

Vaccine-Preventable Diseases in Colorado's Children, 2007

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Vaccines have been highly effective and very safe in Colorado having had a dramatic effect on reducing vaccine-preventable diseases such as diphtheria, tetanus, polio, measles, mumps, rubella, smallpox, chickenpox, *Streptococcus pneumoniae*, and *Haemophilus influenzae* disease. Vaccines are very safe: 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. Colorado has made progress over the last several years in vaccinating its children but still has not achieved the national goal of a 90% vaccination rate. For some diseases, current vaccination rates in Colorado (e.g. pertussis, influenza, viral gastroenteritis) are not sufficient to prevent high rates of disease. Although immunization laws require complete vaccination by the time a child enters school, the greatest risk for many of these diseases is still in young infants and children under two years of age. For pertussis, varicella, influenza, viral gastroenteritis, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there were still over \$25 million of hospital charges for severe disease associated with these infections in Colorado children in 2006, with significant impact in both the public and private sectors. The odds of getting a VPD are 3.0 times more for children in Colorado with Medicaid/SCHIP or no coverage than for private insurance. VPD rates are higher in counties with a high percentage of children living under two times the Federal Poverty Level. Implementing systems such as CIIS 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, and may improve access to other essential 'medical home' based primary care services. **SHCC, 2008; 5:1, 1-4**

■ Introduction

The Centers for Disease Control ranks vaccination as one of the top ten most effective public health measures in the last 100 years. To assure the maximum benefit of this most important preventive health resource, the national Childhood Immunization Initiative goal, as set in 1993, was "by 2000, [to] ensure that at least 90 percent of all two-year-olds receive the recommended series of vaccinations, and that a system is in place to sustain high immunization coverage." In 2002 and 2003 National Immunization Surveys (NIS) ranked Colorado as the worst of 50 states in overall childhood vaccination rates. There has been some improvement in the last several years, although our State has yet to achieve the desired 90%. This ongoing analysis of Colorado data is undertaken to evaluate the progress, consequences and opportunities that exist in preventing vaccine-preventable diseases for Colorado's children.

■ Summary of Methods

The data sources and methods are summarized in previous yearly reports (*Vaccine-Preventable Diseases in Colorado's Children, 2003; 2004*).

■ Results

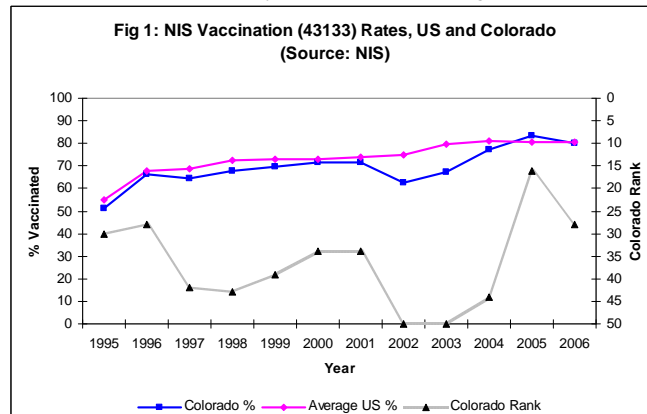
Vaccines are very effective in Colorado. Vaccines are highly effective having reduced the incidence of many common and often fatal childhood infections by >99% in the United States. Previous yearly summaries have documented the dramatic effect of vaccines on several of these diseases in Colorado from 1920-2002. The introduction of vaccines in Colorado had a dramatic effect on reducing vaccine-preventable diseases such as diphtheria, tetanus, polio, measles, mumps, rubella, smallpox, and, more recently, *Haemophilus influenzae* meningitis, pneumococcal disease and chickenpox. If these vaccines were not routinely used, Colorado could expect more than 70,000 cases of these infections in children per year (*Vaccine-Preventable Diseases in Colorado's Children, 2003*).

Vaccines are very safe in Colorado. Severe adverse events associated with FDA-approved vaccines are very rare. As shown by Colorado data in 2002 and 2003 there were rare "severe" adverse events in children (resulting in hospitalization) reported to VAERS, resulting in no deaths as compared to thousands of illnesses prevented. 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 (*Vaccine-Preventable Diseases in Colorado's Children, 2003, 2004*).

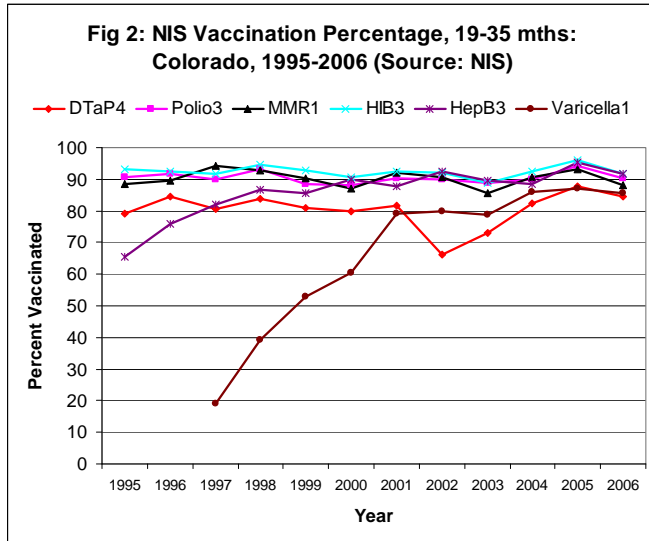
Although some advocate against the use of vaccines, claiming their possible role in the causation of various adverse events including asthma, autism and other neurological conditions, a rigorous review of evidence does not support these hypotheses. As an example, a recent, thorough review by the Institute 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>).

The 2006 National Immunization Survey (NIS) shows Colorado has improved in vaccination rate since 2002-2003 but we still lag behind national goals. 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); and 3 hepatitis B. As shown in Figure 1, Colorado had consistently ranked in the bottom half of states in the percentage of children with complete 4:3:1:3:3 coverage but made some progress in 2005, moving up to a rank of 16th. However, the rate in 2006 dropped slightly resulting in a rank of 28th overall. The rank is less informative than the absolute vaccination rate of 80.3% (estimated range 73.0-87.6%) still well below the year 2000 target of 90%. If the highly effective chickenpox vaccine is included (4:3:1:3:3:1), Colorado had a predicted 2006 vaccination rate of 75.9%. Figure 2 suggests that our extremely low rankings in 2002 and 2003 in part may have been exaggerated by DTaP vaccine

shortages but the overall ranking increase in the last several years has likely been due to some progress in awareness of the importance of vaccines and efforts to track and improve vaccination status.



Reported NIS vaccination rates correlate with actual vaccine-preventable disease rates in Colorado (as vaccination goes up disease goes down). See VPD reports for 2003, 2004 and 2005.

Vaccine-preventable diseases occur in all parts of Colorado, both urban and rural but are more common in children living in poverty. The rate of VPD is higher in Colorado children who have public or no health insurance coverage than those with private insurance (Table 1). In fact, the odds in 2006 of being hospitalized for a VPD were 3.0 times higher for children in Colorado with Medicaid/SCHIP/None than private insurance. The strongest correlate of the incidence of VPD in Colorado counties with populations > 5,000 children < 18yrs of age is the % of children in families with incomes less than two times the Federal Poverty Level (p=0.004) [VPD 2006]. Possible explanations for this observation include lack of insurance, lack of access to care givers, and/or delays in implementing the immunization schedule.

Evidence that the NIS rankings may not reflect gaps in 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 in 1999, 2001, and 2002. HEDIS reports document that children enrolled in Colorado's Unassigned Fee-for-service (UFFS) 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 [Berman S, Armon C, Todd J. *Impact of a decline in Colorado Medicaid managed care enrollment on access and quality of preventive primary care services Pediatrics 2005;116(6):1474-9.*]. 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. Vaccination rates 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.

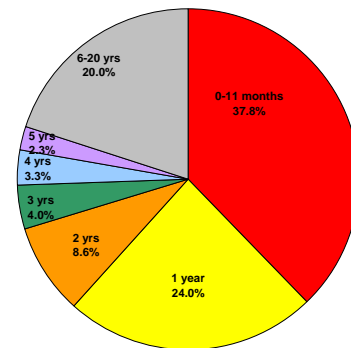
Table 1: Rates of hospitalization of Colorado children for VPD in 2006 (Data Source: CHA, US Census)

Insurance	Total VPD	Insurance Coverage	VPD Rate per 100,000
Public/No Insurance	82	420,469	19.5
Private Insurance	62	951,983	6.5

Vaccination timing is important.

Delaying vaccination puts Colorado children, especially the most vulnerable infants and young children, at risk for vaccine-preventable diseases and their complications. Figure 3 shows the age distribution of vaccine-preventable diseases in Colorado in 2006; almost two thirds 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 may improve vaccination rates 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.

Figure 3: VPD Hospitalizations of Colorado Children in 2006, including influenza and rotavirus

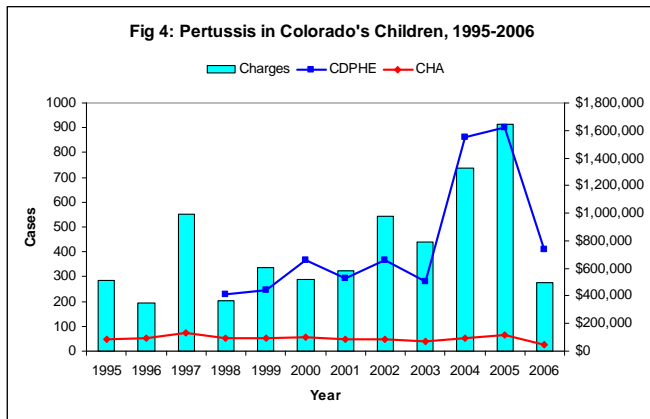


For some diseases, current vaccination rates in Colorado are not sufficient to prevent increasing rates of disease. Since 1920, vaccines have reduced the incidence of many common childhood diseases such as diphtheria in Colorado by 99% - especially those with rare external (imported) exposures; but those due to the more common, internal exposures (e.g. pertussis, which is common in Colorado) and those diseases with vaccines that have not been widely implemented (e.g. influenza, rotavirus) 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).

Table 2: Cases and charges for hospitalized children in Colorado with vaccine-preventable diseases, 2006. [Source: CHA]

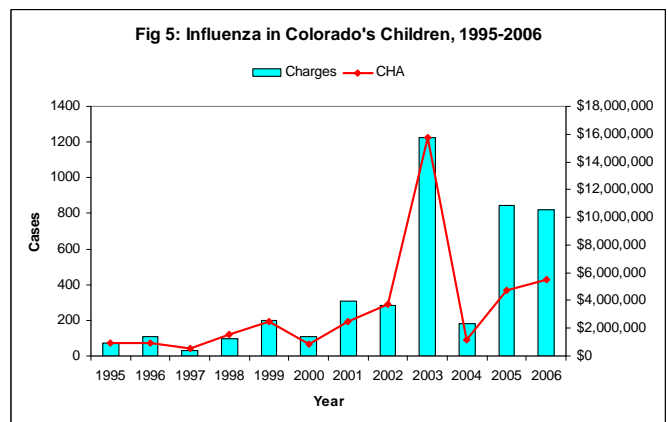
Vaccine	CDPHE Reportable 0-19yrs	CHA Hospitalized 0-20 yrs	CHA Hospitalized Charges	CHA Hospitalized Public Cases	CHA Hospitalized Public Charges
Pertussis	901	61	\$1,415,174	42	\$762,568
Pneumococcal Disease	71	71	\$3,849,767	35	\$1,900,092
Influenza	268	367	\$9,618,008	203	\$4,905,408
H.influenzae	13	3	\$156,572	1	\$49,693
Varicella	1746	13	\$170,918	9	\$120,560
Viral Gastroenteritis	not reported	881	\$9,967,938	403	\$4,639,725
Total Charges			\$25,178,377		\$12,378,046

It is often pointed out that an immunization rate of 80% is high enough to confer so-called "herd immunity". With that in mind, Colorado's current rate of 80.3% could be considered sufficient. However, this number is misleading and not applicable for Colorado's children for several reasons: First, this assumes that all individuals who are vaccinated become immune to the target disease. Although highly effective, most vaccines do not give immunity to 100% of recipients. Second, herd immunity is a phenomenon that is used to explain prevention of outbreaks of disease, not individual cases. It does not mean that those that are not immune to a disease will not get it if a certain percentage of the population is immunized. Third, the herd immunity threshold varies by the disease. For example, pertussis, since it is more easily transmitted, requires a higher threshold than diphtheria, which is not as easily transmitted. Fourth, and perhaps most important for Colorado's children, is that for several of the vaccine preventable diseases (Pneumococcal and Haemophilus disease), there is ongoing chronic internal exposure independent of the number of people vaccinated. These bacteria live in the noses and throats of many people, even though vaccination prevents them from getting sick. Further, several of the VPDs circulate in a seasonal pattern yearly causing mild or moderate disease in some, but potentially severe disease in the young and old (influenza, rotavirus).



CDPHE data show the rate of whooping cough infection in children in Colorado from 1995-2006 (Figure 4). In 2005, Colorado had the greatest number of pertussis cases in many years. 2006 shows a ~4-fold drop in both the number of pertussis cases and dollars spent on hospitalization. This may in part be explained by the introduction and implementation of the Tdap vaccine in school aged children and adolescents.

Figure 5 shows similar data for Colorado children with influenza. Although the 2004-2006 influenza seasons were much milder than that of 2003, hospitalization charges still exceeded \$10 million in 2005 and 2006 and the experience of 2003 shows the impact if (or when) a more virulent epidemic strain (e.g. avian influenza) emerges.



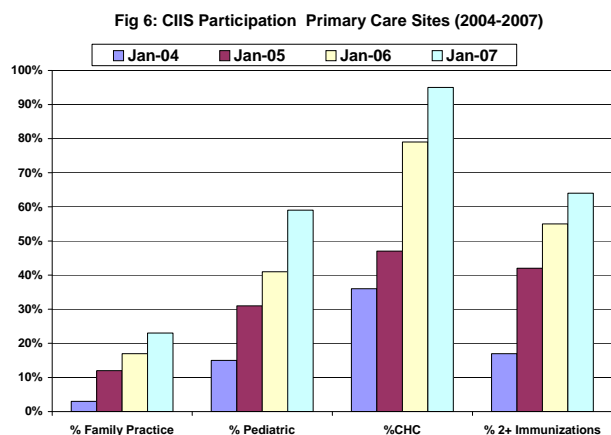
Besides the morbidity and mortality associated with vaccine-preventable diseases, delaying or not giving vaccines costs all the people of Colorado money. As shown in Table 2, for pertussis, varicella, influenza, viral gastroenteritis, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there was over \$25 million (\$12 million in public support) in hospital charges for severe disease associated with these infections in Colorado children in 2006. 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. Better immunization of children will also lead to less exposure of adults -- resulting in an even greater cost savings, and reduced work absenteeism. For certain vaccine preventable diseases, particularly influenza and hepatitis A, this may in fact be where the greatest impact is felt.

As shown in Table 3, high benefit/cost ratios can be achieved by many recommended vaccines as 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.

Vaccine	Benefit / Cost Ratio
DTaP	27.0
Hib	5.4
MMR	23.3
Polio (inactivated)	5.5
Perinatal Hepatitis B	14.7
Varicella	4.76-5.61
Hepatitis A	1.96
Pneumococcal conjugate	0.7-1.1

New vaccines can further reduce the rate of VPDs in Colorado.

Besides the recommended Tdap booster in adolescence, other opportunities for preventing disease in older children include the meningococcal vaccine and the human papillomavirus vaccine (HPV). The new rotavirus vaccines show great promise in reducing hospital morbidity and mortality especially in young children.



System improvements are also necessary to reduce the rate of VPDs in young children. Since many of the most effective vaccines must be given in the first year of childhood, a more efficient and effective early delivery system is essential. There are an estimated 160,000 uninsured children in Colorado – more than half may be eligible but not enrolled in Medicaid/CHP+. The majority of children who are enrolled are in the Unassigned-Fee-For-Service (UFFS) program and do not necessarily have a regular source of primary care and/or vaccination. Implementing statewide newborn enrollment, consolidation of vaccination information in one easily accessible record for each child and a recall program via the Colorado Immunization Information System (CIIS) could improve vaccination rates and simultaneously could provide information to parents about the importance of (and access to) primary preventive care for their children.

The Colorado Immunization Information System (CIIS) was developed and implemented by the Department of Pediatrics of the University of Colorado School of Medicine with a 5 year grant from the Centers for Disease Control and Prevention from 1996 to 2001. In

2002 CIIS became the statewide immunization information system of the Colorado Department of Public Health and Environment (CDPHE). In 2007 legislation expanded CIIS to accept immunization related data for people of all ages—not just children and adolescents. The participation of providers of childhood immunizations has greatly increased during the past 3 years. Currently 100% of local health public health offices and Community Health Clinics (CHC) participate in CIIS (Figure 6). From 2004 to 2007 the participation rates of private practice pediatricians and family physicians increased from 15% to 73% and from 5% to 31%. Kaiser Health Plan, Rocky Mountain Health Plans, Children's Hospital, and Denver Health all participate. Demographic information for all children born in Colorado (and administration of Hepatitis B at birth) is entered into CIIS through a transfer of data from the vital statistics division of CDPHE. The percentage of children under age 6 years with at least 2 immunization records in CIIS has increased from 15% in 2004 to 78% in 2007. As of December 2007 among the 20,539 children from 19 to 24 months of age who had been seen by a immunization provider and received an immunization in the prior 12 months the up- to- date rate was 51%. As of December 2007 among the 53,124 children from 19 to 35 months of age who had been seen by an immunization provider and received an immunization in the prior 12 months the up- to date- rate was 61%.

When confounding factors are considered, the rates in CIIS are quite similar to rates reported in the national immunization survey for Colorado. However the increase in rates from 51% to 61% when children from 19 to 35 months of age are compared to children 19 to 24 months of age suggests that many children are being immunized late and this provides an incentive to rapidly implement recall to get Colorado's children immunized on schedule. Physicians who routinely use CIIS find additional value in the ease of tracking immunizations especially when they may be received at several different locations. Once the CIIS is used continuously and comprehensively in Colorado it could additionally be used to track and manage inventory for a universal purchase, just-in-time delivery system that many physicians would welcome as a major advance in providing immunization to all children while improving practice efficiency and efficacy.

■ Summary:

There is clear evidence in Colorado of the safety and efficacy of vaccines in preventing many severe childhood illnesses and reducing health care costs. Although progress has been made in the past several years in improving vaccination rates, Colorado still has not met the national target of 90%. There remains a disparity in vaccinating our youngest and poorest children. The hospital-related charges for treating these vaccine-preventable diseases in children still runs in the tens of millions of dollars yearly, significantly impacting both the public and private sectors. Although requiring vaccinations prior to school entry ensures that most school-aged children are ultimately protected, most vaccine-preventable diseases occur prior to school age. Implementing 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. Such systems may have the added benefit of educating families about the importance of and access to primary preventive health care – enhancing Colorado's Medical Home initiative.