

School Exemptions and Disease Risk in Ashland, Oregon

Background

Ashland, Oregon is a community of 19,522 people in Jackson County, located in the southwestern part of the state. It has 11% of Jackson County's total population [2000 US Census data]. It is located along Interstate Five, the main north-south interstate along the West Coast. Ashland is home to Southern Oregon University, with an enrollment of 5,130 students, 143 of which are international students¹. The Oregon Shakespeare Festival also makes its home in Ashland, hosting over 380,000 visitors each season.

For the school year 2000/2001, Ashland had one of the highest rates in Oregon of religious exemption from mandated school and daycare immunization requirements. From summary reports submitted to the counties by local schools, in 2000/2001 Ashland had an 11% rate of religious exemption, as compared to 3% for Jackson County overall, and 2.7% for the state. In response, Jackson County Health and Human Services (HHS) formed Project Immunity during 2001, with the goals of determining the significance of the problem and finding solutions to decreasing immunization levels in Ashland. The current study, by providing a more complete assessment of exemptions in Ashland, is part of the second phase of Project Immunity to help in designing strategies for Phase III.

Oregon schools and children's facilities have immunization requirements for nine diseases: diphtheria, tetanus, hepatitis B, polio, measles, mumps, rubella, and varicella. *Haemophilus influenzae* type B (HIB) is also required for preschool children under age five. Signed medical exemptions from physicians and religious exemptions from parents are allowed in place of immunizations. In Oregon, physician-signed medical exemptions are rare compared to religious exemptions signed by parents. In school year 1998/1999, hepatitis B vaccine was added to the requirements for children's facilities and kindergarten, and a second dose of measles-containing vaccine (MCV) was added to kindergarten requirements. In school year 2000/2001, hepatitis B, a second dose of MCV, and varicella vaccines were added to requirements for seventh graders, and varicella vaccine was added as a requirement for children in children's facilities and kindergarten. Oregon is

phasing these requirements into all grades over time. Each school year, the requirements advance one grade level along with the original cohort of students, such that by school year 2005/2006 all students will be required to have hepatitis B, a second dose of MCV and varicella vaccines.

The Ashland School District has 3,188 students in six elementary schools, one middle school and one high school. Pinehurst School District has one elementary school serving grades K to 8, with 30 students. In addition, there are two certified childcare facilities, four private preschool/kindergarten programs and 3 private schools offering multiple grade levels in Ashland. The names of the public schools and their enrollments as of October 2001, and the names of private schools and facilities and their enrollments as of January 2001, are listed in Table 1².

Table 1: October 2001 Enrollments

Public Schools	Grades Offered	Enrollment
Ashland High School	9-12	1185
Ashland Middle School	6-8	797
Bellview Elementary	K-5	223
Briscoe Elementary	K-5	237
Helman Elementary	K-5	200
Lincoln Elementary	K-5	272
Pinehurst Elementary	K-8	30
Walker Elementary	K-5	274
Private Schools	Grades Offered or Ages	Enrollment
ABC Christian Group Daycare	6 weeks-5 years	12
Ashland Family YMCA	12 months-5 years	106
Children's World (E. Main St.)	2.5-6 years	26
Children's World (Garfield St.)	2.5-6 years	33
Children's World (N. Main St.)	2.5-6 years	18
Grace Lutheran School	3 years-5th grade	80
Kid's House Preschool	2.5-12 years	36
Lithia Springs Programs	13-18 years	29
Rogue Valley Christian School	4 years-12th grade	34

In order to check on the accuracy of reported numbers of exemptions, and to determine which vaccines, if any, exempted students had received, Jackson County HHS, with technical assistance from the Immunization Program of the Oregon Department of Human Services, reviewed the Certificate of Immunization Status (CIS) of each child with a signed religious exemption in November of 2001. Each school was subsequently contacted again in March of 2002 for updated exemption figures.

Methods

On November 13 and 14, 2001, staff from Jackson County HHS, the Immunization Program of Oregon DHS, and Rogue Valley Medical Center visited the eight public schools in Ashland (excluding Pinehurst). During these visits, they copied the CIS form and any other immunization documentation for each child with a religious exemption or picked up copies previously made by school staff. In addition, computerized printouts showing vaccination dates, if any, for each student were collected. During the visit, school staff members were given informal training in Oregon's school immunization requirements.

Prior to the November visits, Jackson County Health and Human Services requested copies of the CIS form on file for each child with a religious exemption from each private school and children's facility. Due to its small enrollment, Pinehurst School District was also asked to mail in copies of the CIS for children with a religious exemption. All schools and facilities complied with the request. School immunization records for all of the children through middle school were compared with records in the Immunization Program's ALERT, Oregon's statewide immunization registry. Any additional vaccine doses found were taken into account when determining whether children had adequate protection from each disease.

Data were reviewed to determine whether each student had received enough doses to be protected against each disease. "Adequately protected" was defined as meeting the school and children's facility age- and grade-specific immunization requirements for each individual antigen as defined by Oregon Administrative Rule 333-050-0050³. Children not required to be vaccinated for a specific antigen were not counted as adequately protected for that antigen in the overall summary. Children with a reported history of

chickenpox disease were included as adequately protected for varicella, whether or not the vaccine was required for their grade level.

Results

The review by Jackson County HHS and the Oregon DHS Immunization Program on November 13th and 14th, 2001, found 381 religious exemptions from vaccination requirements on file for students in Ashland public schools, and 55 exemptions in private school, preschool and daycare settings. Students counted in the private and daycare figure include those enrolled in nine daycare/preschool programs and in four private programs with some elementary and higher school grades. A review of current exemption certificates on March 6, 2002, found 480 exemptions, of which 407 were in public schools. However, this total includes the addition of four preschools not counted in November. The results by school are presented in Table 2. Note that a child is counted only once for enrollments or exemptions; a child who attended classes at more than one school, or who participated in an after- or before-school daycare program at another site would only be counted at their main school site.

In comparison to the 2000/2001 school year, Jackson County's exemption rate for 2001/2002 has increased from 3% to 4%. The rate for Ashland public schools for 2001/2002 has increased from 11% to approximately 12%. The statewide rate during this period has decline slightly, from 2.7% in 2000/2001 to 2.4% in the 2001/2002 school year.

The nine Ashland-area preschools covered in this review have a total enrollment of 362 children and an exemption rate of 18.8%. This includes Crescent Moon Nursery, with an enrollment of 18 children and no reported immunizations; the required review forms indicate that exemptions will be sought for all 18. The public school systems (Ashland and Pinehurst) have a total enrollment of 3,285 students with a 12.4% rate of exemption. Private schools have a total enrollment of 89 students, with a 4.9% rate of exemption.

Among the six public elementary schools, the total enrollment is 1,299 students, with an average exemption rate of 15.2%. Bellview Elementary, with a 4.4% exemption rate, is significantly below this average. In contrast, Walker Elementary, with a 23.4% rate of exemption, is significantly higher than the rest (Table 2).

Table 2: Ashland Religious Exemptions to Immunizations: By School*March 6th, 2002*

Preschool	Enrollment	Exemptions	Percentage Exempt
ABC Christian Daycare	9	0	0.0%
Ashland Family YMCA	98	14	14.3%
Chautauqua Garden School	19	3	15.8%
Children's World Montessori	60	11	18.3%
Crescent Moon Nursery	18	18	100.0%
Grace Lutheran (preschool)	30	4	13.3%
Kid's House Preschool	45	8	17.8%
Lil' Rascals Preschool	30	2	6.7%
Schneider Children's Center	53	8	15.1%
Private School			
Children's World Montessori (K &1)	20	1	5.0%
Grace Lutheran (K thru 4th)	32	2	6.3%
Rogue Valley Christian (K thru 12)	36	1	2.8%
Lithia Springs (high school)	30	1	3.3%
Public- Elementary			
Pinehurst (K thru 5)	18	3	16.7%
Bellview Elementary	250	11	4.4%
Briscoe Elementary	244	45	18.4%
Helman Elementary	224	24	10.7%
Lincoln Elementary	267	47	17.6%
Walker Elementary	282	66	23.4%
Public -Middle and High Schools			
Pinehurst (6, 7, 8)	14	2	14.3%
Ashland Middle School	791	103	13.0%
Ashland High School	1190	106	8.9%
Totals			
All Preschool	362	68	18.8%
All Public K-12 Schools	3280	407	12.4%
All Private K-12 Schools	118	5	4.2%
Grand Total	3760	480	12.8%

The following is a brief review of results by setting.

Preschools

The preschools in Ashland vary greatly in their rates of exemptions, ranging from a low of 0% for ABC Christian Daycare to a potential 100% rate at Crescent Moon Nursery. An age-specific breakdown of enrollment and exemptions is not currently available for preschoolers, limiting the type of analysis and the questions that might be answered about this population. A concern about current preschoolers is whether they are representative of the level of exemptions to expect in future elementary school enrollment. Preschoolers are in closer proximity in school, giving them more opportunities to share diseases.

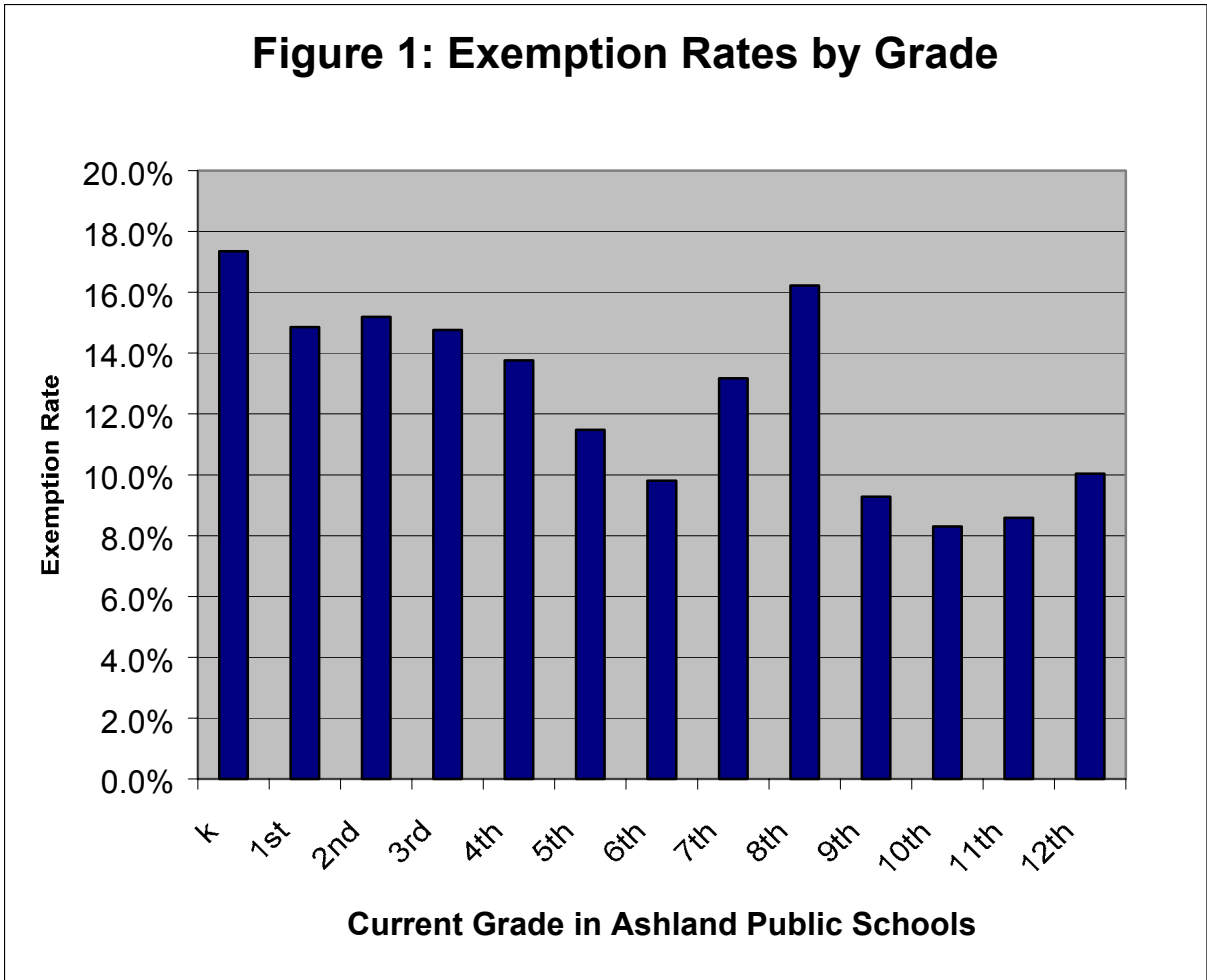
Private Schools

The two private elementary schools, Children's World Montessori (K to 1st grade) and Grace Lutheran (K through 4th grade), have small enrollments and exemption rates significantly below the average of the public elementary schools.

There is one private high school, Lithia Springs, in this review. It has 30 students and only a single exemption.

Public Schools

Students in public schools account for 88% of the enrollment in Table 2 and 85% of exemptions. These values, together with a greater availability of data on public schools, leads to a greater emphasis on analyzing exemptions in the public school setting. Figure 1 presents rates of exemption by grade for the public school system.



In the above chart, there are two salient features. First is the high rate of exemptions among seventh- and eighth-grade students. These are probably from new vaccination requirements that affected middle school students in school year 2000/2001.

The other significant feature of this graph is that younger students have more exemptions than older students. As with middle-school students, this may be related to the recent implementation of new vaccination requirements.

Public Elementary Schools

The Ashland School District operates five elementary schools, with an average enrollment of 214 students per school. Table 3 provides more detail about exemptions in the elementary schools. Note that due to small grade sizes, Pinehurst is not included in this table.

Table 3:						
Exemption Rates For Public Elementary Schools By Grade						
School	K (n=194)	1st (n=202)	2nd (n=199)	3rd (n=209)	4th (n=242)	5th (n=239)
Bellview	7.7%	4.2%	2.8%	8.2%	6.1%	0.0%
Briscoe	18.2%	15.8%	13.6%	18.3%	28.6%	9.6%
Helman	15.4%	7.5%	12.1%	6.7%	11.1%	7.1%
Lincoln	19.6%	25.9%	13.5%	25.0%	12.8%	9.3%
Walker	27.0%	14.3%	32.7%	18.8%	15.3%	29.6%
Average	17.3%	14.9%	15.2%	14.8%	13.8%	11.5%

Walker Elementary is significantly higher in exemptions than other elementary schools, in both Tables 2 and 3; in the above, Walker is the highest for three out of six grade levels. While overall the rate of exemption is increasing, this pattern is less obvious in individual schools. For example, Walker's grade with the highest exemption rate is the second grade, with 32.7% of students exempt, followed by their fifth grade at 29.6% of students.

Public Middle Schools

Ashland Middle School and Pinehurst School District both provide middle school services. Pinehurst had 14 students in the 6th through 8th grades and two exemptions. Ashland Middle School, with 791 students, had a total exemption rate of 13%. Many of these exemptions were added in response to changes in immunization requirements for 7th graders in school year 2000/2001.

Public High School

Ashland High School is the only public high school in Ashland. With 1,195 students, the size of the school itself could facilitate the spread of vaccine-

preventable disease. Ashland High School has an 8.9% exemption rate, with the highest rate of exemption in the 12th grade.

Immunizations among Students with Exemptions

The November review of exemptions on a school-by-school basis also provided information about immunizations received by students with current exemptions. The State of Oregon’s ALERT immunization registry supplemented the school-based record of immunizations received by students with exemptions.

	Diphtheria (4 or more doses)	Tetanus (3 or more doses)	Measles Containing Vaccines (1 or more doses)	Varicella (1 or more doses)
Ashland Public Schools				
Bellview Elementary (n=11)	41.7%	75.0%	9.1%	50.0%
Briscoe Elementary (n=45)	16.7%	27.8%	2.9%	16.1%
Helman Elementary (n=24)	21.7%	34.8%	15.0%	43.8%
Lincoln Elementary (n=47)	22.9%	39.6%	14.3%	29.7%
Walker Elementary (n=66)	18.3%	38.3%	13.2%	22.4%
Ashland Middle School (n=103)	28.3%	34.3%	19.3%	52.3%
Ashland High School (n=106)	11.8%	14.7%	0.0%	17.2%
Average	20.5%	21.8%	9.8%	29.7%

Table 4 presents the immunization rates for students with religious exemptions to immunization. The listed ‘n’ for each school is the number of exempt students. Most of these immunizations were received prior to their exemptions, as is the case with past receipt of immunizations during well-baby visits. Some exemptions appear to apply only to certain vaccinations, rather than to all, because some parents specifically object to, e.g., measles containing vaccines (MCVs) or varicella immunization. Here the lowest rate of immunization among exempt students is for MCVs. This matches with anecdotal evidence that parents have a higher level of objection to MCVs than to others. The current recommendation for measles is two immunizations; Table 4 counts as complete students with a single immunization, as many grades currently only require one, and one

immunization will provide at least partial immunity. In addition, a single immunization suffices for mumps or rubella. Note that immunizations for diphtheria and tetanus are usually given in combination, in a DTaP series. The fourth shot in the early DTaP series, or a later fifth booster, is usually given for the purpose of ensuring adequate diphtheria coverage.

Discussion

While it is difficult to estimate the chances that an infectious disease such as measles or varicella will be introduced in Ashland, it is possible to estimate what could happen afterwards because of low immunization rates. The principle focus on a vaccine-preventable risk here is for measles, with lesser focus on tetanus and pertussis.

Measles

Measles is considered by medical experts no longer to be indigenous to the United States⁴. However, measles is still endemic in much of Asia and the Pacific Rim. The majority of reported cases of measles in the US are traceable to a foreign source, coming here either from Americans traveling abroad or from foreign visitors and students. International students at SOU, foreign high school students, visitors at the Shakespearean Festival, and Ashland residents returning from abroad are all potential introducers of measles into Jackson County. To the extent that Ashland has a greater international connection than the majority of small Oregon cities, it is at higher risk for a re-introduction of measles.

Recent European Measles Outbreaks in Partially Vaccinated Populations

As with the US, measles cases in Europe are expected to result from introduction from abroad rather than indigenous sources. Two recent outbreaks in Europe demonstrate the potential for measles to be reintroduced to a partially immunized population. The first, an outbreak in 1999/2000 in the Netherlands, started in a religious group objecting to vaccinations. From five initial clusters, this outbreak produced 2,961 measles cases⁵. The second and more recent instance is from 2002 in southern Germany, where the population is estimated to have only a 60% coverage rate for two measles vaccinations. As of March 2002, over 700 cases of measles have been reported in this outbreak⁶.

Recent U.S. Measles Outbreaks

Despite high levels of vaccination, the U.S. has experienced several measles outbreaks during the 1990's. The most recent large outbreak occurred in Alaska in 1998, when a student traveling in Japan returned with measles. Of a reported 33 cases, 51% occurred in the local high school. In this instance, while most of the students catching measles had one vaccination, few had a second measles vaccination⁷. Where there are large numbers of contacts among students, such as in high schools, a single measles vaccination is not sufficient to convey "herd" immunity to the group. Experiences like those led to the requirement for a second measles vaccination.

An outbreak occurred in Utah in 1996, with 107 cases, with a median age of 14 years. This outbreak started in a high school with a case in an unvaccinated student. Redolent of the situation in Ashland, this outbreak occurred in the Utah county with the highest level of school religious exponents, and in the school district with the highest exemption levels in the county⁸. This outbreak is discussed further below.

Other US outbreaks have occurred in the 1990's in connection with groups with low vaccination rates, such as in 1994 among students in Christian Science schools in Missouri and Illinois⁹. During 1989 to 1991, there was a general resurgence of measles in the United States. This resurgence was in part due to complacency about the non-appearance of the disease and resulting declines in immunization levels.

Measles Risk

Measles is perhaps the most contagious disease known to man, and is spread by the airborne route. The number of people catching it from a single, initial case is largely a function of the number of susceptible people who come into the same room with the infectious party. Schools and families are both good places for measles to spread. While the risk of initial introduction of measles seems to fall more on older students and adults, families and other mixed-age social settings provide a route for the spread of measles into younger ages. People in close contact with measles, without prior vaccination or exposure, are likely to catch the disease nine out of ten times. A single measles vaccination has been estimated to provide approximately 95% protection against catching measles¹⁰. A second measles vaccination provides 99% protection. In a school setting with a large, mixed population of vaccinated once, twice, and un-vaccinated students, the concern is that not

only are the unvaccinated at risk, but that they will act as source for spread of the disease into those with only a single vaccination.

Recent studies in the Journal of the American Medical Association (JAMA) have addressed the risk of measles in partially vaccinated populations. A study of measles in Colorado by Feiken, et al., determined that those with religious exemptions are 22 times as likely to catch measles than those with at least one vaccination¹¹. The same study suggested that this rate might be almost three times higher for preschool and primary school students, and that the risk of spreading measles from unvaccinated to partially vaccinated students is greatest in the daycare and primary school ages. Another study by Salmon, et al., in the Journal of the American Medical Association in 1999 estimated the risk of catching measles for those with exemptions at 35 times that of those with a vaccination¹².

In the 1996 Utah outbreak, the attack rate of measles in the vaccinated population was measured at approximately 1%, while the attack rate among the unvaccinated and exempt was 33%¹³. These figures were reported in the Center for Disease Control's MMWR for August 27th, 1997. The attack rate is the percentage of the exposed population that actually caught measles. This implies a vaccine efficiency of 97%, and a risk of catching measles for an exempt student that is 33 times greater than for one with vaccinations. This figure is consistent with those cited above from Feiken, et al., and Salmon, et al.

In a school setting, the factors that influence the risk of measles spreading include the size of classes and the number of unvaccinated students. Larger classes imply more potential contacts. These two features determine a critical threshold for measles, such that an initial case of measles will continue to spread to at least a second round of infected kids¹⁴. Table 5 presents critical thresholds for the current levels of religious exemption and enrollment in Ashland schools. Note that most schools have a higher observed level of exemptions than their critical levels needed to sustain an outbreak.

The calculation of a critical threshold here is based upon the observed attack ratios in the Utah outbreak¹⁵. Other assumptions include that the initial infected student will come into close contact with all of their class, and with 5% of other students in their school. This is a conservative assumption compared to those made in other studies such as that of Salmon, et al.¹⁶, and

does not include the risk of spreading measles to another class or school through siblings or contacts outside of school such as in restaurants or while shopping. Additionally, exemptors reporting at least one measles vaccination were not included in the observed exemption rate in Table 5.

Table 5: Chances of Measles Outbreaks in Ashland Schools			
	Exemption Rate		Measles
	Observed	Critical Value	Likely to Spread?
Preschool			
ABC Christian Daycare	0%	33%	No
Ashland Family YMCA	14%	8%	Yes
Chautauqua Garden School	16%	14%	Yes
Children's World Montessori	18%	7%	Yes
Crescent Moon Nursery	100%	15%	Yes
Grace Lutheran (preschool)	13%	8%	Yes
Kid's House Preschool	18%	11%	Yes
Lil' Rascals Preschool	7%	7%	No
Schneider Children's Center	15%	8%	Yes
Private Schools			
Children's World Montessori (k & 1st)	5%	13%	No
Grace Lutheran (k to 4th)	6%	7%	No
Rogue Valley Christian School(k to 12)	3%	14%	No
Lithia Springs(highschool)	3%	18%	No
Public- Elementary			
Pinehurst (k thru 5 th)	16%	31%	No
Bellview Elementary	4%	7%	No
Briscoe Elementary	18%	7%	Yes
Helman Elementary	11%	9%	Yes
Lincoln Elementary	18%	7%	Yes
Walker Elementary	23%	6%	Yes
Public Middle and High Schools			
Pinehurst (6th, 7th & 8th)	14%	22%	No
Ashland Middle School	13%	2%	Yes
Ashland High School	9%	1%	Yes

Other Vaccine-Preventable Diseases

Pertussis

Pertussis ("whooping cough") is more common but not as infectious as measles. Salmon, et al. estimate that those with exemptions to vaccination are six times as likely to catch pertussis as those with complete vaccinations¹⁷. Pertussis vaccine is not required for attendance in Oregon schools and children's facilities. Other issues regarding pertussis are its potential to re-emerge not only among children, but also among adults due to waning immunity. Pertussis can be fatal in infants.

Tetanus

Tetanus is more of an individual risk than a community risk, but it is noteworthy that at least 10% of Ashland students have no filed documentation of having completed the initial series for tetanus immunity. In the case of acute injuries, whether received as a student or adult, vaccine may not induce antibodies quickly enough to prevent tetanus. For adults, tetanus risk is related to accidental injury, occupational category, working with soil and animals in any capacity, and injection drug users.

Summary

As discussed earlier, the results of the review of immunization records for religious exemptors in Ashland showed low rates of immunization for all required antigens. Of particular concern is the vaccination rate for measles, where only an average of 9.8% of exemptors have documentation of meeting the required number of measles-containing vaccine doses. Critical threshold calculations clearly show that if measles were ever introduced, disease spread would be likely in most of Ashland's schools.

Several limiting factors affect the ability to design appropriate interventions to lower the number of exemptors in Ashland. Some of these factors include: attitudes of parents who sign exemptions; attitudes of medical practitioners who provide immunizations; and attitudes of school personnel. In order to investigate some of these factors, Jackson HHS has decided to conduct additional information gathering activities.

The first activity, a brief survey of parents of students in Ashland schools, will be designed to gather views about immunization for children in general and about immunizations specifically for their children. It will also attempt

to determine if negative attitudes about immunization derive from personal experiences with shots or from information received from outside sources. It is expected that the survey will be conducted in Summer 2002.

To determine the views of local medical practitioners, Jackson HHS will sponsor an open forum where pediatricians, family practitioners, general practitioners and naturopaths can openly discuss views expressed by their patients, as well as their own views, about immunizations. It is expected that the forum will be scheduled in Summer 2002.

Endnotes

- ¹ From the Southern Oregon University website, www.sou.edu.
- ² The names and enrollments for public schools are from the Oregon Department of Education website, www.ode.state.or.us; the names and enrollments for private schools are from the Primary Review Summaries, 2001.
- ³ From the Department of Human Services website, www.ohd.hr.state.or.us/imm/law.
- ⁴ Centers for Disease Control and Prevention. Epidemiology of Measles – United States, 1998. *MMWR* 1999;48(34):749-753.
- ⁵ Centers for Disease Control and Prevention. Epidemiology of Measles – United States, 1998. *MMWR* 1999;48:749-753.
- ⁶ Centers for Disease Control and Prevention. Measles Outbreak ---- Netherlands, April 1999--January 2000. *MMWR* 2000; 49(14):299-303.
- ⁷ Centers for Disease Control and Prevention. Measles Outbreak Among School-Aged Children -- Juneau, Alaska, 1996. *MMWR* 1996; 45(36):777-780.
- ⁸ Centers for Disease Control and Prevention. Measles Outbreak -- Southwestern Utah, 1996. *MMWR* 1997; 46(33):766-769.
- ⁹ Centers for Disease Control and Prevention. Outbreak of Measles Among Christian Science Students -- Missouri and Illinois, 1994. *MMWR* 1994; 43(25):463-465.
- ¹⁰ Centers for Disease Control and Prevention. Measles. In: *The pink Book: Epidemiology and Prevention of Vaccine-Preventable Disease*. 7th Edition, 2002:104.
- ¹¹ Feiken DR, Hamman RF, Chen RT. Individual and Community Risks of Measles and Pertussis Associated with Personal Exemptions to Immunization. *JAMA* 2000; 284(24):3145.
- ¹² Salmon DA, Gangarosa EJ, Smith NJ. Health Consequences of Religious and Philosophical Exemptions from Immunization Laws. *JAMA* 1999; 282(1):47.
- ¹³ Centers for Disease Control and Prevention. Measles Outbreak -- Southwestern Utah, 1996. *MMWR* 1997; 46(33):766-769.
- ¹⁴ The phrase “critical threshold” is used here synonymously with the epidemiologist’s phrase of “basic reproduction number”; which is summarized by Herbert Hethcote as “... the threshold quantity that determines when an infection can invade and persist in a new host population”. From Hethcote, “*The Mathematics of Infectious Disease*”, in the *SIAM Review*, Vol 42, No 4 pp.593-653, published electronically at <http://www.siam.org/journals/sirev/42-4/37190.html>.
- ¹⁵ Mathematical derivation.
- ¹⁶ Salmon DA, Gangarosa EJ, Smith NJ. Health Consequences of Religious and Philosophical Exemptions from Immunization Laws. *JAMA* 1999; 282(1):47
- ¹⁷ Salmon DA, Gangarosa EJ, Smith NJ. Health Consequences of Religious and Philosophical Exemptions from Immunization Laws. *JAMA* 1999; 282(1):47