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An assessment of the health and economic outcomes of the Advisory Committee on Immunization Practices (ACIP) recommended adult immunization schedule across US states and within low-income populations – a mathematical model

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BACKGROUND

- State-level aggregate health and economic outcomes associated with the Advisory Committee on immunization Practices (ACIP)-recommended adult immunization schedule (A-IS) have not been studied previously
- Outcomes in special populations such as adults eligible for Medicaid's new health care reform provisions may also be of interest
- Vaccination has been shown to prevent substantial morbidity and mortality and reduce cost, providing immense public health benefit in a US pediatric cost-benefit modeling study[1]; an analysis of this kind has not been done previously in the US adult population

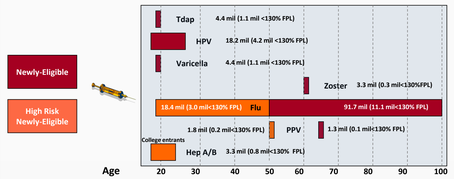
OBJECTIVE

- Use a mathematical model to investigate health and economic outcomes associated with the ACIP-recommended A-IS compared with no vaccination in each of the United States and for Medicaid-eligible populations[2] under new health care reform provisions (<130% of the Federal Poverty Level - FPL)

METHODS

- A cross-sectional, newly-eligible population analysis was performed in which adults (18+ years) were assumed to receive vaccinations as they became eligible based on ACIP guidelines[3]* (Figure 1)

Figure 1: Adult populations eligible for vaccination



- Incremental per-person estimates of discounted costs (updated to 2009$), discounted quality-adjusted life-years (QALYs), and undiscounted disease cases avoided for target vaccinations versus no vaccination were derived from published cost-effectiveness studies (Table 1) [4-11]

* ACIP also recommends adult vaccination against measles-mumps-rubella (MMR) and meningococcal virus for selected adults. However, no published estimates were identified for cost-effectiveness in the adult population, nor are MMR and meningococcal vaccine recommended for all adults. Revised 2010 flu recommendations have not been included in the present analysis.

Table 1. Model Inputs: Per-Patient Estimates of Incremental Costs and Quality-Adjusted Life-Years (QALYs)

Vaccine	Age of Eligibility (years)	Characteristics	Cost/ Person	QALYs/ Person	Case Definition	Cases Avoided/ 100,000
Tetanus, Diphtheria, Pertussis[4]	19	All	$25.41	0.0003	*[None Reported]*	N/R
Human Papillomavirus (HPV)[5]	18-26	Women	$146.00	0.0156	Cervical cancer	149
Varicella*[6]	19	All	$20.54	0.0019	*[None Reported]*	N/R
Herpes Zoster[7]	60	All	$118.83	0.0010	*[None Reported]*	N/R
Influenza (Flu)**[8,9]	19-49	High risk	($1.18)	0.0006	Flu hospitalization	49
	50-64	Healthy	$44.64	0.0009	Flu hospitalization	32
	50-64	High risk	($55.71)	0.0035	Flu hospitalization	162
	65+	All	$40.48	0.0081	Flu hospitalization	313
Pneumococcal polysaccharide[10]	50,65	High risk 50; Healthy: 65	$6.02	0.0014	Invasive Pneumococcal Disease (IPD)	251
Hepatitis A and Hepatitis B[11]	18-24	College entrants	$104.46	0.0091	Acute Hepatitis A hospitalization	169
					Acute Hepatitis B hospitalization	158
					Chronic Hepatitis B hospitalization	2,236

*Varicella strategy analyzed is universal testing, followed by vaccination on positive test result; ** Flu vaccination is annual

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METHODS (continued)

- Health-related outcomes and costs were summed within each state and for the adults with income <130% FPL according to the age-distribution within the target population (Figures 1-2)
- The average state population was estimated as 5,800,000, ranging from 520,000 (WY) to 35,760,000 (CA)
- The average state <130% FPL population was estimated as 1,010,000, ranging from 90,000 (WY) to 7,190,000 (CA)
- Total incremental costs, QALYs, and potential cases avoided were calculated in each state, and then per 100,000 persons in a "normalized" analysis

Figure 1: State age distributions (All FPL levels)

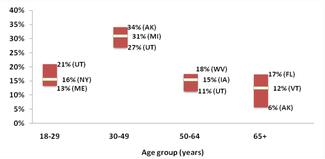
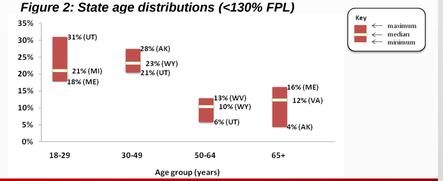


Figure 2: State age distributions (<130% FPL)



RESULTS

- Compared with no vaccination, the adult vaccination schedule was economically favorable in each state with incremental costs per 100,000 persons at or below $2.33 million for all adults, and $2.73 million for adults with income <130% FPL
- Incremental QALYs gained per 100,000 persons were estimated at or below 290 for all adults and 330 for those with income <130% FPL

Figure 3: Top 5 States by Incremental Costs and QALYs Gained

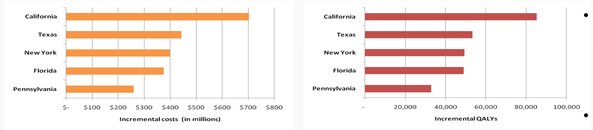


Figure 4: Top 5 States by Incremental Costs and QALYs gained (normalized)

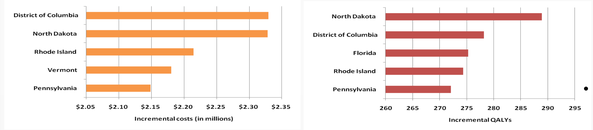
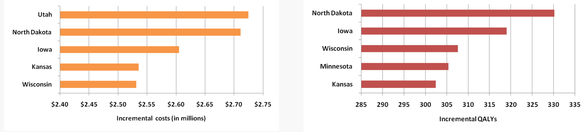


Figure 5: Top 5 States by Incremental Costs and QALYs gained in <130% FPL population (normalized)



- California, the most populous state, would benefit most from A-IS but would also be the most costly (Figure 3)
- In a normalized analysis, North Dakota is estimated to gain the most QALYS per 100,000 population, while Washington DC has the highest incremental costs (Figure 4)
- Figure 5 displays the results of the normalized analysis in the <130% FPL population
- The A-IS was most economically favorable in Florida, the state with the oldest population, with minimal variation across states

RESULTS (continued)

- Appropriate A-IS vaccination of newly-eligible adults in the total US population, compared to no vaccination, could potentially prevent 165,000 hospitalized flu cases annually and 119,000 lifetime serious cases (cervical cancer, invasive pneumococcal disease, hepatitis hospitalizations) across all states
- Among those with the lowest income, compared with no vaccination, 23,000 hospitalized flu cases annually, and 28,000 lifetime serious cases of disease potentially could be prevented across all states (Table 2)

Table 2. Total Cases Potentially Avoided

	Hospitalized Influenza (Flu)		Cervical Cancer		Invasive Pneumococcal Disease (IPD)		Acute Hepatitis A hospitalization		Acute Hepatitis B hospitalization		Chronic Hepatitis B hospitalization	
	All FPL Levels	<130% FPL	All FPL Levels	<130% FPL	All FPL Levels	<130% FPL	All FPL Levels	<130% FPL	All FPL Levels	<130% FPL	All FPL Levels	<130% FPL
National	165,083	23,485	27,122	6,208	7,686	866	5,546	1,376	5,185	1,287	73,381	18,212
Minimum *	253	21	48	10	13	1	10	2	9	2	132	30
Maximum **	17,790	2,401	3,433	873	846	97	705	189	659	177	9329	2503
Median	2,295	337	369	89	106	12	72	20	68	18	958	262

* In the total population, the minimum hospitalized flu cases could be avoided in Alaska and the minimum cervical cancer, IPD, and all hepatitis cases could be avoided in Wyoming. In the population<130% FPL, Alaska could have the minimum cases avoided (all reported case types).

**In both the overall and <130% FPL population, the maximum number of cases could be avoided in California

LIMITATIONS

- It should be noted that this analysis compares a scenario in which newly eligible adults are vaccinated in accordance with the ACIP schedule, versus a scenario with no vaccination at all
- Estimates in this analysis are based on results from individual studies carried out over period of almost 10 years from 1999 (varicella) through 2009 (HPV); thus, estimates from older studies may be outdated with respect to costs of vaccination, disease-related costs, and disease incidence
- Costs are estimated from the payer perspective
- Indirect (herd) effects from unprotected individuals receiving benefit due to a decreased likelihood of coming into contact with an infected individual were not factored into the current analysis; therefore, the results of the present study may underestimate benefits of vaccination
- This analysis does not account for any interaction between infections from multiple diseases or economies of scope from coordination of vaccination programs and bundling of vaccine services
- The cost effectiveness of HPV vaccination in this analysis is limited to cervical cancer prevention
- Source studies make assumptions on healthcare delivery costs which may not take into account regional differences in the delivery of healthcare, or the use of complementary sites for vaccination
- Source studies may not take into account annual variation in influenza disease burden and vaccine match
- Generation of additional data for further study is necessary in order to overcome the limitations of this review and to provide stronger evidence

CONCLUSIONS

- Our modeling results suggest that implementing adult immunization according to the current ACIP schedule has the potential to substantially reduce disease burden across all states and to be economically favorable
- States with relatively large populations and states with relatively older populations would benefit the most

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