Vaccine Preventable Disease and Foodborne Illness

Chapter 9

Infectious Disease

Evidence of infectious diseases has been documented in ancient Egyptian mummies, and infectious diseases continue to affect people across the world. An infectious, or communicable,[a] disease is an illness due to a specific infectious agent that is transmitted from a source to a susceptible host. The source can be an infected person, animal, or inanimate source, such as peanut butter in recent salmonella outbreaks. The modes of transmission include direct contact and droplet spread (i.e. sneezing and coughing) or indirect transmission through a vector (i.e. mosquito or person), common vehicle (i.e. food), or the air.[1]

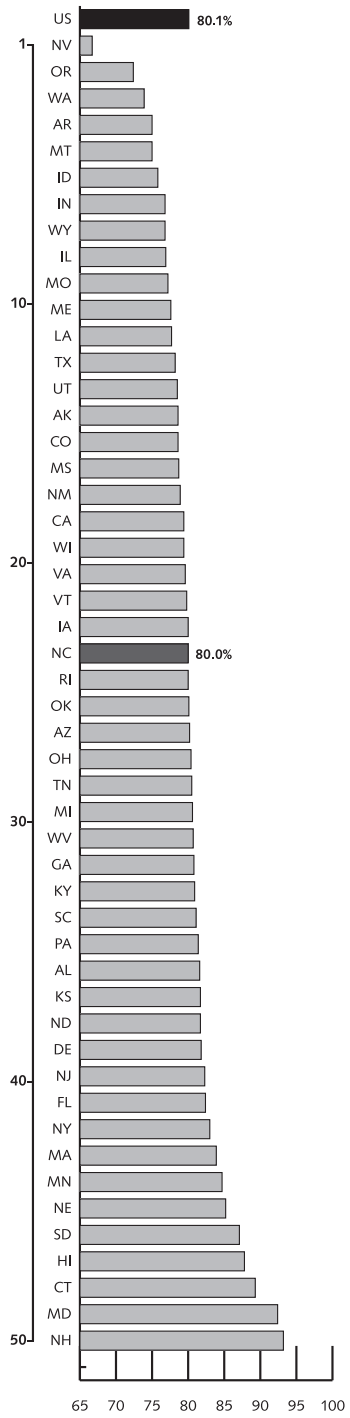
Over the last century, the number of deaths from infectious diseases in the United States generally decreased until the 1980s. With the exception of the influenza pandemic in 1918, the number of deaths decreased steadily until a number of factors including HIV/AIDS related deaths and antibiotic resistance caused the number to increase again.[2] Public health and prevention methods are useful tools to help reduce the number of deaths from infectious diseases. The Task Force on Prevention chose to focus on two particular classes of infectious diseases, vaccine preventable diseases and foodborne illnesses, as prevention efforts are especially effective in preventing these health problems.

Vaccine Preventable Disease

Many diseases, such as chicken pox, measles, influenza, and hepatitis B, can be prevented by vaccines. However, every year people become sick, disabled, or die because of the lack of vaccinations. Nationally, influenza causes 36,000 deaths and 226,000 hospitalizations each year, while hepatitis B causes 2,000 to 4,000 deaths yearly.[3-5] Infectious diseases, including pneumonia and influenza, were the 10th leading cause of death among North Carolinians in 2007, causing 1,644 deaths.[6] Deaths from pneumonia and influenza were the reason for the loss of more than 50,000 disability-adjusted life years (DALYs) for North Carolinians.[b] (See Figure 2.3 in Chapter 2.) These diseases can and should be prevented with vaccines.

Vaccines are excellent tools, proven both to prevent disease and save money. Described as one of the ten great public health achievements of the 20th century, vaccines helped eradicate smallpox worldwide, eliminate polio in the Americas, and control many infectious diseases.[7] More recently, the United States' childhood immunization program saved almost $10 billion in direct health care costs and more than $40 billion in additional costs to society, including lost productivity from missed days of work. For every dollar spent on childhood vaccination, the program saves five dollars in direct costs and eleven dollars in additional costs to society.[8]

Percent of Children Ages 19-35 Months Who Have Received the Suggested Early Childhood Immunizations, 2007



Source: United Health Foundation. America's Health Rankings: data tables. United Health Foundation website. http://www.americashealthrankings.org/2008/tables.html. Published 2008. Accessed December 4, 2008.

a "Infectious" diseases can potentially be transmitted from person to person, while a "communicable disease" is an infectious disease that is readily transferred from person to person. Although they have slightly different meanings, they are used interchangeably here.

b See Chapter 2 for an explanation of DALYs.

Despite the immense benefits, some parents chose not to vaccinate their children. The American Academy of Pediatrics notes that during a 12-month period, 85% of pediatricians reported encountering a parent who refused or delayed one or more vaccines, and 54% reported encountering a parent who refused all vaccines.[9] Parents may choose not to vaccinate their children for religious or philosophical reasons. There is also concern over the link between vaccination and autism spectrum disorders. The Institute of Medicine of the National Academies conducted a series of reports on the topic of vaccination safety. In the final report in the series, expert panels agreed that autism is not caused by vaccination.[c]

Childhood and adolescent vaccinations are a hallmark of preventive care.

Recommended Vaccination Schedules

Childhood and adolescent vaccinations are a hallmark of preventive care. The recommended vaccination schedule for children ages 0-18 is approved by the Advisory Committee on Immunization Practices, the American Academy of Pediatrics, and the American Academy of Family Physicians.[10] It includes three vaccine schedules: one for children ages 0-6, one for children and adolescents ages 7-18, and a catch-up schedule for children and adolescents ages 4 months-18 years who start late or are more than one month behind on their vaccinations.[d]

Vaccines for Young Children Ages 0-6 Years

The recommended vaccines for children ages 0-6 include hepatitis B (HepB); rotavirus (RV); combined diphtheria and tetanus toxoids and acellular pertussis (DTaP); Haemophilus influenzae type b (Hib); pneumococcal (PCV or PPSV); influenza (TIV or LAIV); measles, mumps, and rubella (MMR); varicella; hepatitis A (HepA); and meningococcal for children up to age 6. (See Table 9.1.)

Table 9.1
Recommended Immunization Schedule for Persons Ages 0-6 Years, United States, 2009.

Vaccine ▼ Age ►	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	19–23 months	2–3 years	4–6 years
Hepatitis B[1]	HepB	HepB		see footnote 1	HepB						
Rotavirus[2]			RV	RV	RV[2]						
Diphtheria, Tetanus, Pertussis[3]			DTaP	DTaP	DTaP	see footnote 3	DTaP				DTaP
Haemophilus influenzae type b[4]			Hib	Hib	Hib[4]	Hib					
Pneumococcal[5]			PCV	PCV	PCV	PCV				PPSV	
Inactivated Poliovirus			IPV	IPV		IPV					IPV
Influenza[6]					Influenza (Yearly)						
Measles, Mumps, Rubella[7]						MMR		see footnote 7			MMR
Varicella[8]						Varicella		see footnote 8			Varicella
Hepatitis A[9]						HepA (2 doses)				HepA Series	
Meningococcal[10]										MCV	

Range of recommended ages

Certain high-risk groups

Source: Centers for Disease Control and Prevention. Recommended immunization schedules for persons ages 0-18 years—United States 2009. *MMWR.* 2009;57(51&52)

c The final report focused on the measles, mumps, and rubella (MMR) vaccine and thimerosal-containing vaccines.

d More information on the catch-up vaccination schedule is available online at http://www.cdc.gov/vaccines/recs/schedules/downloads/child/2009/09_catch-up_schedule_pr.pdf

Vaccines for Children and Adolescents Ages 7-18 Years

Combined tetanus and diphtheria toxoids and acellular pertussis (Tdap); human papillomavirus (HPV); meningococcal (MCV); influenza, pneumococcal (PPSV); hepatitis A (HepA); hepatitis B (HepB); inactivated polio (IPV); measles, mumps, and rubella (MMR); and varicella are recommended vaccines for children and adolescents through age 18. (See Tables 9.1 and 9.2.) Nationally, among adolescents ages 13-18, the vaccination and immunity rates vary widely from 91.7% for varicella (either having the disease or receiving the vaccine) to 25.1% for HPV vaccination.

Table 9.2
Recommended Immunization Schedule for Persons Ages 7-18 Years, United States, 2009.

Vaccine ▼ Age ▶	7–10 years	11–12 years	13–18 years
Tetanus, Diphtheria, Pertussis[1]	see footnote 1	Tdap	Tdap
Human Papillomavirus[2]	see footnote 2	HPV (3 doses)	HPV Series
Meningococcal[3]	MCV	MCV	MCV
Influenza[4]	Influenza (Yearly)		
Pneumococcal[5]	PPSV		
Hepatitis A[6]	HepA Series		
Hepatitis B[7]	HepB Series		
Inactivated Poliovirus[8]	IPV Series		
Measles, Mumps, Rubella[9]	MMR Series		
Varicella[10]	Varicella Series		

Range of recommended ages
Catch-up immunization
Certain high-risk groups

Source: Centers for Disease Control and Prevention. Recommended immunization schedules for persons ages 0-18 years—United States 2009. *MMWR.* 2009;57(51&52)

North Carolina provides DTaP, Hep A, Hep B, Hib, IPV, MMR, Tdap, and varicella vaccines to both public and private medical providers at no charge to cover all children ages 0-18.

Disparities in Vaccination Rates

Vaccination rates vary among children of different racial and ethnic backgrounds, even after accounting for differences in socioeconomic status.[11] A recent Tennessee study showed that white children are more likely to receive the complete recommended vaccination series by age 24 months than their African American counterparts.[12] Timely vaccinations may be achieved by improving health providers' reminder systems, implementing educational interventions that address barriers to vaccination, and increasing parents' awareness of the Vaccines for Children program.[13]

North Carolina Vaccination Programs

North Carolina is making strides toward vaccinating all children appropriately. The North Carolina Immunization Branch of the North Carolina Department of Health and Human Services operates the Universal Childhood Vaccine Distribution Program (UCVDP). The program was designed to remove financial barriers, assure vaccination access to all children, and simplify the vaccination process for health care providers. North Carolina UCVDP provides DTaP, Hep A, Hep B, Hib, IPV, MMR, Tdap, and varicella vaccines to both public and private medical providers at

no charge to cover all children ages 0-18.[e,14] (See Table 9.3.) All children of appropriate age are eligible to receive state supplied vaccines, and any immunization provider may participate in the program. In 2007, the Immunization Branch purchased and distributed vaccines to more than 1,250 private providers and local health departments.[15] The current state appropriation for the UCVDP is $20 million. That funding is not adequate to provide all the vaccines for children and adolescents recommended by the Centers for Disease Control and Prevention (CDC).

Children who are eligible for Medicaid or who are uninsured, underinsured, or an Alaskan Native or American Indian may receive additional vaccinations through the federal Vaccines for Children Program (VFC). In North Carolina, VFC provides MCV4, HPV, rotavirus, and PCV7 to children in the program, in addition to those universally available. The CDC annually provides approximately $118 million in federal vaccine funding for the North Carolina Immunization Branch VFC.

Virtually all cervical cancer cases result from infection with HPV…The vaccine prevents a person from contracting HPV types 16 and 18 (which are responsible for about 70% of cervical cancers).

Table 9.3
North Carolina's Universal Childhood Vaccine Distribution Program Covers Many Recommended Immunizations for Children

	DTaP, Hep A, Hep B, Hib, IPV, MMR, Tdap, and varicella	MCV4, HPV, rotavirus, and PCV7
Medicaid, uninsured, underinsured, or Alaskan native or American Indian	COVERED BY UCVDP	COVERED BY VFC (federal funds)
All other children	COVERED BY UCVDP	Not covered

Source: North Carolina Immunization Branch, North Carolina Department of Health and Human Services

Because North Carolina generally does a good job in vaccinating children with vaccines covered through the UCVDP, the Task Force on Prevention chose to focus on the vaccines that are recommended by the CDC but are not currently included in North Carolina's UCVDP. Those vaccines prevent human papillomavirus (HPV), influenza, meningococcal diseases (MCV4), and pneumococcal diseases (PCV7). The Task Force also focused on the combined tetanus, diphtheria, and pertussis (Tdap) vaccine, as fewer children receive the recommended booster shot.

Specific Vaccines

Human Papillomavirus Vaccination (HPV)

Virtually all cervical cancer cases result from infection with HPV.[16] Although the death rate has been falling steadily, cervical cancer was responsible for about 130 deaths in North Carolina in 2006.[17] In 2006 a vaccine became available that is effective in preventing both moderate and severe precancerous lesions of the cervix and genital and laryngeal warts. The vaccine prevents a person from contracting

e Grimshaw A. Data Collection and Analysis Unit Supervisor, Immunization Branch, North Carolina Department of Health and Human Services. Written (email) communication. June 30, 2009.

HPV types 16 and 18 (which are responsible for about 70% of cervical cancers), and HPV types 6 and 11 (which are responsible for about 90% of genital warts).[18,16] The vaccine is most effective when given to girls before they become sexually active; however, it is also effective for women who are sexually active but have not been exposed to the targeted strains of HPV.

The Advisory Committee on Immunization Practices of the CDC recommends that girls ages 11-12 years be routinely vaccinated against HPV. Additionally, the committee recommends that girls as young as age 9 receive the vaccine at a physician's discretion and that females ages 13-26 also be vaccinated.[19] However, the current cost of the vaccination is approximately $350, which is cost-prohibitive to many families. There is no state funding in the UCVDP for the HPV vaccine.

Influenza Vaccination

Influenza (or "the flu") is a contagious disease spread by coughing, sneezing, or nasal secretions. It can cause fever, sore throat, chills, headache, fatigue, and muscle aches, while lasting only a few days. Although many illnesses have similar symptoms, true cases of influenza are only caused by the influenza virus. It can affect anyone, but children have higher rates of influenza infection. In children, influenza can lead to high fever, diarrhea, and seizures. In people with weakened immune systems, influenza can also lead to pneumonia. Nationally each year, influenza causes 226,000 hospitalizations and 36,000 deaths, primarily among the elderly.[20] In North Carolina, pneumonia and influenza cause 6,000-10,000 hospitalizations each year and led to approximately 1,700 deaths in 2007.[6]

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The Advisory Committee on Immunization Practices recommends that all children and adolescents ages 6 months to 18 years and all adults over the age of 50 should be vaccinated against the flu. The committee also recommends that anyone at risk of complications from influenza or who cares for someone at risk for complications should also be vaccinated. These include people who are pregnant, have weakened immune systems, have certain specific nerve or muscle disorders, use long-term aspirin treatment, or live in a nursing or other chronic care facility. The influenza vaccine is not currently included in North Carolina's universal vaccine program.[20]

Meningococcal Vaccination (MCV4)

Meningococcal disease is rare but can have fatal outcomes. The most common forms of invasive meningoccocal disease include meningitis (49%), blood infections (33%), and meningococcal pneumonia (9%). The disease can have abrupt onset and progress rapidly. It occurs most often in the first year of life and during late adolescence. Annually, 1,400 to 2,800 cases of invasive meningococcal disease occur in the United States. Of those, 20% of cases occur among adolescents and young adults ages 14-24 and 16% of cases occur among infants under one year of age. College freshmen living in dormitories are at higher risk than the general population of similar age.[f] Although meningitis is a communicable disease, the majority of cases (97%) affect specific individuals but not large groups.[21]

Meningococcal disease is rare but can have fatal outcomes.

The meningococcal vaccine is recommended by the CDC for adolescents (ages 11-12 or at high school entry if not previously vaccinated) and for those at elevated risk of meningococcal disease (college freshmen living in dorms, military recruits, people with compromised immune systems, and people who come in contact with the bacteria *Neisseria meningitides*).[21] From 2004-2008, there were 138 cases and 13 deaths from meningococcal disease in North Carolina.[8] This vaccine is not currently covered in North Carolina's universal vaccine program.

Pneumococcal disease is one of the most common causes of serious illness in both children and adults.

Pneumococcal Vaccination (PCV7)

Pneumococcal disease is one of the most common causes of serious illness in both children and adults. Associated illnesses can range from ear infections and sinusitis to pneumococcal pneumonia, blood infections, and pneumococcal meningitis. Each year more than 175,000 people are hospitalized with pneumococcal pneumonia, with 50,000 cases of blood infections and 3,000-6,000 cases of meningitis. More than half of the deaths from pneumococcal diseases involve people for whom the CDC recommends the pneumococcal vaccine.[22] In North Carolina, there were 173 cases of pneumococcal meningitis and 25 reported deaths between 2004 and 2008.[23]

The pneumococcal vaccine is recommended in four doses for children under two years of age. For those between ages 2-5 who have not received the vaccine, it is recommended if there is serious risk of pneumococcal disease due to other complications.[h] The vaccine should also be considered for all children under five years of age, especially those at increased risk for pneumococcal disease, including children who are of Alaskan native, American Indian, or African American descent, or who attend group daycare.[24] This vaccine is not included in North Carolina's universal vaccine program.

Immunity to pertussis wanes approximately 5-10 years after completion of childhood pertussis vaccination, leaving adolescents and adults susceptible to the disease.

Tetanus, Diphtheria, and Pertussis Vaccination (Tdap)

Pertussis, an acute, infectious cough illness, remains endemic in the United States despite routine childhood pertussis vaccination for more than 50 years and high coverage levels in children for more than a decade. One of the primary reasons for the continued circulation of Bordetella pertussis is that immunity to pertussis wanes approximately 5-10 years after completion of childhood pertussis vaccination, leaving adolescents and adults susceptible to the disease. Among all of the diseases for which universal childhood vaccination has been recommended, pertussis is the least well-controlled in the United States. Tetanus is unique in that it is the only noncommunicable disease for which vaccination is routinely recommended. It cannot be passed from person to person, but can have very devastating effects such as respiratory failure and neurological damage resulting in death. Diphtheria

f College students other than freshmen have risk similar to the general population.

g Maillard JM. Acting State Epidemiologist, Communicable Disease Branch, Epidemiology Section, Division of Public Health, North Carolina Department of Health and Human Services. Written (email) communication. March 23, 2009

h PCV7 is recommended for children between 2-5 with sickle cell disease, damaged or no spleen, HIV/AIDS, or weakened immune systems from diabetes, cancer, or liver disease; take medication that affects the immune system (like chemotherapy or steroids), or have chronic heart or lung disease.

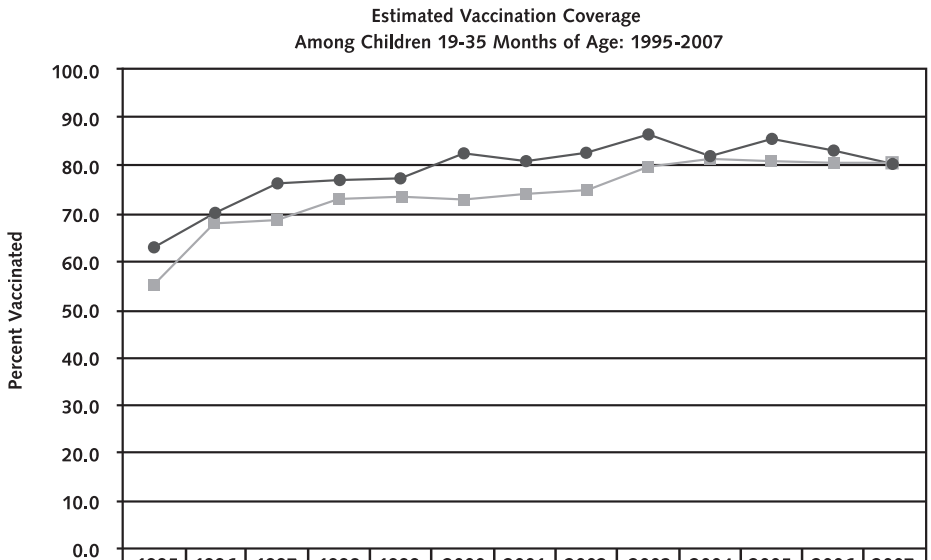
can cause a range of diseases from acute respiratory infections to heart and nervous system complications. The disease is rare in the United States, but exposure is possible when travelling to places where it is still common.[25]

Vaccination against tetanus, diphtheria, and pertussis is recommended by the CDC for young children in the DTap form and then for adolescents as a booster in the Tdap form. Both vaccines are currently covered by North Carolina's universal vaccine program, but many adolescents do not receive the Tdap booster.

With few exceptions, North Carolina has ranked among the top ten states for childhood vaccination rates over the past ten years. Figure 9.1 shows that North Carolina had immunization rates higher than the national average in nearly every year since 1995.[26]

Vaccination against tetanus, diphtheria, and pertussis is recommended by the CDC for young children in the DTap form and then for adolescents as a booster in the Tdap form.

Figure 9.1
North Carolina's Childhood Vaccination Rates Higher than United States



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US	55.1	67.7	68.5	72.7	73.2	72.8	73.7	74.8	79.4	80.9	80.8	80.5	80.1
NC	62.5	69.8	76.5	76.7	77.1	82.8	80.4	82.4	86.7	81.6	85.2	82.8	80.0
NC Ranking[1]	8th	18th	5th	11th	20th	Top 5	Top 5	Top 5	Top 5	29th	6th	2nd	23rd

[1] Grimshaw A. Data Collection and Analysis Unit Supervisor, Immunization Branch, North Carolina Department of Health and Human Services. Written (email) communication. July 9, 2009 and August 17, 2009

Source: State Center for Health Statistics. Health Profile of North Carolinians 2009 Update. May 2009. Available at http://www.schs.state.nc.us/SCHS/pdf/HealthProfile2009.pdf. Accessed June 29, 2009

In order to ensure the negative effects of vaccine preventable diseases are as limited as possible, the Task Force recommends

Recommendation 9.1: Increase Immunization Rates (PRIORITY RECOMMENDATION)

a) The North Carolina Division of Public Health (DPH) should aggressively seek to increase immunization rates for all vaccines recommended by the Centers for Disease Control and Prevention (CDC) Advisory Committee on Immunization Practices (ACIP), including the pneumococcal (PCV7), rotavirus, meningococcal (MCV4), human papillomavirus (HPV), and influenza vaccines which are not currently covered through the state's universal childhood vaccine distribution program (UCDVP).

b) All public and private insurers should provide first dollar coverage (no co-pay or deductible) for all CDC recommended vaccines that the state does not provide through the UCVDP, and should provide adequate reimbursement to providers to cover the cost and administration of the vaccines.

c) Health care providers should offer and actively promote the recommended vaccines, including educating parents about the importance of vaccinations.

- **1) The influenza vaccination should be actively promoted for children ages 5-18.**
- **2) The HPV vaccination should be made available to females ages 9-26; however, vaccine delivery should be targeted toward adolescents ages 11-12, as recommended by the CDC's Advisory Committee on Immunization Practices (ACIP).**

d) Parents should ensure that their children receive age appropriate vaccinations.

e) DPH should monitor the vaccination rate for the PCV7, MCV4, HPV and influenza vaccines not currently covered through the UCVDP to determine whether the lack of coverage through the UCVDP leads to lower immunization rates. If so, the DPH should seek recurring funds from the North Carolina General Assembly to cover these vaccines through the UCVDP, work with insurers to ensure first dollar coverage and adequate reimbursement for these recommended vaccines, or seek new financial models to cover vaccines for children not adequately covered through the UCVDP.

f) DPH should conduct an outreach campaign to promote immunizations of the flu, the new Tdap vaccine and all the recommended childhood vaccines among all North Carolinians. Emergency rooms patients and newborn contacts should be targeted specifically for Tdap immunizations. The North Carolina General Assembly should appropriate $1.5 million in recurring funds in SFY 2011 to support this effort.

Pandemic Influenza

Pandemic influenza preparedness has been an ongoing effort in the North Carolina Division of Public Health for many years, with increased efforts made possible by federal funding beginning in 2006. The public health response to an influenza pandemic involves every aspect of public health and will impact all other

public health issues. During the preparation of this Task Force report, a novel strain of influenza, H1N1, was identified in the United States by the CDC. By the beginning of August 2009, H1N1 had infected over 160,000 people in 138 countries worldwide, with over 430 deaths in the United States, eight of which were in North Carolina.[i,27]

North Carolina's response to this influenza pandemic, declared by the World Health Organization in June 2009, has involved all branches of government at the state and local level. Public health mitigation efforts will be calibrated based on the severity of illness and are focused in three areas: 1) vaccination, 2) targeted antiviral treatment and prophylaxis, and 3) nonpharmaceutical interventions consisting of hand hygiene, respiratory etiquette, isolation and quarantine, and social distancing (e.g. school closures, cancellation of large gatherings, teleworking).

Foodborne Illness

Foodborne illnesses are among the most common infectious diseases.

Foodborne illnesses are among the most common infectious diseases. Foodborne diseases cause a total of approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths each year in the United States.[28] One study estimated the cost of foodborne illness in 1985 was $8.4 billion, or roughly $700 per case, while a more recent study put the costs at $1.4 trillion.[29,30]

Foodborne illnesses can often be prevented with proper food safety and defense.

Foodborne illnesses can often be prevented with proper food safety and defense. Food can be contaminated either intentionally or unintentionally. Intentional contamination occurs when someone deliberately tampers with food or the food production system, so as to cause harm to the end user.[j] The Rajneeshee cult spreading salmonella in restaurant salad bars in 1984 was an example of intentional food/drug contamination or agroterrorism.[31] Typically, however, foodborne illnesses are caused by accidental contamination.[k] For example, bacteria can grow on some foods that are left in warm temperatures for several hours. Some food pathogens, such as salmonella or *E. coli*, can survive in foods if the food is not prepared properly (i.e. cooked for the proper length of time or at an appropriate temperature). Illness can also result from other types of contamination.[l]

It is often difficult to determine the exact cause of foodborne illness. There are more than 200 known diseases transmitted through food. They can be caused by viruses, bacteria, parasites, toxins, metals, and prions.[m] Of the total number of foodborne illnesses, known pathogens cause only an estimated 14 million of the 76 million illnesses, 60,000 of the 325,000 hospitalizations, and 1,800 of the

i Davies M. State Epidemiologist and Section Chief, Epidemiology Section, Division of Public Health, North Carolina Department of Health and Human Services. Written (email) communication. August 13, 2009.
j Preventing intentional contamination is referred to as food defense.
k Preventing unintentional contamination is referred to as food safety.
l Contamination by direct contact with a pathogen from an animate or inanimate host is not an example of foodborne illness.
m A prion is an abnormal infectious agent that is composed of protein that causes rapidly progressive, fatal brain damage. (Centers for Disease Control and Prevention. Prion Diseases. US Department of Health and Human Services website. Available at http://www.cdc.gov/ncidod/dvrd/prions/. Accessed July 20, 2009.)

5,000 deaths.[28] Salmonella, listeria, and toxoplasma are the most common pathogens, causing more than 75% of those foodborne illnesses caused by known pathogens. The symptoms of foodborne illness range from mild gastrointestinal discomfort to life-threatening problems in the brain, liver, and kidneys.

Food Safety & Defense

Keeping food safe and protecting the food supply is a multifaceted process. There are 12 different federal agencies with more than 35 laws affecting food safety.[32] The United States Department of Agriculture (USDA) inspects and regulates meat, poultry, and processed egg products. The Food and Drug Administration (FDA) has regulatory responsibility for all other foods.[33] In North Carolina, the agency responsible for oversight depends on the step in the food process chain. When food is at the ingredient stage or located on the farm, the North Carolina Department of Agriculture (NCDA) and the North Carolina Department of Environment and Natural Resources (NCDENR) are responsible. In transit by rail or truck, the North Carolina Department of Transportation and North Carolina Division of Motor Vehicles are responsible for food safety. When food is in processing or distribution centers, the NCDA and NCDENR resume responsibility. Local health departments, under the authority of NCDENR, are responsible for routinely inspecting food stands, meat markets, restaurants, and school cafeterias. Other federal and state agencies may be involved depending on the route and processing of the food. A performance review of the North Carolina food safety system noted that the system is fragmented and might be better served by consolidating some responsibilities. In comparison, almost half of all states have only two agencies with major food safety responsibilities.[32]

The food safety system needs common standards to ensure quality.

Food Industry Regulation

The food safety and defense system is very complex. The GAO listed revamping federal oversight of food safety on its high-risk list in July 2009.[34] The food safety system needs common standards to ensure quality. Most industries have some type of quality control measures. Food safety and defense has three major initiatives aimed at protecting the food supply, from the farm or plant through delivery and preparation: Hazard Analysis and Critical Control Points system (HACCP), Voluntary National Retail Food Regulatory Standards Program, and the Manufactured Food Regulatory Standards Program.[n]

Hazard Analysis and Critical Control Points system (HACCP)

The HACCP system is a quality control measure that has been used in many different industries and can be adapted to most any process. HACCP is based on a set of principles that begins with analyzing possible hazards, determines critical points at which those hazards might occur, establishes preventive procedures and strategies for mitigating the hazards, and makes proper documentation of the entire process. HACCP was first introduced into law for the food safety and

n Jenkins P. Director, Center for Lifelong Learning, University of North Carolina at Chapel Hill School of Nursing; Consultant, Foodborne Disease Epidemiology, Institute of Food Technologists. Oral Communication. July 16, 2009.

defense industry through the United States Department of Agriculture (USDA) in 1998.[o] The law gives the USDA the authority to sanction or close any meat, poultry, or egg product industry or organization that does not have HACCP plans, update them, or have them readily available during their daily inspections. The USDA provides half of the funding for the North Carolina Department of Agriculture and requires its adherence to the federal HACCP standards.[p] More recently, the FDA began recommending HACCP plans for the sectors of the food safety and defense industry that it regulates. There are specialized HACCP versions for dairy, retail and food service, and seafood.[35] NCDENR has no authority to enforce HACCP plans, but does recommend them for certain high risk processes (e.g. reduced oxygen processing for cook-chill foods, in which warm food is flash frozen in an impermeable container).[q] Due to the broad scope of food products under its regulation and limited resources, NCDENR does not have daily inspections that might help facilitate statewide HACCP plan implementation.

FDA Voluntary National Retail Food Regulatory Standards Program

NCDENR is taking other steps to improve food safety and defense. The Food Protection Branch of NCDENR enrolled in the FDA Voluntary National Retail Food Regulatory Standards Program in 2007. The program serves as a guide for retail and food service managers in many settings (e.g. restaurants, grocery stores, and institutions like nursing homes) to improve food safety by implementing a common set of standards. These standards focus on reducing and managing risk factors known to contribute to foodborne illness by implementing Hazard Analysis and Critical Control Points (HACCP) plans and adopting the FDA Food Code.[36] The FDA Food Code is a model that helps the members of the retail and food service industry develop their own food safety rules based on national food regulatory policy.[37] Adopting the FDA Food Code allows states and territories to update their codes and ensure the same level of food safety and security across state and regional lines. The new code is available and has been adopted by 48 states and 3 territories. North Carolina is among the two states yet to adopt the code, although it is currently pursuing Food Code adoption through rulemaking.[38]

Manufactured Food Regulatory Standards Program

One of six states selected, the North Carolina Department of Agriculture is participating in a national pilot of the Manufactured Food Regulatory Standards Program, designed to bring all states to a national standard for regulation of food plants. These program standards describe best practices of a high quality regulatory program for manufactured food (only meat, poultry, or egg products). The 10 standards are designed to focus on the critical areas of a program that protect the public from foodborne illness and injury.[39] These programs along with the experience and expertise of the workforce form the strengths of the North Carolina food safety program.

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o 9CFR417

p Delozier D. State Director, Meat and Poultry Division, North Carolina Department of Agriculture. Oral communication. July 17, 2009

q Michael L. Food Protection Branch Head, Division of Environmental Health, North Carolina Department of Environment and National Resources. Oral Communication. July 17, 2009.

Managing Outbreaks

In addition to the systems that North Carolina has in place to protect food safety in the production, distribution, and preparation stages, North Carolina also has a system to detect and respond to outbreaks. The North Carolina Disease Event Tracking and Epidemiological Collection Tool (NC DETECT) can help with outbreak detection. It can also be used to identify non-foodborne illness epidemics such as the H1N1 virus. NC DETECT collects data from emergency departments, the North Carolina Poison Center, the statewide Emergency Management System data collection system, and a regional wildlife center at least daily. It then uses CDC recommended algorithms to monitor patterns in the data to detect outbreaks, emerging diseases, or other public health hazards. As of May 2008, 110 of the 112 North Carolina emergency departments open 24 hours a day were reporting patient symptoms into the system. NC DETECT may be accessed by hospital-based and public health users at local, regional, and state levels.[40]

Local public health agencies are usually the first line of defense in large outbreak investigations, food protection efforts, or other natural or man-made public health emergencies.

Recent outbreaks[r] of foodborne illness, including the recent outbreaks of salmonella from spinach and peanut butter, have received a lot of media attention. Outbreaks of foodborne illnesses, or the spread of communicable and infectious diseases, are usually investigated by local and state health departments. Typically, the CDC does not get involved in local outbreak investigations. The CDC only becomes involved when an outbreak is sufficiently large or covers multiple states, or in the event of a novel and virulent strain of an infectious disease.[33] Local public health agencies are usually the first line of defense in large outbreak investigations, food protection efforts, or other natural or man-made public health emergencies that require a coordinated and unified national, statewide, or regional response. However, these efforts can be very labor intensive.

In order to better protect the safety of the food we eat and to ensure that the state has the necessary resources to detect and respond to outbreaks of foodborne illnesses, new and emerging infectious agents, or other public health emergencies, the Task Force recommends:

r Two or more cases of similar illness related to ingesting a common food is an outbreak.

Recommendation 9.2: Strengthen Laws to Prevent Foodborne Illnesses

The North Carolina General Assembly should enact laws to strengthen North Carolina's ability to prevent and respond to foodborne illnesses by

a) **Directing the North Carolina Department of Agriculture and Consumer Services, the North Carolina Department of Environment and Natural Resources, and the North Carolina Department of Health and Human Services to create a committee to develop a "single-agency" approach for addressing foodborne illness in North Carolina. The committee should work to**

   1) **Develop a unified proactive, scientifically-based strategy to prevent, detect, and respond to foodborne illness.**

   2) **Identify ways to maintain adequate funding for a holistic food safety and defense program at the state and local level.**

   3) **Strengthen industry ties.**

   4) **Educate policy makers.**

b) **Appropriating $1.6 million in non-recurring funds in SFY 2011 and $300,000 in recurring funds beginning in SFY 2012 to the North Carolina Division of Public Health to develop and maintain an enhanced surveillance system that facilitates sharing of data from the North Carolina Department of Environment and Natural Resources and North Carolina Department of Agriculture and Consumer Services complaint lines, public health surveillance systems, US Department of Agriculture, Centers for Disease Control and Prevention, and Food and Drug Administration (FDA) when needed to detect or prevent the spread of foodborne illnesses.**

c) **Requiring all industries to develop Hazard Analysis Critical Control Point (HACCP) plans or use government risk-based inspections. HACCP plans should be made available to government agencies with jurisdiction.**

d) **Ensuring that the Governor can use the state's rainy day funds to pay for the additional personnel or other costs needed to address public health emergencies. Funds should be made available, when needed, to help pay for the additional costs involved in large outbreak investigations, food protection efforts, or other natural or man-made public health emergencies that require a coordinated and unified national, statewide, or regional response.**

e) **The North Carolina Department of Agriculture and Consumer Services and Department of Environment and Natural Resources should adopt, through regulations, the current FDA Food Code and maintain it in such a manner as to continually address updates to the Code.**

References

1 American Public Health Association. *Control of Communicable Diseases Manual.* Ed. Heymann DL. Washington, DC: American Public Health Association; 2008.

2 Armstrong GL, Conn LA, Pinner RW. Trends in infectious disease mortality in the United Stated during the 20th century. *JAMA.* 1998;281(1):61-66.

3 Thompson WW, Shay DK, Weintraub E, et al. Mortality associated with influenza and respiratory syncytial virus in the united states. *JAMA.* 2003;289(2):179-186.

4 Thompson WW, Shay DK, Weintraub E, et al. Influenza-associated hospitalizations in the United States. *JAMA.* 2004;292(11):1333-1340.

5 Vogt T, Wise ME, Shih H, et al. Hepatitis B mortality in the United States, 1990-2004. Presented to: Annual Meeting of the Infectious Diseases Society of America; October 4-7, 2007; San Diego, CA.

6 North Carolina State Center for Health Statistics, North Carolina Department of Health and Human Services. 2007 NC Vital Statistics, volume 2: leading causes of death. Table A-F. http://www.schs.state.nc.us/SCHS/deaths/lcd/2007/pdf/TblsA-F.pdf. Published December 4, 2008. Accessed August 10, 2009.

7 Centers for Disease Control and Prevention. Home radiator burns among inner-city children—Chicago, September 1991-April 1994. *MMWR Morb Mortal Wkly Rep.* 1996;45(38):814-815.

8 Zhou F, Santoli J, Messonnier ML, et al. Economic evaluation of the 7-vaccine routine childhood immunization schedule in the United States, 2001. *Arch Pediatr Adolesc Med.* 2005;159(12):1136-1144.

9 American Academy of Pediatrics. Documenting parent refusal to have their children vaccinated. American Academy of Pediatrics website. http://www.cispimmunize.org/pro/pdf/RefusaltoVaccinate.pdf. Published December 17, 2008. Accessed August 5, 2009.

10 Centers for Disease Control and Prevention. Recommended immunization schedules for persons 0-18: United States 2009. *MMWR Morb Mortal Wkly Rep.* 2009;57:51-52.

11 Wooten KG, Luman ET, Barker LE. Socioeconomic factors and persistent racial disparities in childhood vaccination. *Am J Health Behav.* 2007;31(4):434-445.

12 Parikh S, Moore KL. Racial disparities in immunization coverage levels among children aged 24 months: Tennessee. Presented to: 42nd National Immunization Conference; March 17-20, 2008; Atlanta, GA. http://cdc.confex.com/cdc/nic2008/webprogram/Paper15801.html. Accessed July 26, 2009.

13 Smith PJ, Jain N, Stevenson J, Mannikko N, Molinari N. Progress in timely vaccination coverage among children living in low-income households. *Arch Pediatr Adolesc Med.* 2009;163(5):462-468.

14 Immunization Branch, North Carolina Department of health and Human Services. Immunize North Carolina. North Carolina's UVCVDP. North Carolina Department of Health and Human Services website. http://www.immunizenc.com/UCVDP.htm. Published January 14, 2008. Accessed June 30, 2009.

15 Immunization Branch. North Carolina Department of Health and Human Services. *Universal Vaccine Purchase Issues, 2004.* Raleigh, NC: North Carolina Department of Health and Human Services: 2007.

16 Cutts FT, Franceschi S, Goldie S, et al. Human papillomavirus and HPV vaccines: a review. Bull. *World Health Organ.* 2007;85(9):719-726.

17 Porterfield DS, Dutton G, Gizlice Z. Cervical cancer in North Carolina. Incidence, mortality and risk factors. *NC Med J.* 2003;64(1):11-17.

18 Centers for Disease Control and Prevention. HPV vaccine information for young women. http://www.cdc.gov/std/HPV/STDFact-HPV-vaccine.htm. Published June 26, 2008.

19 Kuehn BM. CDC panel backs routine HPV vaccination. *JAMA.* 2006;296(6):640-641.

20 Centers for Disease Control and Prevention. Vaccine information statement: inactivated influenza vaccine. Centers for Disease Control and Prevention website. http://www.cdc.gov/vaccines/pubs/vis/downloads/vis-flu.pdf. Published July 24, 2008. Accessed July 13, 2009.

21 Centers for Disease Control and Prevention. Factsheet: meningococcal diseases and meningococcal vaccines. Centers for Disease Control and Prevention website. http://www.cdc.gov/vaccines/vpd-vac/mening/vac-mening-fs.htm#disease. Published April 25, 2006. Accessed July 13, 2009.

22 National Foundation for Infectious Diseases. Facts about pneumococcal diseases. National Foundation for Infectious Diseases website. http://www.nfid.org/factsheets/pneumofacts.shtml. Published October 2002. Accessed July 13, 2009.

23 Cline JS. Infectious disease in North Carolina: Overview. Presented to: the North Carolina Institute of Medicine Task Force on Prevention; March 27, 2009; Morrisville, NC.

24 Centers for Disease Control and Prevention. Vaccines and preventable diseases: pneumococcal disease in short. Centers for Disease Control and Prevention website. http://www.cdc.gov/vaccines/vpd-vac/pneumo/in-short-both.htm#who. Published May 18, 2009. Accessed July 14, 2009.

25 Broder KR, Cortese MM, Iskander JK, et al. Preventing tetanus, diphtheria, and pertussis among adolescents: use of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccines. *MMWR Recomm Rep.* 2006;55:1-34.

26 North Carolina State Center for Health Statistics, North Carolina Department of Health and Human Services. Health profile of North Carolinians: 2009 update. http://www.schs.state.nc.us/SCHS/pdf/HealthProfile2009.pdf. Published May 2009. Accessed May 18, 2009.

27 World Health Organization. Pandemic (H1N1) 2009: update 60. World Health Organization website. http://www.who.int/csr/don/2009_08_04/en/index.html. Accessed August 14, 2009.

28 Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. *Emerging Infectious Diseases.* 1999;5(5):607-625.

29 Todd ECD. Preliminary estimates of costs of foodborne diseases in the United States. *J Food Protect.* 1989;52:595-601.

30 Roberts T. WTP estimates of the societal cost of US foodborne illness. *Am J Agric Econ.* 2007;5:1183-1188.

31 Monke J. Library of Congress. Agroterrorism: threats and preparedness. http://www.fas.org/irp/crs/RL32521.pdf. Published August 13, 2004. Accessed July 17, 2009.

32 Office of the State Auditor, State of North Carolina. Performance review North Carolina food safety system. Raleigh, NC: Office of the State Auditor; 2002.

33 Center for Science in the Public Interest. Outbreak alert! 2008. http://www.cspinet.org/new/pdf/outbreak_alert_2008_report_final.pdf. Published December 2008. Accessed July 16, 2009.

34 US Government Accountability Office. High-risk list. http://www.gao.gov/docsearch/featured/2009_high_risk_list.pdf. Published July 2009. Accessed August 3, 2009.

35 Food and Drug Administration. Hazard analysis and critical control points. Food and Drug Administration, US Department of Health and Human Services website. http://www.fda.gov/Food/FoodSafety/HazardAnalysisCriticalControlPointsHACCP/default.htm. Published July 20, 2009. Accessed July 15, 2009.

36 Food and Drug Administration. Voluntary national retail food regulatory program. Food and Drug Administration, US Department of Health and Human Services website. http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/ProgramStandards/ucm125031.htm. Published May 29, 2009. Accessed July 15, 2009.

37 Food and Drug Administration. FDA food code. Food and Drug Administration, US Department of Health and Human Services website. http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/default.htm. Published July 10, 2009. Accessed July 15, 2009.

38 Food and Drug Administration. Real progress in food code adoptions. Food and Drug Administration, US Department of Health and Human Services website. http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FederalStateCooperativePrograms/ucm108156.htm. Published April 30, 2009. Accessed July 15, 2009.

39 Food and Drug Administration. Manufactured food regulatory program standards. Washington, DC: US Department of Health and Human Services; 2007

40 NC DETECT Team, Carolina Center for Health Informatics, Department of Emergency Medicine, University of North Carolina at Chapel Hill. The North Carolina Disease Event Tracking and Epidemiologic Collection Tool annual report: North Carolina emergency department data, January 1,2007-December 31, 2007. http://www.ncdetect.org/NC_DETECT_Annual_Report_ED_2007_FINAL20090130.pdf. Published January 30, 2009. Accessed July 15, 2009.