

❖ Summary

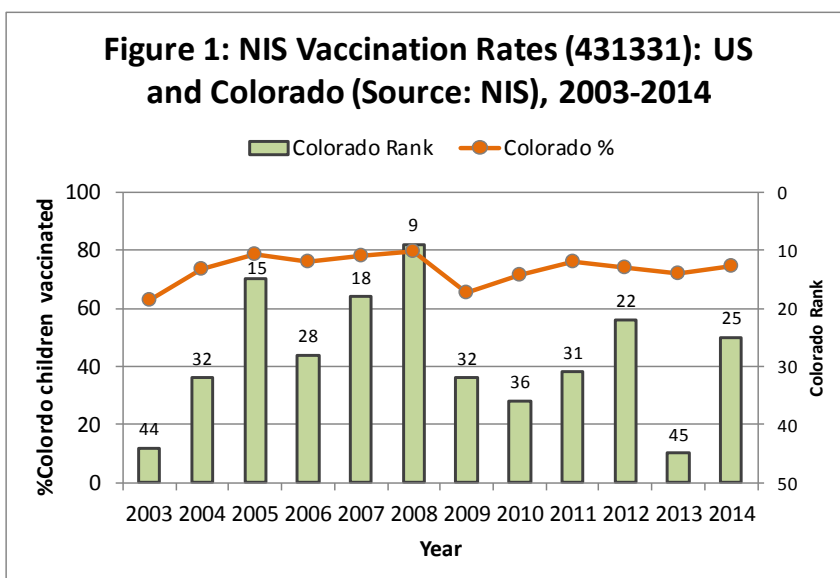
The 2015 *Vaccine-Preventable Diseases in Colorado's Children* report summarizes our annual analysis of rates of childhood vaccination and vaccine-preventable illness in 2014 (see Methods in Appendix A). Colorado ranks 25th among US states in on-time vaccination rates for children 19-35 months of age with cumulative rates continuing to hover under 80%. The highest proportion of hospitalizations for children with vaccine-preventable diseases continues to be in those under four years of age. Overall, hospitalization charges for children with potentially preventable infectious diseases exceeds \$20 million annually.

Vaccination of children represents perhaps the most effective public health intervention of the past century, and has protected countless children from serious illness around the world and in Colorado. However, maintaining the gains that vaccination has achieved against these infectious diseases requires insuring that populations retain high levels of vaccine-induced immunity. Outbreaks of disease (including measles, mumps, influenza, and pertussis) continue to occur when rates of vaccination are insufficient to prevent acquisition and transmission among vulnerable populations. Our results support the need for continued strengthening of on-time vaccine delivery systems, improving access to primary pediatric care, and increasing efforts to provide accurate information regarding the safety and benefits of childhood vaccination to parents who wish to protect their children from vaccine-preventable diseases.

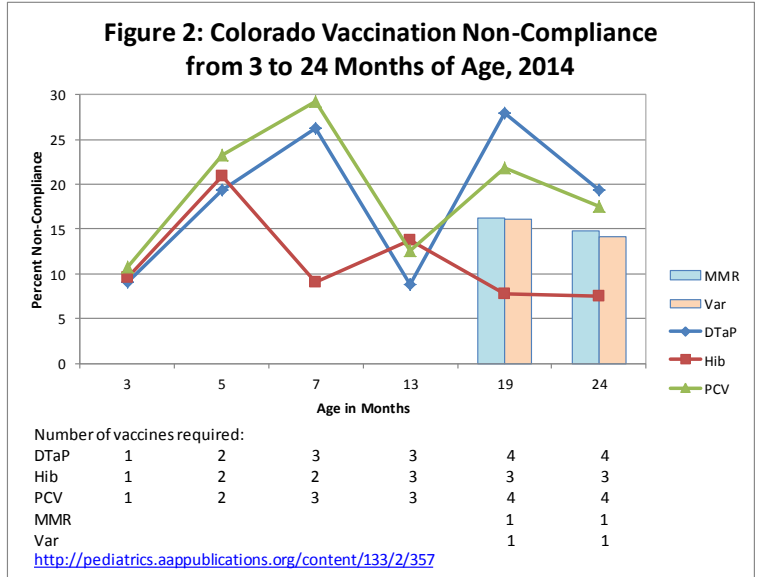
❖ Analysis

Colorado's vaccination gap is in our youngest children

In 2014, Colorado ranked 25th among US States in vaccination rates for children 19-35 months of age (Figure 1). More importantly, 25.7% of children surveyed in the NIS had received less than the recommended number of doses of Colorado Board of Health approved vaccines (431331: 4 doses of DTaP, 3 doses of polio [IPV], 1 dose of measles/mumps/rubella [MMR], 3 doses of hepatitis-B, 3 doses of *Haemophilus influenzae* type B [HiB] and 1 dose of varicella), leaving them vulnerable to these diseases.

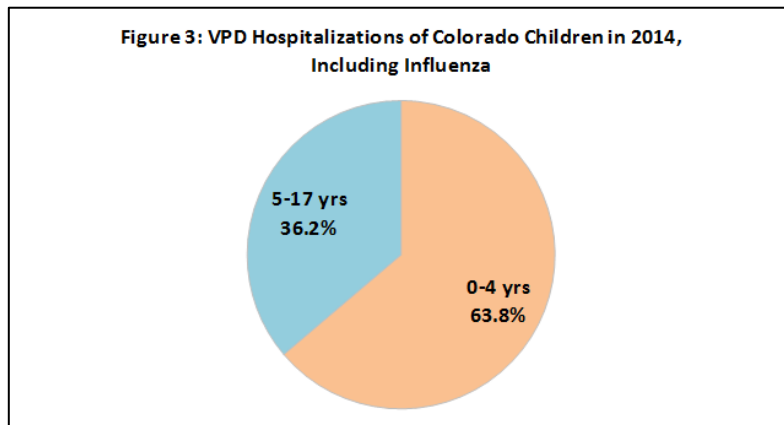


Much of this gap stems from incomplete vaccination of young children (Figure 2). This is especially concerning, since the highest burden of preventable illness overall occurs in this age group. For instance, coverage with MMR vaccine was only 85.2%, well below the >93-95% levels, which are required to protect a population against outbreaks of measles¹. More than a quarter of all 7 month infants in Colorado are behind in DTaP and PCV vaccinations, and pneumococcal disease and pertussis were the second and third most common reasons for hospitalization from vaccine-preventable diseases in young children in Colorado in 2014 (Table 1). Furthermore, Colorado's overall vaccination rate has not improved significantly in the last 10 years, and is; in fact lower in the last 5 years than in the 5 years prior.



Vaccine-preventable diseases hospitalize Colorado's youngest children

By far the greatest burden of disease requiring hospitalization falls on infants and young children (Figure 3), who are over five times more likely than older children to be hospitalized with a serious vaccine-preventable disease (Table 1). A more detailed breakdown of hospitalization from vaccine-preventable illnesses by age is presented in Table 1, using data from the Colorado Hospital Association. These data document not only the numbers of cases of preventable disease, but also the hospital charges associated with these illnesses. The most common vaccine-preventable cause of hospitalization was influenza, which resulted in 224 cases in children under 5 years of age, and 141 cases in children ages 5-19. Hospital charges for influenza cases alone exceeded \$10 million and total charges for childhood vaccine-preventable hospitalization were over \$20 million in 2014.



Additionally, there were three deaths among Colorado children (ages 1, 5, and 10 years) in 2014 while hospitalized for influenza. The Colorado Department of Public Health and the Environment reported that during September 28, 2014 and May 23, 2015, there were six pediatric deaths due to influenza among persons less than 18 years of age.

Table 1: Cases, rates, and charges for children in Colorado with vaccine-preventable diseases, 2014.

Vaccine	0-4 Years of Age CHA Hospitalizations			5-19 Years of Age CHA Hospitalizations		
	Hospitalized	Rate per	Hospital	Hospitalized	Rate per	Hospital
	Cases	100,000	Charges	Cases	100,000	Charges
Diphtheria	0	0.0	\$0	0	0.0	\$0
H. influenzae	1	0.3	\$45,672	0	0.0	\$0
Influenza, hospitalized	224	67.4	\$5,086,995	141	13.2	\$5,872,550
Measles	1	0.3	\$181,916	1	0.1	\$9,968
Mumps	0	0.0	\$0	0	0.0	\$0
Pertussis	30	9.0	\$1,296,138	5	0.5	\$710,488
Pneumococcal disease	23	6.9	\$4,057,838	25	2.3	\$2,767,584
Polio	0	0.0	\$0	0	0.0	\$0
Rubella	0	0.0	\$0	0	0.0	\$0
Tetanus	0	0.0	\$0	0	0.0	\$0
Varicella	5	1.5	\$75,608	4	0.4	\$499,859
Total	284	85.4	\$10,744,167	176	16.4	\$9,860,449

There were 3 deaths among these listed hospitalizations, hospitalized for influenza with respiratory manifestations: 1 among those 0-4 years of age and 2 among those 5-19 years of age.

*Population estimates for Colorado children for 2014 by age range were obtained from the Census Bureau using DataFerrett.

Estimated annual hospitalization charge savings due to vaccination in 2014

Table 2 estimates the hospital charges avoided in 2014 through vaccination of Colorado's children. Using historical rates of vaccine-preventable illness in Colorado, the number of potential prevented hospitalizations in 2014 and the associated average hospital charges were estimated for each condition. This model suggests that current vaccination programs prevent tens of thousands of pediatric hospitalizations and save hundreds of millions of dollars in hospital costs every year.

Table 2: Hospital cases and charges prevented among Colorado children due to vaccination, 2014

Disease	Index years ^a	Statewide pre-vaccination rate per 100,000 ^b	Statewide rate per 100,000 2014 ^b	Statewide reportable cases prevented: 2014 ^c	Actual hospitalized cases: 2014 ^d	Estimated hospitalized cases prevented: 2014 ^e	Estimated hospital charges prevented: 2014 ^f
Diphtheria	1920-1922	461	0.0	6,471	0	1,760	\$75,359,651
H. influenzae	1984-1986	12.4	1.0	173	1	47	\$2,051,743
Measles	1960-1962	784	0.0	11,004	2	2,993	\$128,153,488
Mumps	1964-1966	408	0.0	5,736	0	1,560	\$66,800,189
Pertussis	1945-1947	328	66.4	4,577	35	1,245	\$68,223,045
Pneumococcal disease	1997-1999	14.8	2.6	159	48	148	\$21,045,008
Polio	1952-1954	68	0.0	948	0	258	\$11,040,083
Rubella	1966-1968	124	0.0	1,743	0	474	\$20,301,335
Tetanus	1927-1929	1.1	0.0	15	0	4	\$174,691
Varicella	1995-1997	8.7	22.6	113	9	114	\$7,289,274
Total		2,210	92.6	30,939	95	8,603	\$400,438,507

^a Index years are the three years preceding first availability of vaccine.

^b Case counts from CDPHE, population estimates from US Census.

^c Calculated as the difference between pre-vaccination rate times 2014 population minus 2014 reported cases.

^d From CHA inpatient database.

^e Based on 26.0% of reported cases hospitalized among Colorado children ages 0-19 years: 2014, except for pneumococcal disease and varicella.

^f Calculated using average total hospitalization charges for VPD-related admissions of Colorado children ages 0-19 years from CHA inpatient database: 2014 where no hospitalized cases occurred; or average charges during 2014 for each VPD.

❖ Appendix A (Methods)

Data Sources:

1. National Immunization Survey (NIS), 2014: The NIS is a list-assisted random-digit-dialing telephone survey conducted by the Centers for Disease Control and Prevention (CDC) followed by a mailed survey to children's immunization providers. (www.cdc.gov/nchs/nis.htm)
2. Colorado Hospital Association, 2014: The CHA is a consortium representing over 100 hospitals and health systems throughout the state, and provides hospital utilization data from its online database program that collects monthly self-reported hospital utilization and financial data from health care facilities. (www.cha.com/Resources/Colorado-Hospital-Utilization-Data.aspx)
3. Colorado Department of Public Health and Environment, 2014: CDPHE collects data on statewide reportable infectious diseases, which include all infections preventable by routine Colorado childhood vaccinations. (https://www.colorado.gov/pacific/sites/default/files/DC_ComDis_Reports_Diag_Age_2014.pdf)

Case counts of hospitalization and corresponding hospital charges due to vaccine-preventable disease (VPD) among Colorado children 0-19 years of age were calculated from the Colorado Hospital Association (CHA) Inpatient Database for 2014. Additionally, the 2014 CDPHE reportable disease statistics were used to obtain VPD case counts for children 0-19 years of age and to calculate the case rate per 100,000, including VPD cases that were not hospitalized, such as pertussis and varicella. Population estimates to calculate incidence rates were obtained from the Current Population Survey, March Supplement from 2015 using DataFerrett².

Archived infectious disease reports from the Colorado Department of Public Health and the Environment (CDPHE) provided reported infectious disease cases among the entire Colorado population from 1920 through 2014. Using population estimates from the US census³ for these children, pre-vaccination disease rates were calculated for selected VPDs in the three years before their respective vaccines were approved for use in children. Additional morbidity reports for years 1955-1957 and 1984-1986 were used to determine the average percentage of polio and *H.influenzae* cases that were among children 0-19 years of age. This percentage was applied to estimate the number of hospitalizations in 2014 for selected VPDs that were prevented by vaccination among these children, similar to the methodology of van Panhuis, et al⁴. Archived data were not available for reported cases of pneumococcal disease or varicella so their prevented hospitalizations and respective total charges could not be calculated.

References

1. World Health Organization. Measles vaccines: WHO position paper. WHO Weekly epidemiological record. No. 35, August 2009(349-360) 28 August. Available at: <http://www.who.int/wer/2009/wer8435.pdf?ua=1>. Accessed 18 December, 2014.
2. <http://dataferrett.census.gov/launchDFA.html>
3. <http://www.census.gov/prod/www/decennial.html>
4. van Panhuis WG, Grefenstette J, Jung SY, Chok NS, Cross A, Eng H, Lee BY, Zadorozhny V, Brown S, Cummings D, Burke DS. Contagious diseases in the United States from 1888 to the present. *N Engl J Med*. 2013 Nov 28;369(22):2152-8.