Ranking Vaccines: Applications of a Prioritization Software Tool

Committee on Identifying and Prioritizing New Preventive Vaccines for Development, Phase III

NVAC, 10 February 2015

INSTITUTE OF MEDICINE
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A Multi-User Approach

2012

http://www.nap.edu/catalog.php?record_id=13382

2013

http://www.nap.edu/catalog/13531/ranking-vaccines-a-prioritization-software-tool-phase-ii-prototype-of

2014

http://www.nap.edu/catalog.php?record_id=18763

A Multi-Criteria Approach

Health Considerations	• Premature Deaths Averted per Year • Incident Cases Prevented per Year • QALYs Gained or DALYs Averted
Economic Considerations	• Net Direct Costs (Savings) of Vaccine Use per Year • Workforce Productivity Gained per Year • One-Time Costs • Cost-Effectiveness ($/QALY or $/DALY)
Demographic Considerations	• Benefits Infants and Children • Benefits Women • Benefits Socioeconomically Disadvantaged • Benefits Military Personnel • Benefits Other Priority Population
Public Concerns	• Availability of Alternative Public Health Measures • Potential Complications Due to Vaccines • Disease Raises Fear and Stigma in the Public • Serious Pandemic Potential
Scientific and Business Considerations	• Likelihood of Financial Profitability for the Manufacturer • Demonstrates New Production Platforms • Existing or Adaptable Manufacturing Techniques • Potential Litigation Barriers Beyond Usual • Interests from NGOs and Philanthropic Organizations
Programmatic Considerations	• Potential to Improve Delivery Methods • Fits into Existing Immunization Schedules • Reduces Challenges Relating to Cold-Chain Requirements
Intangible Values	• Eradication or Elimination of the Disease • Vaccine Raises Public Health Awareness
Policy Considerations	• Interest for National Security, Preparedness, and Response • Advances Nation's Foreign Policy Goals
User-Defined Attributes	• Up to Seven Attributes

A compliant version of the table can be found on Page 34

Use Case Scenarios

Public Health Agency of Canada

STATE OF NEW YORK DEPARTMENT OF HEALTH

POONAWALLA GROUP

SERUM INSTITUTE OF INDIA LTD.

SALUD

SECRETARÍA DE SALUD

ESTADOS UNIDOS MEXICANOS

Microsoft

Logo sources: http://trybarefoot.ca/wp-content/uploads/2013/01/Public-Health-Canada.jpg;http://vaccinenewsdaily.com/wp-content/uploads/2013/03/New_York_State_Department_of_Health_Logo.jpg; http://www.moneycontrol.com/news_image_files/2012/s/Serum_Institute_190.jpg; http://portal.salud.gob.mx/; http://inntrending.com/microsoft-logo-2014/

Key New Features in SMART Vaccines 1.1

www.nap.edu/smartvaccines

Expanded Set of Nations

SMART Vaccines

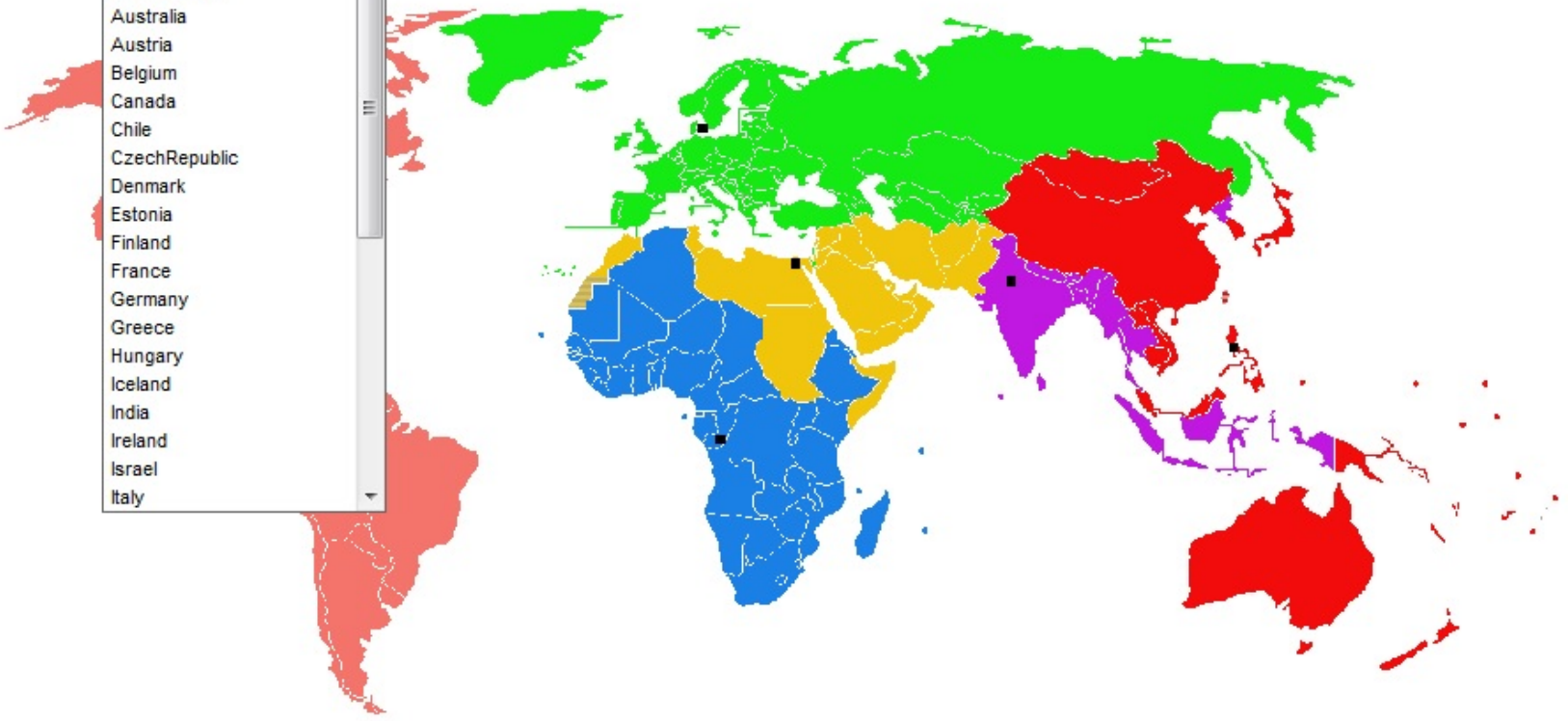
Specify: ● Population ○ Disease ○ Vaccine

Evaluate: ○ Attributes ○ Weights ○ Priorities

Select the country or region and sub-population. NOTE: SMART Scores are calculated for the total population.

Population: select

- select
- UnitedStates
- Australia
- Austria
- Belgium
- Canada
- Chile
- CzechRepublic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- India
- Ireland
- Israel
- Italy



SMART Scores

SMART Vaccines

Specify: ○ Population ○ Disease ○ Vaccine
Evaluate: ○ Attributes ○ Weights ◉ Priorities

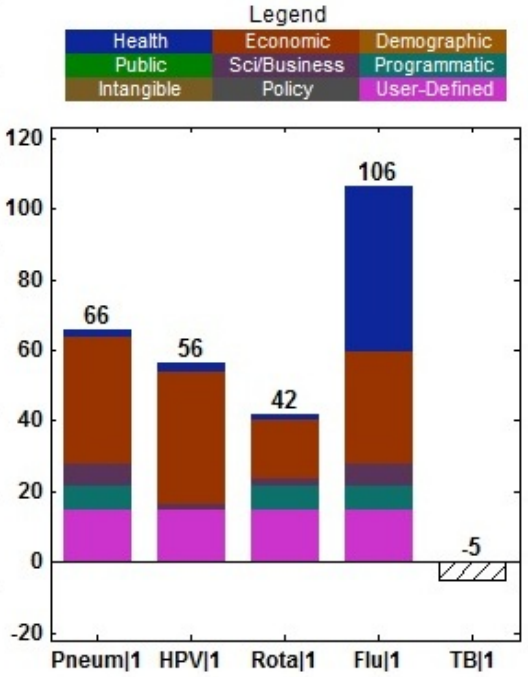
Select vaccine candidates to compare. Set attributes and scores. View SMART Score calculated for total population.
NOTE: Orange highlighted scores have been altered in Analysis; Vaccine Profile.

United States Vaccine Candidates: Values (Scores)

Attributes Selected	Pneumo|vac...	HPV|vaccine1	Rota|vaccin...	Flu|vaccine1	TB|vaccine1
Incident Cases Prevented per Year	6562 (0)	2340 (0)	222928 (4)	6119401 (122)	6580 (0)
Quality adjusted life-years (QALYs) Gained	7725 (8)	13416 (13)	2965 (3)	136271 (136)	7035 (7)
Cost-Effectiveness ($/QALY)	-1030 (101)	-3264 (103)	54194 (46)	10836 (89)	118126 (-18)
Demonstrates New Production Platforms	yes (100)	yes (100)	yes (100)	yes (100)	no (0)
Existing or Adaptable Manufacturing Techniques	yes (100)	no (0)	no (0)	yes (100)	no (0)
Potential to Improve Delivery Methods	yes (100)	no (0)	yes (100)	yes (100)	no (0)
Impact on Public Education	fav... (100)	fav... (100)	fav... (100)	fav... (100)	ad... (0)

NOTE: Hatched bars contain negative scores.

SMART Score



Analysis
◉ Assessment ○ Weights
○ Vaccine Profile ○ Print

Transparent Results

SMART Vaccines

Specify: ● Population ● Disease ● Vaccine

Evaluate: ● Attributes ● Weights ◉ Priorities

Print

09-Sep-2014 13:55:59

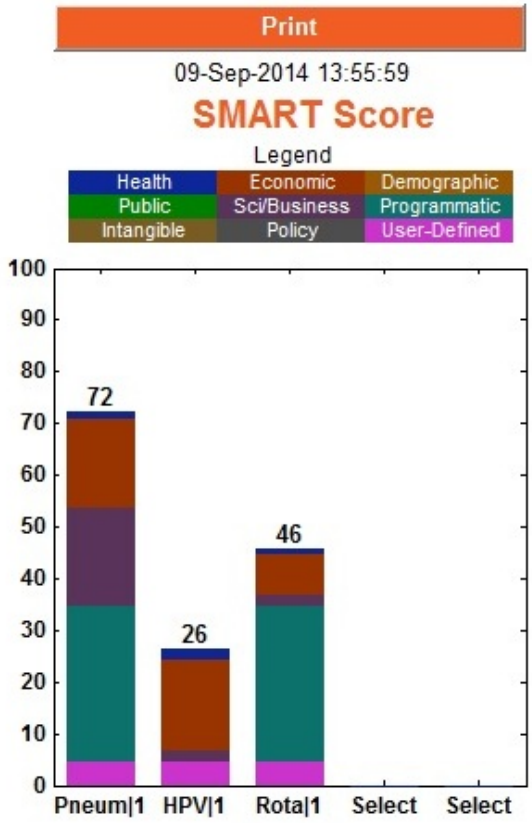
Output

Attribute	Weight	Pneumo vaccine1 Value	Pneumo vaccine1 Score	HPV vaccine1 Value	HPV vaccine1 Score	Rota vaccine1 Value	Rota vaccine1 Score
Incident Cases Prevented per Year	15%	6562	0	2340	0	222928	4
Quality adjusted life-years (QALYs) Gained	14%	7725	8	13416	13	2965	3
Cost-Effectiveness ($/QALY)	17%	-1030	101	-3264	103	54194	46
Demonstrates New Production Platforms	2%	yes	100	yes	100	yes	100
Existing or Adaptable Manufacturing Techniq...	17%	yes	100	no	0	no	0
Potential to Improve Delivery Methods	30%	yes	100	no	0	yes	100
Impact on Public Education	5%	favora...	100	favora...	100	favora...	100

Input

Vaccine Characteristics	Pneumo vaccine1	HPV vaccine1	Rota vaccine1
Coverage	35%	33%	67%
Effectiveness	41%	90%	74%
Length of Immunity (years)	Life	Life	Life
Doses Required per Person (number)	3	3	3
Cost per Dose ($)	$10	$10	$6
Cost to Administer per Dose ($)	$10	$10	$10
R&D and Licensure Costs ($ Millions)	< $100	> $1 billion	< $100
Likelihood of Licensure within 10 Years (%)	100%	100%	100%

SMART Score



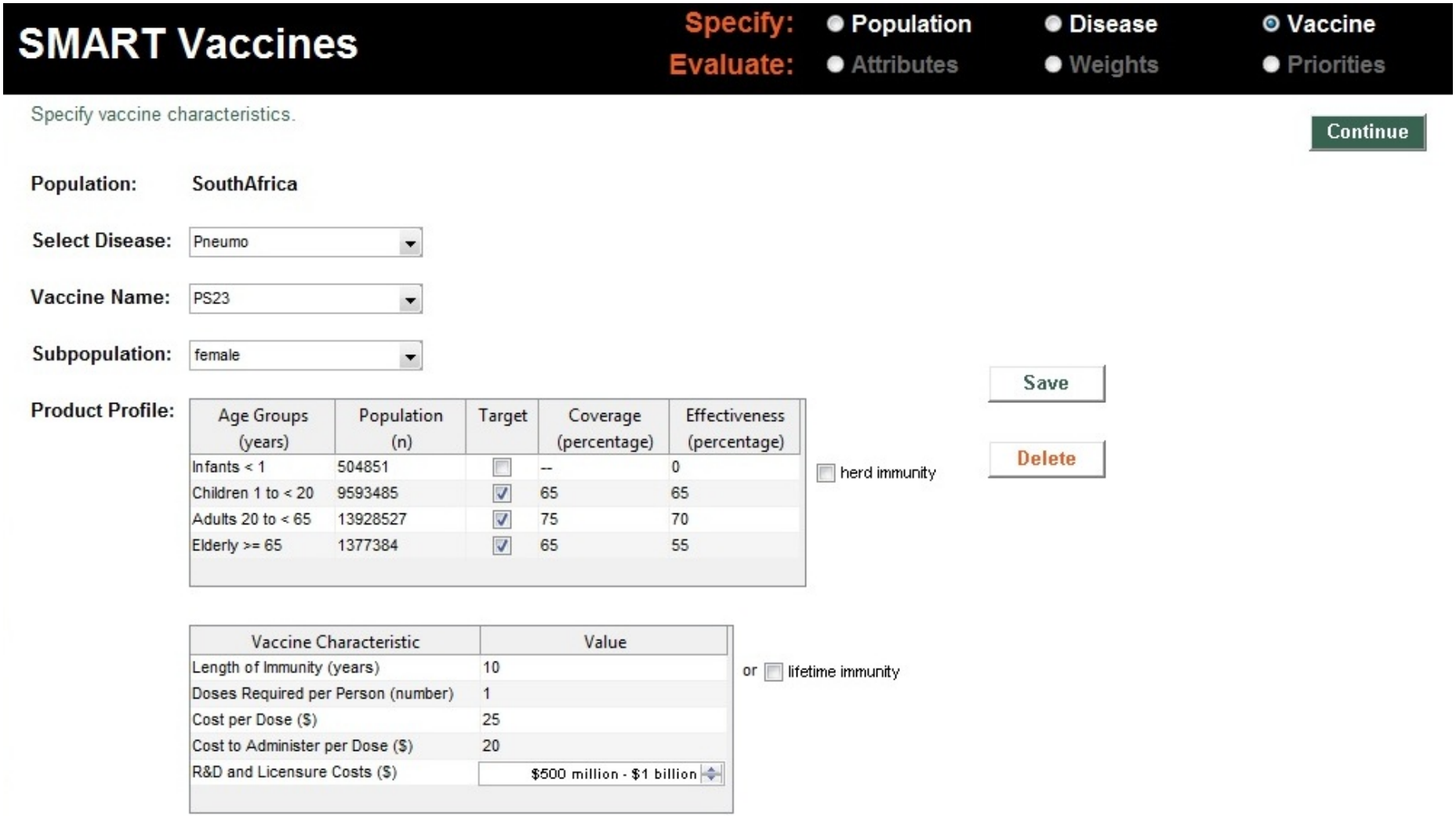
Analysis

○ Assessment ○ Weights

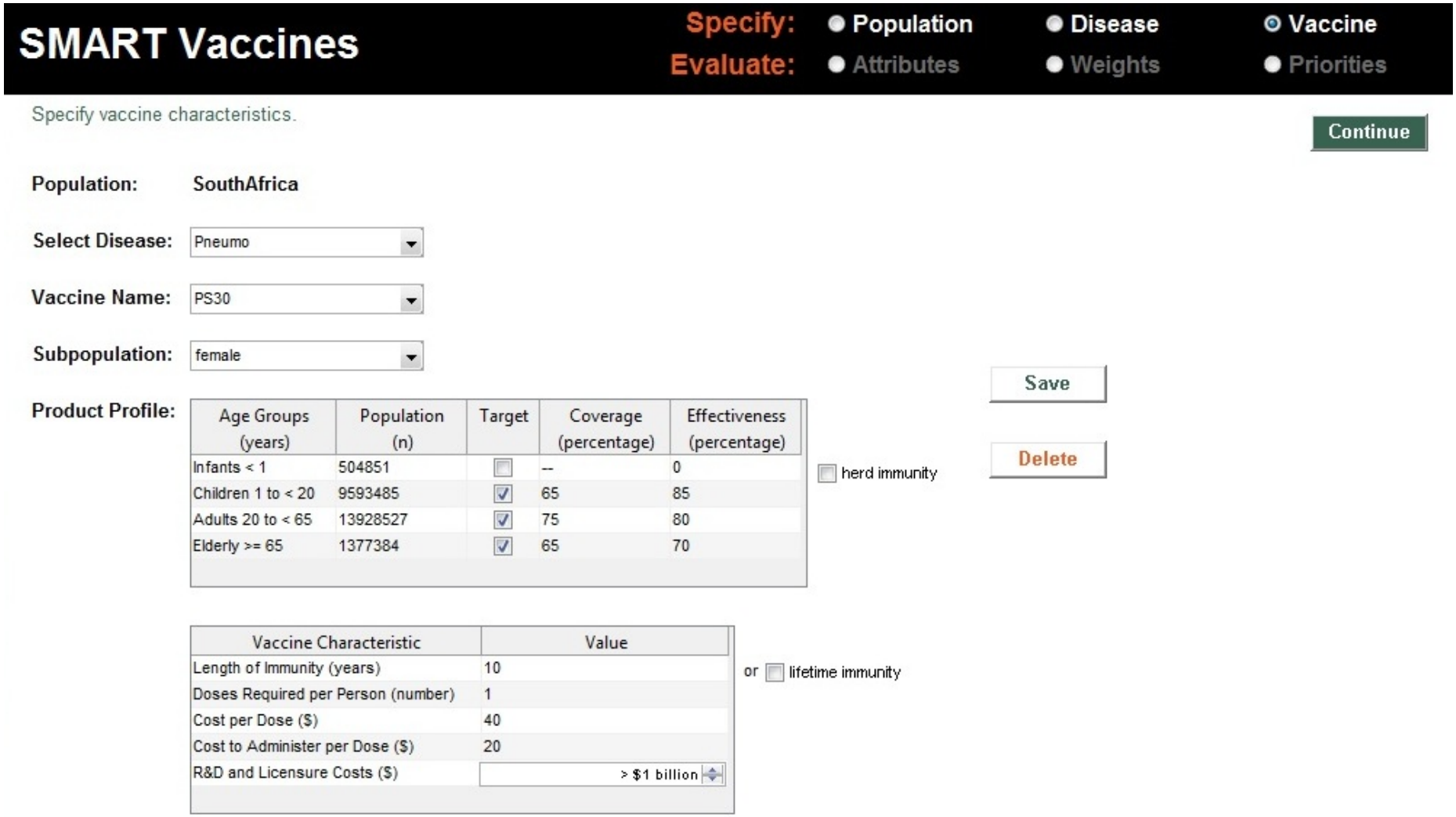
○ Vaccine Profile ◉ Print

Product Profile Design Using SMART Vaccines 1.1

Characteristics of PS23



Characteristics of PS30



Characteristics of PC

SMART Vaccines

Specify: ● Population ● Disease ◉ Vaccine

Evaluate: ● Attributes ● Weights ● Priorities

Specify vaccine characteristics.

Continue

Population: SouthAfrica

Select Disease: Pneumo

Vaccine Name: PC

Subpopulation: female

Save

Delete

Product Profile:

Age Groups (years)	Population (n)	Target	Coverage (percentage)	Effectiveness (percentage)
Infants < 1	504851	☑	70	70
Children 1 to < 20	9593485	☑	65	75
Adults 20 to < 65	13928527	☑	75	80
Elderly >= 65	1377384	☑	70	65

☐ herd immunity

Vaccine Characteristic	Value
Length of Immunity (years)	10
Doses Required per Person (number)	3
Cost per Dose ($)	30
Cost to Administer per Dose ($)	20
R&D and Licensure Costs ($)	$100 - $500 million

or ☐ lifetime immunity

Attributes and Weights

SMART Vaccines

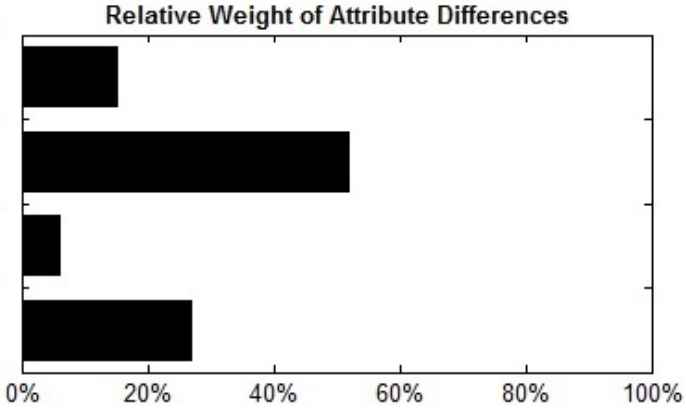
Specify: ● Population ● Disease ● Vaccine

Evaluate: ● Attributes ◉ Weights ● Priorities

Rank attributes in order of importance (1 = MOST IMPORTANT) and fine tune weights.

Continue

Attributes Selected	Least Favorable	Most Favorable	Rank	Modify	Weight
Premature Deaths Averted per Year	0	5000	3		15%
Quality adjusted life-years (QALYs) Gained	0	100000	1		52%
Net Direct Costs (Savings) of Vaccine Use per Year (Millions)	50	0	4		6%
Cost-Effectiveness ($/QALY)	10000	0	2		27%



Initial SMART Scores

SMART Vaccines

Specify: ● Population ● Disease ● Vaccine
Evaluate: ● Attributes ● Weights ● Priorities

Select vaccine candidates to compare. Set attributes and scores. View SMART Score calculated for total population.
NOTE: Orange highlighted scores have been altered in Analysis; Vaccine Profile.

SouthAfrica Vaccine Candidates: Values (Scores)

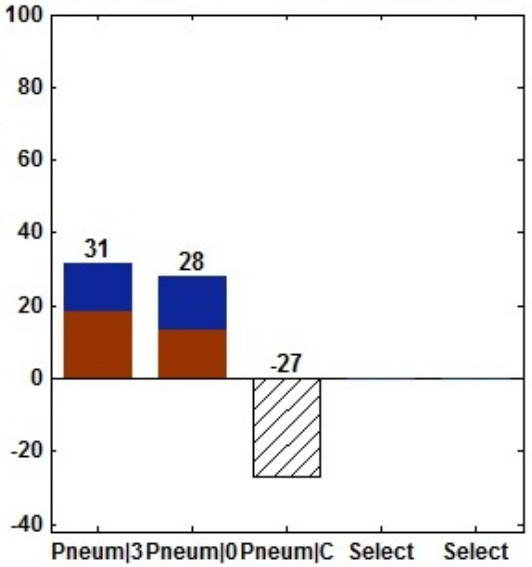
Attributes Selected	Pneumo|PS23	Pneumo|PS30	Pneumo|PC	Select	Select
Premature Deaths Averted per Year	1265 (25)	1444 (29)	1460 (29)		
Quality adjusted life-years (QALYs) Gained	16702 (17)	18930 (19)	19354 (19)		
Net Direct Costs (Savings) of Vaccine Use per Year (Millions)	20 (60)	39 (22)	204 (-309)		
Cost-Effectiveness ($/QALY)	4417 (56)	5412 (46)	18437 (-84)		

NOTE: Hatched bars contain negative scores.

SMART Score

Legend

Health	Economic	Demographic
Public	Sci/Business	Programmatic
Intangible	Policy	User-Defined



Analysis

● Assessment ○ Weights
○ Vaccine Profile ○ Print

Coverage Adjustment

SMART Vaccines

Specify: ● Population ● Disease ● Vaccine
Evaluate: ● Attributes ● Weights ◉ Priorities

Examine vaccine profile effects on attributes and SMART Score.

SouthAfrica Vaccine

Vaccine				
	Pneumo|PC			
Likelihood of Licensure within 10 Years	0%		100%	100%
Coverage (%)	0%		100%	80%
Effectiveness (%)	0%		100%	77%
Length of Immunity (Years)	1Yr		Life	10Yrs
Doses per Person	1		5	3
Cost per Dose	$1		$1,000	$30
Cost to Administer per Dose	$1		$1,000	$20
R&D and Licensure Costs ($100 Millions)	<$1		>$10	$5-10

Update

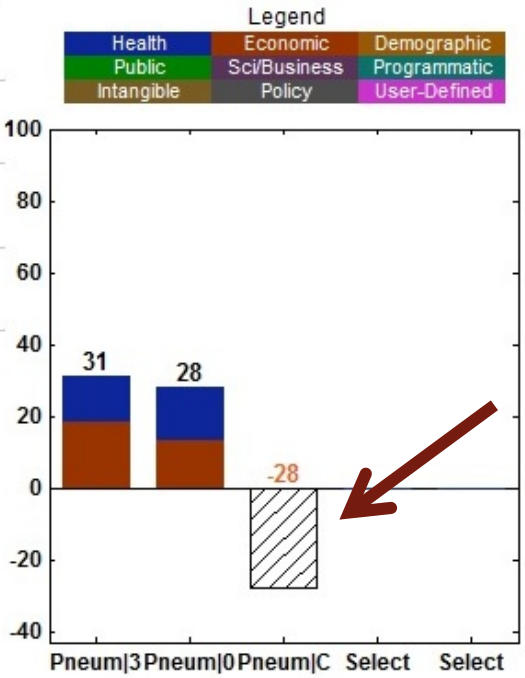
Vaccine updated

Coverage and effectiveness changes uniformly redistributed to vaccine target population sub-groups.

Attributes	Values (Scores)
Premature Deaths Averted per Year	1645 (33)
Quality adjusted life-years (QALYs) Gained	21805 (22)
Net Direct Costs (Savings) of Vaccine Use per Year (Millions)	230 (-361)
Cost-Effectiveness ($/QALY)	18412 (-84)

NOTE: Hatched bars contain negative scores.

SMART Score



Analysis

◯ Assessment ◯ Weights
◉ Vaccine Profile ◯ Print

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Effectiveness Adjustment

SMART Vaccines

Specify: ● Population ● Disease ● Vaccine
Evaluate: ● Attributes ● Weights ● Priorities

Examine vaccine profile effects on attributes and SMART Score.

SouthAfrica Vaccine

Vaccine: Pneumo|PC

Likelihood of Licensure within 10 Years	0%		100%	100%
Coverage (%)	0%		100%	71%
Effectiveness (%)	0%		100%	80%
Length of Immunity (Years)	1Yr		Life	10Yrs
Doses per Person	1		5	3
Cost per Dose	$1		$1,000	$30
Cost to Administer per Dose	$1		$1,000	$20
R&D and Licensure Costs ($100 Millions)	<$1		>$10	$5-10

Update

Vaccine updated

Coverage and effectiveness changes uniformly redistributed to vaccine target population sub-groups.

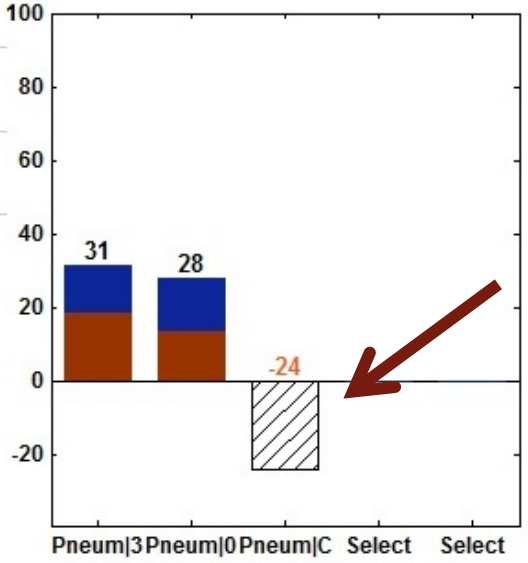
Attributes	Values (Scores)
Premature Deaths Averted per Year	1502 (30)
Quality adjusted life-years (QALYs) Gained	19902 (20)
Net Direct Costs (Savings) of Vaccine Use per Year (Millions)	202 (-305)
Cost-Effectiveness ($/QALY)	17652 (-77)

NOTE: Hatched bars contain negative scores.

SMART Score

Legend

Health	Economic	Demographic
Public	Sci/Business	Programmatic
Intangible	Policy	User-Defined



Analysis

● Assessment ● Weights
● Vaccine Profile ● Print

Immunity Adjustment

SMART Vaccines

Specify: ○ Population ○ Disease ○ Vaccine
Evaluate: ○ Attributes ○ Weights ◉ Priorities

Examine vaccine profile effects on attributes and SMART Score.

SouthAfrica Vaccine

Vaccine	Pneumo|PC			
Likelihood of Licensure within 10 Years	0%	100%	100%
Coverage (%)	0%	100%	71%
Effectiveness (%)	0%	100%	77%
Length of Immunity (Years)	1Yr	Life	15Yrs
Doses per Person	1	5	3
Cost per Dose	$1	$1,000	$30
Cost to Administer per Dose	$1	$1,000	$20
R&D and Licensure Costs ($100 Millions)	<$1	>$10	$5-10

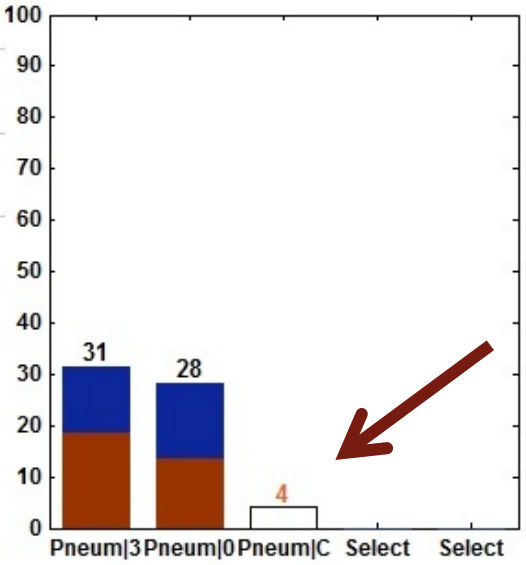
Update Vaccine updated

Attributes	Values (Scores)
Premature Deaths Averted per Year	1460 (29)
Quality adjusted life-years (QALYs) Gained	19354 (19)
Net Direct Costs (Savings) of Vaccine Use per Year (Millions)	113 (-125)
Cost-Effectiveness ($/QALY)	11142 (-11)

NOTE: Hatched bars contain negative scores.

SMART Score

Legend: Health | Economic | Demographic | Public | Sci/Business | Programmatic | Intangible | Policy | User-Defined



Analysis
○ Assessment ○ Weights
◉ Vaccine Profile ○ Print

Product Profile Change

SMART Vaccines

Specify: ○ Population ○ Disease ○ Vaccine
Evaluate: ○ Attributes ○ Weights ◉ Priorities

Examine vaccine profile effects on attributes and SMART Score.

SouthAfrica Vaccine

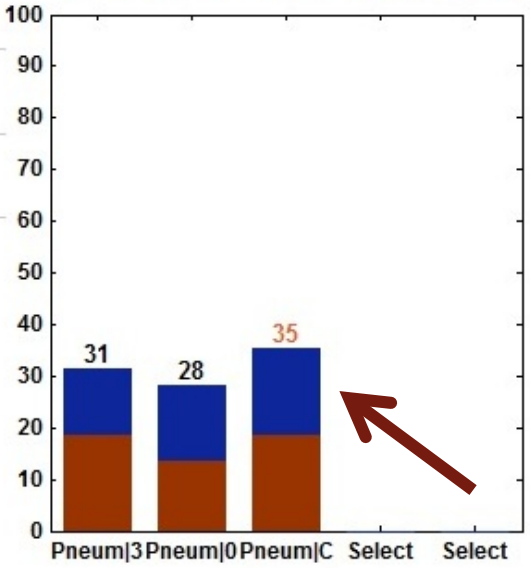
Vaccine				
	Pneumo|PC			
Likelihood of Licensure within 10 Years	0%	100%	100%	
Coverage (%)	0%	100%	80%	
Effectiveness (%)	0%	100%	80%	
Length of Immunity (Years)	1Yr	Life	15Yrs	
Doses per Person	1	5	2	
Cost per Dose	$1	$1,000	$20	
Cost to Administer per Dose	$1	$1,000	$20	
R&D and Licensure Costs ($100 Millions)	<$1	>$10	$5-10	

Update — Vaccine updated

Attributes	Values (Scores)
Premature Deaths Averted per Year	1693 (34)
Quality adjusted life-years (QALYs) Gained	22423 (22)
Net Direct Costs (Savings) of Vaccine Use per Year (Millions)	28 (44)
Cost-Effectiveness ($/QALY)	4050 (60)

SMART Score

Legend: Health | Economic | Demographic | Public | Sci/Business | Programmatic | Intangible | Policy | User-Defined



Analysis
○ Assessment ○ Weights
◉ Vaccine Profile ○ Print

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Beyond Cost-Effectiveness

SMART Vaccines

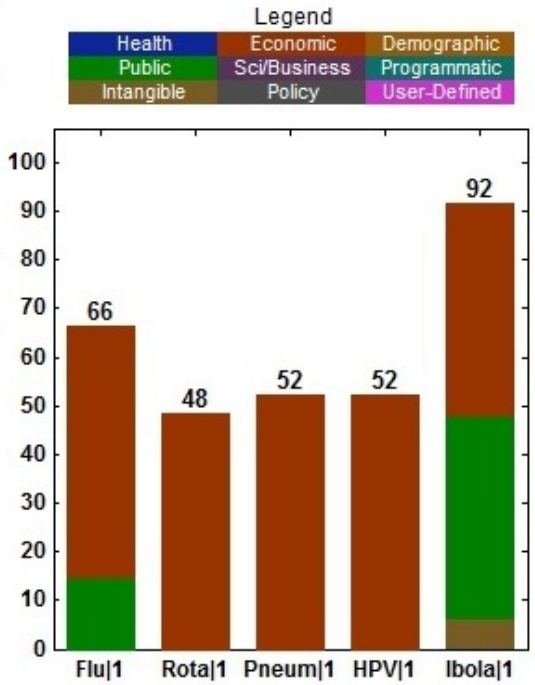
Specify: ○ Population ○ Disease ○ Vaccine
Evaluate: ○ Attributes ○ Weights ◉ Priorities

Select vaccine candidates to compare. Set attributes and scores. View SMART Score calculated for total population.
NOTE: Orange highlighted scores have been altered in Analysis; Vaccine Profile.

United States Vaccine Candidates: Values (Scores)

Attributes Selected	Flu|vaccine1	Rota|vaccin...	Pneumo|vac...	HPV|vaccine1	Ibola|vaccin...
Cost-Effectiveness ($/QALY)	10836 (99)	54194 (93)	-1030 (100)	-3264 (100)	125799 (84)
Disease Raises Fear and Stigma in the Public	no (0)	no (0)	no (0)	no (0)	yes (100)
Serious Pandemic Potential	yes (100)	no (0)	no (0)	no (0)	yes (100)
Eradication or Elimination of the Disease	no (0)	no (0)	no (0)	no (0)	yes (100)

SMART Score



Analysis
◉ Assessment ○ Weights
○ Vaccine Profile ○ Print

Demonstrated Benefits of SMART Vaccines

1. Transparency.
2. Discussion Facilitation.
3. Decision Convergence.

Guiding Principle

SMART Vaccines will have the greatest potential and value if it is programmed as a dynamic, continuously evolving software application and made freely available in an open-source environment to all decision makers and developers around the world.*

* *Ranking Vaccines: A Prioritization Software Tool* (Phase II, 2013).

Increasing Awareness

The committee places a strong emphasis on the importance of additional outreach and communication efforts to achieve the best use of SMART Vaccines.

IOM Dissemination Efforts

EMORY UNIVERSITY

Berkeley UNIVERSITY OF CALIFORNIA

UNIVERSITY of WASHINGTON

Institut Pasteur

THE JENNER INSTITUTE
DEVELOPING INNOVATIVE VACCINES
UNIVERSITY OF OXFORD

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

World Health Organization

Gavi The Vaccine Alliance

ecdc
EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

dcvmn
Developing Countries Vaccine Manufacturers Network

Logo sources: Google images

Going Forward

A transition strategy to a permanent home for SMART Vaccines is necessary for the ongoing use, enhancement, and the survival of the software as a tool for strategic planning.

Transition Process

The National Vaccine Program Office and the Fogarty International Center of the National Institutes of Health will be best served if they promptly create a process to facilitate the transition of SMART Vaccines to a permanent home.

Permanent Host

The ultimate future applications and benefits of SMART Vaccines depend on the strengths of the organization or consortium that becomes the permanent host.

Partnership Model

The committee believes not only that the best hosting organization will have a significant international presence and reputation, but also will best serve the user community if it is—or partners with—a research-intensive institution of higher education.

Community Development

The committee urges that a community of users, developers, and decision makers be created, fostered, and supported (most likely by the host of SMART Vaccines) to facilitate further use of the tool, data development and curation, and to guide additional software improvements and enhancements.

Data Requirements

The data requirements that may seem to loom large in the eyes of potential users are not created by the software itself—it merely brings them to the forefront. One cannot make intelligent, data-informed decisions about vaccine priorities without these data.

Web-based Platform

The committee believes that a fully Web-based version is an essential next step in the development of SMART Vaccines.

Critical R&D Priorities

1. Software enhancements.
2. Integrated database system development.
3. Community of users, developers, and decision makers.
4. Group consensus process.

Leading Change

As a multi-stakeholder decision support system, the software has the potential to change the practices of many parties in the vaccine enterprise—suppliers, users, and supporters of vaccine deployment, both domestically and internationally.

A Sense of Urgency

The economic challenges and profound changes seen in today's health care system should create a sense of urgency to improve disease prevention strategies using tools such as SMART Vaccines.

Health Considerations	• Premature Deaths Averted per Year • Incident Cases Prevented per Year • QALYs Gained or DALYs Averted
Economic Considerations	• Net Direct Costs (Savings) of Vaccine Use per Year • Workforce Productivity Gained per Year • One-Time Costs • Cost-Effectiveness ($/QALY or $/DALY)
Demographic Considerations	• Benefits Infants and Children • Benefits Women • Benefits Socioeconomically Disadvantaged • Benefits Military Personnel • Benefits Other Priority Population
Public concerns	• Availability of Alternative Public Health Measures • Potential Complications Due to Vaccines • Disease Raises Fear and Stigma in the Public • Serious Pandemic Potential
Scientific and Business Considerations	• Likelihood of Financial Profitability for the Manufacturer • Demonstrates New Production Platforms • Existing or Adaptable Manufacturing Techniques • Potential Litigation Barriers Beyond Usual • Interests from NGOs and Philanthropic Organizations
Programmatic Considerations	• Potential to Improve Delivery Methods • Fits into Existing Immunization Schedules • Reduces Challenges Relating to Cold-Chain Requirements
Intangible Values	• Eradication or Elimination of the Disease • Vaccine Raises Public Health Awareness
Policy Considerations	• Interest for National Security, Preparedness, and Response • Advances Nation's Foreign Policy Goals
User-Defined Attributes	• Up to Seven Attributes