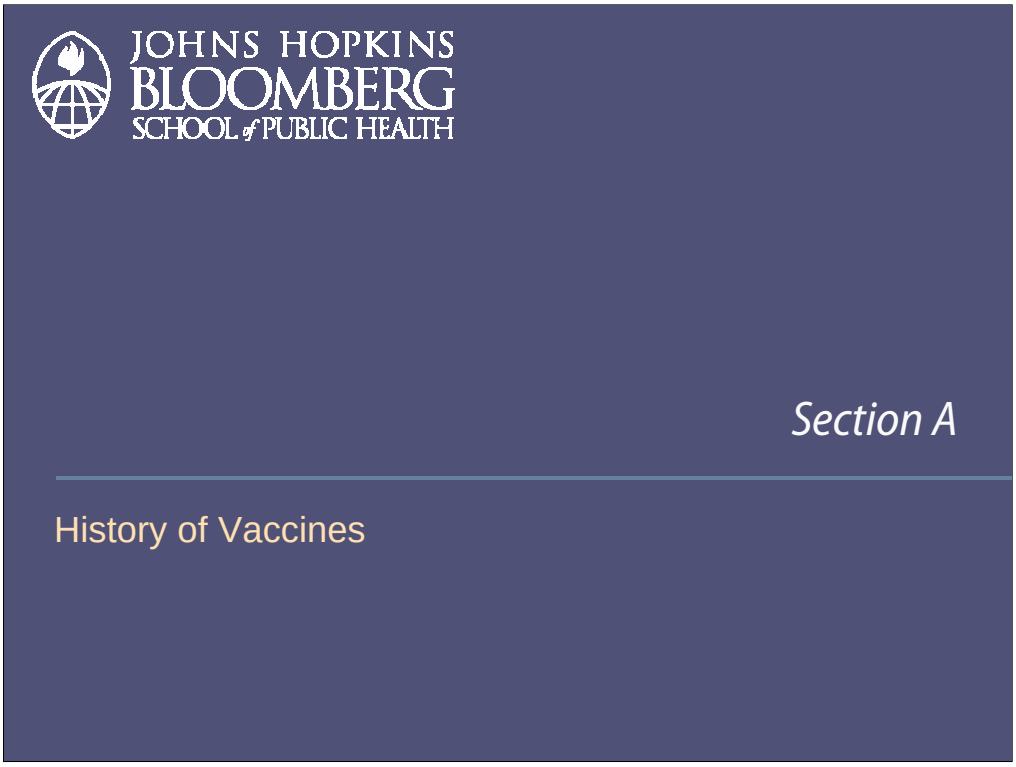
JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Vaccines and Vaccination Program Essentials

Michael J. McQuestion, PhD, MPH
Johns Hopkins University

Definition

- **Vaccine**: “A preparation of killed microorganisms, living attenuated organisms, or living fully virulent organisms that is administered to produce or artificially increase immunity to a particular disease” – Merriam-Webster Dictionary, 2005


JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH
Section A
History of Vaccines

Vaccine Timeline

- **1000 AD:** first records of Chinese variolation
- **1721:** Lady Mary Wortley Montagu, wife of British ambassador to Turkey, has first variolation in England performed on her three-year-old daughter
- **1796:** Edward Jenner uses cowpox viruses to vaccinate a child against smallpox

Vaccine Timeline

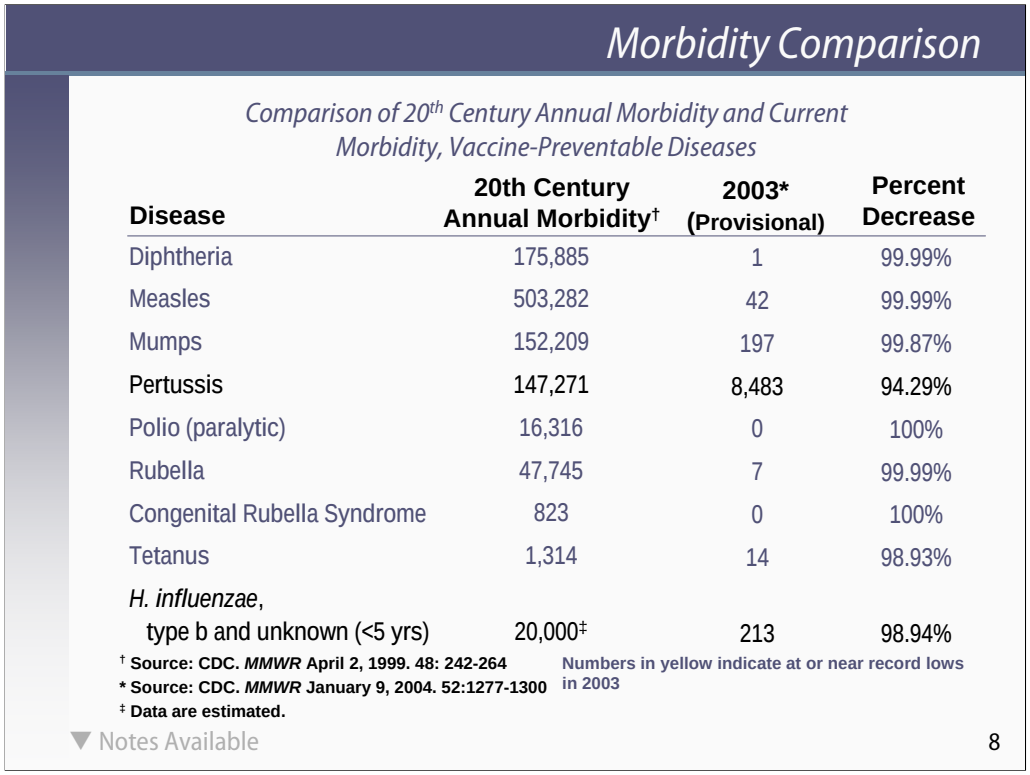
- **1881:** Louis Pasteur, Emile Roux, and Charles Chamberland publicly immunize livestock against anthrax
- **1885:** Pasteur vaccinates a nine-year-old boy against rabies
- **1896:** Richard Pfeiffer and Almoth Wright independently develop heat-inactivated typhoid vaccine

Vaccine Timeline

- **1921:** Camille Calmette and Alphonse Guerin develop attenuated BCG vaccine
- **1955:** Jonas Salk's inactivated polio vaccine
- **1960:** Albert Sabin's live attenuated oral polio vaccine
- **1963:** first measles vaccine licensed in United States

Vaccine Timeline

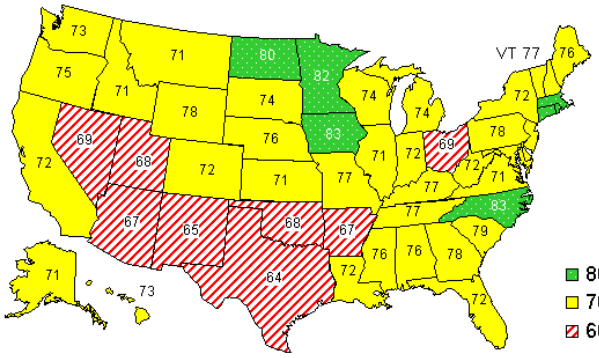
- **1971:** live attenuated measles/mumps/ rubella (MMR) vaccine licensed in United States
- **1981:** recombinant DNA hepatitis B vaccine
- **1985:** first Haemophilus influenzae B (Hib)
- **1989:** conjugate Hib vaccine licensed
- **2000:** pneumococcal conjugate vaccine (PCV) licensed



This favorite slide of Walt's demonstrates continued success of the program in achieving and maintaining record lows in virtually all of the vaccine-preventable diseases listed as indicated in yellow

Estimated Vaccination Coverage with the 4:3:1:3:3* Series, by Coverage Level and State

National Coverage = 73%

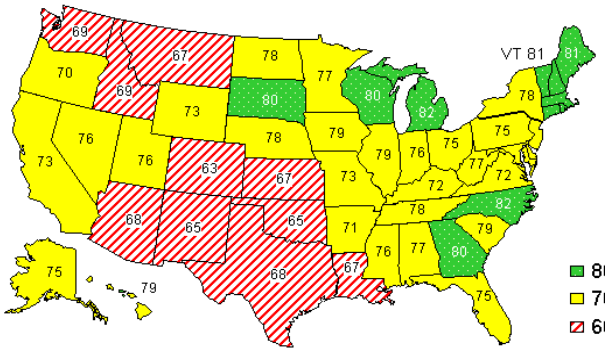


*4+DTP, 3+Polio, 1MCV, 3+Hib, 3+HepB

Source: National Immunization Survey, 2000
Children in the 2000 NIS were born between February 1997 and May 1999

Estimated Vaccination Coverage

Estimated Vaccination Coverage with the 4:3:1:3:3* Series, by Coverage Level and State
National Coverage = 75%



*4+DTP, 3+Polio, 1MCV, 3+Hib, 3+HepB

Source: National Immunization Survey, 2002
Children in the 2002 NIS were born between February 1999 and May 2001

SAFER·HEALTHIER·PEOPLE™

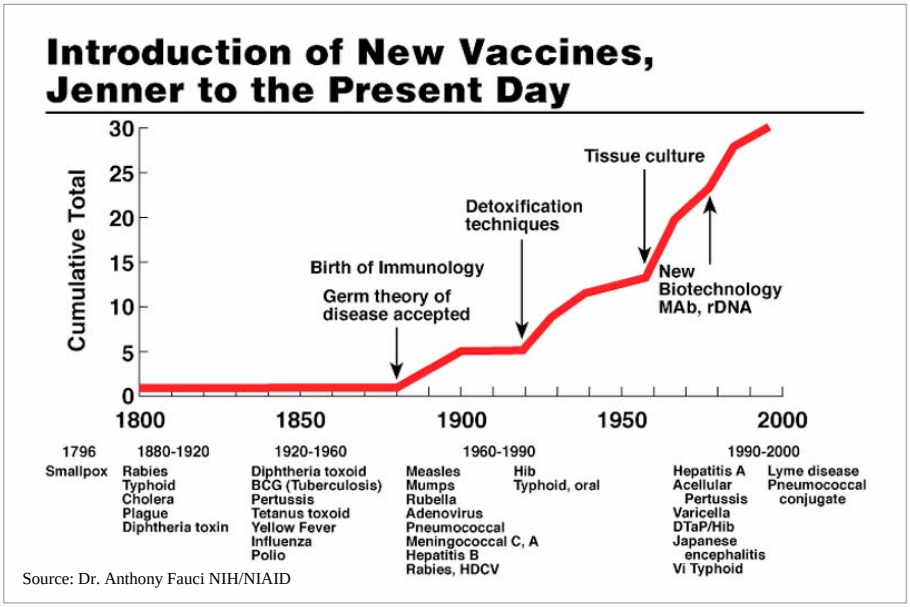
Printable Vaccine Schedule

- http://www.cdc.gov/nip/recs/child-schedule.htm#Printable

WHO-Recommended Vaccination Schedule

WHO-Recommended Vaccination Schedule			
Age	*Vaccine*	*Scheme A*	*Scheme B*
Birth	**BCG, OPV**	**HB1**	
6 weeks	**DPT1, OPV1**		
10 weeks	**DPT2, OPV2**		**HB2**
14 weeks	**DPT3, OPV3**	**HB3**	**HB3**
9 months	**Measles**		
	Yellow fever (where risk exists)		
	Hepatitis B Vaccine**		
**According to perinatal transmission rates From UNICEF, 1996			

Increased Demands



Source: Bruce Gellin, MD, MPH, Executive Director, National Network for Immunization Information. May 31, 2001, National Immunization Conference

Live Attenuated Vaccines

- Attenuated (weakened) form of the “wild” virus or bacteria
- Must replicate to be effective
- Immune response similar to natural infection
- Usually effective with one dose

CDC

Inactivated Vaccines

- Generally require 3–5 doses
- Immune response mostly humoral
- Antibody titer falls over time
- Principal antigen may not be defined

CDC

Types of Vaccines

- Inactivated
  - DPT, TT, DT
  - IPV
  - Hib
  - HepB
- Live attenuated
  - BCG
  - OPV
  - Measles, MMR

General Rules

- There are no contraindications to simultaneous administration of any vaccines—except cholera and yellow fever vaccines
- Increasing the interval between doses of a multi-dose vaccine does not diminish the effectiveness of the vaccine
- Decreasing the interval between doses of a multi-dose vaccine may interfere with antibody response and protection
- It is not necessary to restart the series of any vaccine* due to extended intervals between doses * (except oral typhoid vaccine in some circumstances)

CDC

Vaccine Efficacy

- Most routine childhood vaccines are effective for 85% to 95% of recipients

Source: WHO

Vaccine Adverse Reactions

- Adverse reaction
  - Extraneous effect *caused by the vaccine*
  - "Side effect"
- Adverse event
  - Any event following a vaccine
  - May be true adverse reaction
  - May be only coincidental

CDC

Adverse Events

Estimated Serious Adverse Events Rates Following Some Childhood Vaccines	
Vaccine	*Estimated Rate*
BCG	1 in 1,000 to 1 in 50,000 doses
OPV (Oral polio vaccine)	1 in 3 million doses for the first dose of OPV
Measles	1 in 1 million doses
DTP	1 in 750,000

Source: WHO

Contraindications and Precautions

- **Contraindication**
  - A condition in a recipient that greatly increases the chance of a serious adverse reaction
- **Precaution**
  - A condition in a recipient that may increase the chance of an adverse event
  - May compromise the ability of the vaccine to produce immunity

CDC

Continued

Contraindications and Precautions

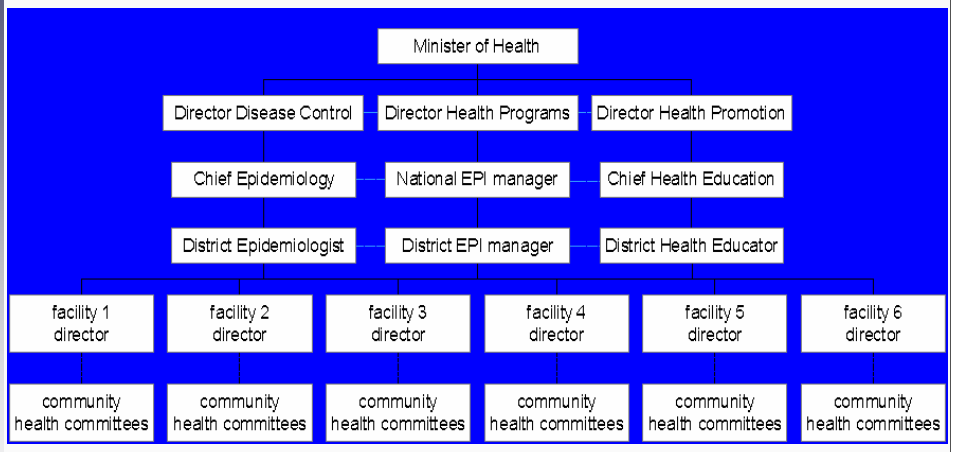
- Permanent contraindications to vaccination
  - Severe allergy to a prior dose of vaccine or to a vaccine component
  - Encephalopathy following pertussis vaccine
- In fact, serious adverse reactions to vaccination are rare, and the misdiagnosis of precautions and contraindications is a leading cause of missed vaccination opportunities

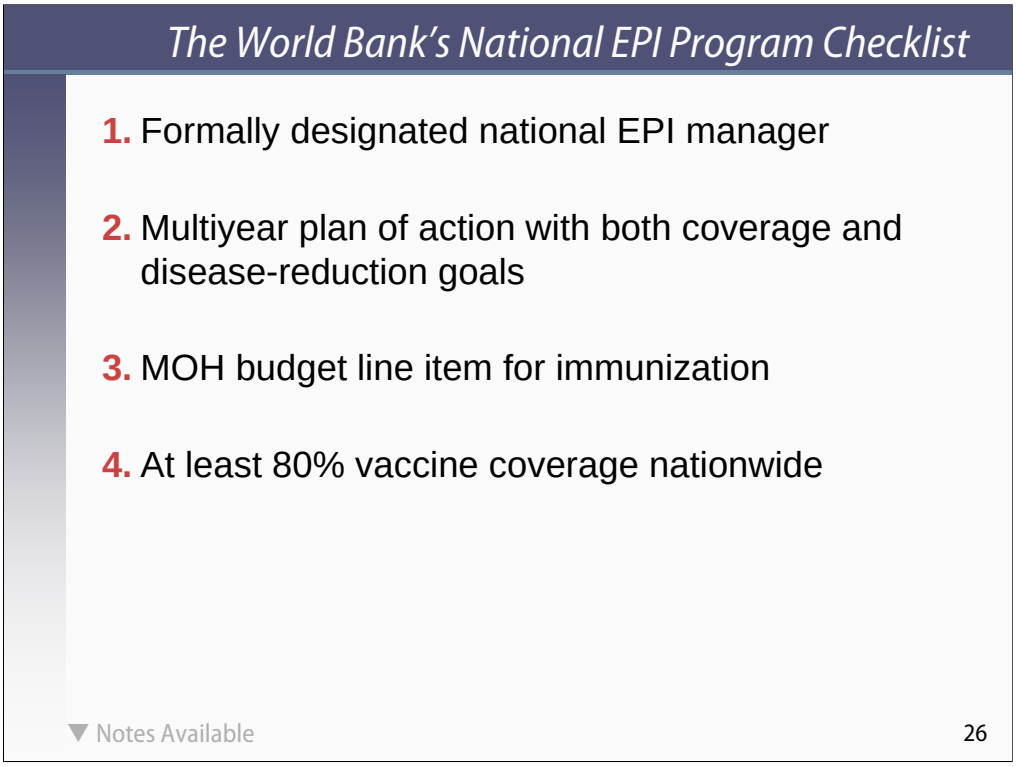
JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Section B

National EPI Programs: The Developing World and the United States

Anatomy of an EPI Program





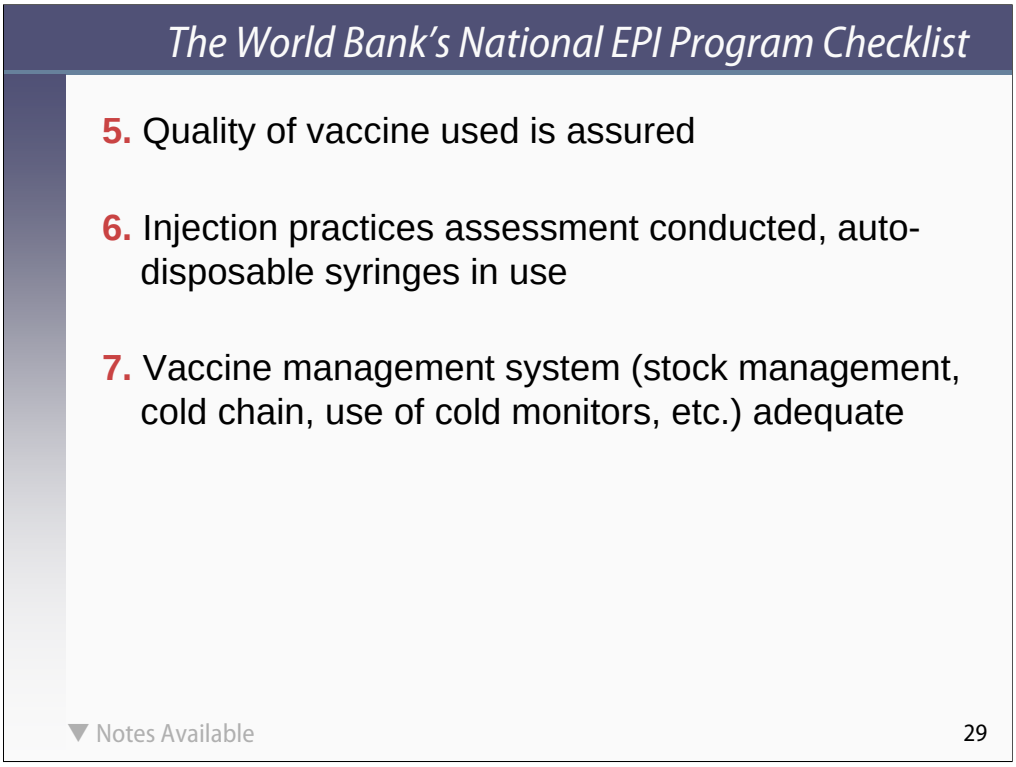
Source: World Bank, 2002

Integrated EPI Budget														
Component	Type of Cost	External—Partners									Gov.		Grand Total	Shortfall
Functional areas		WHO		Total WHO	E.g. USAID	E.g. JICA	E.g., UNICEF	Others	Total External		$	%		
		Regional	WR						$	%				
Immunization Services	Inv.													
	Rec.													
	Tot.													
Logistics	Inv.													
	Rec.													
	Tot.													
——	Inv.													
	Rec.													
	Tot.													
——	Inv.													
	Rec.													
	Tot.													

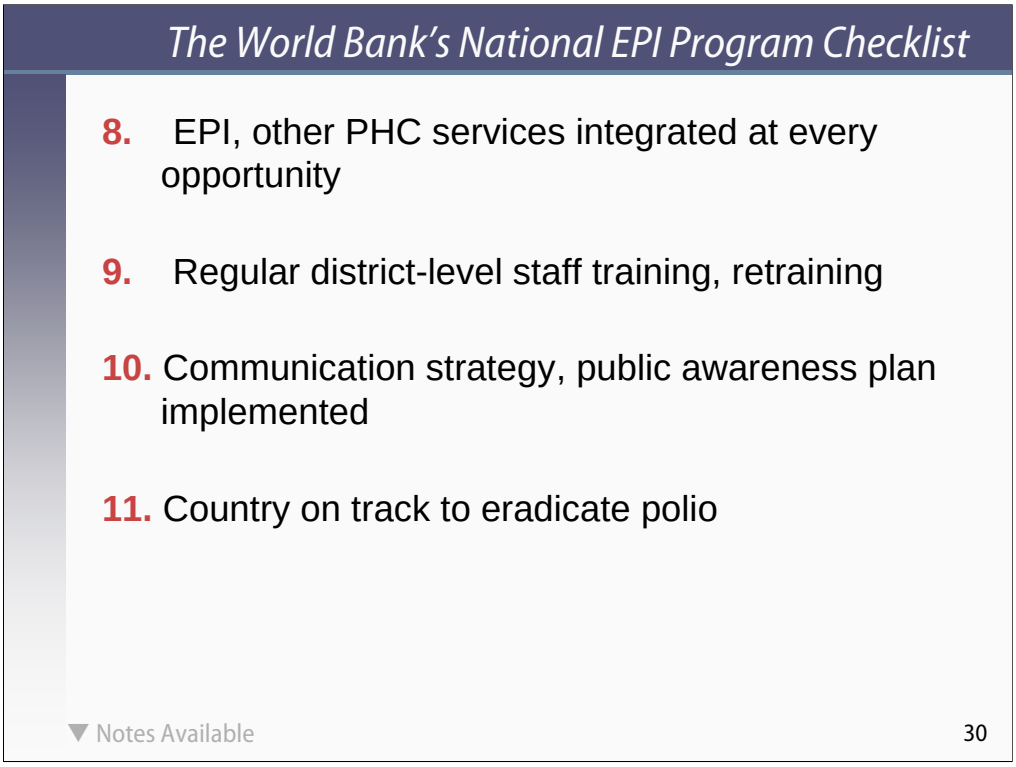
TYPE: Rec. = Recurrent; Inv. = Investment

Interagency Coordination

- A single, multi-year work plan with major government, donor inputs specified
- Inputs by functional area (e.g., logistics, training, surveillance) and year
- Recurrent, capital costs shown separately



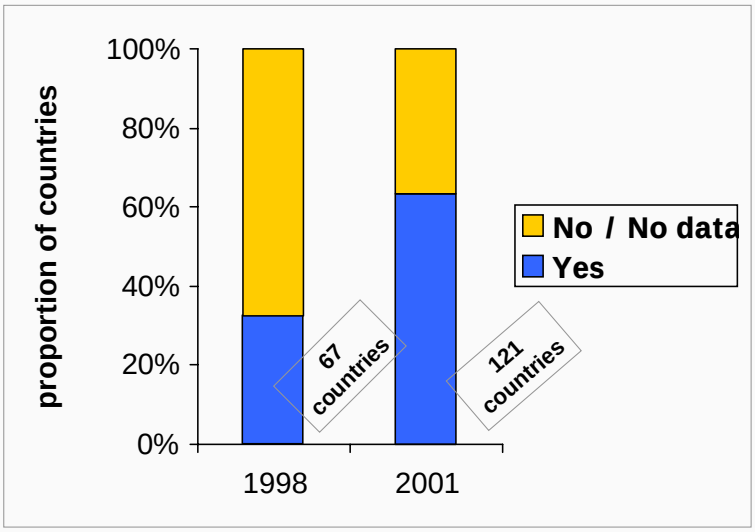
Source: World Bank, 2002



Source: World Bank, 2002

Written Feedback on Immunization to District Level

- (At least every quarter, 1998–2001)



Notes Available

31

Source: WHO/UNICEF joint reporting form, 1998, 2001 data from 191 WHO member states

The World Bank's National EPI Program Checklist

12. Surveillance system functioning well

13. Hepatitis B, yellow fever, H. influenzae b disease burdens estimated

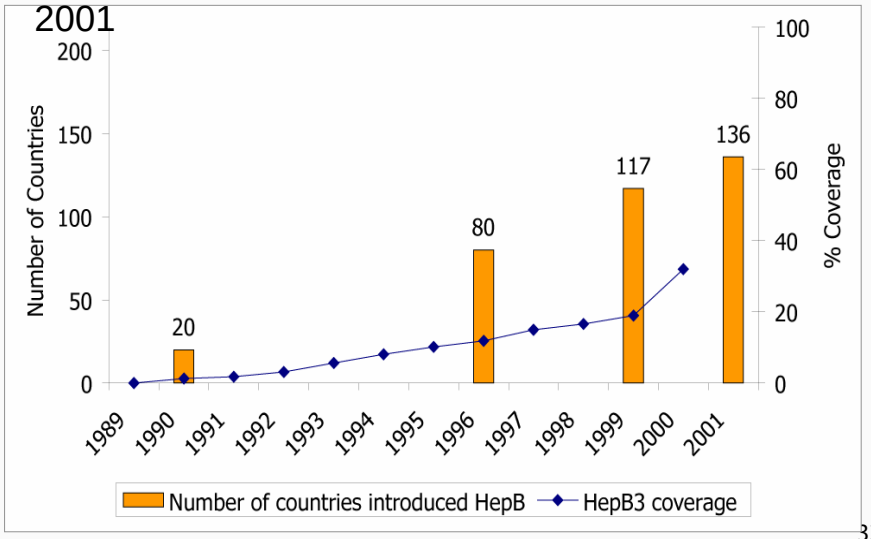
14. Multi-year plan budgets for introducing new vaccines

▼ Notes Available

Source: World Bank, 2002

Hepatitis B Vaccine

- Number of countries introduced Hepatitis B vaccine and global Hepatitis B3 coverage, 1989–2001



Question

- What does the U.S. National Immunization Program look like?

U.S. National Immunization Program

- A mix of federal, state, and local government—as well as private sector providers
- 60% of vaccinations given by private sector in 1999
- Increasing private sector share due to increasing coverage by Medicaid and Childhood Health Insurance Program

Continued

U.S. National Immunization Program

- About 80% of all U.S. vaccines are publicly provided; 53% are purchased for states by CDC through the Vaccines for Children Program, begun in 1994
- Grants to states and territories to strengthen immunization programs
- Continuous epidemiological surveillance, vaccine monitoring, research
- Increasing international involvement

U.S. State and Municipal Immunization Programs

- Manage public immunization sites
- Supervise both public and private providers
- Operate immunization registries
- Investigate local outbreaks
- Provide health education

U.S. National Vaccine Advisory Committee Standards

- Immunization services are readily available
- No barriers or unnecessary prerequisites to the receipt of vaccines
- Immunization services free or for a minimal fee
- Providers utilize all clinical encounters to screen for needed vaccines
- Providers educate parents and guardians
- Providers question parents and guardians about contraindications, advise them of risks, benefits
- Providers follow only true contraindications
- Providers administer simultaneously all vaccine doses for which a child is eligible

Continued

U.S. National Vaccine Advisory Committee Standards

- Providers use accurate, complete recording procedures
- Providers co-schedule immunization appointments with appointments for other child-health services
- Providers report adverse events
- Providers operate a tracking system
- Providers appropriately manage vaccines
- Providers conduct semi-annual audits

Continued

U.S. National Vaccine Advisory Committee Standards

- Providers maintain up-to-date, easily retrievable medical protocols
- Providers practice patient-oriented and community-based approaches
- Vaccines are administered by properly trained persons
- Providers receive ongoing education and training

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Section C

Evolution of Vaccination Programs

Early Years

- **Circa 1900:** U.S., European governments begin routine smallpox vaccination of high-risk groups (port, transportation, health care workers, etc.)
- **1955:** Advent of IPV stimulates systematic mass polio vaccination campaigns in developed countries

Smallpox Eradication

- **1956:** WHO calls for smallpox eradication
- **1967:** WHO effort begins; countries soon attain high vaccine coverage, develop active surveillance and case containment
- **1977:** Last smallpox case occurs in Somalia
- **1980:** WHO certifies smallpox eradication

Expanded Program on Immunization

- **1974:** EPI launched; LDC coverage ~ 5%
- **1977:** WHO sets 1990 target for Universal Childhood Immunization (UCI)
- **1980:** All LDCs have national EPI programs; coverage ~ 20%
- **1990:** UCI achieved: 90% of LDC children 0–11months immunized against the six EPI target diseases
- **2002:** 72% of LDC children 8–23 months receiving DTP3, 78% receiving OPV3 or IPV3

▼ Notes Available

Source: WHO/UNICEF

Next Target

Polio Eradication

- **1985:** PAHO sets 2000 polio eradication goal for Americas Region
- **1988:** WHO adopts 2000 global eradication goal; polio incidence ~ 350,000 cases/year
- **1991:** Last confirmed wild poliovirus case in the Americas

Continued

Polio Eradication

- **1994:** Polio eradication certified in the Americas region
- **2001:** 480 polio cases worldwide, confined to 10 LDCs
- **2005:** Revised target for certifying global eradication

Vaccination as an Organizational Accomplishment

- Through UN, governments cooperate multilaterally to vaccinate, eradicate diseases
- Nations have developed EPI programs, disease eradication capabilities
- Donor agencies routinely coordinate inputs

Interagency Coordination

- **1977:** WHO, UNICEF issue Alma-Ata Declaration, which incorporates EPI
- **1984:** UNICEF, WHO, UNDP, World Bank, and Rockefeller Foundation join forces for UCI—1990
- **1988:** WHO, UNICEF, Rotary International, U.S. Centers for Disease Control form Global Polio Eradication Initiative

Continued

Interagency Coordination

- **1999:** Bill & Melinda Gates Foundation, WHO, UNICEF, World Bank, and other donor and technical agencies form the Global Alliance on Vaccines and Immunization (GAVI) http://www.vaccinealliance.org/

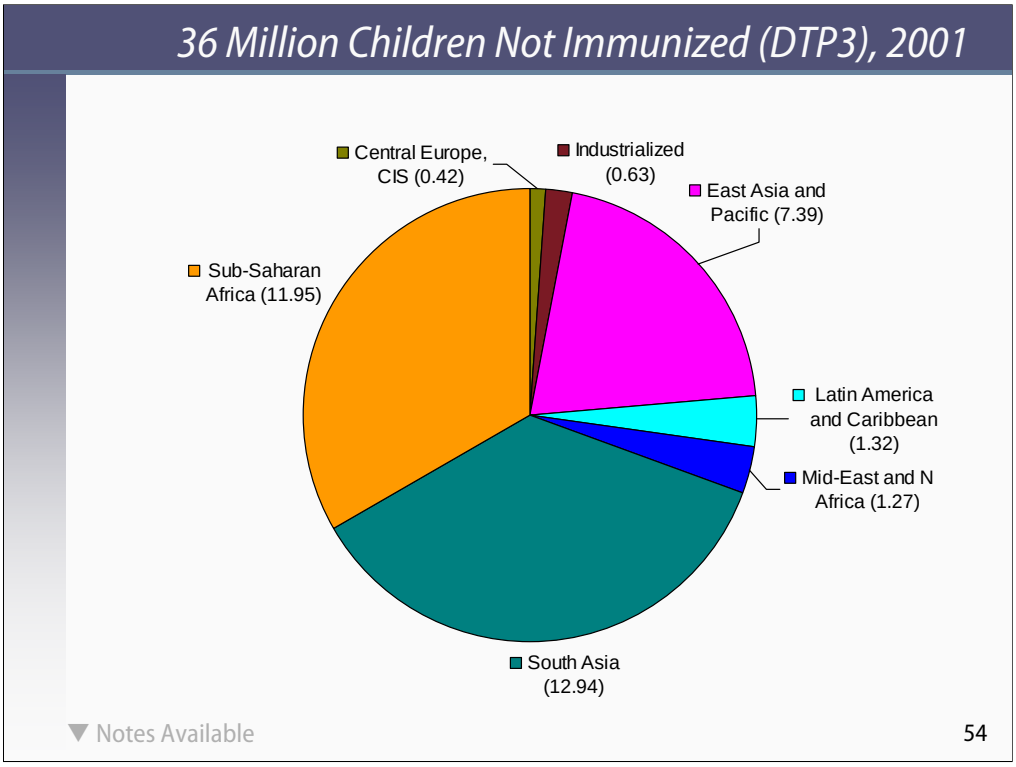
Vaccination as an Organizational Accomplishment

- Through UN, governments cooperate multilaterally to vaccinate, eradicate diseases
- Nations have developed EPI programs, disease eradication capabilities
- Donor agencies routinely coordinate inputs
- **Communities are educated, mobilized**

Turning out in Force

But Operational Problems Persist

- Still 3 million deaths per year from EPI target diseases



Source: WHO/UNICEF estimates, 2002

Child with Polio

But Operational Problems Persist

- Still 3m deaths/yr from EPI target diseases
- Expanding vaccination schedule increases client-provider dependency

But Operational Problems Persist

- Still 3m deaths/yr from EPI target diseases
- Expanding vaccination schedule increases client-provider dependency
- Increasingly complex delivery systems require more management support

Management Is Key

But Operational Problems Persist

- Still 3m deaths/yr from EPI target diseases
- Expanding vaccination schedule increases client-provider dependency
- Increasingly complex delivery systems requires more management support
- Populations still unvaccinated most difficult

Continued

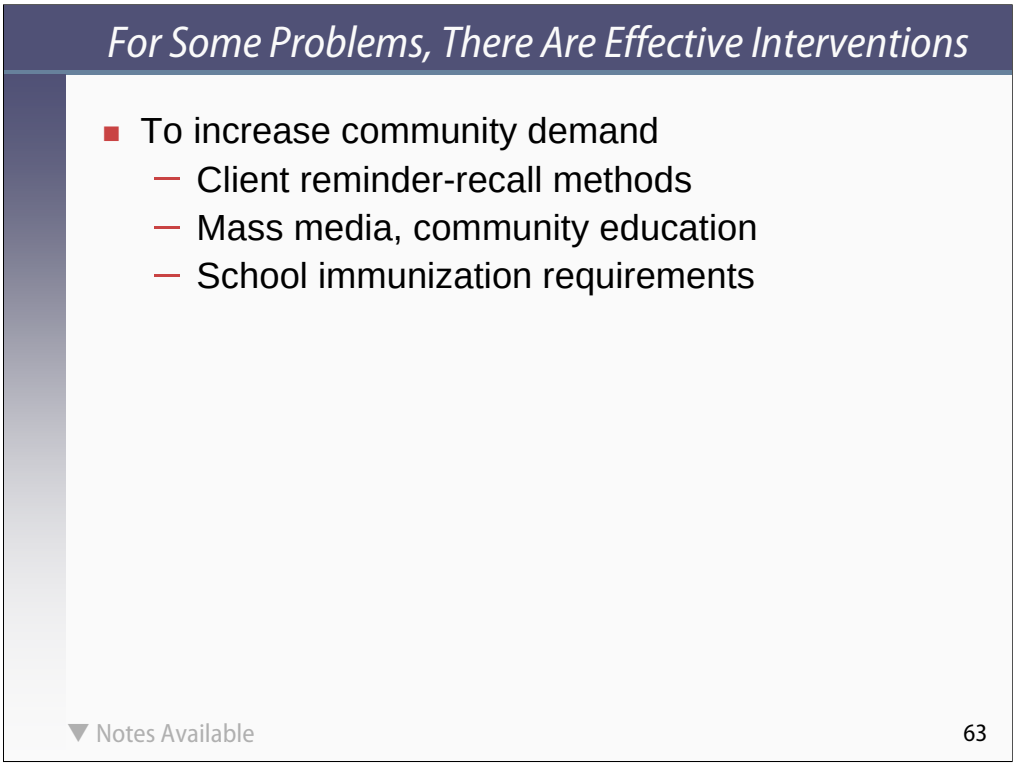
But Operational Problems Persist

… As Do Global Problems

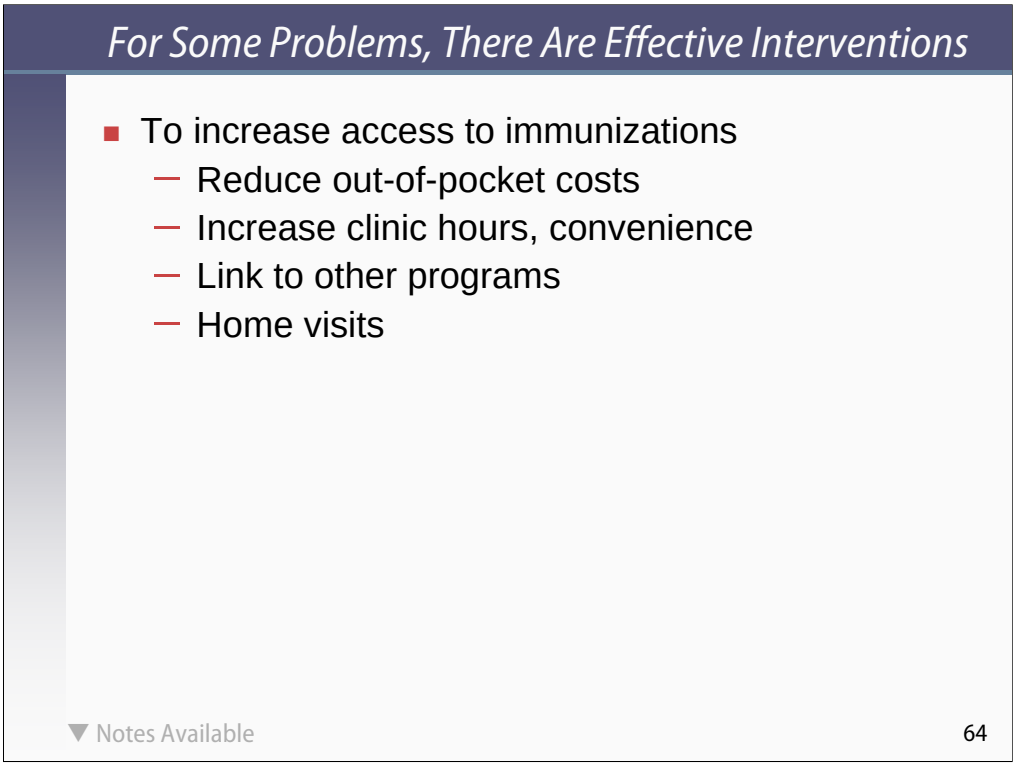
- Eradication efforts may weaken routine EPI
- LDCs unable to finance vaccination efforts
- AIDS decimating health manpower
- Global migration flows increase disease transmission, risk of reintroduction

If Community-Level Program Efforts Wane

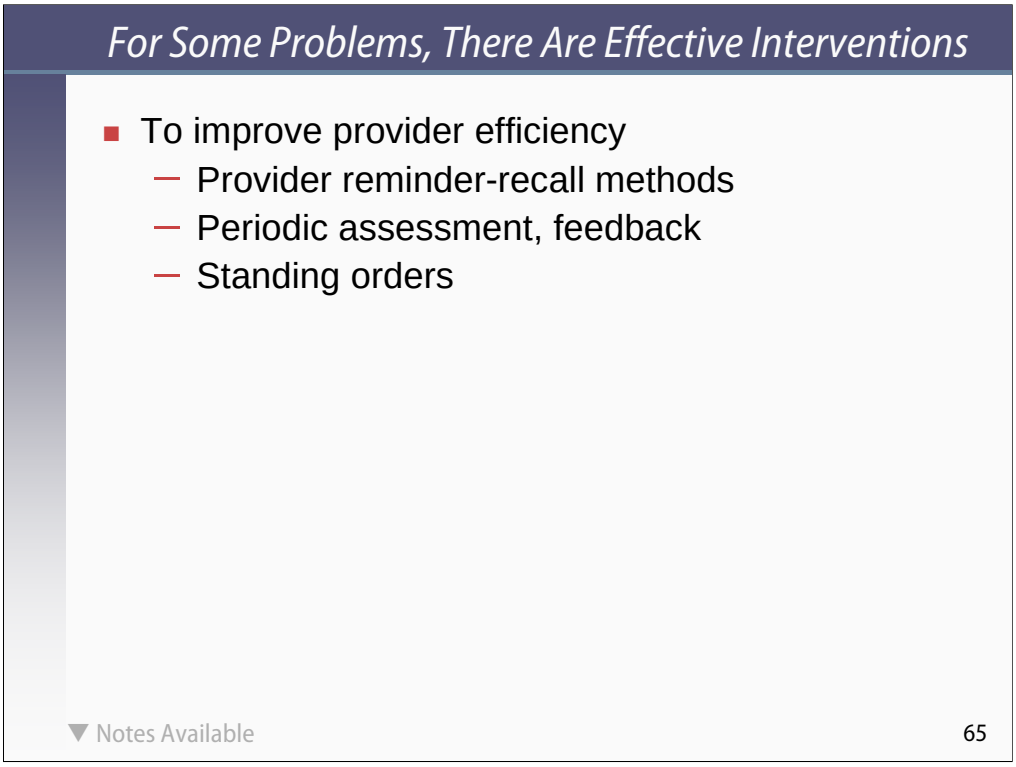
- Disease risks increase
- Stocks of health knowledge decrease
- Potential for other forms of collective action is lost



Source: Task Force on Community Preventive Services, 2000



Source: Task Force on Community Preventive Services, 2000



Source: Task Force on Community Preventive Services, 2000

Less Is Known About Sustainability

- Once attained, how does the community maintain high vaccine coverage?
- Some promising theories to build on
  - Collective action
  - Social learning
  - Trust

Summary

- Vaccines are a powerful public health tool
- Vaccination programs are multilevel collective action exercises
- Interventions exist to strengthen them
- More research is needed to understand how they are sustained