Why Immunizations Matter

ACHI
Arkansas Center for Health Improvement

FACT SHEET • **January 2017**

Arkansas policymakers and parents are asking tough questions about the state's response to the recent mumps outbreak in Arkansas with more than 2,400 cases under investigation.[1,2] The mumps outbreak has provoked meaningful discussion about the role of public health agencies in detection and control of infectious diseases.[1] Perhaps more importantly, it has elevated awareness of the critical importance of immunizations. The number of mumps cases has significantly declined since the initiation of the vaccination program in 1967,[3] but outbreaks remind us that viral diseases such as mumps are extremely contagious and can lead to serious complications.[4] This fact sheet describes paths to immunity, the impact of vaccination programs, and immunization safety, effectiveness, and recommendations.

IMMUNITY

Immunity is "protection against a disease… as indicated by the presence of antibodies in the blood [and] can usually be determined with a laboratory test."[5] Immunization is "the process by which a person becomes protected from disease."[6] People may gain protection from infectious diseases through individual immunity or through the community.

Individual Immunity

There are two ways to acquire individual immunity—actively or passively.[5]

- **Active immunity—**acquired by disease contraction or vaccination (usually permanent)
- **Passive immunity—**acquired from antibodies produced by another source, e.g., mother to child (limited protection)

Vaccines are an altered version or component of the bacteria or virus associated with the disease.[7] When the vaccine is injected, the body's immune system detects a dead or weakened organism and reacts by producing antibodies against the organism.[6] Depending on the disease, one dose of a vaccine is enough to protect a person but in most cases, multiple doses boost antibody production.[8-10] Even with multiple doses, rates of effectiveness vary (see Table 1).[8-10] Because no vaccine is 100 percent effective in preventing initial disease, vaccines need to be tested regularly and updated to maximize effectiveness in preventing disease outbreaks.[11]

Table 1: Vaccine Effectiveness for Four Diseases by Number of Doses

Vaccine	Effectiveness	Dose(s)
Measles	97%	2
Mumps	88%	2
Inactivated Polio	99%	3
Varicella	85%	1

Community Immunity

People without individual immunity may be protected from infectious diseases in the community. Community, or herd, immunity occurs when enough people are immune to an infectious disease (through vaccination and/or prior illness) to decrease the spread of disease when it occurs.[5] For community immunity to protect people without individual immunity, a certain number of people must be resistant to the disease in order to prevent the disease from spreading from person to person (or at least lower the likelihood of disease spread).[12] This number is the herd immunity threshold. The threshold varies by the contagiousness of the disease, but most efforts target a goal of 90 percent protected.[12]

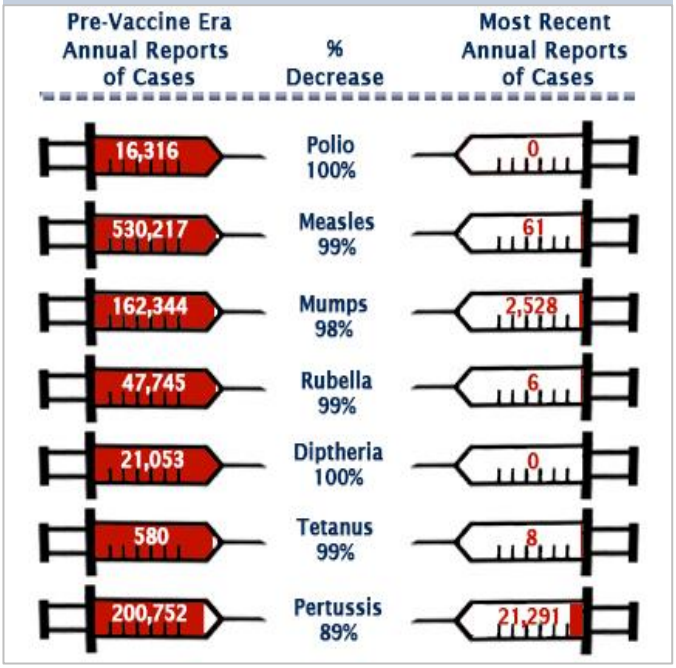
A case study of a measles outbreak in 1970 on the Texas-Arkansas border[13] highlights two issues: 1) the effectiveness of vaccinations, and 2) the importance of herd immunity in protecting all individuals (vaccinated or unvaccinated).[8-10]

Case Study: 1970 Texas-Arkansas Border Measles Outbreak[13]

- In 1970, there was a measles outbreak in Texarkana, TX and Texarkana, AR.
- Of 606 reported cases, 95 percent occurred in Texarkana, TX.
- Measles immunization was required for children admitted into school in Arkansas but not in Texas.
- Vaccination rates for children aged 1-9 were 95 percent in Arkansas and 57 percent in Texas.

This case study demonstrates the effectiveness of a vaccination program in creating community immunity.

Figure 1. Decrease in Reported Cases



An increased level of individualized immunity leads to greater community immunity. Projections indicate that vaccinations of children born between 1994 and 2013 will prevent 322 million illnesses, help avoid 732,000 deaths, and save nearly $1.4 trillion in total societal costs, including $295 billion in direct costs.[14]

Immunizations at Work

Before the introduction of vaccinations at the beginning of the 20th century, infectious diseases exacted an enormous toll on the U.S. population.[15] For example, at its peak in 1952, there were more than 21,000 cases of parylitic polio.[16] During the 20th century, some of the diseases that had caused illness and significant numbers of deaths had been eradicated or significantly reduced by advances in science.[15] Figure 1 (left) shows pre-vaccine-era annual reported cases and the most recent reported cases for select diseases, as of 2010.[17] Incidence reductions have led not only to health protection but also tremendous cost-benefit savings.[13] These savings highlighted in a 2007 report noted a benefit of $4.76-$5.61 for each dollar spent on varicella vaccine and a benefit of $1.96 for each dollar spent on hepatitis A vaccine.[18]

SAFETY AND EFFECTIVENESS

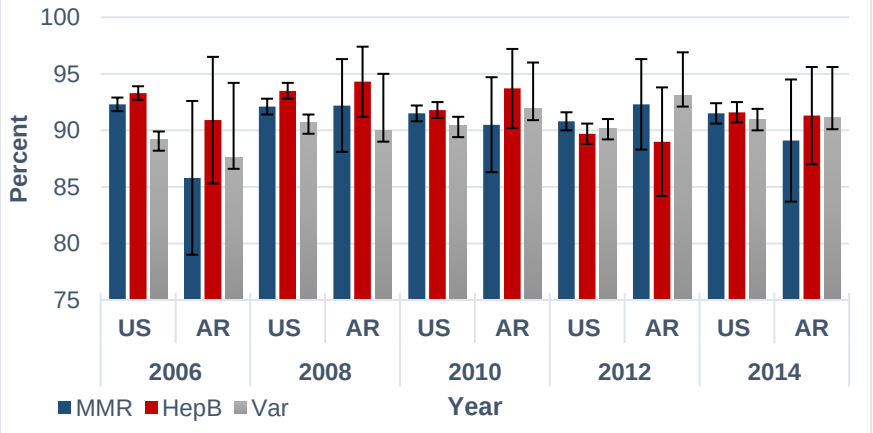
Modern vaccines are safe and effective, but no vaccine is completely effective or completely safe for all recipients. Unfavorable or adverse events after immunization have been reported with all vaccines, ranging from frequent, minor, local reactions to extremely rare, severe, systemic illness, such as that associated with yellow fever vaccine.[14] Despite anecdotal reports and considerable media attention regarding a connection between vaccines and autism spectrum disorder (ASD), no credible scientific proof has connected vaccines to ASD. This issue has been studied extensively in the U.S. and abroad, and no linkage between vaccines and ASD has been found.[20-23]

IMMUNIZATION RECOMMENDATIONS

The U.S. Department of Health & Human Services Centers for Disease Control and Prevention (CDC) recommends following the vaccination recommendations and scheduling unless otherwise medically indicated.[24] For children entering kindergarten, the Arkansas Department of Health follows CDC's recommendations requiring children to have the following six vaccinations: polio vaccine; measles / mumps / rubella vaccine; hepatitis B vaccine; hepatitis A vaccine; varicella (chickenpox) vaccine; and diphtheria / tetanus / acellular pertussis (DTaP), diphtheria / tetanus / pertussis (DTP), or diphtheria / tetanus (DT pediatric) vaccine.[25] However, Arkansas is one of 18 states that offer an exemption for medical, religious, and/or philosophical reasons.[18,19] Increased concentrations of individuals with exemptions may decrease overall herd immunity and contribute to an increase in vaccine-preventable disease outbreaks.[12]

Figure 2 (right) depicts vaccination coverage among children aged 19-35 months in the U.S. and in Arkansas from 2006-2014.[a,27] Arkansas ranked among the worst states for overall vaccination rates from 2009 to 2016.

Figure 2. Vaccination Coverage among Children Aged 19-35 Months



[a] Given the error rates depicted in the graph, there was no statistical difference in the coverage rates between U.S. and Arkansas.

In 2013,[b] Arkansas ranked last among states, with 39.4 percent of Arkansas' children aged 19 to 35 months not having all recommended immunizations. Ranking first among states was Iowa at 18.1 percent.[28]

Even with these vaccination gaps and variation in vaccination rates over time, there remains a level of consistency in vaccination rates nationally and locally that contributes to the relatively few outbreaks when compared to the pre-vaccination era.[3]

CONCLUSION

Public health practitioners recognize that not all diseases can be prevented by vaccines and may require different approaches to protect Americans.[14] A more fully vaccinated population has less potential risk of disease than a less vaccinated population does, because vaccination helps limit the size, length, and spread of disease. Public health policy should aim for 100 percent coverage.[29]

REFERENCES

1. State lawmakers discuss mumps outbreak in northwest Arkansas. 2016, *YAHOO! News*.
2. Mumps update as of Thursday, December 1, 2016. 2016, Arkansas Department of Health: Little Rock, AR.
3. Mumps cases and outbreaks. 2016 [cited 2016 September 15]; Available from: http://www.cdc.gov/mumps/outbreaks.html
4. Diseases and the vaccines that prevent them. 2013, Centers for Disease Control and Prevention: Atlanta, GA. p. 2.
5. Vaccines and immunizations glossary. 2015 [cited 2016 September 13]; Available from: http://www.cdc.gov/vaccines/terms/glossary.html#commimmunity
6. Vaccine: basics. [cited 2016 September 27]; Available from: https://www.vaccines.gov/basics/index.html
7. Understanding How Vaccines Work. 2013, Centers for Disease Control and Prevention: Atlanta, Ga.
8. Vaccines and Preventable Diseases. 2014 [cited 2016 November 17]; Available from: http://www.cdc.gov/vaccines/vpd/polio/hcp/index.html
9. Vaccines & Immunizations: Varicella Vaccine Effectiveness and Duration of Protection. 2012 [cited 2016 November 17]; Available from: http://www.cdc.gov/vaccines/vpd-vac/varicella/hcp-effective-duration.htm
10. Vaccines and Preventable Diseases: Measles, Mumps, Rubella (MMR) Vaccination: What Everyone Shuld Know. 2016 [cited 2016 November 17]; Available from: http://www.cdc.gov/vaccines/vpd/mmr/public/index.html
11. What You Need to Know About Vaccine Safety. Centers for Disease Control and Prevention: Atlanta, Ga.
12. Willingham, E.a.L.H. What is herd immunity? 2014 [cited 2016 September 19]; Available from: http://www.pbs.org/wgbh/nova/body/herd-immunity.html
13. Hinman, A.R., W.A. Orenstein, and A. Schuchat, Vaccine-preventable diseases, immunizations, and the Epidemic Intelligence Service. Am J Epidemiol, 2011. 174(11 Suppl): p. S16-22.
14. Report shows 20-year US immunization program spares millions of children from diseases. 2014 [cited 2016 September 16]; Available from: http://www.cdc.gov/media/releases/2014/p0424-immunization-program.html
15. Achievements in public health, 1900-1999: Impact of vaccines universally recommended for children -- United States, 1990-1998, N.I. Program, Editor. 1999, Centers for Disease Control and Prevention. p. 243-248.
16. Centers for Disease Control and Prevention. Epidemiology and Prevention of Vaccine-Preventable Diseases. Hamborsky J, Kroger A, Wolfe S, eds. 13th ed. Washington D.C. Public Health Foundation, 2015. Available from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/polio.pdf
17. Farrant, L., Vaccine Infographic, in Graphic Design. 2012, Behance. p. Pre-Vaccinne Era Estimated Annual Morbidity.
18. Armstrong, E.P., Economic benefits and costs associated with target vaccinations. *J Manag Care Pharm*, 2007. 13(7 Suppl B): p. S12-5.
19. Chapter 2: The pre-travel consultation. 2015 [cited 2016 September 26]; Available from: http://wwwnc.cdc.gov/travel/yellowbook/2016/the-pre-travel-consultation/general-recommendations-for-vaccination-immunoprophylaxis
20. Vaccines do not cause autism. 2015 [cited 2016 September 15]; Available from: http://www.cdc.gov/vaccinesafety/concerns/autism.html
21. MMR: No MMR-autism link in large study of vaccinated vs. unvaccinated kids. 2015 [cited 2016 September 15]; Available from: https://www.autismspeaks.org/science/science-news/no-mmr-autism-link-large-study-vaccinated-vs-unvaccinated-kids
22. DeStefano, F., C.S. Price, and E.S. Weintraub, Increasing exposure to antibody-stimulating proteins and polysaccharides in vaccines is not associated with risk of autism. J Pediatr, 2013. 163(2): p. 561-7.
23. Madsen, K.M., et al., A population-based study of measles, mumps, and rubella vaccination and autism. N Engl J Med, 2002. 347(19): p. 1477-82.
24. Who and when. [cited 2016 September 16]; Available from: https://www.vaccines.gov/who_and_when/index.html
25. Arkansas State Board of Health: Rules and regulations pertaining to immunization requirements. 2015, Arkansas Department of Health: Little Rock, AR. p. 17.
26. Vaccine Exemptions. 2015 [cited 2016 October 20]; Available from: http://www.vaccinesafety.edu/cc-exem.htm
27. CDC, Vaccine-specific coverage among children 19-35 months, National Immunization Survey, 1994-2014. 2015, Centers for Disease Control and Prevention.
28. Key health data about Arkansas. 2015 [cited 2016 October 12]; Available from: http://www.healthyamericans.org/states/?stateid=AR#section=1,year=2015,code=undefined
29. Fine, P., K. Eames, and D.L. Heymann, "Herd immunity": a rough guide. Clin Infect Dis, 2011. 52(7): p. 911-6.

[b] This is 2013 data reported in 2015 (see reference 28).

