Relative Public Health of Vaccine Workgroup: Report of the Economic Subgroup

Internal Document Only

Washington State Department of Health
Community and Family Health
Immunization Program CHILD Profile

October 18, 2006

I. Introduction

Washington's universal vaccine distribution system, which provides vaccine without cost for children younger than 19 years, is stressed by the increasing number and cost of new vaccines. The universal system now provides vaccine for 14 different vaccine-preventable diseases at a public sector cost of $823 per child. This is an increase of 7 vaccines and $637 per child over what was required 10 years ago. The Advisory Committee on Immunization Practices currently recommends children and adolescents receive 31 shots by the time they are 18 years old, not including influenza. This growth trend is expected to continue over the next few years.

As a result of these unceasing fiscal pressures, Washington State may be faced with the decision to move away from a universal vaccine distribution system to some version of a modified system (known as "universal select" in some circles). As preparation for discussing possible system changes, the Department of Health (the department) and its partners began preparing a thorough policy analysis of options to the universal vaccine distribution system.

The department has been engaged in multiple policy conversations over the past year. Some of the projects include a panel discussion at the 2005 Washington State Joint Conference on Health, the Vaccine Summit sponsored by the Washington Chapter of the American Academy of Pediatricians, and the soon to be implemented Vaccine Management Business Improvement Project with the Centers for Disease Control and Prevention. The Relative Public Health Value of Vaccine Workgroup (the workgroup) is also one of these projects.

The workgroup was created to provide recommendations to the department on criteria to determine the relative public health value of vaccine. The criteria could then be applied to existing universally available vaccines and any new vaccines using a consistent methodology in order rank them. If feasible, this process would provide the department with a method to make difficult decisions should there be inadequate resources to fund all recommended vaccines.

To date, the workgroup has developed a list of criteria to be used as the basis for evaluating vaccines. These criteria are grouped into four categories:

- Public Health Factors (e.g., vaccine effectiveness);
- Economic Factors (e.g., vaccine cost);
- Other Considerations (e.g., public perception); and
- Implications of Systems Change (e.g., rescinding state supplied vaccine).

(For the complete list of criteria, see Appendix A.)

At the December 5, 2005 meeting, the workgroup noted there are no core economic criteria or formulas for comparative vaccine analysis available. The

workgroup recommended, and the department approved, that a subgroup be created to evaluate economic formulas and models to determine if a comparative economic evaluation of vaccines is feasible.

To begin the work of determining if a comparative economic evaluation of vaccines is feasible, the economic subgroup considered the merits and limitations of the cost-effectiveness and the cost-benefit analysis models. Also discussed was a cost-benefit analysis published on December 5, 2005 in the Archives of Pediatric and Adolescent Medicine entitled "Economic Evaluation of the 7-Vaccine Routine Childhood Immunization Schedule in the United States, 2001." (See Appendix B). The objective of this research was to "evaluate the economic impact of the routine US childhood immunization schedule." This article provided the economic subgroup with the potential methodology to estimate cost-benefit indexes for Washington State. Considering the options, the economic subgroup decided to proceed with a state level cost-benefit and cost-effectiveness analysis for three antigens, measles, mumps, and rubella, based on this national study.

II. Limitations

The primary limitation of using the national analysis as the basis for state analysis is that cost and benefit data is limited to the vaccines evaluated in the national study. Any application of the methodology for new vaccines is limited by available data and resources.

III. Cost-Benefit and Cost-Effectiveness Analyses

METHODOLOGY

The purpose of this study is to evaluate the economic value of MMR, the vaccine that is used for the prevention of measles, mumps, and rubella. Following the national study, "Economic Evaluation of the 7-Vaccine Routine Childhood Immunization Schedule in the United States, 2001", a retrospective, pre-post cost-offset study was used to examine the benefits as well as the medical and social costs of disease.

Benefit is defined as costs saved or averted in this study and is estimated as the difference between pre- and post-vaccination period medical and social costs of disease. Benefit data was taken directly from the national study. 2001 direct and indirect benefits (costs saved-converted) and their cases saved were used to calculate per-case benefit (costs saved) figures for the three diseases. These benefit figures were then converted to 2005 dollar values and applied to the actual Washington State cases to estimate the total benefits (savings) for the MMR vaccine.

Actual state-specific disease cases and death figures were used to calculate benefits (costs saved). The average disease cases and number of deaths during

the ten years preceding vaccine licensure was used for the pre-vaccination period and the average figures for cases and deaths during the most recent 5 years of data available (2001-2005) was used for the post vaccination period. Table 1 below contains case and death data for all 3 diseases.

TABLE 1: MEASLES, MUMPS, AND RUBELLA CASES AND DEATHS[1]	
Measles	
1953 – 1962	**2001 – 2005**
Pre Vaccination Period	**Post Vaccination Period**
Case average: 14,805 (range 9,271 – 22060)	Case average: 4 (range 0 – 15)
Case rate average: 542.4/100,000 (range 320 – 844)	Case rate average: 0.08/100,000 (range 0.0 – 0.3)
Average number of deaths per year: 4.8 (range 1 – 12)	Average number of deaths per year: 0
Mumps	
1957 – 1966	**2001 – 2005**
Case average: 11,955 (range 6,137 – 21,496)	Case average: 3 (range 2 – 11)
Case rate average: 408.5/100,000 (range 226 – 715)	Case rate average: 0.04/100,000 (range 0.0 – 0.2)
Average number of deaths per year: 0.4 (range 0 – 1)	Average number of deaths per year: 0
Rubella	
1959 – 1968	**2001 – 2005**
Case average: 7,289 (range 2038 – 25,258)	Case average: 3 (range 2 – 11)
Case rate average: 246.7/100,000 (range 61 – 824)	Case rate average: 0.0/100,000
Average number of deaths per year: 0.3 (range 0 – 1)	Average number of deaths per year: 0

A conversion index was used to extrapolate the cost data for Washington State from the national study. The conversion factor is the ratio of the estimated Washington State birth cohort to the 3,803,295 hypothetical national level birth cohort used in the national study. This can be expressed as a 2.16% conversion index. Per-case costs of vaccine were calculated from these extrapolated state cost figures. The 2005 actual state cost of vaccine for MMR were then used to adjust these extrapolated per-case costs of vaccine. To estimate the actual state-specific total costs for MMR vaccination, these per-case cost figures were applied to the 2005 Washington State actual birth cohort.

State-specific costs and benefits were then compared to obtain total net benefits, direct net benefits, and total and direct benefit-cost ratios. Cost-effectiveness is expressed as total cost per death prevented and total cost per case prevented.

RESULTS

Costs

Table 2 below lists the state direct and indirect costs of vaccinating children for measles, mumps, and rubella. State costs are extrapolated from the national study using the 2.16% conversion index described in the "Methodology" section of this report.

The extrapolated per child costs were then made state-specific by applying the ratio between the actual 2005 Washington State cost of vaccine ($34.56) and the extrapolated cost of vaccine ($31) as shown in Table 2. The adjusted per child costs were then multiplied by the 2005 Washington State actual birth cohort of 81,347 to obtain the state-specific costs of vaccination. Table 2 below shows the state-specific direct, indirect, and total costs of vaccination.

TABLE 2: SUMMARY OF STATE COSTS FOR MMR VACCINE

	Extrapolated Total Costs	Extrapolated Unit Costs	State-Specific Unit Costs	State-Specific Total Costs
Direct:				
Vaccine costs	2,572,614	31.00	34.6	2,811,353
Administration costs	2,425,171	29.00	32.6	2,650,228
Adverse events (Direct)	420,068	5.00	5.6	459,051
Travel	256,003	3.00	3.4	279,760
Direct Subtotal	5,673,857	69.00	76.2	6,200,392
Indirect:				
Parental time lost	1,243,079	15.00	16.7	1,358,437
Adverse events (Indirect)	39,223	0.00	0.5	42,863
Indirect Subtotal	1,282,302	16.00	17.2	1,401,300
TOTAL	6,956,159	85.00	93.5	7,601,691

BENEFITS

Benefit is defined as costs saved or averted in this analysis. We used costs saved figures from the national study data to calculate per-case benefits for the Washington study. Benefit (costs saved) figures were converted to their 2005 dollar values using a 19% medical inflation adjustment factor for the

direct costs and a 14% general inflation adjustment factor for the total costs saved. The shaded lines in Table 3 show the per case direct and total benefits for the three diseases

TABLE 3. DIRECT AND TOTAL BENEFITS (COSTS SAVED) FOR US (2001)

Note: same as Table 4. in the national study article

Disease	Benefits: Prevented or Saved by Vaccination Program				
	Extrapolated Number of Cases	Direct Costs (Millions) 2001 $	Total Costs (Millions) 2001 $	Per Case Direct Costs Saved(Millions) 2005 $	Per Case Total Costs 2005 $
Measles	3,433,036	2,645	5,874	917	1,951
Mumps	2,095,917	934	1,456	530	792
Rubella	1,784,030	88	380	59	243

The per-case benefit figures were then multiplied by Washington-specific numbers of cases averted (pre-vaccination cases less post-vaccination cases) to calculate the state-specific direct and total benefits (cost savings) for measles, mumps, and rubella. Table 4 below shows the direct and total costs saved calculated by using extrapolated per case costs from the national study and actual Washington State cases.

TABLE 4: STATE-SPECIFIC DIRECT AND TOTAL COSTS SAVED WITH VACCINATION

Disease	Number of Cases Averted	Number of Deaths Averted	Per Case Direct Costs Saved	Per Case Total Costs Saved	State Direct Costs Saved	State Total Costs Saved
Measles	14,801	4.8	917	1,951	13,570,172	28,870,313
Mumps	11,954	0.4	530	792	6,338,118	9,465,264
Rubella	7,388	0.3	59	243	433,665	1,793,962
Total	**34,143**	**5.5**			**20,341,955**	**40,129,539**

BENEFIT-COST RATIO

Table 5 below illustrates the direct and total benefit-cost ratios for measles, mumps, and rubella vaccination.

TABLE 5: STATE-SPECIFIC BENEFIT-COST RATIOS	
Total Costs	$7,601,691
Total Benefits	$40,129,539
Total Net Benefits	$32,527,847
Benefit-Cost Ratio	**5.3**
Direct Costs	$6,200,392
Direct Benefits	$20,341,955
Direct Net Benefits	$14,141,536
Benefit-Cost Ratio	**3.3**

Cost Effectiveness Analysis

Table 6 below represents cost-effectiveness as cost per death prevented and cost per case prevented with measles, mumps, and rubella vaccination.

TABLE 6: STATE-SPECIFIC COST-EFFECTIVENESS RESULTS	
Deaths Prevented	6
Total Cost per Death Prevented	**$1,382,126**
Cases Prevented	34,149
Total Cost per Case Prevented	**$223**

Comparisons: Extrapolated VS Actual Washington State Disease and Death Cases

Table7 below shows the extrapolated state case and death figures from the national analysis using the conversion index of 2.16% and the actual numbers of cases and deaths used in this Washington-specific analysis.

TABLE 7: CASES AND DEATHS FROM MEASLES, MUMPS, AND RUBELLA WASHINGTON STATE EXTRAPOLATED VS ACTUAL DISEASE CASES

	Disease	No. of Cases US	No. of Deaths US	Conversion Index	No. of Cases WA	No. of Deaths WA
Extrapolated	Measles	3,433,036	2,794	2.16%	74,154	60
Extrapolated	Mumps	2,095,917	11	2.16%	45,272	0
Extrapolated	Rubella	1,784,030	14	2.16%	38,535	0
Actual	Measles				14,805	4.8
Actual	Mumps				11,955	0.4
Actual	Rubella				7,389	0.3

It is noteworthy that the extrapolated cases of disease and deaths from disease are significantly higher than the actual cases and deaths from Washington State data. The extrapolated numbers of disease cases and deaths were roughly five times greater than the actual disease case and death numbers. The differences may be related to the difference in the pre and post period timeframe used to quantify cases and deaths. It could also be that incidence of disease is more random throughout the country than the 2.16% conversion index indicates.

As a result of these differences in data, benefits, benefit-cost ratios, and cost-effectiveness results were 5 times greater for extrapolated numbers than for state-specific numbers. Tables 8, 9, and 10 below illustrate these differences

TABLE 8: DIRECT AND TOTAL COSTS SAVED FROM MEASLES, MUMPS, AND RUBELLA WA ST. EXTRAPOLATED VS ACTUAL DISEASE CASES

		Benefits: Saved with Vaccination		
	Disease	No. of Cases	Total Direct costs Saved $	Total Total Costs Saved $
Extrapolated	Measles	74,208	68,036,593	151,095,255
Extrapolated	Mumps	45,305	24,025,016	37,452,274
Extrapolated	Rubella	38,563	2,263,599	9,774,634
Extrapolated	Total	158,075	94,325,209	198,322,162
Actual	Measles	14,801	13,570,172	28,870,313
Actual	Mumps	11,952	6,338,118	9,465,264
Actual	Rubella	7,388	433,665	1,793,962
Actual	Total	34,143	20,341,955	40,129,539

TABLE 9: COMPARISON OF EXTRAPOLATED AND STATE-SPECIFIC BENEFIT-COST RATIOS		
	State-Specific Data	**Extrapolated Data**
Total Costs	$7,601,691	$6,956,159
Total Benefits	$40,129,539	$190,283,674
Total Net Benefits	$32,527,847	$183,237,515
Benefit-Cost Ratio	**5.3**	**27.4**
Direct Costs	$6,200,392	$5,673,857
Direct Benefits	$20,341,955	$93,923,229
Direct Net Benefits	$14,141,536	$88,249,372
Benefit-Cost Ratio	**3.3**	**16.6**

TABLE 10: COMPARISON OF EXTRAPOLATED AND STATE-SPECIFIC COST-EFFECTIVENESS RESULTS		
	State-Specific Data	**Extrapolated Data**
Deaths Prevented	6	61
Total Cost per Death Prevented	**$1,382,126**	**$114,158**
Cases Prevented	34,149	$158,075
Total Cost per Case Prevented	**$223**	**$44**

Conclusions

1. Considerable time and resources were saved by extrapolating cost and benefit data from the national study. Had this information not been available, it is unknown how resource intensive this analysis would have been.

2. Even with the limitations articulated in section II, this analysis demonstrates that the methodology and formulas used in the national study can be successfully applied at the state level by using a combination of extrapolated and state-specific data. Consequently, a ranked list using the variables identified in this analysis can be created for the vaccines included in the national analysis.

3. The differences noted in tables 7 through 10 above do not affect the validity of this activity. The Relative Public Health Value of Vaccine Workgroup is charged with developing criteria to rank vaccines relative to one another. Vaccines can be ranked using the methodology and formulas from this analysis as long as they are applied consistently to the vaccines and the state-specific results are not compared to extrapolated national results.

IV. Recommendations

1. Apply the methodologies in this analysis to the other 6 vaccines evaluated in the national study. This activity is estimated to take approximately _____ additional FTEs to complete.

2. Given the number of new vaccines, limited incidence data for certain illnesses, limited cost and benefit data, and limited state resources; further state-level cost-benefit and cost-effectiveness analysis of vaccines not included in the national analysis does not appear feasible.

3. Review all workgroup criteria to determine which are addressed by the national and state level analyses, keeping in mind that other criteria not included have risks and benefits associated with them. For example, the implications of removing a vaccine from the universal distribution system in order to add a new higher ranked vaccine could be more important than the comparative value the vaccines hold.

4. Use the national and state level analyses as part of a broader evaluation of the workgroup's criteria to develop a methodology to demonstrate the relative value of vaccines without relying exclusively or in large part on cost-benefit or cost-effectiveness data.

5 Brainstorm other methods to determine how the universal vaccine distribution system might be modified to address the stress on the system other than relative ranking of vaccines.

---

[1] Need reference for numbers in this table.