

Vaccine-preventable Diseases in Colorado's Children, 2004

James Todd MD^{1,2}, Marsha Anderson MD^{1,2}, Carl Armon MSPH¹, Michael Rannie RN MS¹, Stephen Berman MD^{1,2}

Vaccines have been highly effective and very safe in Colorado. The introduction of vaccines in Colorado has had a dramatic effect on reducing vaccine-preventable diseases such as diphtheria, tetanus, polio, measles, mumps, rubella, smallpox, and *Haemophilus influenzae* disease. For every one possible severe event reported in Colorado children in 2002-2003, vaccines prevented an estimated 4,000-8,000 severe vaccine-preventable illnesses. The 2002 and 2003 National Immunization Survey ranked Colorado behind other states in vaccinating its children. Reported NIS vaccination rates correlate with actual vaccine-preventable disease rates in Colorado (as vaccination goes up disease goes down). For some diseases, current vaccination rates in Colorado (e.g. pertussis, influenza) are not sufficient to prevent increasing rates of disease. Although immunization laws result in a high rate of vaccination by the time a child gets to school, the greatest risk for many of these diseases is in young infants. For pertussis, varicella, influenza, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there were over \$23 million of hospital charges for severe disease associated with these infections in Colorado children in 2003, with significant impact in both the public and private sectors. The odds of getting a VPD are 2.3 times more for children in Colorado with Medicaid/SCHIP or no coverage than for private insurance. Vaccine-preventable diseases appear to be a state-wide problem – both urban and rural. Developing systems that assure timely access to vaccines for all children will be critically important, especially during the first 2 years of life, when children are at the highest risk of these diseases.

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■ Introduction

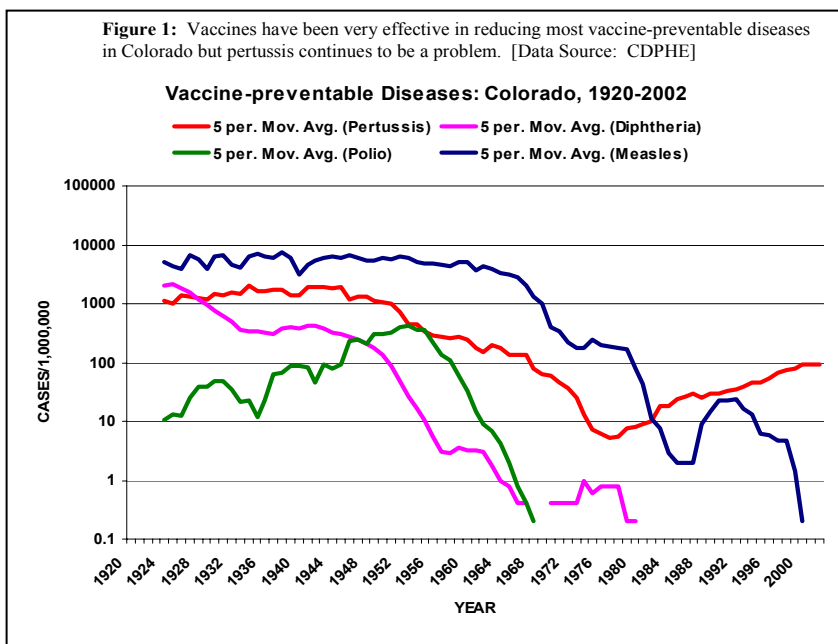
The Centers for Disease Control ranks vaccination as one of the top ten most effective public health measures in the last 100 years, and yet the 2002 and 2003 National Immunization Surveys (NIS) rank Colorado as the worst of 50 states in overall childhood vaccination rates. This ongoing analysis was undertaken to determine if the low vaccination rates reported by NIS are accurate, if they are associated with an increased rate of vaccine-preventable diseases in Colorado, and to identify the consequences and risk factors associated with these illnesses.

■ Summary of Methods

A number of data sources are available to measure vaccination and disease rates in Colorado. The Colorado Department of Public Health and Environment (CDPHE) has collected data on reportable diseases since 1920. The Colorado Hospital Association (CHA) provides data on all hospital discharges from 1995 through 2003. Similar data for hospital discharges are available in the KIDs 2000 database for children < 18 years of age from 29 states. The Vaccine Adverse Event Reporting System (VAERS) is a national system for state-wide reporting of possible adverse events that might be associated with vaccines. Using a phone survey, the National Immunization Survey (NIS) measures vaccination rates annually throughout the United States.

Vaccine-preventable infections continue to circulate in the population and to cause disease and death in children in our State. Using the above data sources it is possible to estimate the impact of various vaccine-preventable diseases on the children of Colorado. For the purposes of this analysis, the focus was on patients discharged with discharge codes for one or more of five vaccine-preventable diseases¹ known to occur in Colorado at the present time. These include: varicella (chicken pox), pertussis (whooping cough), influ

Figure 1: Vaccines have been very effective in reducing most vaccine-preventable diseases in Colorado but pertussis continues to be a problem. [Data Source: CDPHE]



enza, *S. pneumoniae* (a common cause of meningitis), and *H. influenzae*. An analysis of the patients selected in 2002, showed that 82% of the cases had such codes as either the principal diagnosis or the second diagnosis. The number of hospital admissions and charges associated with each vaccine-preventable disease category were measured and the patient's insurance status was grouped into one of two categories: no insurance or Medicaid/SCHIP (public/none), or private insurance to estimate the public and private costs of hospitalization for these diseases. Public insurance was combined with none since children admitted to the hospital without prior insurance coverage are often qualified retroactively for Medicaid.

¹Department of Epidemiology, The Children's Hospital;

²Departments of Pediatrics and Preventive Medicine University of Colorado School of Medicine; Denver, Colorado

■ Results

Vaccines are highly effective. Figure 1 shows the effect of vaccines on several of these diseases in Colorado from 1920-2002. Vaccines have reduced the incidence of many common and often fatal childhood infections by >99% in the United States. Similarly, the introduction of vaccines in Colorado has had a dramatic effect on reducing vaccine-preventable diseases such as diphtheria, tetanus, polio, measles, mumps, rubella, smallpox, and *Haemophilus influenzae* meningitis. As shown in Table 1, if these vaccines were not routinely used, Colorado could expect more than 70,000 cases of vaccine preventable infections (DTP, MMR, Polio) in children per year (based on the assumptions that 22% of the population are children and that 75% of these diseases primarily occur in children).

Table 1: Low rate of severe adverse events in Colorado children possibly related to vaccines compared to high vaccine efficacy (Data Source: VAERS, CDPHE).

Disease/ Vaccine	Estimated # Cases of Dis- ease Prevented	Unverified Adverse Events (VAERS)		Disease Prevented to Severe Adverse Event Ratio
		# Mild	# Severe	
2002	72,850	169	9	8094:1
2003	73,843	375	17	4344:1

Vaccines are very safe in Colorado. Severe adverse events to FDA-approved vaccines are very rare. As illustrated in Table 1, Colorado data in 2002 and 2003 show that there were only 26 “severe” adverse events in children (resulting in hospitalization) reported to VAERS, resulting in no deaths as compared to thousands of illnesses prevented.

It is important to be aware that NIS emphasizes that: “when reporting and evaluating data from VAERS, it is important to note that for any reported event, no cause and effect relationship has been established. The event may have been related to an underlying disease or condition, to drugs being taken concurrently, or may have occurred by chance shortly after a vaccine was administered.” Even so, for every one possible severe event reported, vaccines prevented an estimated 4,000-8,000 severe vaccine-preventable illnesses in Colorado children in 2002-2003.

Although some advocate against the use of vaccines, claiming their alleged role in the causation of various adverse events including asthma, autism and other neurological complications, a rigorous review of evidence does not validate these hypotheses. As an example, a

recent, thorough review by the Institute of Medicine concluded that “the body of epidemiological evidence favors rejection of a causal relationship between thimerosal-containing vaccines (and/or MMR) and autism” (Immunization Safety Review: Vaccines and Autism <http://www.nap.edu/catalog/10997.html>).

In spite of proven efficacy and safety, the 2002 and 2003 National Immunization Survey has ranked Colorado as 50th of 50 states in childhood overall vaccination rates. By 19-35 months of age, children should have received the following vaccine doses: 4 diphtheria, pertussis, tetanus (DTP); 3 polio; 1 measles, mumps, rubella (MMR); 3 *Haemophilus influenzae* (Hib); 3 hepatitis B; and 1 varicella. Colorado ranked the lowest (63%) of all states in 2003 in meeting this important 4:3:1:3:3:1 goal. Although this low ranking in recent years may, in part, have been exaggerated by vaccine shortages, Colorado has consistently ranked in the bottom half of states for most vaccines since 1996 (Figure 2). Although efforts are made to account for a biased sample, NIS may actually overestimate the percentage of Colorado children vaccinated since it is conducted by a phone survey that includes only households with land-line phones.

Additional evidence that the NIS rankings are, at the least, relative if not absolute indicators of the vaccination status of Colorado children include the results of a series of HEDIS audits of the vaccination status of Colorado children covered by Medicaid (Table 2, next page) in 1999, 2001, and 2002. HEDIS reports document that children enrolled in Colorado's Unassigned Fee-for-service (UFS) program compared to the PCPP program and HMO program are the least likely to have a visit with a primary-care physician, the least likely to receive preventive health care, and the least likely to be fully immunized [SHCC: July 2004]. In these surveys only 28.5% to 45.7% of two year old children without an assigned primary care provider had received 4 DTaP doses as compared to 76.2% in the Kaiser Medicaid managed care program (Table 2). Vaccination rates

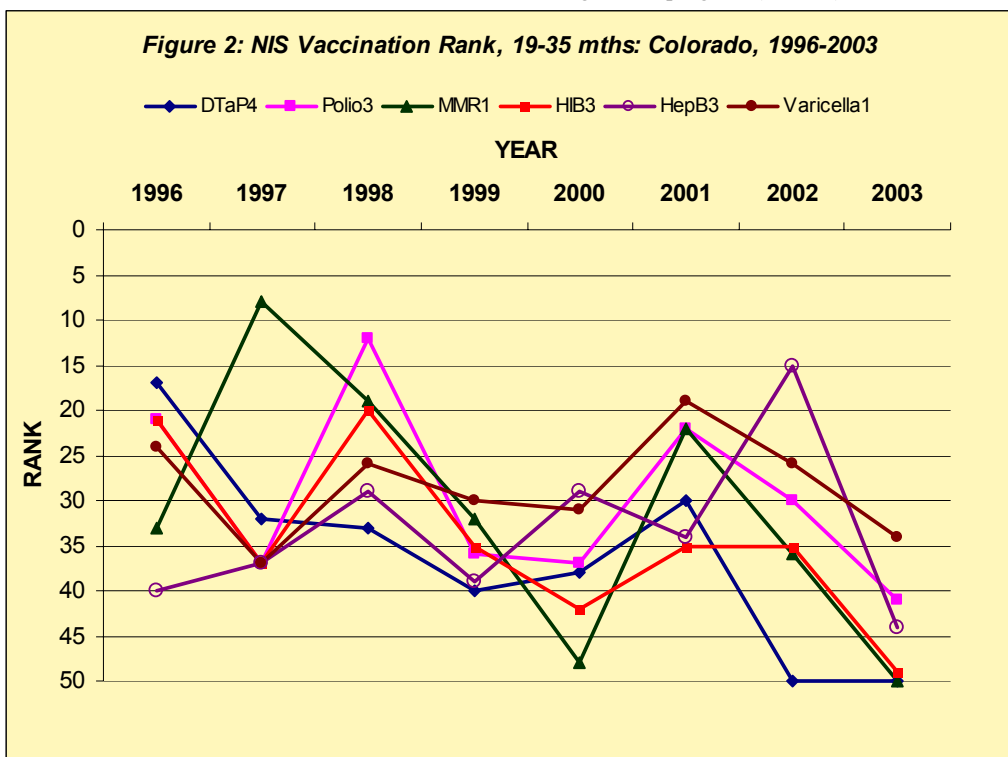


Table 2: HEDIS immunization rates for Medicaid enrollees in Unassigned Fee-for-Services for 1999, 2001, and 2002 as reported by the Colorado Department of Health Care Policy and Financing. [Data Source: HCPF]

Age 2 years	1999	2001	2002	Kaiser 2001
4:3:1:2:1	20.9%	33.8%	21.7%	66.2%
4 DTaP	31.9%	45.7%	28.5%	76.2%
1 MMR	49.4%	58.4%	62.0%	92.9%
3 OPV or IPV	37.0%	54.3%	60.1%	85.2%
2 HiB	36.7%	48.9%	50.4%	86.7%
3 Hepatitis B	29.9%	51.3%	53.5%	83.3%
1 VZV	33.6%	52.6%	55.5%	92.4%
Adolecents				
2MMR	29.7%	37.2%	44.0%	76.9%
1 Hepatitis B	21.4%	29.9%	35.3%	67.3%
MMR and Hep B	18.3%	26.3%	32.1%	61.5%
VZV	4.1%	11.4%	12.4%	57.7%

worsened in 2002 for UFFS enrollees compared to 2001, perhaps because of shortages of DTaP. Compared to Kaiser Medicaid clients in 2001, UFFS clients had vaccination rates one and a half to three times lower, suggesting that it is not the patient but rather the system (or lack thereof) that most influences vaccination rates.

Whatever the true overall vaccination rate in Colorado there is reasonable evidence that there are pockets of under-vaccination that may leave young children vulnerable to vaccine-preventable diseases.

Delaying vaccination puts Colorado children, especially the more vulnerable infants and young children, at risk for vaccine-preventable diseases and their complications. Figure 3 shows the distribution of vaccine-preventable diseases in Colorado in 2003; over half of the cases occur in children under two years of age. This distribution showing the highest incidence of vaccine preventable diseases in the youngest children holds true even if influenza cases are excluded. In addition these diseases are commonly more severe in the youngest children. As an example, fatality rates are highest for whooping cough in children under one year of age.

Although school immunization laws result in a high rate of vaccination by the time a child gets to school, the greatest risk for many of these diseases is in young infants emphasizing the critical need for a system to assure timely vaccination of our youngest children and not waiting until they become school-age.

Reported NIS vaccination rates correlate with actual vaccine-preventable disease rates in Colorado (as vaccination goes up disease goes down). As an example of the correlation of vaccination rates

from the National Immunization Survey with disease rates in Colorado, Figure 4a (next page) demonstrates the clear inverse relationship between the decreasing number of chicken pox cases in Colorado (in vaccinated infants and their younger siblings) and the vaccination rate for varicella (increasing) as measured by NIS. Chicken pox hospitalizations have decreased significantly from 1995-2003 in Colorado toddlers (ages 12-36 months) proportionate to the increasing varicella immunization rates in Colorado children ages 19-35 months (NIS). Similar results are documented for the pneumococcal vaccine Disease rates have also decreased in infants even though vaccine is not given to them ("herd immunity" from protected siblings) emphasizing the additional collateral value of timely vaccination. This is due to the lower disease rate in children who are vaccinated resulting in a lower likelihood for exposure of their younger siblings and contacts.

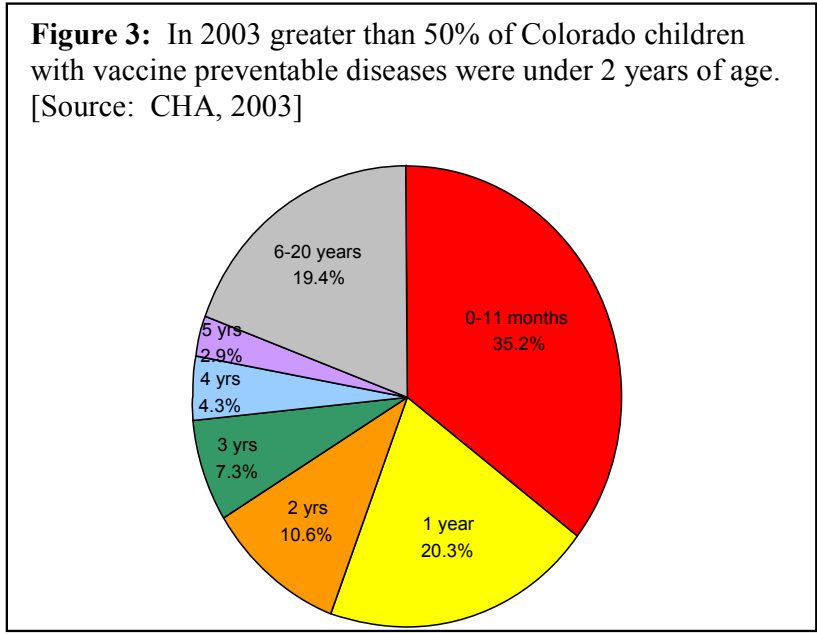


Figure 4a: Decreasing chicken pox hospitalization rates for Colorado children associated with increasing NIS vaccination rates [Source: NIS, CHA]

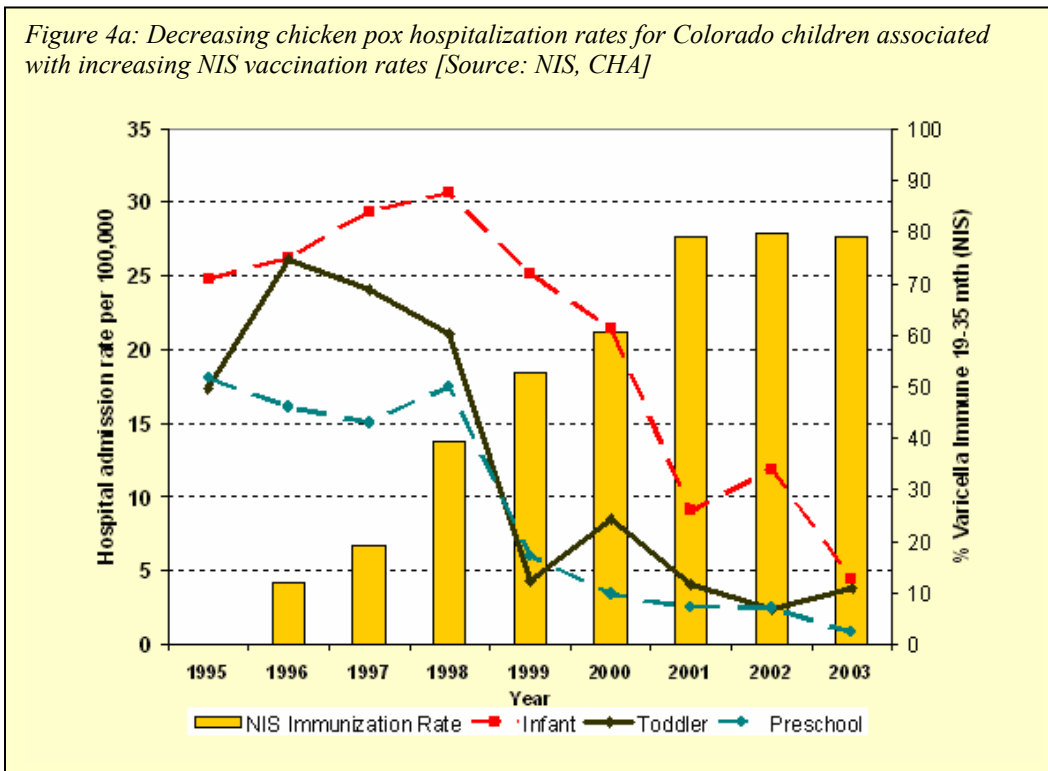


Figure 4b shows estimated chicken pox hospitalization rates in toddlers (ages 12-36 months) in states in 2000 correlate significantly with the corresponding state varicella vaccination rates in children ages 19-35 months (NIS). At least for varicella, states with higher vaccination rates have lower disease rates. Disease rates were also lower in infants even though vaccine is not given to them (“herd immunity” from protected siblings).

For some diseases, current vaccination rates in Colorado are not sufficient to prevent increasing rates of disease. As shown in Figure 1, since 1920, vaccines have reduced the incidence of many common childhood diseases such as diphtheria in Colorado by 99% - especially those with rare external (imported) exposures; but those due to the more common, internal exposures (e.g. pertussis) and those diseases with vaccines that have not been widely implemented (e.g. influenza) continue to cause significant morbidity, mortality and cost. Even so, rare external exposures have caused outbreaks in Colorado children who haven't been vaccinated (e.g. diphtheria, measles).

Other diseases require on-going vigilance. Commensurate with Colorado's low NIS vaccination rates for pertussis, CDPHE data show a rising rate of whooping cough infection in children that is significantly higher and increasing faster than the rate for the entire

Table 4b: Correlation by state in 2000 of NIS varicella vaccination rates with chickenpox hospitalization rates (Source: NIS, KIDs)

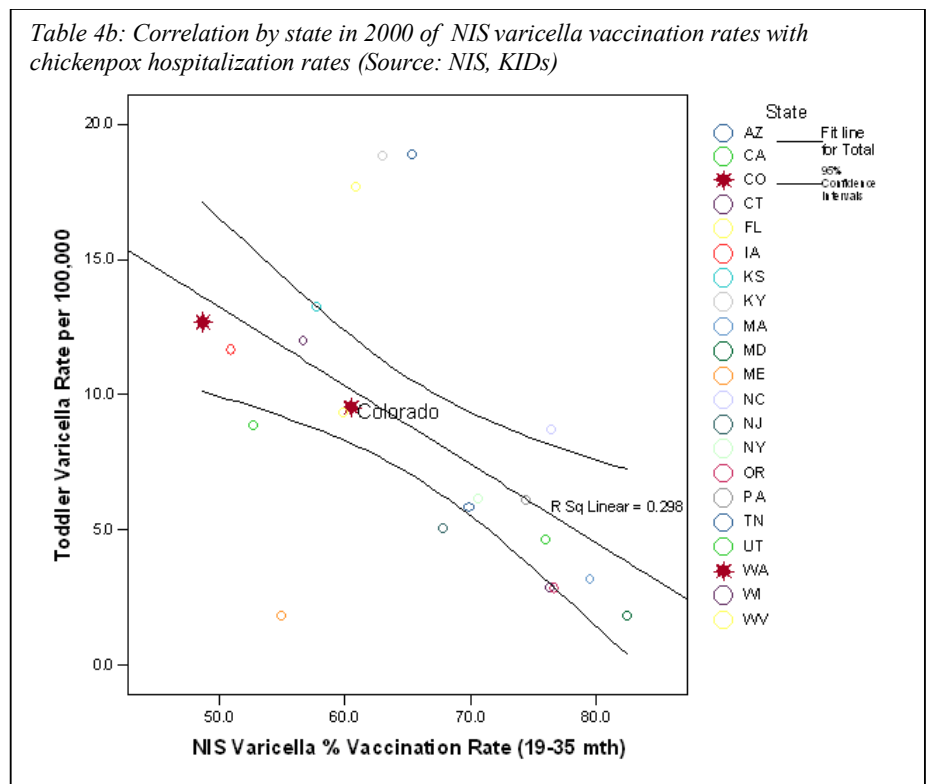
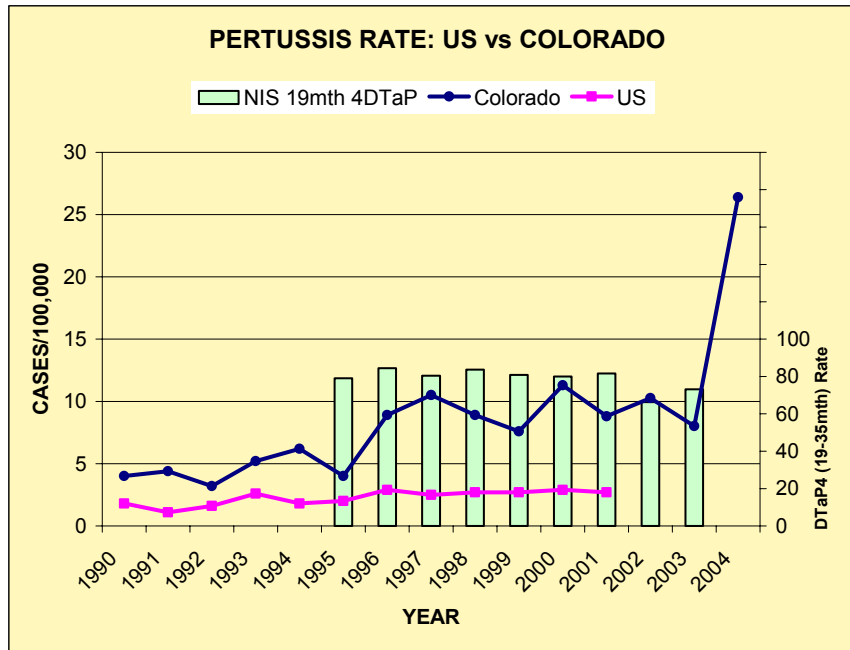


Figure 5: Whooping cough (pertussis) rates in Colorado are higher than the rest of the US and correlate with low Colorado DTaP4 vaccination rates. [Data Source: CDPHE, NIS]



United States (Figure 5). In 2004, Colorado had by far the greatest number of pertussis cases in many years.

Besides the morbidity and mortality associated with vaccine-preventable diseases, delaying or not giving vaccines costs all the people of Colorado money. As shown in Table 3, for pertussis, varicella, influenza, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there were over \$23 million of hospital charges for severe disease associated with these infections in Colorado children in 2003.

The table actually underestimates the potential cost savings, since it does not include those hospitalized children with respiratory disease that can be attributed to influenza, or children with vaccine-preventable diseases who are not admitted to the hospital – in the case of influenza and pertussis this may be as much as ten to twenty-fold higher. Better immunization of children will also lead to less exposure of adults -- resulting in an even greater cost savings, and reduced work absenteeism. This may be of great importance in mitigating the impact of influenza outbreaks in the US in the future.

Between 2002 and 2003, there was a 396% increase in the number of statewide pediatric hospital admissions due to influenza. Infants and toddlers made up nearly 58% of the 2003 projected inpatient total. The number of pediatric ED and hospital outpatient influenza visits was estimated to be over 22,820 in 2003 [Children's Outcomes/SHCC Volume I Number 1 June, 2004]. This means that for each patient that was treated as an inpatient, 24 more were treated on an outpatient basis. The cost of caring for this influx of patients is high. Hospital charges alone for the treatment of inpatients and outpatient children with influenza in 2003 was estimated to be nearly 16 million dollars but based on the actual inpatient charges shown in Table 3 were likely much higher. Once again, infants and toddlers accounted for 60% of this total.

In contrast to these hospital charges for treating influenza, estimated charges associated with immunizing every infant and toddler aged 6-23 months against influenza are relatively low. Depending on the patient's age, the charge for influenza vaccination is \$30 per dose (\$20 for vaccine and \$10 for administration). Two doses are required for infants and/or children the first time the

vaccine is given. Assuming the vaccine is 90% effective, the charges for vaccinating infants, toddlers, and preschool children are comparable to the charges associated with the hospital care of an unvaccinated population. Factoring in the order-of-magnitude higher additional costs associated with secondary contact illness (parents, grandparents, siblings, etc), missed workdays, and ill child care, implementing the recommendation for universal influenza vaccination of children 6-23 months of age would yield a benefit much greater than its cost.

Similar benefit/cost ratios that can be achieved by other recommended vaccines have been estimated by the Institute of Medicine (<http://www.iom.edu/report.asp?id=14451>). Excess benefit ranges from 27-fold for DTaP to 1-fold for the pneumococcal conjugate vaccine.

Table 3: Hospital charges for vaccine-preventable diseases in Colorado cost both the public and private sectors millions in 2003.[Data Source: CHA]

Vaccine	2003 Cases Reported to CDPHE	2003 Hosp Cases, CHA	2003 Total Charges Colorado Hosp Cases, CHA	2003 CHA Hosp Cases with State Coverage	2003 Total Charges for CHA Hosp Cases with State Coverage
Pertussis	282	37	789,461	22	480,988
Pneumococcal	79	102	6,702,919	38	1,628,319
Influenza	10,586	1222	15,752,567	640	8,131,491
H. influenzae	8	2	192,581	1	157,402
Varicella	Not reported	15	381,630	3	16,892
Total			23,819,158		10,415,092

Vaccine-preventable disease occurs in all parts of Colorado, both urban and rural, and all social strata. The rate of VPD is higher in children who have publicly funded coverage than those with private insurance (Table 4). In fact, the odds of getting a VPD are 2.3 (95% CI: 2.11, 2.61) times more for children in Colorado with Medicaid/SCHIP coverage than private insurance. Possible explanations for this observation include problems in access to care or delays in implementing the immunization schedule.

Summary: There is a clear association between vaccine-preventable diseases and low vaccination rates in Colorado's children. This appears to be a state-wide problem. The hospital-related charges for treating these vaccine-preventable diseases in children run in the tens of millions of dollars yearly, and significantly impact both the public and private sectors. The fact that Colorado compares poorly in its vaccination rates suggests that proven approaches might be effectively adopted from other states. Although requiring vaccinations prior to school entry ensures school-aged children are ultimately protected, most vaccine-preventable diseases occur prior to school age. Developing systems that assure access to vaccines for all children, as well as timely vaccination will be critically important, especially during the first two years of life, when children are at the highest risk of these diseases. Developing systems that assure access to vaccines for all children, as well as timely vaccination, will be critically important, especially during the first 2 years of life, when children are at the highest risk of these diseases.

Insurance	Total VPD	Insurance Coverage	VPD Rate per 100,000
None/Govt. Insurance	695	360,000	193.1
Private Insurance	662	803,000	82.4

Of the \$24 million in charges for vaccine-preventable diseases in 2003, it is estimated that access to care and vaccination rates equal to private insurance patients could save hospital charges of almost \$7 million for Medicaid/SCHIP/No Insurance children.

As shown in Figure 6, there are high rates of vaccine-preventable disease that occur in many areas throughout Colorado both urban and rural. The number of cases of disease (dots shown if greater than 2 cases) are predominately clustered in metropolitan areas while the highest rates of disease as compared to the Colorado average (shaded) are found in many rural areas in Colorado.

Figure 6: High rates of VPD in 2001-2 occur both in urban and rural areas of CO (orange = 2-3 times CO average, red = 4-24 times CO average; Dots = number of cases > 2 per zip code area). [Source: CHA, US Census]

