU days and days outside of the ICU. For ICU patients, we calculated HAI rates by using NNIS ICU data for each major site of infection (number of patient-days × infection rate/patient-days = number of infections) (see Figure).

Step 3. Estimate of HAIs among hospitalized adults and children outside of ICUs. NNIS HAI rates outside of ICUs were likely underestimated from 1990 to 1995; therefore, we used a different method from those above to estimate HAIs among adults and children outside of ICUs. Specifically, we estimated the number of infections from a single major site and then used the distribution percentage for that site from NNIS hospital-wide surveillance to extrapolate to the total number of HAIs in adults and children outside of ICUs. We chose the surgical site for our calculations because the number of surgical procedures is available for the U.S. population in the NHDS. We multiplied the number of surgical procedures in the NHDS by the surgical site infection rate from NNIS 2002 surveillance. From this estimate, we subtracted surgical site infections among newborns and among adults and children in ICUs, which yielded the total number of such infections among hospitalized adults and children outside of ICUs, i.e., 244,385. Surgical site infections accounted for 20% of all HAIs in NNIS hospital-wide surveillance; thus, we used that percentage to estimate the number of infections for other body sites (see Figure).

Step 4. Adjustment to include federal hospitals. Because NHDS does not include federal hospitals, we used AHA data to adjust the HAI estimate to reflect the burden of these infections in federal hospitals. To do this, we calculated an adjustment factor by which we multiplied the number of non-newborn patient-days and non-newborn infection estimates. The number of newborn patient-days in federal hospitals was minimal, so we did not adjust the newborn estimates. From the AHA survey of 2000, we took the number of patient-days in federal hospitals (11.6 million), added the number of nonfederal hospital patient-days among adults and children (192.4 million) and divided the sum by the nonfederal hospital patient-days among adults and children (192.4 million). The result was 1.06, which we used as a multiplier of the number of adult and children NHDS patient-days and infection estimates. The multiplier increased the number of HAI by 6%.

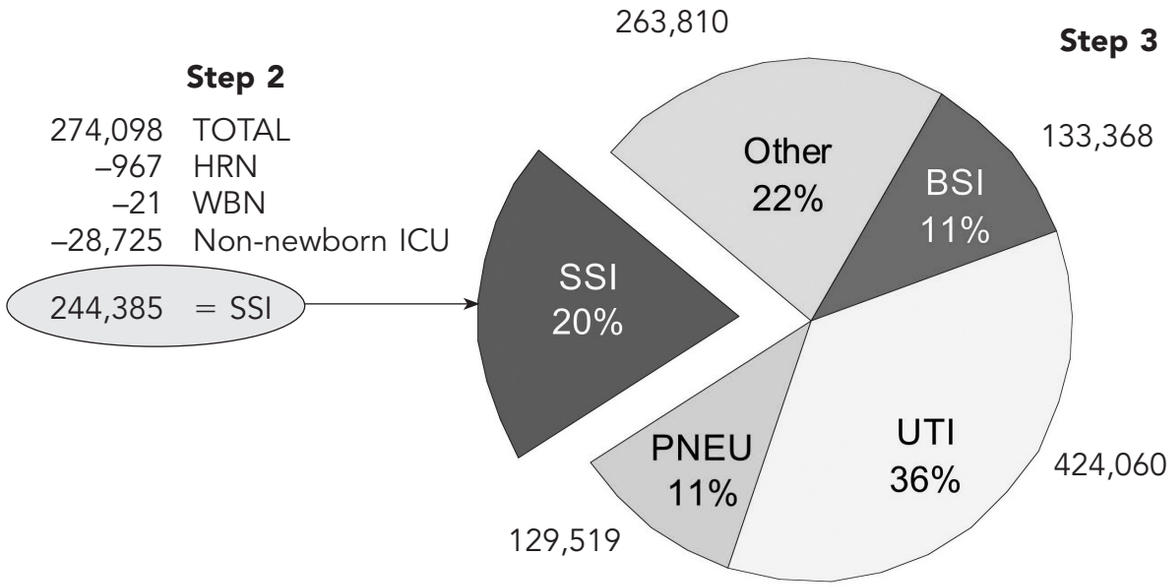
Estimate of deaths

When patients with an HAI die during hospitalization at participating NNIS facilities, infection control professionals make an assessment of the relationship of the HAI to the death and classify the relationship as causal, contributory, not related, or unknown. If a patient has multiple HAIs and dies during hospitalization, the infection control professional makes an assessment of each infection separately. For this estimate, we included deaths in which the HAI caused or contributed to the death, and refer to these as deaths associated with HAIs. Using NNIS infection data from 1999 to 2003, we calculated the percentage of patients with an HAI who died and the percentage of those whose death was associated with their HAI. We then multiplied the percentages within each of the four subpopulations by the estimate of patients with an HAI derived through steps 1–4.

RESULTS

The total number of patient-days from NHDS in 2002 was 176.4 million. Adults and children accounted for 93.1% of patient-days (30.2 million in ICUs and 133.9 million outside ICUs) and newborns for 6.9% (7.4 million in well-baby nurseries, and 4.8 million in high-risk

Figure. Calculation of estimates of health care-associated infections in U.S. hospitals among adults and children outside of intensive care units, 2002



NOTES: From the total number of surgical site infections (SSI) obtained from the National Hospital Discharge Dataset and the National Nosocomial Infections Surveillance (NNIS) system, we subtracted the number of SSI among newborns and adults and children in intensive care units. The remaining SSI were among adults and children outside of intensive care units. From hospital-wide surveillance in NNIS, we had the distribution of infections by major site and calculated the corresponding number of infections for pneumonias (PNEU), urinary tract infections (UTI), bloodstream infections (BSI), and other sites.

HRN = high-risk newborns

WBN = well-baby nurseries

ICU = intensive care unit

SSI = surgical site infections

BSI = bloodstream infections

UTI = urinary tract infections

PNEU = pneumonia

nurseries). The infection rate per 1,000 patient-days was highest in ICUs (13.0), followed by high-risk nurseries (6.9), and well-baby nurseries (2.6) (Table 1).

We estimated 274,098 surgical site infections in the U.S. population for procedures monitored in the NNIS system, or about two surgical site infections per 100 procedures (Figure). Of these, 244,385 surgical site infections were among adults and children outside of ICUs. Knowing that the estimate of surgical site infections was 244,385 and that these were approximately 20% of all infections, we estimated that for adults and children outside of ICUs, there were 424,060 urinary tract infections, 129,519 pneumonias, 133,368 bloodstream infections, and 263,810 other infections. The estimated total HAIs among adults and children in hospitals but outside of ICUs was 1,195,142.

We estimated 33,269 HAIs among newborns in high-risk nurseries, 19,059 among newborns in well-baby nurseries, 394,288 among adults and children in ICUs, and 1,195,142 among adults and children outside of ICUs (Table 2). The total number of HAIs among these subpopulations (1,641,758), adjusted to include federal facilities, was 1,737,125 HAI in the United States for 2002. This number represents a rate of 9.3 infections per 1,000 patient-days or 4.5 per 100 admissions in 2002.

Among the 1.7 million patients with an HAI in 2002, there were 155,668 deaths, of which 98,987 were caused by or associated with the HAI. The percentage of patients whose deaths were associated with an HAI varied by major site and subpopulation. The lowest percentage was 0% of infants in well-baby nurseries with urinary tract infections, bloodstream infections, and surgical site infections. The highest percentage of patients with an HAI whose death was associated with the infection was among adults and children

Table 1. Rates of healthcare-associated infections in newborns and adults and children by site of infection, National Nosocomial Infections Surveillance (NNIS) system

	Well-baby nursery[a]	*High-risk nursery*[b]	*Intensive care unit*[b] *(adults and children)*
Patient-days[c]	7,436,520	4,835,702	30,236,811
Major site of infection	*Rate of infection per 1,000 patient-days*		
Urinary tract	0.19	0.5	3.38
Bloodstream	0.76	3.06	2.71
Pneumonia	0.24	0.91	3.33
Surgical site	0.003	0.2	0.95
Other	1.37	2.21	2.67
Total	2.56	6.88	13.04

[a]From NNIS hospital-wide surveillance, 1990–1995

[b]From NNIS surveillance 2002, high-risk nursery and ICU component

[c]From the National Hospital Discharge Survey (NHDS) for the U.S. population in non-federal hospitals

in ICUs, where the percentage varied from 11% for surgical site infections to 25% for bloodstream infections. The number of deaths associated with HAIs by major site combining the subpopulations was greatest for pneumonia (35,967) and bloodstream infections (30,665). An estimated 13,088 deaths were associated with urinary tract infections, 8,205 with surgical site infections, and 11,062 with infections of other sites.

DISCUSSION

We estimate that 1.7 million HAIs occurred in U.S. hospitals in 2002 and were associated with approximately 99,000 deaths. The number of HAIs exceeded the number of cases of any currently notifiable disease,[13] and deaths associated with HAIs in hospitals exceeded the number attributable to several of the top ten leading causes of death reported in U.S. vital statistics.[14] These estimates are sobering and reinforce the need for improved prevention and surveillance efforts.

These estimates have several limitations. We used 1990s data from hospital-wide surveillance for estimates in 2002 in two areas: infection rates in well-baby nurseries and the distribution of infections by major site. Similar data are not available for a more recent time period. The impact of using old infection rates in well-baby nurseries is minimal because the rate was the lowest among the subpopulations and the total number of infections (19,059) was only 1.1% of the total number of infections. The distribution by major site of infection has a large impact on our estimates because adults and children outside of ICUs accounted for 68.8% of all HAIs. However, there is a lack of data in the United States to suggest that the distribution has changed since the 1990s. In other countries, recent studies provide support for using at least 20% for

Table 2. Estimated number of healthcare-associated infections in U.S. hospitals by subpopulation and major site of infection, United States, 2002

Major site of infection	*Well-baby nursery*	*High-risk nursery*	*Intensive care unit (adults and children)*	*Outside of intensive care units (adults and children)*[a]	*Unadjusted total*	*Adjusted total*[b]	*Percentage*
Urinary tract	1,413	2,418	102,200	424,060	530,091	561,667	32
Bloodstream	5,652	14,797	81,942	133,368	235,759	248,678	14
Pneumonia	1,785	4,400	100,689	129,519	236,393	250,205	15
Surgical site	21	967	28,725	244,385	274,098	290,485	22
Other	10,188	10,687	80,732	263,810	365,417	386,090	17
Total	19,059	33,269	394,288	1,195,142	1,641,758	1,737,125	100

[a]See proportions applied from description in Figure.

[b]Adjusted for inclusion of federal hospitals by multiplying non-newborn values by 1.06

surgical site infections as a percentage of infections by site.[15–17]

We may have underestimated the total number of HAIs because surgical site infections are likely underreported in the NNIS system. Most surgical site infections become evident after discharge,[18,19] and the completeness and accuracy of post-discharge surveillance is variable in NNIS hospitals. Since we extrapolated from the number of surgical site infections among adults and children outside of ICUs to other infection sites in the same population using NNIS infection rates, the total number might be underestimated. In addition, the decrease in the average hospital length of stay over time might have increased the chance of missing post-discharge surgical site infections.[20] There may be other factors, however, such as a higher rate of infections that might result in an overestimate of infections. Therefore, we acknowledge a lack of precision in our estimates.

Infection rates from NNIS hospitals might be different than those in other hospitals. NNIS hospitals are frequently larger, more likely to be affiliated with academic institutions, and located in the mid- and south-Atlantic regions of the United States.[21] Rates of HAIs from NNIS hospitals cannot be applied to other healthcare settings.

Finally, our death estimate is limited in that attributable mortality is often difficult to determine from a patient's records. Even for experts, it can be problematic to determine whether patients die from their infection or from their co-morbidities.[22]

Other methods might be useful to estimate national burden including prevalence surveys and use of surrogate data. Annual prevalence surveys are used to measure the burden of HAIs in many countries. For example, prevalence per 100 admissions was 9.1 in Greece in 1999,[15] 8.0 in Denmark in 1999,[16] 7.0 in Spain in 1997,[17] 5.1 in Norway in 2002,[23] and 4.6 in Slovenia in 2001.[24] A disadvantage to annual prevalence surveys is that trends might reflect changes in case ascertainment over time rather than true changes in prevalence.[25] In addition, data from annual prevalence surveys is less useful for prevention at the facility level. In the United States, prevalence surveys could be used periodically to supplement surveillance data to estimate HAIs in hospitals.

There are several examples of using surrogate data from administrative records for surveillance purposes (e.g., the International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes).[26] An evaluation of administrative data to identify injuries in children demonstrated high correlation, sensitivity, and specificity.[27] Previously unrecognized differences in sepsis by race were described at the national level using ICD-9-CM codes;[28] however, the frequency of HAIs has been more difficult to capture using administrative data. Some HAIs are captured in estimates using the Agency for Healthcare Research and Quality patient safety indicators to estimate patient safety events during Medicare hospitalizations[29] and by the mandatory reporting system in Pennsylvania.[30] Evaluations of these surrogate systems have so far indicated low sensitivity[31,32] and low predictive value.[31] An evaluation of the performance of five different measures of bloodstream infections demonstrated improved performance of clinical indicators over administrative indicators.[33] In general, the difficulty may be related to the need to determine if the infection is associated with the delivery of healthcare services. Standardized definitions and methods are features associated with the success of HAI surveillance.[8]

In 1995, CDC estimated that 1.9 million HAIs occurred in U.S. hospitals.[34] In 2002, we estimated 1.7 million HAIs. Direct comparison of these estimates should be avoided because both are based on the same hospital-wide surveillance data. However, our estimates of surgical site infections do not depend on hospital-wide data and might be useful to compare. In 1995, we estimated that there were 269,268 surgical site infections, or 2.21% of surgical procedures monitored in NNIS. In 2002, we estimated there were 274,268 surgical site infections, or 1.96% of procedures monitored.

New attention to HAIs and advances in information technology could lead to greater participation of hospitals in organized surveillance efforts.[35] At CDC, the evolution of the NNIS system into the NHSN has provided a web-based platform that could help address the need for HAI data at the local, state, and national levels.

The authors are indebted to the NNIS/NHSN system participants for their ongoing efforts to monitor infections and improve patient safety.

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

REFERENCES

1. Leape LL, Brennan TA, Laird N, Lawthers AG, Localio AR, Barnes BA, et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. N Engl J Med 1991;324:377-84.
2. Leape LL, Berwick DM. Five years after To Err is Human: what have we learned? JAMA 2005;293:2384-90.
3. Burke JP. Infection control–a problem for patient safety. N Engl J Med 2003;348:651-6.
4. Leape LL. Reporting of adverse events. N Engl J Med 2002; 347:1633-8.

5. Association for Professionals in Infection Control and Epidemiology (APIC). Government advocacy [cited 2005 Sep 22]. Available from: URL: http://www.apic.org/Content/NavigationMenu/GovernmentAdvocacy/MandatoryReporting/Abouttheissue/about_the_issue.htm
6. Horan TC, Gaynes RP. Surveillance of nosocomial infections. In: Mayhall CG, editor. Hospital epidemiology and infection control. 3rd ed. Philadelphia: Lippincott Williams & Wilkins, 2004. p. 1659-702.
7. National Nosocomial Infections Surveillance (NNIS) Report, data summary from January 1992 through June 2004, issued October 2004. Am J Infect Control 2004;32:470-85.
8. Tokars JI, Richards C, Andrus M, Klevens M, Curtis A, Horan T, et al. The changing face of surveillance for health care-associated infections. Clin Infect Dis 2004;39:1347-52.
9. Sartor C, Edwards JR, Gaynes RP, Culver DH. Evolution of hospital participation in the National Nosocomial Infections Surveillance System, 1986 to 1993. Am J Infect Control 1995;23:364-8.
10. Centers for Disease Control and Prevention (US). National Center for Health Statistics 2002 NHDS data file documentation [cited 2005 Mar 11]. Available from: URL: http://www.cdc.gov/nchs/about/major/hdasd/nhdssam.htm
11. Dennison C, Pokras R. Design and operation of the National Hospital Discharge Survey: 1988 redesign. Vital Health Stat 1 2000;(39):1-42.
12. American Hospital Association. Hospital statistics 2004. Chicago: Health Forum LLC; 2005.
13. Summary of notifiable diseases—United States, 2002. MMWR Morb Mortal Wkly Rep 2004;51(53):1-84.
14. Deaths: leading causes for 2001. Natl Vital Stat Rep 2003;52(9); Table E.
15. Starakis I, Marangos M, Gikas A, Pediaditis I, Bassaris H. Repeated point prevalence survey of nosocomial infections in a Greek university hospital. J Chemother 2002;14:272-8.
16. Christensen M, Jepsen OB. Reduced rates of hospital-acquired UTI in medical patients. Prevalence surveys indicated effect of active infection control programmes. J Hosp Infect 2001;47:36-40.
17. Vaqué J, Rosselló J, Arribas L. Prevalence of nosocomial infections in Spain: EPINE study 1990–1997. EPINE Working Group. J Hosp Infect 1999;43 Suppl:S105-11.
18. Manian F, Meyer L. Adjunctive use of monthly physician questionnaires for surveillance of surgical site infections after hospital discharge and in ambulatory surgical patients: report of a seven-year experience. Am J Infect Control 1997;25:390-4.
19. Sands K, Vineyard G, Platt R. Surgical site infections occurring after hospital discharge. J Infect Dis 1996;173:963-70.
20. National Center for Health Statistics. Health, United States, 2004 with chartbook on trends in the health of Americans with special feature on drugs [cited 2005 Sep 22]. Hyattsville (MD): 2005. Available from: URL: http://www.cdc.gov/nchs/hus.htm
21. Richards C, Emori TG, Edwards J, Fridkin S, Tolson J, Gaynes R. Characteristics of hospitals and infection control professionals participating in the National Nosocomial Infections Surveillance system 1999. Am J Infect Control 2001;29:400-3.
22. Hiatt HH, Barnes BA, Brennan TA, Laird NM, Lawthers AG, Leape LL, et al. A study of medical injury and medical malpractice. N Engl J Med 1989;321:480-4.
23. Eriksen HM, Iversen BG, Aavitsland P. Prevalence of nosocomial infections in hospitals in Norway, 2002 and 2003. J Hosp Infect 2005;60:40-5.
24. Klavs I, Bufon Luznik T, Skerl M, Grqic-Vitek M, Lejko Zwpanc T, Dolinsek M, et al. Prevalence of and risk factors for hospital-acquired infections in Slovenia—results of the first national survey, 2001. J Hosp Infect 2003;54:149-57.
25. Sartor C, Delchambre A, Pascal L, Drancourt M, De Micco P, Sambuc R. Assessment of the value of repeated point-prevalence surveys for analyzing the trend in nosocomial infections. Infect Control Hosp Epidemiol 2005;26:369-73.
26. Kostylova A, Swaine B, Feldman D. Concordance between childhood injury diagnoses from two sources: an injury surveillance system and a physician billing claims database. Inj Prev 2005;11:186-90.
27. Public Health Service and Health Care Financing Administration. International Classification of Diseases, 9th Revision, Clinical Modification. Washington: Public Health Service. 4th ed. 1991.
28. Martin GS, Mannino DM, Eaton S, Moss M. The epidemiology of sepsis in the United States from 1979 through 2000. N Engl J Med 2003;348:1546-54.
29. Healthgrades Inc. Second annual patient safety in American hospitals report. (Accessed on September 22, 2005, at http://www.healthgrades.com/media/dms/pdf/HealthGradesNinthAnnualHospitalQualityinAmericaStudy.pdf
30. Pennsylvania Health Care Cost Containment Council (PHC4). Hospital-acquired infections in Pennsylvania [cited 2006 Dec 14]. PHC4 Research Briefs 2005;(5). Available from: URL: http://www.phc4.org
31. Sherman E, Heydon K, Teszner E, Alexander S, Rettig S, St. John KH, et al. Mandatory reporting of healthcare-associated infections: a long way to go. Abstract #304, Final Program of the Society for Healthcare Epidemiology of America, Alexandria, VA; April 9-12, 2005. p. 136.
32. Julian KG, Brumback A, Chicora M, et al. Collaborative approaches to mandatory nosocomial infection reporting in Pennsylvania. Abstract #303, Final Program of the Society for Healthcare Epidemiology of America, Alexandria, VA; April 9-12, 2005. p. 136.
33. Braun BI, Kritchevsky SB, Kusek L, Wong ES, Solomon SL, Steele L, et al. Comparing bloodstream infection rates: the effect of indicator specifications in the evaluation of processes and indicators in infection control (EPIC) study. Infect Control Hosp Epidemiol 2006;27:14-22. Epub 2006 Jan 6.
34. Weinstein RA. Nosocomial infection update. Emerg Infect Dis 1998;4:416-20.
35. Aspden P, Corrigan JM, Wolcott J, Erickson SM, editors. Committee on Data Standards for Patient Safety. Patient safety: achieving a new standard for care [cited 2005 Oct 3]. Available from: URL: http://www.iom.edu/report.asp?id=16663