Vaccine-Preventable Diseases in Colorado's Children – 2009

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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, pertussis, 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 substantial progress over the last several years in vaccinating its children but still has not achieved the national goal of a 90% vaccination rate. Although immunization laws require complete vaccination by the time a child enters school, the greatest risk for many of these diseases is still in children under two years of age. For pertussis, varicella, influenza, viral gastroenteritis, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there were still over $28 million of hospital charges for severe disease associated with these infections in Colorado children in 2008, with significant impact in both the public and private sectors. Colorado children with Medicaid, SCHIP, or no insurance are twice as likely to get a VPD as children with private insurance. SHCC 2009; 6:1, 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 significant improvement in the last several years, although our State has yet to achieve the desired 90% vaccination rate. This ongoing analysis of Colorado data is undertaken to evaluate the progress 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*) and updated annually using the most recent data available (2008) from NIS, Colorado Hospital Association (CHA) and the Colorado Department of Health and Environment (CDPHE).

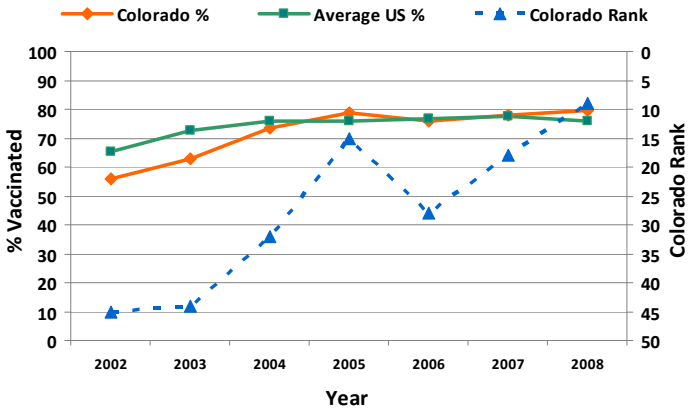
■ Results

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 reduced the incidence of 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 every 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 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 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 2008 National Immunization Survey (NIS) shows Colorado has improved its vaccination rate since 2002-2003. 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); 3 hepatitis B and 1 varicella vaccination (referred to collectively as "431331"). As shown in Figure 1, Colorado has consistently improved on its initially low national vaccination ranking exceeding the national average and moving up to a rank of 9th in 2008.

Fig 1: NIS Vaccination Rates (431331): US and Colorado (Source: NIS)

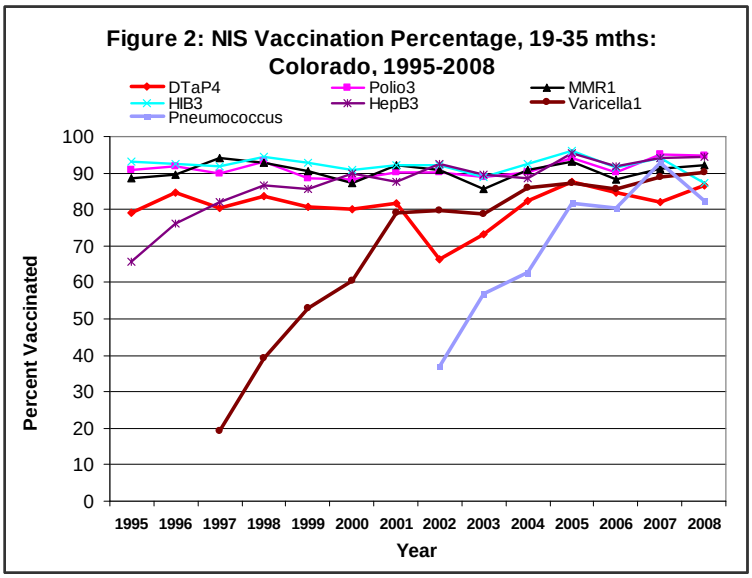


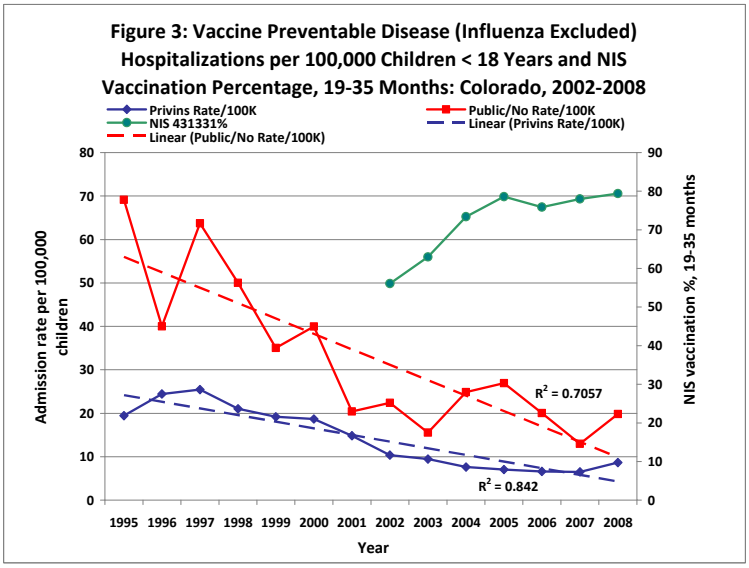
The rank is less informative than the absolute vaccination rate of 79.4% (estimated range 72.6-86.2%) still below the year 2000 target of 90%.

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 progress in awareness of the importance of vaccines and efforts to track and improve vaccination status.

Reported increases in NIS vaccination rates correlate with actual decreases in vaccine-preventable disease hospitalization rates in Colorado (as vaccination goes up disease goes down). Figure 3 shows that as the vaccination rate has increased in Colorado, rates of hospitalization for vaccine-preventable diseases have decreased. Interestingly, although hospitalization rates for children with public or no health insurance are still higher than for privately insured children, the gap between the two is narrowing suggesting the success of efforts to provide primary care to all Colorado's children. Figure 4 shows the clear impact of two recent additions to the vaccine regimen (varicella, pneumococcus) on the reduction of related hospitalization rates in Colorado but also the reminder that the potential for severe disease remains in children who are not completely immunized.

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 are still higher in Colorado children who have public or no health insurance coverage than those with private insurance. In fact, the odds in 2008 of being hospitalized for a VPD were twice as high for children in Colorado with Medicaid/SCHIP/None than private insurance. In past studies, 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]. A recent report suggests that the number of children living in poverty is increasing in Colorado which could aggrevate this disparity in vaccination rates and vaccine-preventable diseases (http://www.coloradokids.org/includes/downloads/kidscountwhitepaper6.9.08.pdf).





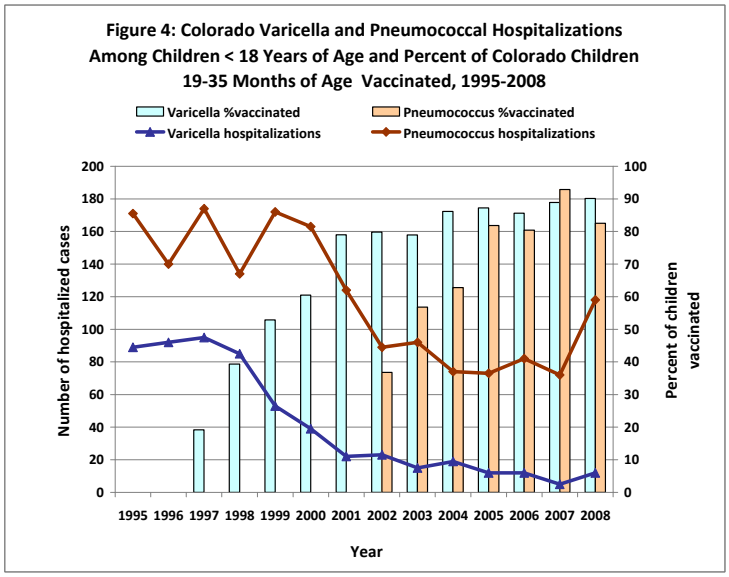
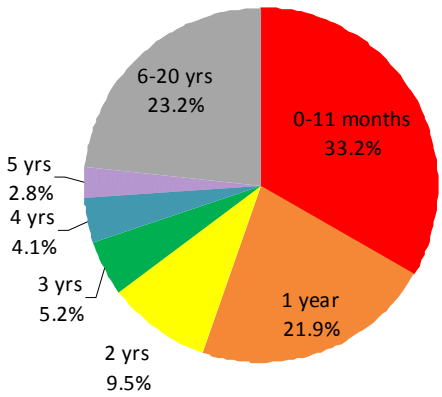


Figure 5: VPD Hospitalizations of Colorado Children in 2008, Including Influenza and Rotavirus



Vaccination timing is important.
Delaying vaccination puts Colorado's most vulnerable infants and young children at risk for vaccine-preventable diseases and their complications. Figure 5 shows the age distribution of vaccine-preventable diseases in Colorado in 2008; 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.

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, 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 create the risk for cases in Colorado children who haven't been vaccinated (e.g. diphtheria, measles).

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 79.4% might 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 exposed. The recent outbreak of measles in unvaccinated children in the US demonstrates this. Third, and perhaps most important for Colorado's children, for several of the vaccine preventable diseases (Pneumococcal and Haemophilus disease), there is ongoing chronic 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 it does not protect others who are not vaccinated.

Continued efforts to vaccinate Colorado's Children are critical.
CDPHE data show the rate of whooping cough infection in children in Colorado from 1998-2008 (Figure 6). 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.

Fig 6: Pertussis in Colorado's Children: 1995-2008

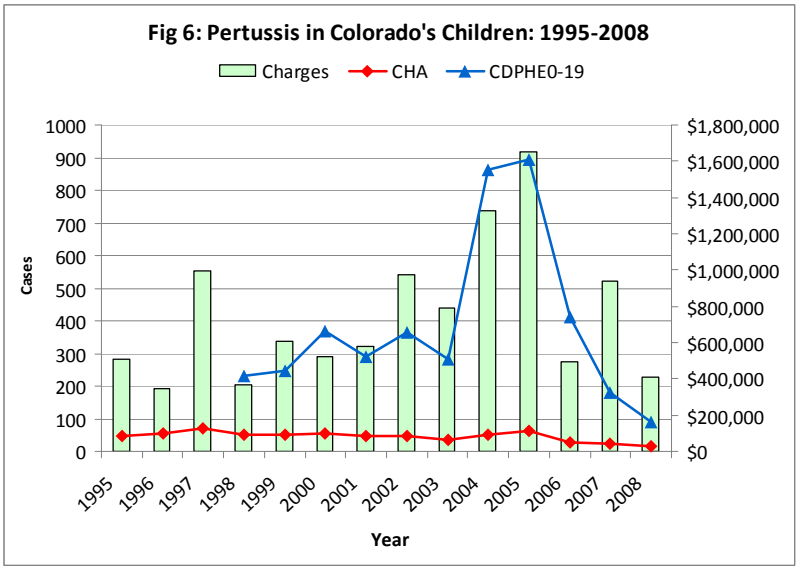


Figure 7 (next page) shows similar data for Colorado children with influenza. Although the 2004-2007 influenza seasons were much milder than that of 2003, hospitalization charges still exceeded $10 million in 2005 and 2006 and the experience of 2003 shows the impact if (or when) a more virulent epidemic emerges. The dotted line predicts that 2009 will again be a year when we see many more children hospitalized with influenza because of the emergence of just such a new influenza strain (2009 H1N1).

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 1, for pertussis, varicella, influenza, viral gastroenteritis, *Streptococcus pneumoniae*, and *Haemophilus influenzae*, there was over $28 million ($16 million in public support) in hospital charges for severe disease associated with these infections in Colorado children in 2008. 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 2, 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.

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.

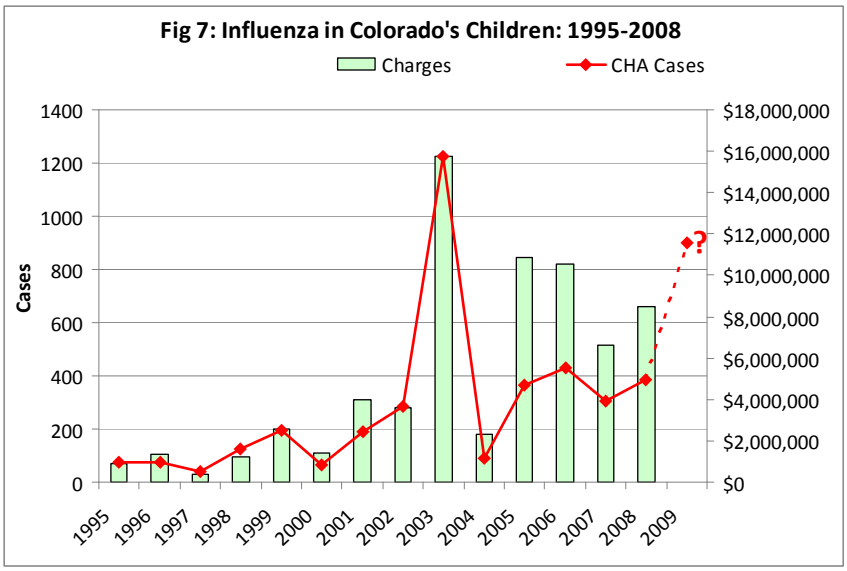


Table 2: Benefit-cost ratios for selected vaccines [Source: *Financing Vaccines in the 21st Century. The National Academies Press, 2004*]

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

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, an efficient and effective early delivery system is essential. 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.coloradokids.org/includes/downloads/kidscount2009forweb.pdf]

Table 1: Cases and charges for children in Colorado with vaccine-preventable diseases, 2008.

Vaccine	CDPHE Reported Cases 0-19yrs	CHA Hospitalized 0-20 yrs	CHA Hospitalized Charges	CHA Hospitalized Public Cases	CHA Hospitalized Public Charges
Pertussis	90	15	$410,184	10	$261,059
Pneumococcal Disease	89	126	$10,787,044	63	$4,875,183
Influenza	277	387	$8,509,094	226	$5,724,453
H.influenzae	13	8	$660,966	7	$648,529
Varicella	839	13	$396,346	6	$227,148
Viral Gastroenteritis	not reported	610	$7,865,322	331	$4,455,213
Total Charges			**$28,628,956**		**$16,191,585**

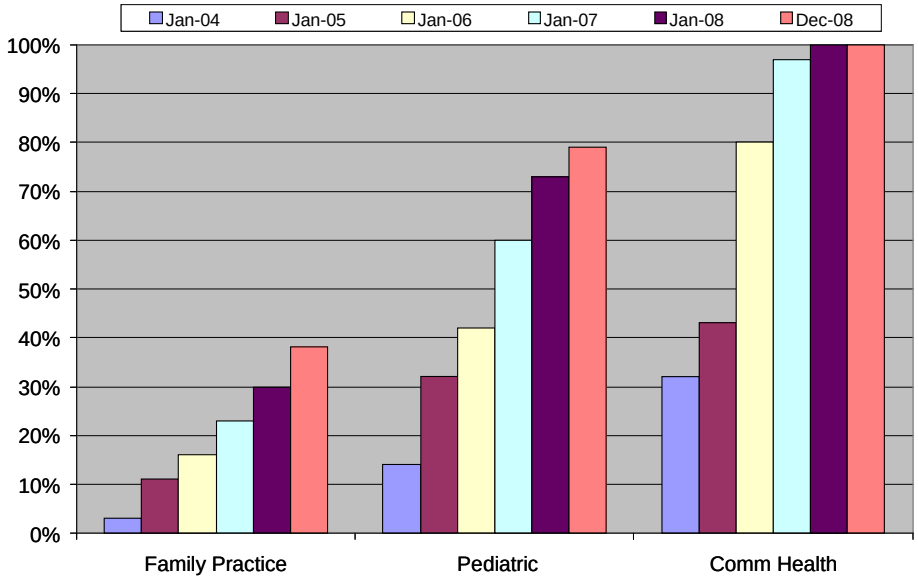
In addition, they noted "165,000 children, or 14 percent, were uninsured in Colorado in 2006. This is a higher percent of children than the national average of 11 percent." Increasing the number of these children enrolled in Medicaid and SCHIP and implementing state-wide newborn enrollment, consolidation 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.

The Colorado Immunization Information System (CIIS) is now a part of the Immunization program 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 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. CIIS was transitioned to CDPHE in late 2008.

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 2008 the participation rates of private practice pediatricians and family physicians increased from 15% to 79% and from 5% to 38%. 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 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 82% in 2008.

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.

Figure 6: CIIS Saturation - Primary Immunization Provider Sites, Public & Private (2004-2008)



This data does not include Public Health offices

■ **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.