

Vaccine-Preventable Diseases in Colorado's Children – 2010

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Vaccines have been highly effective and very safe in Colorado and have had a dramatic effect on reducing vaccine-preventable diseases (VPD) such as diphtheria, tetanus, pertussis, polio, measles, mumps, rubella, smallpox, chickenpox, *Streptococcus pneumoniae*, and *Haemophilus influenzae* disease. Vaccines have proven to be very safe. For every possible severe adverse event reported in Colorado children in 2002-2003, vaccines prevented an estimated 4,000-8,000 vaccine-preventable illnesses, many with potentially severe consequences. Colorado has made substantial progress over the last decade in vaccinating its children but still has not achieved the national goal of a 90% vaccination rate and we have seen a drop-off in vaccination rates in 2009. Although regulations require most vaccines by the time a child enters school, the greatest risk for many of these diseases is still in children under two years of age. Colorado children with Medicaid, State Children's Health Insurance Plan (SCHIP), or no insurance are twice as likely to get a VPD as children with private insurance. For pertussis, varicella, influenza, viral gastroenteritis, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there were still over \$31 million in hospital charges for severe disease associated with these infections in Colorado children in 2009, with significant impact in both the public and private sectors. SHCC 2010; 7:1, 1-4

■ Introduction

The Centers for Disease Control and Prevention (CDC) 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 among the worst of 50 states in overall childhood vaccination rates. There has been significant improvement in the last several years, although our State has yet to achieve the desired 90% vaccination rate for most vaccines. This ongoing analysis of Colorado data is undertaken to evaluate the progress and opportunities that exist in preventing vaccine-preventable diseases (VPD) 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*) and updated annually using the most recent data available (2009) from NIS, Colorado Hospital Association (CHA) and the Colorado Department of Health and Environment (CDPHE).

■ Results

The National Immunization Survey (NIS) shows Colorado has improved its vaccination rate since 2002-2003 but has regressed somewhat in 2009. By 19-35 months of age, children should have received the following vaccine doses: 4 diphtheria, pertussis, tetanus (DTaP); 3 polio; 1 measles, mumps, rubella (MMR); 3 *Haemophilus influenzae* (Hib) [4 Hib in 2009]; 3 hepatitis B and 1 varicella vaccination (referred to collectively as "431331" [now "431431" in 2009]). As shown in Figure 1, Colorado has steadily improved on its initially low

national vaccination rank exceeding the national average since 2007 and moving up to a rank of 9th in 2008 and 15th in 2009.

Fig 1: NIS Vaccination Rates (431331 [* 431431 in 2009]):
US and Colorado (Source: NIS)

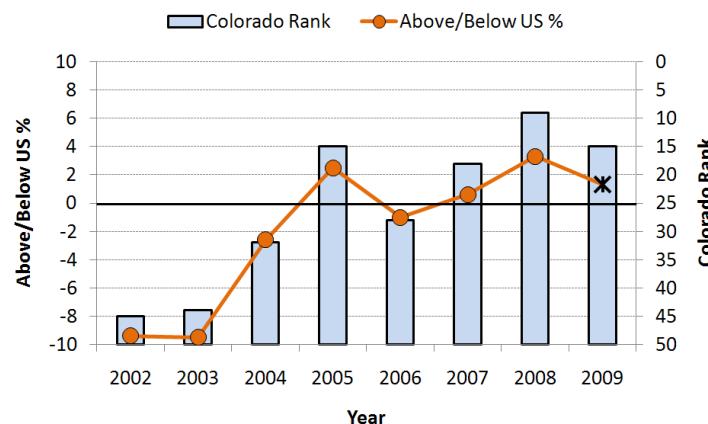
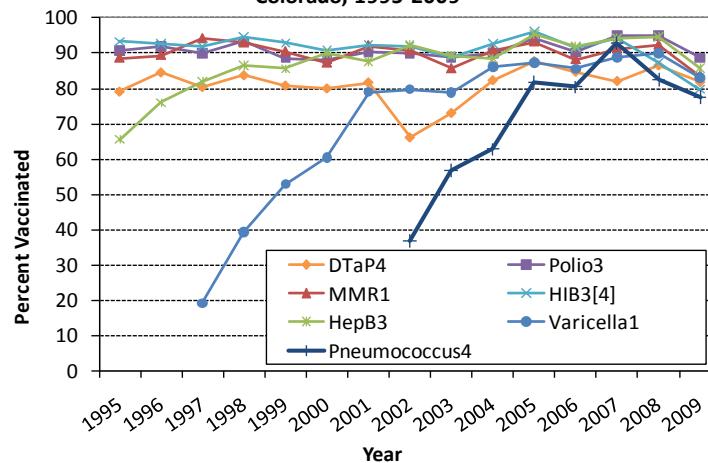


Figure 2 suggests that our extremely low rankings in 2002 and 2003 in part may have been exaggerated by DTaP vaccine shortages. Vaccination rates have fallen off for most vaccines in 2009 coincident with the economic recession. Currently, no vaccine exceeds a 90% vaccination rate.

Figure 2: NIS Vaccination Percentage, 19-35 months:
Colorado, 1995-2009



Reported increases in NIS vaccination rates correlate with actual decreases in hospitalized vaccine-preventable disease rates in Colorado (as vaccination goes up disease rates go down).

Figure 3 shows that as Colorado's vaccination rank for the series 4331331 (2002-2008) and 431431 (2009) has increased, Colorado rates of hospitalization for VPDs (not including influenza) have decreased. The rates of VPD are still higher in Colorado children who have public or no health insurance coverage than those with private insurance. In fact, although the gap appears to be closing, the odds in 2009 of being hospitalized for a VPD are still twice as high for children in Colorado with Medicaid/SCHIP or no insurance than those with private insurance.

Figure 4 shows the clear impact of two recent additions to the vaccine regimen (varicella, pneumococcus) on a similar reduction of related hospitalization rates in Colorado. As varicella (chickenpox) vaccination increased in the late 90's, admissions to the hospital for its complications (many severe such as necrotizing fasciitis and encephalitis) decreased by 90%. As the pneumococcal vaccine rates increased subsequently, a similar reduction in hospitalization for severe pneumococcal disease (sepsis, meningitis) was seen with a recent increase associated with non-vaccine strains that has resulted in the expansion of coverage of the pneumococcal vaccine from 7 to 13 strains. In the prior decade, a sustainable reduction of over 90% in *Haemophilus influenzae* sepsis and meningitis was similarly achieved.

Vaccination timing is important.

Delaying vaccination puts Colorado's most vulnerable infants and young children at risk for VPDs and their complications. Figure 5 shows the age distribution of VPDs in Colorado in 2009; almost two thirds of the cases occur in children under four years of age. This distribution, showing the highest incidence of VPDs in the youngest children, holds true even when influenza (see next page) and gastroenteritis cases are excluded. In addition, these diseases are commonly more severe in the youngest children as demonstrated with children with whooping cough (pertussis) and influenza.

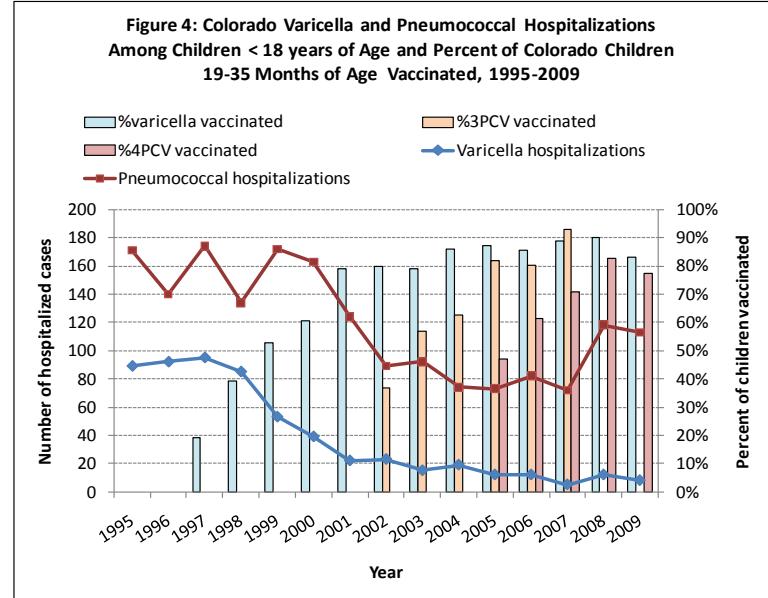
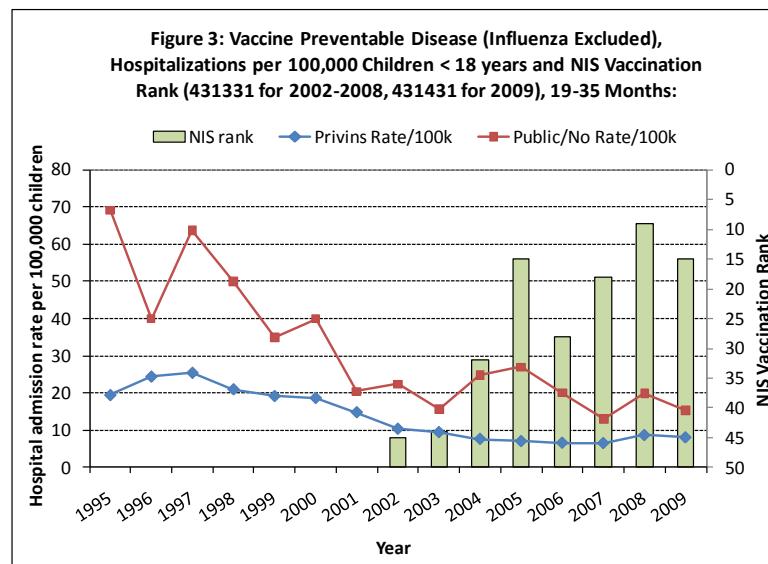
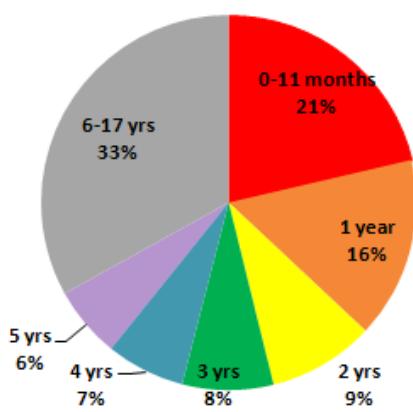


Figure 5: Age Distribution of Vaccine-preventable Disease Hospitalizations of Colorado Children in 2009, Including Influenza and Rotavirus



Continued efforts to vaccinate Colorado's children are critical.

CDPHE data show the number of cases of whooping cough infection in Colorado children admitted to a hospital (CHA, red line), aggregate hospital charges (CHA, blue bar) and those reported to CDPHE, (blue line) from 1998-2009 (Figure 6). These numbers are likely to significantly underestimate the number of non-hospitalized cases and the impact on children and families. In 2004 and 2005, Colorado had the greatest number of pertussis cases in many years. From 2006-8 showed a two-fold drop in both the number of pertussis cases and dollars spent on hospitalizations with a rebound in 2009.

Figure 7 shows similar data for Colorado children with influenza. The 2003 outbreak strain was especially severe in children with 12 influenza-associated deaths (Table 1) reported by CDPHE. Although the 2004-2008 influenza seasons were much milder than that of 2003, hospitalization charges still exceeded \$5 million in 2005 and 2006 and there were 7 deaths in the 2007-2008 season. The 2003 season shows the impact when a new, more virulent strain emerges. This was emphasized in 2009 when Colorado experienced many more children hospitalized, 12 influenza related deaths and \$35 million in hospital charges because of the emergence of a new influenza strain (H1N1).

Figure 8 (next page) shows the hospital admission rate by age group for the 2008-2009 influenza season as reported by CDPHE. The highest admission rates are noted in very young infants and children. As shown in Figure 9 (next page) Colorado has lower influenza vaccination rates than other states.. Colorado's rate of vaccination is low despite a national strategy in reducing morbidity and mortality in this vulnerable age group as well as to reduce transmission to older individuals.

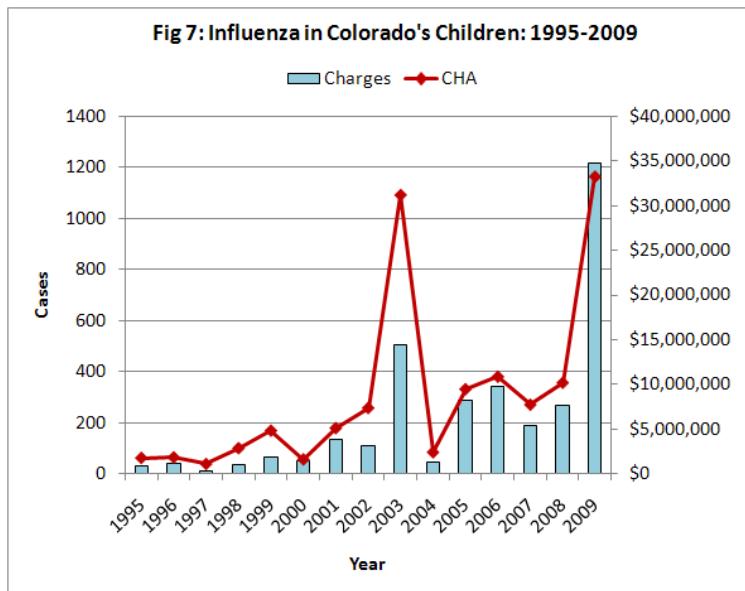
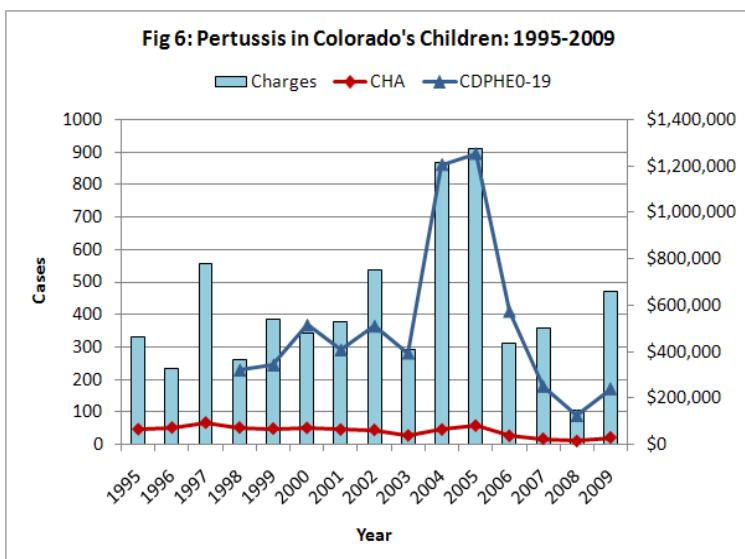


Table 1. Influenza-Associated Pediatric Deaths in Colorado, 2003-04 to 2008-09 Influenza Seasons	
Flu Season	Deaths
2003-04	12
2004-05	2
2005-06	2
2006-07	1
2007-08	2
2008-09	7*

* Includes 1 death in 2009 associated with travel beyond normal season.

Source:
<http://www.cdphe.state.co.us/dc/influenza/Influenza%20Surveillance%20Summary08-09.pdf>

Besides the morbidity and mortality associated with vaccine-preventable diseases, delaying or not giving vaccines costs all Coloradans money.

As shown in Table 2 for pertussis, varicella, influenza, viral gastroenteritis, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there was over \$56 million (\$31 million in those with public or no insurance) in hospital charges for severe disease associated with VPD in Colorado children in 2009. The table actually underestimates the potential savings, since it does not include those hospitalized children with respiratory disease that can be attributed to influenza, or children with VPDs who are not admitted to the hospital.

**Figure 8: Influenza-Associated Hospitalization Rates by Age Group
Colorado, 2008-2009 Influenza Season**

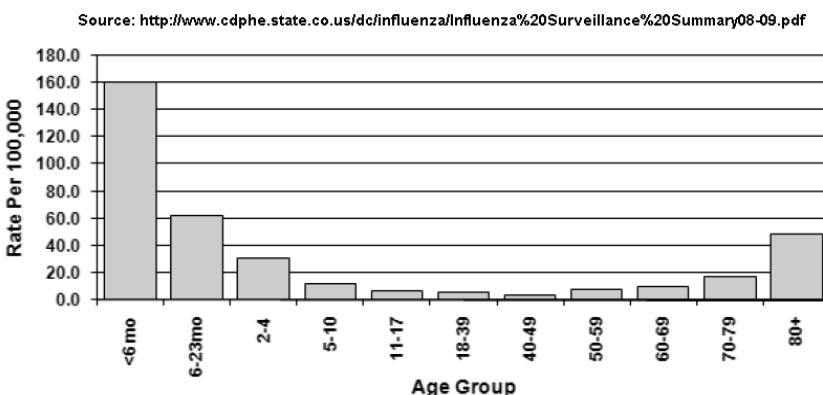
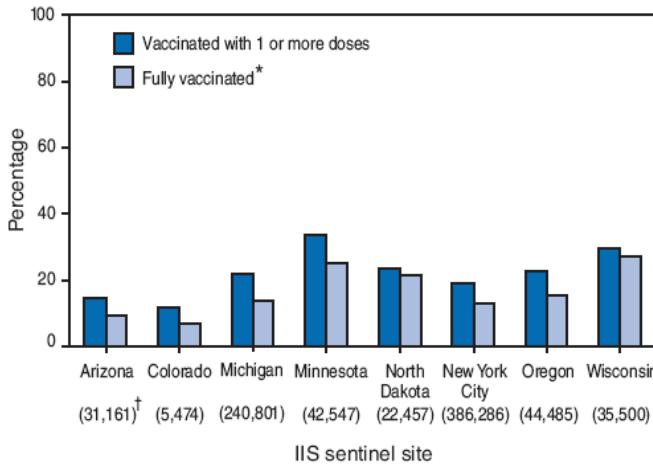


Figure 9: Percentage of children aged 24–59 months who received influenza vaccination — eight immunization information system (IIS) sentinel sites, United States, 2007–08 influenza season <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5738a3.htm>



* Full vaccination = 1) receipt of 2 valid influenza vaccine doses in the current season among influenza vaccine naive children and children who received 1 dose for the first time during September 1, 2006–March 31, 2007, or 2) receipt of 1 vaccine dose in the current season among all other children.

† Number of children aged 24–59 months enrolled in the IIS at the sentinel site as of March 31, 2008.

Table 2: Cases and charges for children in Colorado with vaccine-preventable diseases, 2009.

Vaccine	CDPHE Reported Cases 0-19 yrs	CHA Hospitalized 0-17 yrs	CHA Hospitalized Charges	CHA Hospitalized Public/ No Cases	CHA Hospitalized Public/ No Charges
Pertussis	173	21	\$658,938	13	\$336,923
Pneumococcal Disease	93*	113	\$12,639,693	55	\$7,158,498
Influenza	1041	1167	\$34,798,681	690	\$18,653,768
H.influenzae	13	6	\$2,014,549	5	\$1,044,227
Varicella	477	8	\$342,506	6	\$318,515
Viral Gastroenteritis	not reported	472	\$6,380,988	251	\$3,713,735
Total Charges			\$56,835,355		\$31,225,666

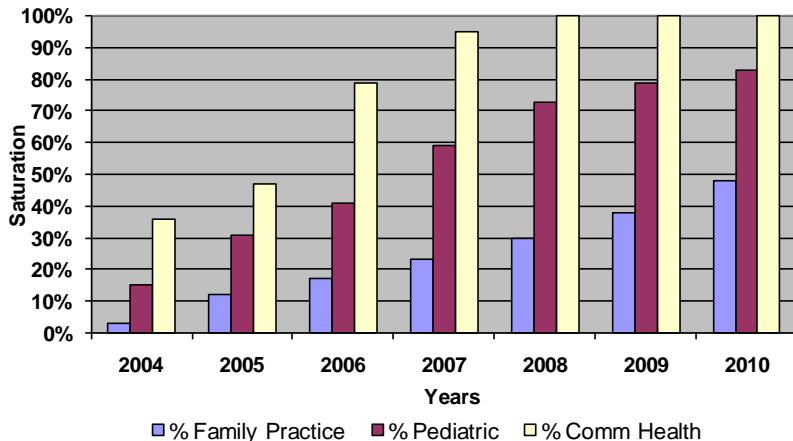
Progress has been made in developing systems to measure and improve childhood vaccination in Colorado.

The Colorado Immunization Information System (CIIS) is an integral part of the Immunization Section within the Colorado Department of Public Health and Environment (CDPHE). CIIS was originally developed and implemented by the Department of Pediatrics of the University of Colorado, School of Medicine with a 5-year grant from the CDC from 1996 to 2001. In 2002, CIIS became the CDPHE's statewide immunization information system. In 2007, legislation expanded CIIS to accept immunization-related data for people of all ages—not just children and adolescents. Operation of CIIS was formally transitioned to CDPHE in late 2008.

The participation of childhood immunization providers in CIIS has greatly increased during the past 3 years. Currently 100% of local health public health agencies and Community Health Centers participate in CIIS (Figure 10). From 2004 to 2010, the participation rates of private practice pediatricians and family physicians increased from 15% to 83% and from 5% to 38% respectively. Kaiser Health Plan, CIGNA, Anthem BCBS (Wellpoint), Aetna (in process) 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 section 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 90% in 2010.

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 CIIS is used continuously and comprehensively in Colorado by all immunization providers, 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 immunizations to all children while improving practice efficiency and efficacy.

Figure 10: CIIS Saturation - Primary Pediatric Immunization Providers 2004 - 2010



● **Comment**

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%, and still has significant childhood morbidity, mortality and social and economic cost related to vaccine-preventable diseases. 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. There is evidence that rates may be easily influenced by economic circumstances and unsubstantiated theories advanced in the social media. There remains a disparity in vaccinating our youngest and poorest children. Although requiring vaccinations prior to school entry ensures that most school-aged children are ultimately protected, most VPD occur prior to school age.

System improvements are necessary to reduce the rate of VPDs in young children Although school immunization regulations may improve vaccination rates by the time a child is school-age, 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. Since many of the most effective vaccines must be given in the first year of childhood, an efficient and effective early delivery system is essential. In past studies, the strongest correlate of the incidence of VPD in Colorado counties with populations > 5,000 children < 18 yrs of age is the percentage of children in families with incomes less than two times the Federal Poverty Level ($p=0.004$) [VPD 2006]. According to the Colorado Children's Campaign, "the number of children living in poverty has increased 85 percent since 2000, with more than 192,000 children living in poverty in 2007, compared to 104,000 in 2000. And our youngest children are the most likely to be living in extreme poverty."

<http://www.coloradolife.org/includes/downloads/kidscount2009forweb.pdf>

In addition, they noted, "165,000 children, or 14 percent, were uninsured in Colorado in 2006. This is a higher percent of children than the national average of 11 percent." Increasing the number of these children enrolled in Medicaid and State Children's Health Insurance Plan (SCHIP) and implementing state-wide 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

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 reduced the incidence of VPDs 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 every year (*Vaccine-Preventable Diseases in Colorado's Children, 2003*). Although hospitalization rates for children with public or no health insurance are still higher than for privately insured children, both are declining and the gap between the two is narrowing suggesting the success of efforts to provide primary care and vaccinations for all Colorado's children.

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 very few "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 have 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 a few advocate against the use of vaccines, claiming their possible role in the causation of various adverse events including asthma, autism and other neurological condi-

tions, rigorous reviews of evidence do 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>). Nonetheless, anti-vaccine proponents continue to advance unsubstantiated theories that misinform the public resulting in decreased vaccination rates and increased morbidity and mortality of vaccine-preventable diseases.

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

Besides the 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. A recent report suggests the Hepatitis A vaccine is underutilized in Colorado as compared to other sentinel states (*MMWR* 2010;54:776).

Current vaccination rates and success in reducing related diseases is no cause for complacency. 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. pneumococcus) 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 create the risk for cases in Colorado children who haven't been vaccinated (e.g. diphtheria, measles).

It is often suggested that a vaccination rate of 80% is high enough to confer so-called "herd" or "community immunity" which limits spread of infection and protects the remaining, unvaccinated individuals from being exposed. However, this number is misleading for several reasons. Measles and whooping cough are highly contagious; for these the rate of vaccination for long-lasting community immunity is believed to be more than 90%. In addition, herd immunity is a phenomenon that is used to explain the spread of outbreaks of disease, not the risk of individual cases. It does not protect those who are not vaccinated from getting a disease if exposed by those visiting or returning from other countries where diseases that are rare in the US are more common. Most importantly, for many of the vaccine-preventable diseases (e.g. chicken-pox, pertussis, pneumococcal and haemophilus infection), there may be an ongoing risk of exposure from seemingly well individuals who still carry the organisms in the community.

Implementing systems that assure access to vaccines for all children, as well as timely vaccination, are critically important to children's health, especially during the first two years of life when children are at the highest risk of VPDs. 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.