

Vaccine-preventable Diseases in Colorado's Children

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❖ Summary

Delays in vaccinating our children in Colorado are putting the youngest and most vulnerable at increased risk of vaccine-preventable disease (VPD) and hospitalization resulting in excess morbidity, mortality and charges in the millions of dollars.

Summarized below is our *State of the Health of Colorado's Children* most recent analysis of the *National Immunization Survey (NIS)*, *Colorado Hospital Association (CHA)* discharge data and *Colorado Department of Public Health and Environment (CDPHE)* data (see Methods).

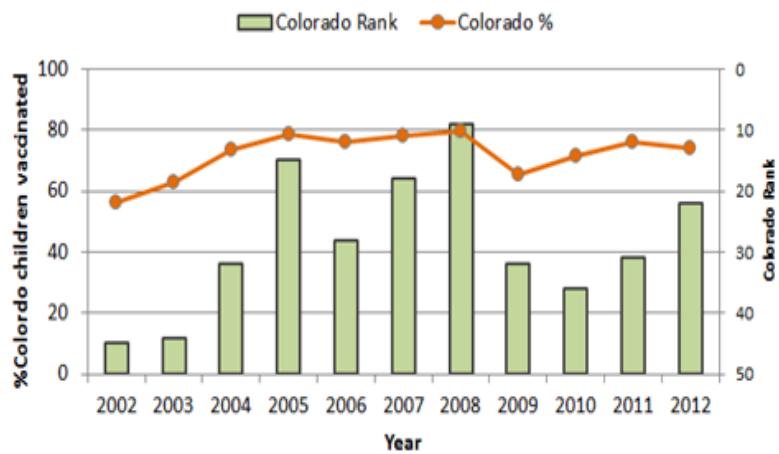
Our analysis confirms that vaccines in Colorado have proven to be highly effective and very safe, dramatically reducing morbidity and mortality in children and their families. Nonetheless, many of our youngest children are not receiving their recommended vaccines on time. The results emphasize the need for improved access and delivery systems and increased efforts to better educate young parents who are often swayed by misinformation that permeates our social media, exaggerating risks of vaccines and promoting unproven, alternative vaccination schedules that unnecessarily delay vaccination of Colorado's children.

❖ Results

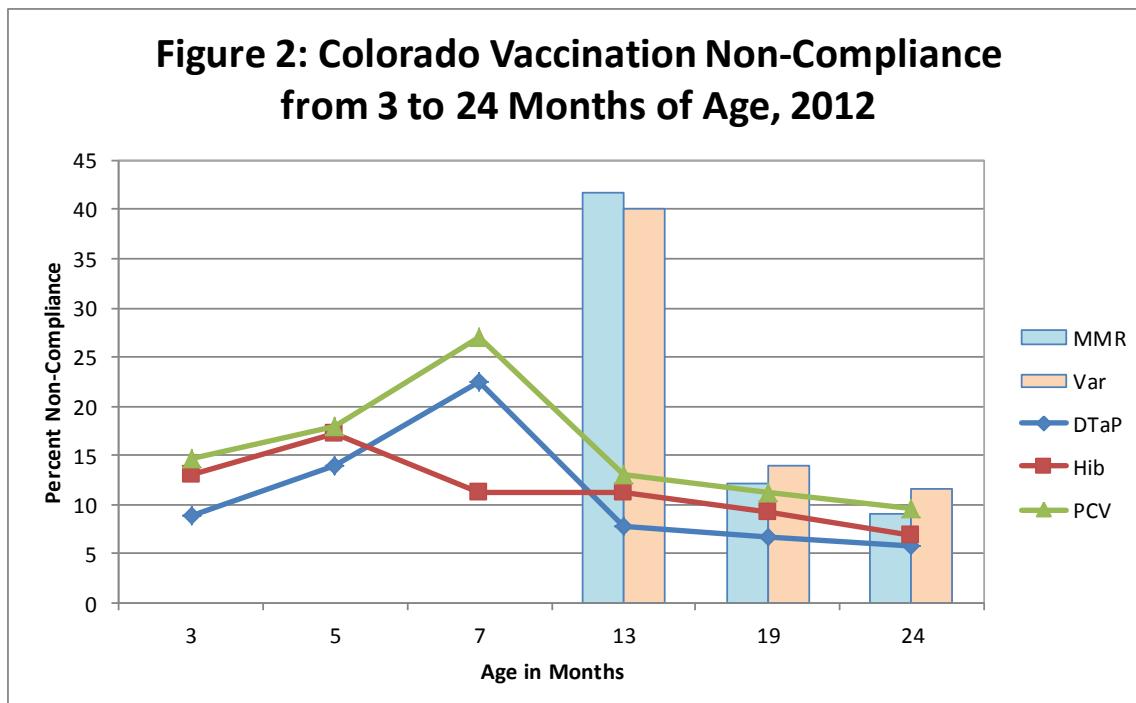
There is a vaccination gap in Colorado

Current data (Figure 1), show that Colorado ranked 22nd among US States in 2012 for the composite NIS vaccination rates for children 19-35 months of age with over 20% receiving fewer than the recommended number of doses of indicated vaccines (4 doses of DTaP, 3 doses of polio virus vaccine, 1 dose of measles/mumps/rubella vaccine, plus 3 doses of hepatitis-B vaccine, 3 doses of *Haemophilus influenzae* vaccine and 1 dose of varicella vaccine).

Figure 1: NIS Vaccination Rates (431331): US and Colorado (Source: NIS), 2002-2012



It is concerning that our overall vaccination rate has not improved significantly in the last 10 years. Of even greater concern is that our on-time vaccination completion rates vary dramatically in young Colorado children, ranging from 10% to over 40% non-compliance in children 24 months of age or less for common vaccines (Measles-Mumps-Rubella (MMR), Varicella (Var), DTaP, *Haemophilus influenzae* (Hib) and pneumococcus (PCV)), implying that there are voluntary or involuntary barriers to timely vaccination (Figure 2).



Younger, unvaccinated children are at greatest risk

The majority (66.2%) of Colorado children hospitalized with vaccine-preventable diseases (including influenza) are four years of age or younger (Figure 3) which emphasizes the potential increased disease risk to young children whose immunizations are delayed. Younger children in Colorado are four times more likely than older children to be hospitalized with a serious vaccine-preventable disease.

Figure 3: VPD Hospitalizations of Colorado Children in 2012, Including Influenza

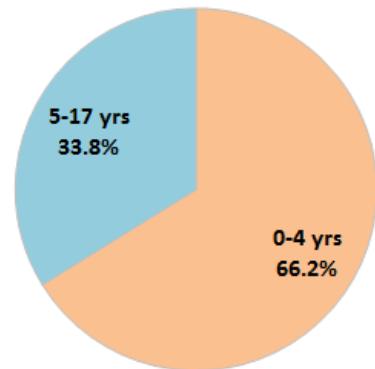


Table 1: Cases, rates, and charges for children in Colorado with vaccine-preventable diseases, 2012.

Vaccine	0-4 Years of Age					5-19 Years of Age				
	CDPHE		CHA Hospitalizations			CDPHE		CHA Hospitalizations		
	Reported Cases	Case Rate per 100,000*	Hospitalized Cases	Rate per 100,000	Hospital Charges	Reported Cases	Case Rate per 100,000	Hospitalized Cases	Rate per 100,000	Hospital Charges
Diphtheria	0	0.0	0	0.0	\$0	0	0.0	0	0.0	\$0
H. influenzae	4	1.3	4	1.3	\$589,066	3	0.3	2	0.4	\$48,934
Influenza, hospitalized	184	57.8	189	59.3	\$5,737,968	104	9.7	101	9.4	\$7,535,224
Measles	0	0.0	0	0.0	\$0	0	0.0	0	0.0	\$0
Mumps	1	0.3	0	0.0	\$0	3	0.3	0	0.0	\$0
Pertussis	314	98.6	47	14.8	\$1,705,118	890	83.1	4	0.4	\$91,131
Pneumococcal disease	35	11.0	26	8.2	\$3,133,614	20	1.9	33	3.1	\$7,507,093
Polio	0	0.0	0	0.0	\$0	0	0.0	0	0.0	\$0
Rubella	0	0.0	0	0.0	\$0	0	0.0	0	0.0	\$0
Tetanus	0	0.0	0	0.0	\$0	1	0.1	0	0.0	\$0
Varicella	155	48.7	4	1.3	\$143,115	285	26.6	4	0.4	\$78,299
Total	693		270		\$11,308,881	1,306		144		\$15,260,681

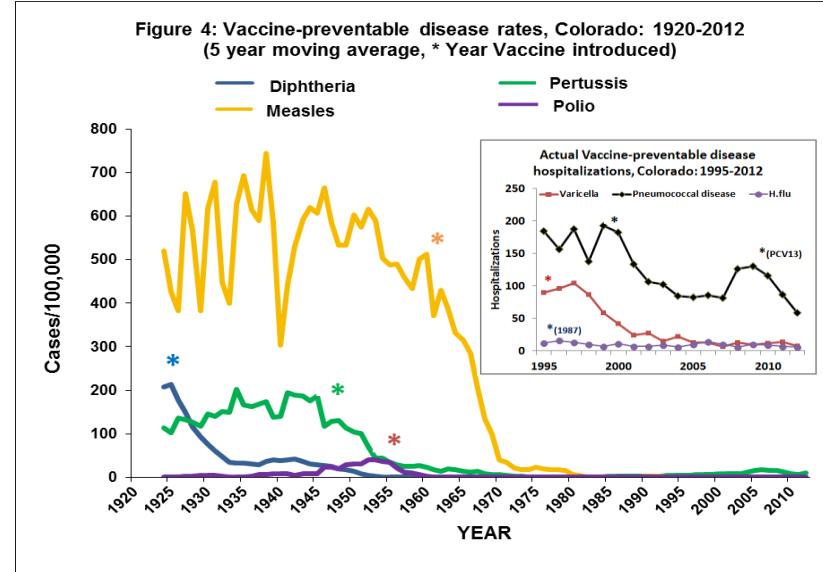
*Population estimates for Colorado children for 2012 by age range were obtained from the Census Bureau using DataFerrett

As shown in Table 1, serious (hospitalized) vaccine-preventable diseases affected hundreds of Colorado children in 2012 (primarily the youngest) with avoidable public and social costs amounting to tens of millions of dollars with hospitalization charges being just the tip of the iceberg.

In 2012, 414 Colorado children ages 0-19 years of age were hospitalized with vaccine-preventable diseases with estimated hospital charges of \$26.6 million. Many more children and many adults (especially with influenza) are ill at home with additional costs of health care visits and lost productivity. Five Colorado children died during the 2012-13 flu season, with four of the five children either unvaccinated or only partially vaccinated (<http://www.colorado.gov/cs/Satellite/CDPHE-Main/CBON/1251642937932>).

Vaccines are highly effective in Colorado

Childhood vaccines have been proven to be safe and effective in Colorado over many years. Figure 4 shows the dramatic decrease in Colorado of reported cases and hospitalizations for many common vaccine preventable diseases (diphtheria, measles, pertussis and polio) since 1920. In recent years (Figure 4, insert), newer vaccines for chickenpox, severe *Haemophilus influenzae* disease (meningitis) and pneumococcal disease have been introduced with a similar dramatic effect.



Such success, however, is no reason for complacency. Pockets of under-immunized children and more frequent global travel create the potential for introduction and spread of such diseases even in states like Colorado, especially when many of its most vulnerable, younger children are the ones who are incompletely vaccinated either due to lack of access to vaccines or parental choice.

Vaccines are highly cost-effective in Colorado

As shown in table 2, vaccines have proven to be both highly effective in reducing the total number of cases and number of hospitalizations for vaccine preventable diseases in Colorado (not including influenza). They have also proven to be highly cost-effective with annualized hospital charge savings estimated, for children alone, to be close to \$400 million per year.

Table 2: Hospital cases and charges prevented among Colorado children due to vaccination							
Disease	Index years*	Pre-vaccination rate per 100,000	Rate per 100,000: 2012	Reportable cases prevented: 2012†	Actual hospitalized cases: 2012	Estimated hospitalized cases prevented: 2012‡	Estimated hospital charges prevented: 2012§
Diphtheria	1920-1922	461	0.0	6,404	0	1,326	\$85,099,612
H. influenzae	1984-1986	12.4	0.5	166	6	34	\$831,878
Measles	1960-1962	784	0.0	10,892	0	2,255	\$144,720,682
Mumps	1964-1966	408	0.3	5,672	0	1,174	\$75,344,603
Pertussis	1945-1947	328	86.6	4,513	51	934	\$21,279,089
Pneumococcal disease	1997-1999	14.8	4.2	146	59	146	\$33,213,199
Polio	1952-1954	68	0.0	938	0	194	\$12,450,471
Rubella	1966-1968	124	0.0	1,725	0	357	\$22,911,434
Tetanus	1927-1929	1.1	0.1	14	0	3	\$192,533
Varicella	1995-1997	8.7	0.6	113	8	113	\$2,211,947
Total		2,210	92.3	30,583	124	6,536	\$398,255,448

* Index years are the three years preceding first availability of vaccine (except for varicella)

† Calculated as the difference between pre-vaccination rate times 2012 population minus 2012 reported cases

‡ Based on 20.7% of reported cases hospitalized among Colorado children ages 0-19 years: 2012, except for pneumococcal disease and varicella

§ Calculated using average total hospitalization charges for VPD-related admissions of Colorado children ages 0-19 years: 2012 where no hospitalized cases occurred; or average charges during 2012 for each VPD

Vaccines are safe in Colorado

Vaccines in the United States undergo very rigorous safety testing and surveillance for unanticipated events. As shown in table 3, there were very few hospitalizations in children associated with vaccine administration while, at the same time, thousands of hospitalizations due to vaccine preventable diseases were avoided with an overall benefit to risk ratio of greater than 1,000:1.

Table 3: Annual case and charge estimates for vaccine preventable disease and vaccine-related adverse event hospitalizations among Colorado children 0-19 years of age in 2012 (Data from Tables 1 and 2)		
	Number of Cases	Hospital Charge Estimate
Colorado Hospitalized Vaccine Adverse Event	5*	\$88,274
Colorado Hospitalized Vaccine Preventable Diseases (Table 1)	414	\$26,569,562
Colorado Avoided Vaccine Preventable Disease Cases (Table 2)	29,170	
Colorado Avoided Vaccine Preventable Disease Hospitalizations (Table 2)	6,536†	\$398,255,448
Crude hospitalization cases and charges benefit:risk ratio	1,307:1‡	4,512:1§

*Primary or secondary diagnosis codes: 978x, 979x, E948x, E949x (see Methods), actual hospital charges reported

†Based on 20.7% of CDPHE reported cases being hospitalized in 2012.

‡Avoided hospitalizations divided by hospitalized vaccine adverse events in 2012

§Avoided estimated hospital charges divided by hospitalized vaccine adverse event charges in 2012

❖ Appendices:

A: Methods

For this report, the National Immunization Survey (NIS)¹ from the Centers for Disease Control and Prevention for years 2002-2012 was used to determine the estimated percent of Colorado children ages 19-35 months receiving the complete “431331” schedule of vaccines (4 doses of DTaP, 3 doses of polio virus vaccine, 1 dose of measles/mumps/rubella vaccine, plus 3 doses of hepatitis-B vaccine, 3 doses of *Haemophilus influenzae* vaccine, and 1 dose of varicella vaccine). The ranking of Colorado among the other states for the percentage of these children completely vaccinated is shown. The NIS was also used to determine specific vaccine non-compliance rates among Colorado children 3 to 24 months of age in 2012 by vaccine type.

The Colorado Hospital Association Inpatient Database was used to obtain case counts of VPD hospitalizations using primary and up to 14 secondary diagnosis codes, as well as vaccine-related hospitalizations, with their corresponding total charges, among children 0-19 years of age during 2012. Population estimates of Colorado children 0-19 years of age in 2012 were obtained from the Current Population Survey, March Supplement from 2013 using DataFerrett², and population estimates of Colorado children 0-19 years of age for years 1920 through 2000 were obtained from the US Census Bureau³. Interpolation was used to estimate this pediatric population during years between each decennial census.

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 2012. Additionally, the 2012 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. Using population estimates from the US census for these children, pre-vaccination 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 2012 for selected VPDs that could have been prevented by vaccination among these children, similar to the methodology of van Panhuis, et al⁴. The five-year moving average rates per 100,000 Colorado children were plotted for pertussis, polio, diphtheria, and measles from 1920-2012. Actual hospitalizations for pneumococcal disease, varicella, and *H.influenzae* were plotted from 1995-2012.

Hospitalized vaccine adverse events among Colorado children ages 0-19 years were determined by the presence of any of the following primary or secondary diagnosis codes: 978x (poisoning by bacterial vaccines), 979x (poisoning by other vaccines), E948x (bacterial vaccines causing adverse effects), or E949x (other vaccines causing adverse effects).

Using the average charge for VPD hospitalizations of children 0-19 years of age in 2012, the hospitalization charges saved by vaccination for several VPDs where no hospitalizations occurred during 2012 were estimated. The average charge for VPD hospitalizations that occurred during 2012 was used to calculate the hospitalization charges saved by vaccination for these specific VPDs. The total hospitalization charges saved were compared to the total charges for vaccine-related hospitalizations as a cost benefit to risk ratio. A similar procedure was used to estimate avoided hospitalizations due to vaccination.

B: Limitations

There are several limitations to this report. 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. VPD case and pediatric population data were unlinked: they came from separate sources.

It was assumed that 85% of archived VPD case counts were in children 0-19 years of age, using only archived polio and *H. influenzae* case counts by age, as other archived VPD case counts were not broken down by age group. The actual percentage of each disease in children may vary. For example, an average of 97% of *H. influenzae* cases in 1984-1986 were among children 0-19 years of age, while an average of 71.4% of polio cases in 1955-1957 were in the same population.

The proportion of hospitalized VPD cases to reported CDPHE cases for 2012, 20.7%, was applied to our calculation of prevented hospitalizations for all of the VPDs in this report, except pneumococcal disease and varicella. The actual value could vary for each VPD.

C: References

1. <http://www.cdc.gov/vaccines/stats-surv/nis/default.htm#nis>
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.