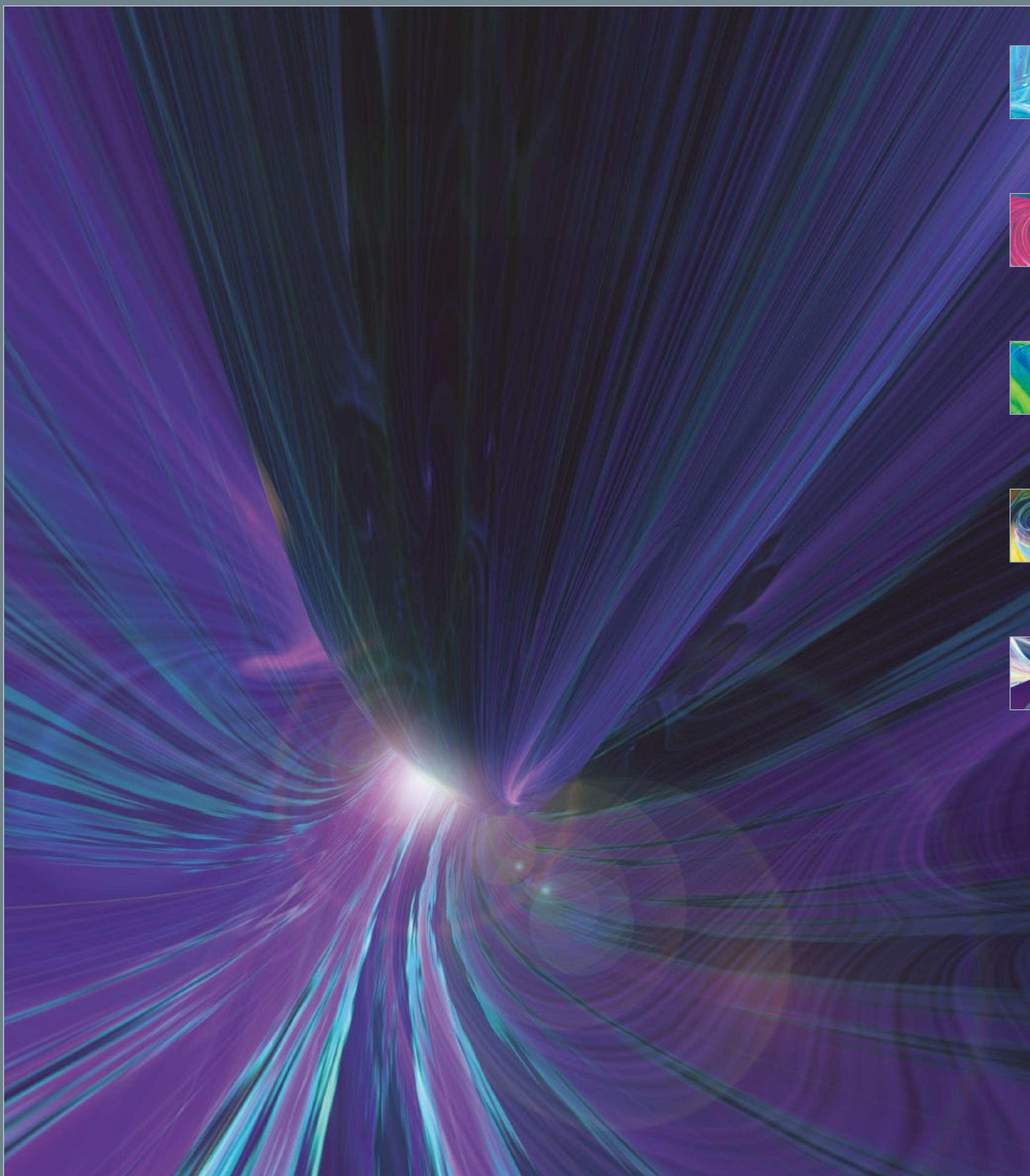
Chronic Disease and Medical Innovation in an Aging Nation

The Silver Book®: Infectious Diseases and Prevention through Vaccination



Alliance
FOR AGING RESEARCH

www.silverbook.org/vaccines
SilverBook@agingresearch.org

Introduction

Cost of Infectious Diseases
Innovative Medical Research
Conclusion
References

With the aging of the Baby Boom generation, every day, more than 10,000 Americans reach their 65th birthday. That means about 3.5 million people will mark this milestone each year until 2030, when a historic one in five Americans will be 65 years or older.

Our aging nation is sure to put our healthcare system to the test because, while the average 65 year-old can expect to live an additional 20 years, that time is not often enjoyed in good health. An estimated 80% of adults age 65 and older have at least one chronic condition and that age group accounts for one-third of all prescription medication use. On top of this—the diseases and conditions of aging, the medications used to treat them, and an increased susceptibility to infection that is seen with age—all put our seniors disproportionately at risk for many infectious diseases.

Between 5 and 10 million Americans acquire pneumonia, 35 to 50 million are afflicted with influenza, and 1 million get herpes zoster (shingles)—each year. Not only are older Americans more likely to get these infections, but as a result, they are much more likely to be hospitalized, suffer more complications, and are significantly more likely to die. In fact, the death rate from pneumonia and influenza combined is close to 130 times higher in people age 85 and older, compared to people ages 45 to 54. This increased risk due to age is even higher than that seen in heart disease, stroke, cancer, and other leading causes of death.

Thankfully, vaccinations are available for many of the most common and deadly infectious diseases in older Americans, and can save countless lives and healthcare dollars. Despite their tremendous potential for prevention, vaccination rates in seniors fall far short of target rates recommended by the Centers for Disease Control and Prevention (CDC). According to the CDC, in 2010, 62.3% of adults age 65 and older received the pneumonia vaccine—much lower than the goal of 90%. Only 67% of adults age 65 and older had received the flu vaccine in the previous year, again lower than the goal of 90%. And in adults 60 and older, only 17.6% received the shingles vaccine, despite a goal of 30%.

This newest volume of *The Silver Book®: Chronic Disease and Medical Innovation in an Aging Nation*, recognizes the tremendous burden of infectious diseases in older Americans, as well as the potential value of innovation in increasing vaccination rates and reducing the impact of infectious diseases. The CDC recommends vaccinations for influenza, Tdap (tetanus diphtheria & pertussis), varicella, herpes zoster (shingles), pneumonia, meningitis, and hepatitis A & B. However, this volume of *The*

continued >

Silver Book focuses in on influenza, pneumonia, and shingles since these particular conditions impact a large number of older Americans, carry a significant burden for those afflicted, and help make the cases for prevention through vaccination for ALL infectious diseases.

Now in its 8th year, *The Silver Book*® has become a trusted resource for policymakers, thought leaders, and health advocates across the nation and promotes national polices that turn to investments in innovation, rather than short-term cost-cutting. An almanac of compelling statistics that spotlight the mounting burden of chronic diseases and the power of innovation to reduce that burden, *The Silver Book* extracts the key findings from dense reports and technical studies, and provides the essential information in a single, easy-to-use, and well-referenced resource. Previous volumes have included data on cancer, cardiovascular disease (including stroke and thrombosis), diabetes, healthcare-associated infections, neurological disease (including Alzheimer's and Parkinson's disease), persistent pain, osteoporosis, and vision loss.

This latest volume brings together the leading data on infectious diseases and prevention through vaccination (note that information pertaining specifically to the older population is in **silver type**). All facts are cited and provide easy access to the original source. All data are also made available and regularly updated on-line at the newly designed **www.silverbook.org.** Now populated by 1,000s of facts and figures from more than 600 sources, the new site includes advanced search features, better organization of data, and a more streamlined design. Data from this volume are available at **www.silverbook.org/vaccines.**

Lindsay Clarke

Lindsay Clarke, JD
Vice President of Health Programs
Alliance for Aging Research

www.agingresearch.org/vaccines
SilverBook@agingresearch.org

Chronic Disease and Medical Innovation in an Aging Nation

The Silver Book®: Infectious Diseases and Prevention through Vaccination

TABLE OF CONTENTS

Cost of Infectious Diseases

Despite advancements in vaccine development that changed the face of public health, infectious diseases continue to take an enormous toll on Americans and our healthcare system. Every year, they account for one in four physician visits, and infectious and parasitic diseases combined account for 4.5 million hospital days.

In too many cases, these diseases also lead to death. Seasonal influenza is a leading cause of mortality, with approximately 23,000 Americans dying of the disease each year. Many infectious diseases are also linked to severe disability that can impact functional abilities, independence, and quality of life. Of the one million people who get herpes zoster (shingles) each year, around 20% will suffer from postherpetic neuralgia (PHN)—a complication that can cause severe and lasting pain.

The burden of infectious diseases tends to fall disproportionately on older Americans. Hospitalization and mortality rates from such diseases are highest among persons older than 85 years. For example, the death rate from pneumonia and influenza is close to 130 times higher in people ages 85 and older—compared to those ages 45 to 54. And for complications like shingles pain, the risk grows from 10% in those younger than 60, to 40% in those over the age of 60.

The economic toll of infectious diseases is also substantial and growing along with our aging population. Direct and indirect medical costs from infectious diseases total $120 billion each year—15% of all healthcare expenditures combined. With influenza, an estimated 64% of the total economic burden comes from those over 65 years old; and with shingles, 74% of the total annual shingles-related hospital charges come from those 60 years and older.

As our nation ages, the health and economic burden of infectious diseases is only going to escalate. We need to invest now in medical research and public health solutions that increase the number of new vaccines and increase rates of coverage for existing ones, to reduce future burdens and improve well-being.

Prevalence and Incidence of Infectious Diseases

Pneumonia

- Between 5 and 10 million Americans get pneumonia each year.

  Niederman et al. 2001, *Guidelines for the Management of Adults with Community-Acquired Pneumonia* AND Garibaldi 1985, *Epidemiology of Community-Acquired Respiratory Tract Infections in Adults*

- Hospital-acquired pneumonia is the second-most frequent cause of hospital-acquired infection, numbering around 300,000 cases each year.

  McEachern & Campbell 1998, *Hospital-Acquired Pneumonia*

- Every year an estimated 2.3% of nursing home residents acquire pneumonia—more than 33,000 residents.

  NCHS 2008, *2004 National Nursing Home Survey*

- In Medicare beneficiaries, the average cumulative annual incidence of any type of pneumonia was 47.4 per 1,000 from 2005 to 2007.

  Thomas et al. 2012, *Incidence and Cost of Pneumonia in Medicare Beneficiaries*

Influenza

- Between 35 and 50 million Americans get influenza each year.

  Right Diagnosis, *Statistics About Flu*

- Every year around 5% to 20% of the U.S. population gets influenza.

  CDC 2011, *Seasonal Influenza*

- Residents of long-term care facilities are particularly vulnerable to influenza, with rates of illness that range as high as 25% to 60%.

  CDC 2006, *Influenza Vaccination of Health-Care Personnel*

Shingles

- Around 1 million Americans get herpes zoster (shingles) each year.

  Harpaz et al. 2008, *Prevention of Herpes Zoster*

- An estimated 1 in 3 people will develop shingles in their lifetime.

  Harpaz et al. 2008, *Prevention of Herpes Zoster*

Age—A Major Risk Factor

Pneumonia

- Each year, more than 900,000 cases of community-acquired pneumonia are estimated to occur in seniors in the U.S.

  Jackson et al. 2004, *The Burden of Community-Acquired Pneumonia in Seniors*

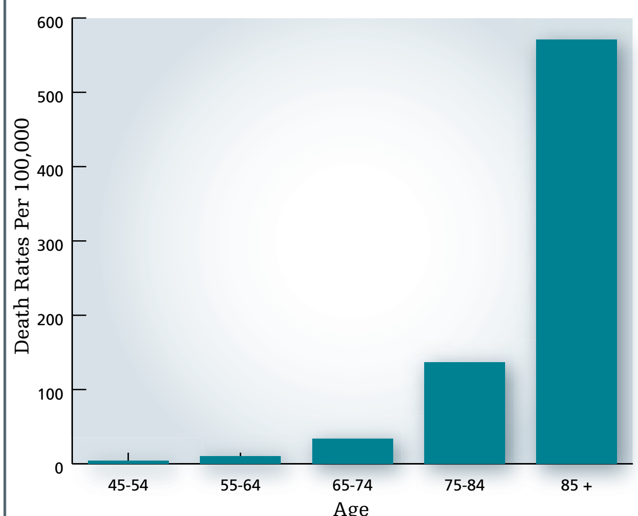
- In the U.S., 1 in every 20 individuals age 85 and older will have a new episode of community-acquired pneumonia each year.

  Jackson et al. 2004, *The Burden of Community-Acquired Pneumonia in Seniors*

- Elderly Medicare patients are hospitalized with community-acquired pneumonia at a rate of 18.3 per 1000, compared to 4 per 1000 in younger populations.

  Kaplan et al. 2002, *Hospitalized Community-Acquired Pneumonia in the Elderly*

- Pneumonia Death Rate Per 100,000 By Age: United States, 2004



Gorina et al. 2008, *Trends in Influenza and Pneumonia Among Older Persons in the U.S.*

Influenza

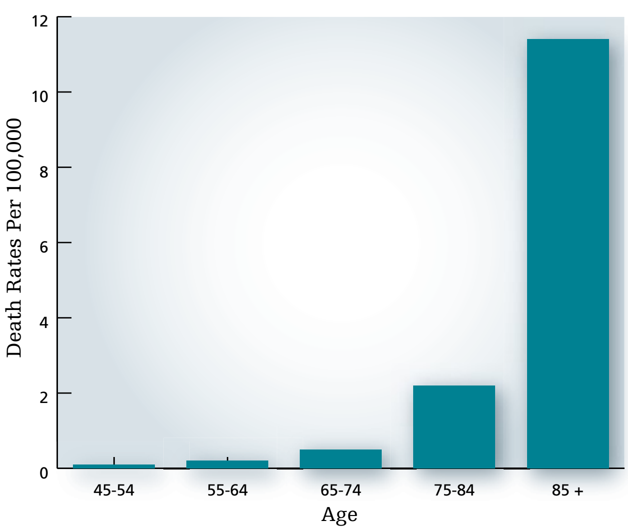
- Individuals age 65 and older account for 50% of hospitalizations for influenza.

  CDC 2013, *CDC Influenza Update for Geriatricians and Other Clinicians Caring for People 65 and Older*

- The death rate from pneumonia and influenza is close to 130 times higher in people age 85 and older, compared to people ages 45 to 54. This increased risk due to age is even higher than that seen in heart disease, stroke, cancer, and other leading causes of death.

  Gorina et al. 2008, *Trends in Influenza and Pneumonia Among Older Persons in the U.S.*

- Influenza Death Rate Per 100,000 By Age: United States, 2004



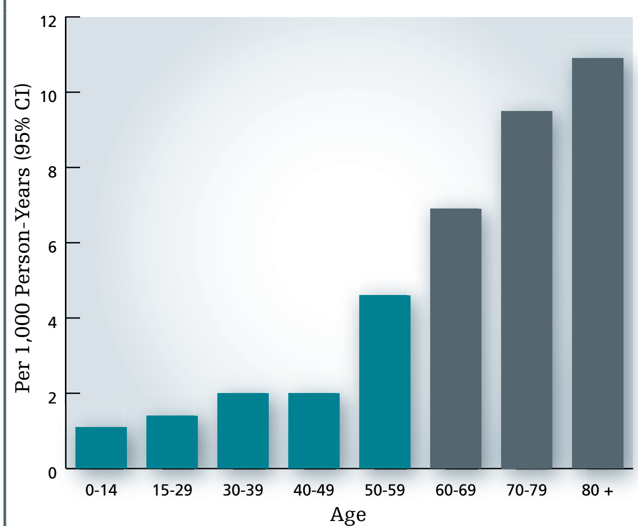
Gorina et al. 2008, *Trends in Influenza and Pneumonia Among Older Persons in the U.S.*

Shingles

- Around 1 in 2 people who live to be 85 will get shingles.

  Schmader 2001, *Herpes Zoster in Older Adults*

- Incidence Of Herpes Zoster Per 1,000 Person-Years By Age



Insinga et al. 2005, *The Incidence of Herpes Zoster in a U.S. Administrative Database*

- Hospitalization rates for shingles are 75 times higher in people over 85 than those younger than 30.

  Lin & Hadler 2000, *Epidemiology of Primary Varicella and Herpes Zoster Hospitalizations*

The Burden of Infectious Diseases

The Human Burden

Pneumonia

- Pneumonia is the 5th most frequent cause of hospitalization in the U.S.

  NCHS 2010, *National Hospital Discharge Survey*

- More than 1.1 million Americans are hospitalized due to pneumonia each year and the average length-of-stay is 5.2 days.

  NCHS 2010, *National Hospital Discharge Survey*

- Community-acquired pneumonia is responsible for 350,000 – 620,000 hospitalizations each year in Americans age 65 and older.

  Martson et al. 1997, *Incidence of Community-Acquired Pneumonia Requiring Hospitalization* AND Kaplan et al. 2002, *Hospitalized Community-Acquired Pneumonia in the Elderly*

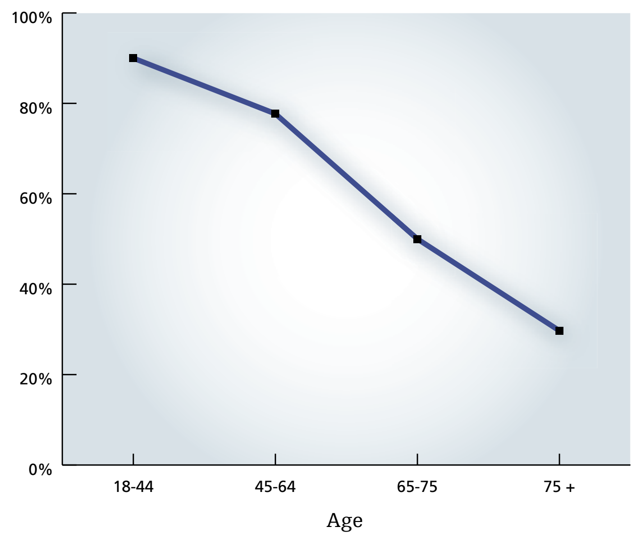
- In one study, one in four inpatient pneumonia hospitalizations were from health-care-associated pneumonia.

  Thomas et al. 2012, *Incidence and Cost of Pneumonia in Medicare Beneficiaries*

- In 2010, pneumonia killed around 50,000 Americans.

  NCHS 2013, *Deaths: Final data for 2010*

- Community-Acquired Pneumonia Long-Term (>6 years) Survival Rate By Age



Mortensen et al. 2003, *Assessment of Mortality after Long-Term Follow-Up of Patients with Community-Acquired Pneumonia*

- Community-acquired pneumonia is the sixth leading cause of death in the U.S. and the number-one cause of death from infection.

  Mortensen 2003, *Assessment of Mortality After Long-Term Follow-Up of Patients with Community-Acquired Pneumonia*

- The mortality rate for hospital-acquired pneumonia ranges from 38% to more than 70%.

  Laessig 2010, *End Points in Hospital-Acquired Pneumonia*

Influenza

- Every influenza epidemic, between 55,000 and 431,000 Americans are hospitalized, with a mean annual hospitalization rate of 226,000.

  Thompson et al. 2004, *Influenza-Associated Hospitalizations in the U.S.*

- In the U.S. influenza epidemics lead to around:
  - 600,000 life years lost
  - 3 million hospitalized days
  - 30 million outpatient visits

  Molinari et al. 2007, *The Annual Impact of Seasonal Influenza in the U.S.*

- In one year (1995), influenza was responsible for more than 200 million days of restricted activity, 100 million days of bed disability, 75 million work absenteeisms, and 22 million health care provider visits.

  NCHS 1998, *Current Estimates from the National Health Interview Survey, 1995*

- The annual number of influenza-associated deaths from respiratory and circulatory cases varies widely from year-to-year ranging from an estimated 3,349 to 48,614.

  CDC 2010, *Estimate of Deaths Associated with Seasonal Influenza*

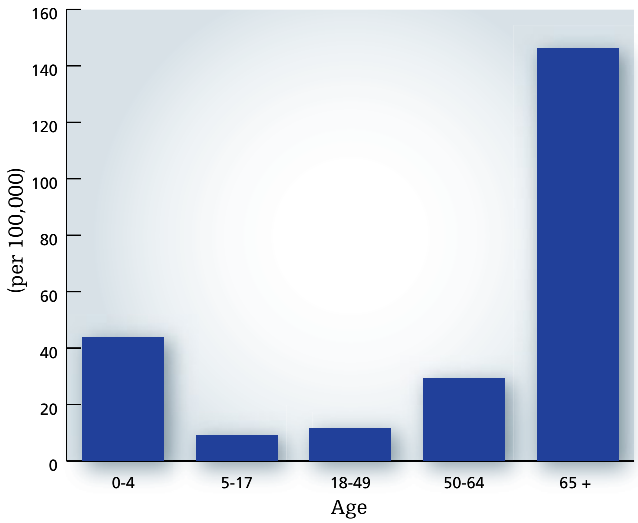
- Case-fatality rates from influenza in residents of long-term care facilities range from 10% to 20%.

  CDC 2006, *Influenza Vaccination of Health-Care Personnel*

- Mortality from influenza increased from between 7,000 and 32,000 annual deaths in the 1970s, to between 36,000 and 72,000 annual deaths in the 1990s.

  Thompson et al. 2003, *Mortality Associated with Influenza and Respiratory Syncytial Virus in the U.S.*

■ Cumulative Hospitalization Rate (Per 100,000) Of Laboratory-Confirmed Influenza By Age From October 1, 2012 To February 9, 2013



CDC 2013, Update: *Influenza activity*

Shingles

- Shingles causes around 50,000 to 60,000 hospitalizations each year in the United States.

  Insinga et al. 2005, *The Incidence of Herpes Zoster in a U.S. Administrative Database*

- Complications—including postherpetic neuralgia (PHN)—occur in almost 50 percent of older persons with shingles.

  Oxman 2005, *A Vaccine to Prevent Herpes Zoster and Postherpetic Neuralgia in Older Adults*

- Approximately 1% to 4% of shingles episodes result in hospitalization and the average length-of-stay is 4.8 days.

  CDC 2008, *Prevention of Herpes Zoster*

The Economic Burden

Pneumonia

- In 2005, pneumonia and influenza combined cost the U.S. $40.2 billion—$34.2 in direct costs and $6 billion in indirect mortality costs.

  American Lung Association 2007, *Influenza Fact Sheet*

- Hospital-treated pneumonia in Medicare patients cost at least $7 billion in 2010.

  Thomas et al. 2012, *Incidence and Cost of Pneumonia in Medicare Beneficiaries*

- Medicare patients hospitalized for pneumonia have medical expenses—during the hospitalization and for a year afterwards—that are $15,682 higher than in Medicare patients without pneumonia.

  Thomas et al. 2012, *Incidence and Cost of Pneumonia in Medicare Beneficiaries*

Influenza

- Influenza costs the United States over $87 billion a year, with $10.4 billion coming from direct medical costs.

  Molinari et al. 2007, *The Annual Impact of Seasonal Influenza in the U.S.*

- An estimated 64% of the total economic burden of influenza comes from those over 65 years old.

  Molinari et al. 2007, *The Annual Impact of Seasonal Influenza in the U.S.*

- Lost productivity and loss of life due to influenza amounts to $16.3 billion of lost earnings annually.

  Molinari et al. 2007, *The Annual Impact of Seasonal Influenza in the U.S.*

- During influenza season, influenza-like-illness is responsible for 45% of workdays lost and for 49% of low productivity days among working adults aged 50–64 years.

  Nichol et al. 2009, *Burden of Influenza-like Illness and Effectiveness of Influenza Vaccination Among Working Adults Aged 50–64 Years*

Shingles

- An estimated $1 billion is spent each year on direct medical expenses for shingles in the U.S.

  CDC 2012, *Vaccines and Preventable Diseases*

- Among patients with acute episodes of shingles, average expenditures ranged from $112 to $287 per episode of outpatient care, $73 to $180 per antiviral treatment, and $3,221 to $7,206 per hospitalization (in 2006 dollars).

  Dworkin et al. 2007, *Healthcare Costs of Acute and Chronic Pain Associated with a Diagnosis of Herpes Zoster* AND Dworkin et al. 2008, *Health Care Expenditure Burden of Persisting Herpes Zoster Pain*

- The shingles vaccine-eligible population (i.e., persons aged 60 years or older) accounted for 74% of the total annual shingles-related hospital charges in 2004.

  Patel et al. 2008, *Herpes Zoster–Related Hospitalizations and Expenditures Before and After Introduction of the Varicella Vaccine in the U.S.*

- Patients with shingles (including those progressing to postherpetic neuralgia) lose an average of over 129 hours of work per episode, including losses of 12 or more hours of work time and 69 hours of leisure time during the first 30 days.

  Pellessier et al. 2007, *Evaluation of the Cost-Effectiveness in the U.S. of a Vaccine to Prevent Herpes Zoster* AND Ortega-Sanchez 2006, *Projected Cost-Effectiveness of Vaccinating U.S. Elderly to Prevent Shingles*

The Value of Vaccines

Innovative Medical Research

During the 20th century, the leading causes of death in the United States underwent a noticeable shift from infectious diseases to chronic, non-communicable diseases. This shift occurred as a culmination of improvements to public health—including widespread vaccination efforts. Through vaccination, the U.S. has seen the eradication of diseases such as polio and small pox; as well as the significant reduction of cases and impact of measles, tetanus, diphtheria, pertussis, and more.

Immunizations are one of the most cost-effective ways to protect the health of individuals and our communities. Use of a pneumonia vaccination in adults age 50 and older, for example, is estimated to have prevented 1.2 million cases of nonbactermic pneumonia; while the influenza vaccine is estimated to reduce the risk of illness in the overall population by around 60%.

The cost savings are also tremendous, with every dollar spent on immunizations estimated to save at least $18.40 in direct and indirect costs. Use of a pneumonia vaccine in older adults has the potential to reduce healthcare costs by an estimated $3.5 billion, and total societal costs by $7.4 billion. And these estimates may very well represent the lower bounds of potential savings since few incorporate all indirect savings, including those from herd immunity—the protective effect for the non-vaccinated in a community from the vaccination of those around them.

With vaccinations most likely cost-saving, not just cost-effective, the 137 new vaccines currently in development for infectious diseases are sure to make a huge impact. However, more medical research is needed to not only develop additional vaccines but to better understand the impact of aging and chronic disease on immune responses and how vaccines optimally work in older adults.

The Human Value

- Compared to estimated deaths without vaccination, global use of vaccination in 2001 prevented:
  • 61% of measles deaths;
  • 69% of tetanus deaths;
  • 78% of pertussis (whooping cough) deaths;
  • 94% of diphtheria deaths; and
  • 98% of polio deaths.

  Brenzel et al. 2006, *Vaccine-Preventable Diseases*

- Infectious disease eradication in the U.S. led to the following annual life years saved (LYS):
  • 5,811,852 for measles;
  • 42,702 for tetanus
  • 212,690 for polio; and
  • 1,685,740 for smallpox.

  Ehreth 2003, *The Global Value of Vaccination*

- Vaccination for measles reduced the number of worldwide deaths from 6 million in 1974 to less than 1 million per year.

  Bloom et al. 2005, *The Value of Vaccination*

- Vaccination has played a significant role in reducing diphtheria cases from 80,000 in 1975 to less than 10,000 per year.

  Birmingham 2003, *The Burden of Vaccine-Preventable Diseases*

- Vaccination helped reduce global pertussis (whooping cough) cases from 3 million per year to less 250,000.

  Birmingham 2003, *The Burden of Vaccine-Preventable Diseases*

- Vaccination for polio reduced the number of worldwide cases from more than 300,000 per year in the 1980s to only 2,000 in 2002—also preventing an estimated 5 million cases of paralysis since 1988.

  Bloom et al. 2005, *The Value of Vaccination* AND WHO 2011, *Benefits of Immunization*

- Since global vaccination efforts wiped out smallpox disease in 1979, infections in 350 million people have been prevented and 40 million lives have been saved.

  Ehreth 2003, *The Global Value of Vaccination*

- 137 vaccines are currently in development in the U.S. for infectious diseases.

  PhRMA 2013, *Medicines in Development*

Pneumonia

- PPSV23 (pneumococcal polysaccharide vaccine) protects against 23 types of pneumococcal bacteria and is 60% to 80% effective in preventing pneumococcal bacteremia in adults over the age of 65 who are not immunocompromised.

  Immunization Action Coalition 2012, *Ask the Experts*

- Use of PCV13 (13-valent pneumococcal conjugate vaccine) in older adults is estimated to have the potential to result in 15,000 fewer cases of invasive pneumococcal disease and 1.2 million fewer cases of nonbacteremic pneumonia in U.S. adults age 50 and older.

  Weycker et al. 2012, *Public Health and Economic Impact of 13-Valent Pneumococcal Conjugate Vaccine in U.S. Adults Aged ≥50 Years*

- Within a year of introduction of PCV7 (7-valent pneumococcal conjugate vaccine) for use in the U.S. in infants, children under 2 years, and high risk children ages 2 to 4; invasive pneumococcal disease rates in unvaccinated individuals age 65 and older fell by 18%.

  Whitney et al. 2003, *Decline in Invasive Pneumococcal Disease After the Introduction of Protein-Polysaccharide Conjugate Vaccine*

Influenza

- Over a 6-year period (2005 - 2011), the influenza vaccine prevented an estimated 13 million influenza cases—between 1.1 million and 5 million annually.

  Kostova et al. 2013, *Influenza Illness and Hospitalizations Averted by Influenza Vaccination in the U.S.*

- Over a 6-year period (2005 - 2011), the influenza vaccine prevented more than 110,000 hospitalizations and 5.8 million medical visits.

  Kostova et al. 2013, *Influenza Illness and Hospitalizations Averted by Influenza Vaccination in the U.S.*

- Recent studies from the Centers for Disease Control and Prevention show that the influenza vaccine can reduce the risk of illness in the overall U.S. population by around 60%. Estimates for the 2012-2013 season are 47% vaccine effectiveness for influenza A (H3N2) and 67% for influenza B.

  CDC 2013, *Vaccine Effectiveness* AND CDC 2013, *Interim Adjusted Estimates of Seasonal Influenza Vaccine Effectiveness*

- Use of the LAIV (live attenuated influenza virus) in healthy adults ages 18 to 64 reduced febrile illness by 19% and upper respiratory tract illnesses by 24%. It also reduced the days of illness by 23% to 27% depending on severity of illness, lost work days by 18% to 28%, and days with visits to health care professionals by 25% to 41%.

  Nichol et al. 1995, *Effectiveness of Live, Attenuated Intranasal Influenza Virus Vaccine in Healthy, Working Adults*

- Use of LAIV (live attenuated influenza virus) in healthy adults ages 18 to 65 reduced antibiotic use by 43% to 47%.

  Nichol et al. 1995, *Effectiveness of Live, Attenuated Intranasal Influenza Virus Vaccine in Healthy, Working Adults*

- Vaccination of staff in a tertiary care facility over a period of 12 influenza seasons increased vaccination coverage from 4% to 67%, reduced laboratory-confirmed cases of influenza amongst staff from 42% to 9%, and reduced nosocomial cases among hospitalized patients from 32% to 0.

  Salgado et al. 2004, *Preventing Nosocomial Influenza by Improving the Vaccine Acceptance Rate of Clinicians*

- Mortality rates in nursing home residents were 42% lower in facilities with higher staff vaccination coverage compared with control facilities.

  CDC 2006, *Influenza Vaccination of Health-Care Personnel*

- Offering the influenza vaccine annually to all people over the age of 50 would save around 275,000 quality-adjusted life years over the lifetimes of a birth cohort of 4 million.

  Maciosek et al. 2006, *Influenza Vaccination Health Impact and Cost Effectiveness*

Shingles

- Approximately one-third of shingles deaths may be preventable through vaccination.

  Mahamud et al. 2013, *Herpes-Zoster Related Deaths in the U.S.*

- Use of a live attenuated VZV (varicella-zoster vaccine) in a randomized trial reduced the incidence of shingles by 51.3%.

  Oxman et al. 2005, *A Vaccine to Prevent Herpes Zoster and Postherpetic Neuralgia in Older Adults*

- Use of a live attenuated VZV (varicella-zoster vaccine) in a randomized trial reduced the burden of illness from shingles by 61.1% and the incidence of postherpetic neuralgia (PHN) by 66.5%.

  Oxman et al. 2005, *A Vaccine to Prevent Herpes Zoster and Postherpetic Neuralgia in Older Adults*

- Use of the shingles vaccine in immunocompetent adults could eliminate more than 300,000 outpatient visits, 375,000 prescriptions, 9,700 emergency room visits, and 10,000 hospitalizations.

  Pellissier et al. 2007, *Evaluation of the Cost-Effectiveness in the U.S. of a Vaccine to Prevent Herpes Zoster*

The Economic Value

- Every dollar spent on immunization saves $6.30 in direct medical costs—a total savings of $10.5 billion. When including indirect costs such as lost days of work, disability, etc., every dollar spent saves $18.40—a total savings of $42 billion.

  Rappaport 2003, *CDC: Immunizations High But Shot in the Arm Still Needed*

- Most vaccinations cost less than $50 per healthy life year saved. In contrast, treating hypertension costs between $4,340 and $87,940 per healthy life year saved.

  Ehreth 2003, *The Global Value of Vaccination*

- For every dollar spent on the MMR (measles, mumps, and rubella) vaccine, $21 is saved.

  IOM 1997, *America's Vital Interest in Global Health*

- One case of measles can cost 23 times as much as a single vaccination to prevent it.

  Ehreth 2003, *The Global Value of Vaccination*

- Eradication of polio is estimated to produce savings to governments of $1.5 billion per year.

  Bloom et al. 2005, *The Value of Vaccination*

- An estimated $100 million spent in eradicating smallpox from 1967 to 1977 saved the world around $1.35 billion a year.

  Barrett 2004, *Eradication Versus Control*

Pneumonia

- Use of PCV13 (13-valent pneumococcal conjugate vaccine) in older adults is estimated to have the potential to reduce total healthcare costs by $3.5 billion and total societal costs by $7.4 billion.

  Weycker et al. 2012, *Public Health and Economic Impact of 13-Valent Pneumococcal Conjugate Vaccine in U.S. Adults Aged ≥50 years*

- Addition of PCV13 (13-valent pneumococcal conjugate vaccine) to previously recommended pneumococcal polysaccharide vaccine for immunocompromised adults cost $70,937 per quality adjusted life year compared to no vaccine.

  Smith et al. 2013, *Cost-Effectiveness of Pneumococcal Conjugate Vaccination in Immunocompromised Adults*

Influenza

- Vaccination for influenza resulted in an average annual cost savings of $13.66 per healthy working adult vaccinated.

  Nichol 2001, *Cost-Benefit Analysis of a Strategy to Vaccinate Healthy Working Adults Against Influenza*

- The influenza vaccination could save between $60 and $4,000 per case prevented.

  Pearson et al. 2006, *Influenza Vaccination of Health-Care Personnel*

- As over 60% of the economic burden of influenza falls on those ages 65 and older, programs to reduce the impact of influenza on older Americans would have the greatest economic benefit.

  Molinari et al. 2007, *The Annual Impact of Seasonal Influenza in the U.S.*

- Vaccination for pandemic influenza (pH1N1) prior to an outbreak produces incremental cost-effectiveness ratios for individuals without high risk conditions, ranging from $8,000 to $52,000 per quality-adjusted life year.

  Prosser et al. 2011, *Cost-Effectiveness of 2009 Pandemic Influenza A(H1N1) Vaccination in the U.S.*

Shingles

- The projected cost-effectiveness of a shingles vaccine for adults age 60 and older was estimated at $15,390 – $22,474 from the payer perspective, and $14,450 – $21,524 from the societal perspective

  Pellessier et al. 2007, *Evaluation of the Cost-Effectiveness in the U.S. of a Vaccine to Prevent Herpes Zoster*

- Vaccination of 1 million people age 60 and over with the shingles vaccine would result in 11,919 non-discounted and 8,782 discounted QALYs (quality of life years) gained and save around $49 million.

  CDC 2006, *Advisory Committee on Immunization Practices*

- Use of the shingles vaccine in immunocompetent adults ages 60 and older could save between $82 million and $103 million in healthcare costs associated with the diagnosis and treatment of shingles, post-herpetic neuralgia, and other complications.

  Pellessier et al. 2007, *Evaluation of the Cost-Effectiveness in the U.S. of a Vaccine to Prevent Herpes Zoster*

- In another cost-effectiveness analysis, investigators estimated the zoster vaccine cost $44,000 per quality-adjusted life year saved for a 70-year-old woman.

  Rothberg et al. 2007, *Cost-Effectiveness of a Vaccine to Prevent Herpes Zoster and Postherpetic Neuralgia in Older Adults*

Conclusion

The Centers for Disease Control and Prevention (CDC) recommends vaccinations through adulthood in order to boost immunity for those vaccinations with decreased effectiveness over time, new immunity for diseases that become more prevalent and burdensome as we age, and some protection through "herd immunity"—where collective immunity contains the disease and protects those in the community who are too young or too sick to receive vaccinations.

Unfortunately, the reality is that vaccine rates for adults are significantly below targets set by the CDC and every year, between 50,000 and 90,000 adults in the U.S. die from infectious diseases that could have been prevented with a vaccination. This underutilization is a result of many things including issues of access and cost barriers, lack of education about the benefits of vaccination, and misconceptions regarding the risks. In addition, healthcare providers and patients often misinterpret adult vaccine effectiveness, as many vaccines only reduce disease impact instead of eliminate it.

In addition to the need for policy changes that will address these causes of underutilization, we continue to need new vaccinations that target evolving viruses and more research that helps scientists understand how vaccines work in older adults with decreased immune function and oftentimes multiple chronic conditions.

These investments in innovation will pay for themselves with decreased medical expenses, enhanced quality of life and independence, and increased productivity. This type of innovation is essential if we want to contain the healthcare costs of our aging nation.

References

American Lung Association. September 2007. *Influenza Fact Sheet*. Last accessed on September 10, 2013 at www.lungusa.org/lung-disease/influenza/in-depth-resources/influenza-fact-sheet.html.

Barrett, Scott. September 2004. Eradication Versus Control: The economics of global infectious disease policies. *Bulletin of the World Health Organization* 82:683-8.

Birmingham, M. and C. Stein. 2003. The Burden of Vaccine-Preventable Diseases. In Barry R. Bloom, Paul-Henri Lambert (eds). *The Vaccine Book*. San Diego, CA: Academic Press.

Bloom, David E., David Canning, and Mark Weston. 2005. The Value of Vaccination. *World Economics* 6(3):15-39.

Brenzel, Logan, Lara J. Wolfson, Julia Fox-Rushby, Mark Miller, and Neal A. Halsey. 2006. Vaccine-Preventable Diseases. In: Dean T. Jamison, Joel G. Breman, Anthony R. Measham, George Alleyne, Maram Claeson, et al. (eds). *Disease Control in Developing Countries*. 2nd edition. Washington, DC: World Bank.

Centers for Disease Control and Prevention. March 15, 2013. *Vaccine Effectiveness: How well does the flu vaccine work?* Last accessed on September 11, 2013 at www.cdc.gov/flu/about/qa/vaccineeffect.htm.

Centers for Disease Control and Prevention. February 22, 2013. Interim Adjusted Estimates of Seasonal Influenza Vaccine Effectiveness: United States, February 2013. *Morbidity and Mortality Weekly Report* 62(07):119-23.

Centers for Disease Control and Prevention. February 22, 2013. Update: Influenza Activity — United States, September 30, 2012–February 9, 2013. *Morbidity and Mortality Weekly Report* 62(07):124-30.

Centers for Disease Control and Prevention. January 23, 2013. *CDC Influenza Update for Geriatricians and Other Clinicians Caring for People 65 and Older*. Last accessed on August 29, 2013 at www.cdc.gov/flu/professionals/2012-2013-guidance-geriatricians.htm.

Centers for Disease Control and Prevention. September 30, 2012 - February 9, 2013. *Morbidity and Mortality Weekly Report* 62(07):124-30.

Centers for Disease Control and Prevention. July 2011. *Seasonal Influenza*. Last accessed on August 27, 2013 at www.cdc.gov/flu/about/qa/disease.htm.

Centers for Disease Control and Prevention. August 27, 2010. Estimates of Deaths Associated with Seasonal Influenza: United States, 1976-2007. *Morbidity and Mortality Weekly Report* 59(33):1057-62.

Centers for Disease Control and Prevention. June 29-30, 2006. *Advisory Committee on Immunization Practices: Record of the proceedings.*

Centers for Disease Control and Prevention. February 24, 2006. Influenza Vaccination of Health-Care Personnel. *Morbidity and Mortality Weekly Report* 55(RR02):1-16.

Dworkin, Robert H., Richard White, Alec B. O'Connor, and Kevin Hawkins. 2008. Health Care Expenditure Burden of Persisting Herpes Zoster Pain. *Pain Med* 9(3):348-53.

Dworkin, Robert H., Richard White, Alec B. O'Connor, Onur Baser, and Kevin Hawkins. 2007. Healthcare Costs of Acute and Chronic Pain Associated with a Diagnosis of Herpes Zoster. *J Am Geriatr Soc* 55(8):1168-75.

Ehreth, Jennifer. 2003. The Global Value of Vaccination. *Vaccine* 21(7-8):596-600.

Garibaldi, Richard A. 1985. Epidemiology of Community-Acquired Respiratory Tract Infections in Adults: Incidence, etiology, and impact. *Am J Med* 78(6B):32-7.

Gorina, Yelena, Tanika Kelly, James Lubitz, and Zahiyah Hines. February 2008. Trends in Influenza and Pneumonia Among Older Persons in the United States. *Trends in Health and Aging 8*. Hyattsville, MD: National Center for Health Statistics

Harpaz Rafael, Ismael R. Ortega-Sanchez, and Jane F. Seward. 2008. Advisory Committee on Immunization Practices (ACIP) Centers for Disease Control and Prevention (CDC). Prevention of Herpes Zoster: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Report*. 57(RR-5):1-30.

Immunization Action Coalition. November 1, 2012. Ask the Experts: *Pneumococcal vaccines*. Last accessed on August 19, 2013 at www.immunize.org/askexperts/experts_pneumococcal_vaccines.asp.

Insinga, Ralph P., Robbin F. Itzler, James M. Pellissier, Patricia Saddier, and Alexander A Nikas. 2005. The Incidence of Herpes Zoster in a United States Administrative Database. *J Gen Intern Med* 20(8):748-53.

Institute of Medicine. 1997. *America's Vital Interest in Global Health: Protecting our people, enhancing our economy, and advancing our international interests*. Washington, DC: National Academy Press.

Jackson, Michael L., Kathleen M. Neuzil, William W. Thompson, David K. Shay, Onchee Yu, et al. 2004. The Burden of Community-Acquired Pneumonia in Seniors: Results of a population-based study. *Clin Infect Dis* 39(11):1642-50.

Kaplan, Vladimir, Derek C. Angus, Martin F. Griffin, Gilles Clermont, R. Scott Watson ,et al. 2002. Hospitalized Community-Acquired Pneumonia in the Elderly. *Am J Respir Crit Care Med* 165(6):766-22.

Kostova, Deliana, Carrie Reed, Lyn Finelli, Po-Yung Cheng, Paul M. Gargiullo, et al. 2013. Influenza Illness and Hospitalizations Averted by Influenza Vaccination in the United States, 2005-2011. *PLoS ONE* 8(6): e66312. doi:10.1371/journal.pone.0066312.

Laessig, Katherine A. 2010. End Points in Hospital-Acquired Pneumonia and/or Ventilator-Associated Pneumonia Clinical Trials: Food and Drug Administration perspective. *Clin Infect Dis* 51(Suppl 1):S117-9.

Lin, Felix, and James L Hadler. 2000. Epidemiology of Primary Varicella and Herpes Zoster Hospitalizations: The pre-varicella vaccine era. *J Infect Dis* 181(6):1897-905.

Maciosek, Michael V., Leif I. Solberg, Ashley B. Coffield, Nichol M. Edwards, and Michael J. Goodman. 2006. Influenza Vaccination Health Impact and Cost Effectiveness Among Adults Aged 50 to 64 and 65 and Older. *Am J Prev Med* 31(1):72-9.

Mahamud, Abdirahman, Mona Marin, Steven P. Nickell, Trevor Shoemaker, John X. Zhang, et al. 2012. Herpes Zoster–Related Deaths in the United States: Validity of death certificates and mortality rates, 1979–2007. *Clin Infect Dis* 55(7): 960-66.

Martson, Barbara J., Joseph F. Plouffe, Thomas M. File, Barbara A. Hackman, Sara-Jane Salstrom, et al. 1997. Incidence of Community-Acquired Pneumonia Requiring Hospitalization. *Arch Intern Med* 157(15):1709-18.

McEachern, Robert, and G. Douglas Campbell. 1998. Hospital-Acquired Pneumonia: Epidemiology, etiology, and treatment. *Infect Dis Clin North Am* 12(3):761-79.

Molinari, Noelle-Angelique M., Ismael R. Ortega-Sanchez, Mark L. Messonnier, William W. Thompson, Pascale M. Wortley, et al. 2007. The Annual Impact of Seasonal Influenza in the U.S.: Measuring disease burden and costs. *Vaccine* 25:5086-96.

Mortensen, Eric M. Wiswha N. Kapoor, Chung-Chou H. Chang, and Michael J. Fine. 2003. Assessment of Mortality After Long-Term Follow-Up of Patients with Community-Acquired Pneumonia. *Clin Infect Dis* 37(12):1617-24.

National Center for Health Statistics. May 8, 2013. Deaths: Final data for 2010. *National Vital Statistics Reports* 61(4).

National Center for Health Statistics. *National Hospital Discharge Survey: 2010 table, average length of stay and days of care—Number and rate of discharges by first-listed diagnostic categories*. Last accessed on August 29, 2013 at www.cdc.gov/nchs/data/nhds/2average/2010ave2_firstlist.pdf.

National Center for Health Statistics. July 30, 2008. 2006 National Hospital Discharge Survey. *National Health Statistics Reports 5*.

National Center for Health Statistics. June 2008. *2004 National Nursing Home Survey, Residents, table 33D*. Last accessed on August 29, 2013 at www.cdc.gov/nchs/data/nnhsd/Estimates/nnhs/Estimates_Diagnoses_Tables.pdf#Table33b.

National Center for Health Statistics. October 1998. Current Estimates from the National Health Interview Survey, 1995. *Vital and Health Statistics*. 10(199).

Nichol, Kristin L., Sarah J. D'Heilly, Michael E. Greenberg, and Edward Ehlinger. 2009. Burden of Influenza-like Illness and Effectiveness of Influenza Vaccination Among Working Adults Aged 50–64 Years. *Clin Infect Dis* 48(3):292-8.

Nichol, Kristin L. 2001. Cost-Benefit Analysis of a Strategy to Vaccinate Healthy Working Adults Against Influenza. *JAMA Intern Med* 161(5):749-59.

Nichol, Kristin L., April Lind, Karen L. Margolis, Maureen Murdoch, Rodney McFadden, et al. 1995. The Effectiveness of Vaccination Against Influenza in Healthy, Working Adults. *NEJM* 333(14):889-93.

Niederman, Michael S., Lionel A. Mandell, Antonio Anzueto, John B. Bass, William A. Broughton, et al. 2001. Guidelines for the Management of Adults with Community-Acquired Pneumonia. *Am J Respir Crit Care Med* 163(7):1730-54.

Ortega-Sanchez, R. June 2006. *Projected Cost-Effectiveness of Vaccinating U.S. Elderly to Prevent Shingles*. Oral Presentation to the Advisory Committee for Immunization Practices (ACIP) Meeting.

Oxman, M.N., M.J. Levin, G.R. Johnson, K.E. Schmader, S.E. Straus, et al.; for the Shingles Prevention Study Group. 2005. A Vaccine to Prevent Herpes Zoster and Postherpetic Neuralgia in Older Adults. *NEJM* 352(22):2271-84.

Patel, Mitesh S., Achamyeleh Gebremariaum, and Matthew M. Davis. 2008. Herpes Zoster-Related Hospitalizations and Expenditures Before and After Introduction of the Varicella Vaccine in the United States. *Infect Control Hosp Epidemiol* 29(12):1157-63.

Pearson, Michael L., Carolyn B. Bridges, and Scott A. Harper. February 24, 2006. Influenza Vaccination of Health-Care Personnel. *Morbidity and Mortality Weekly Report* 55(RR02):1-16.

Pellesier, James M., Marc Brisson, and Myron J. Levin. 2007. Evaluation of the Cost-Effectiveness in the United States of a Vaccine to Prevent Herpes Zoster and Postherpetic Neuralgia in Older Adults. *Vaccine* 25(49):8326-37.

Pharmaceutical Research and Manufacturers of America. 2013. *Medicines in Development: Vaccines-A report on the prevention and treatment of disease through vaccines*. Washington, D.C.: PhRMA.

Prosser, Lisa A., Tara A. Lavelle, Anthony E. Fiore, Carolyn B. Bridges, Carrie Reed, et al. 2011. Cost-Effectiveness of 2009 Pandemic Influenza A (H1N1) Vaccination in the United States. *PLoS ONE* 6(7): e22308. doi:10.1371/journal.pone.0022308.

Rappaport, Ross. August 1, 2003. *CDC: Immunizations High but a Shot in the Arm Still Needed*. Cox News Service.

Right Diagnosis. *Statistics About Flu*. Last accessed on August 29, 2013 at www.right-diagnosis.com/f/flu/stats.htm.

Rothberg , Michael B. Anunta Virapongse, and Kenneth J. Smith. 2007. Cost-Effectiveness of a Vaccine to Prevent Herpes Zoster and Postherpetic Neuralgia in Older Adults. *Clin Infect Dis* 44(10):1280-8.

Salgado, Cassandra D., Eve T. Giannetta, Frederick G. Hayden, and Barry M. Farr. 2004. Preventing Nosocomial Infections by Improving the Vaccine Acceptance Rate of Clinicians. *Infect Control Hosp Epidemiol* 25(11):923-8.

Schmader, Kenneth. 2001. Herpes Zoster in Older Adults. Clin Infect Dis 32(10):1481-6.

Smith, Kenneth J., Mary Patricia Nowalk, Mahlon Raymund, and Richard K. Zimmerman. 2013. Cost-Effectiveness of Pneumococcal Conjugate Vaccination in Immunocompromised Adults. *Vaccine* 31(37):3950-6.

Thomas, Cindy P., Marian Ryan, John D. Chapman, William B. Stason, Christopher P. Tompkins, et al. 2012. Incidence and Cost of Pneumonia in Medicare Beneficiaries. *Chest* 142(4):973-81.

Thompson, William W., David K. Shay, Eric Weintraub, Lynnette Brammer, Carolyn B. Bridges, et al. 2004. Influenza-Associated Hospitalizations in the United States. *JAMA* 292(11):1333-40.

Thompson, William W., David K. Shay, Eric Weintraub, Lynnette Brammer, Nancy Cox, et al. 2003. Mortality Associated with Influenza and Respiratory Syncytial Virus in the United States. *JAMA* 289(2):179-86.

Weycker, Derek, Reiko Sato, David Strutton, John Edelsberg, Mark Atwood, et al. 2012. Public Health and Economic Impact of 13-Valent Pneuomococcal Conjugate Vaccine in U.S. Adults Aged ≥50 Years. *Vaccine* 30(36):5437-44.

Whitney, Cynthia G., Monica M. Farley, James Hadler, Lee H. Harrison, Nancy M. Bennett, et al.; for the Active Bacterial Core Surveillance of the Emerging Infections Program Network. 2003. Decline in Invasive Pneumococcal Disease After the Introduction of Protein-Polysaccharide Conjugate Vaccine. *NEJM* 348(18):1737-46.

World Health Organization (WHO). October 2011. Benefits of Immunization. *The expanded programme on immunization*. Last accessed on August 26, 2013 at www.who.int/immunization_delivery/benefits_of_immunization/en/index.html.

Facts in silver type deal specifically with older Americans.

www.silverbook.org/vaccines
SilverBook@agingresearch.org

Alliance
FOR AGING RESEARCH

Advancing Science. Enhancing Lives.

900 17th St., NW
Suite 710
Washington, DC 20006
202.293.2856

www.agingresearch.org

Alliance for Aging Research

@Aging_Research

Acknowledgements:

The Alliance extends its thanks to the following experts for reviewing *The Silver Book®:Infectious Diseases & Prevention through Vaccination:*

- **David E. Bloom**, PhD, Clarence James Gamble Professor of Economics and Demography, Harvard School of Public Health
- **Lisa Jackson**, MD, MPH, Senior Investigator, Immunization Studies, Group Health Research Institute
- **Kenneth Schmader**, MD, Professor of Medicine Chief, Division of Geriatrics, Duke University Medical Center, Director, GRECC, Durham VA Medical Center

This volume of *The Silver Book®* supported by an educational grant from:

Pfizer