

Smallpox Eradication: ... miracle or template for disease eradication

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50th William J. Holloway Infectious Disease Symposium
Wilmington, Delaware
May 7, 2013

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"There has been no greater medical – or humanitarian – miracle in modern times than the eradication of smallpox...(It is the saga of a) day-to-day struggle for international cooperation in a divided world; it offers a winning blue print for the great medical challenges to come."

David Oshinsky – Winner of the 2006 Pulitzer Prize in History

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Smallpox in history

- Last case –1978
- Most serious of the pestilential diseases
- Ramses V and three other mummies died of smallpox 3500+ years ago
- Smallpox gods in Asia and Africa
- Massive numbers of deaths in Amerindians changed the course of European settlement
- Abraham Lincoln and the Gettysburg address

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Sitala Mata



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Smallpox, the disease

- Virus disease –
Transmitted by face-to-face contact
- Man is the only host
A chain of infection going back >3500+ years
- No treatment -- death rate was 30%
- Permanent immunity upon recovery

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Smallpox in the 20th century

- Deaths – 300,000,000 died
- NYTimes: 120,000,000 died directly or indirectly as a result of armed conflict
- Compulsory vaccination in the U.S. until 1972
Last case in U.S. – 1949
- International travelers carried a "yellow booklet" documenting vaccination in past 3 years

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Summary objectives

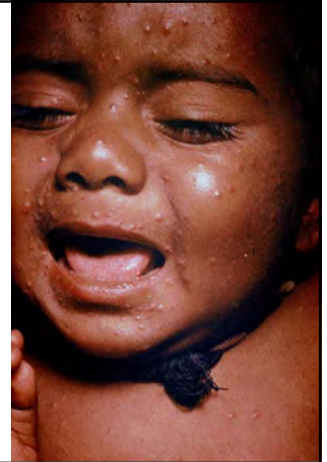
- To portray the principal features of smallpox, a disease last seen in 1978 but still a threat
- To identify the principal landmarks of the eradication campaign
- To highlight the program's legacies. Is it a prototype for other eradication programs?

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Day 3



8

Day 5



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Day 9



10

Day 13



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Confluent
smallpox



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Confluent
smallpox
(recovered)



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Global efforts to eradicate a disease

• Hookworm	1909-23	14 years
• Yellow fever	1915-32	17 years
• Yaws	1948-66	18 years
• Malaria	1955-73	18 years
• Smallpox	1967-80	14 years
• G. worm infection	1986- ?	26 years +
• Poliomyelitis	1988- ?	24 Years +

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The WHO Eradication Program

Assembly requires DG to submit a plan --1966

- o Strategy
 - Systematic mass vaccination to reach 80%
 - Surveillance and containment
- o 10 year program --budget of \$ 2.4 million/year
- Objections by delegates
 - o Not feasible
 - o Demand for no further increases in WHO budget
- 58 votes for acceptance; 60 voted for approval

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Program leadership

- Director General believes program will fail (malaria eradication collapsing)
- Demands an American serve as Director
 - o The candidate declines:
 - Limited resources -- <\$50,000 each for 50 countries
 - Not enough even to buy the vaccine required
 - Inexperience in operating an international program

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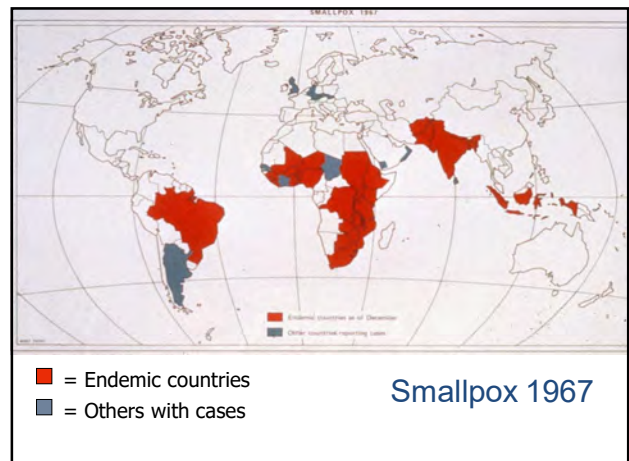
The Challenge

- Status of smallpox – 1967
 - o >10,000,000 cases
 - o 2,000,000 deaths
 - o 43 countries reported cases
- Program staff
 - o Headquarters – 5 medical; 2 admin; 3 secretaries
 - o Regions – one each in 4 WHO Regions
 - o International staff – never more than 150

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Smallpox 1967

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Vaccine Supply

- Heat-stable, potent vaccine is essential
 - Quality control of vaccine
 - No country to receive WHO assistance unless vaccine meets international standards
 - 42 labs producing vaccine
 - Independent international quality control
 - Labs in Netherlands and Canada
 - Development of national capacity
 - Production manual and research
 - On-site consultant assistance

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Vaccination methods

- Research to find faster, better methods
 - Bifurcated needle—multiple puncture method
 - One-fourth as much vaccine required
 - Training time -- 15 minutes
 - Reusable after sterilization
 - Cost -- \$5 per thousand
- Target for coverage – 80%
 - Evaluation teams

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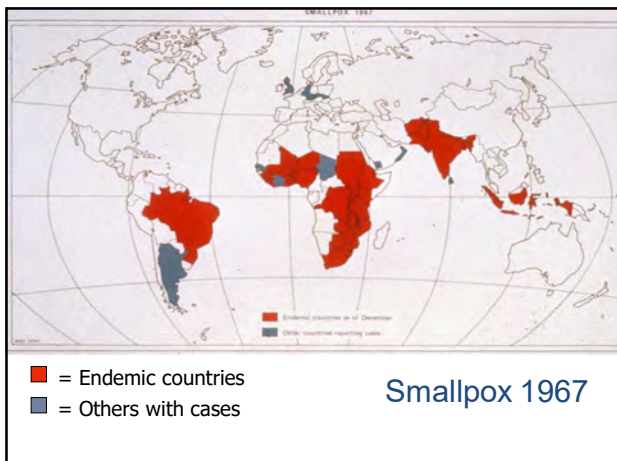


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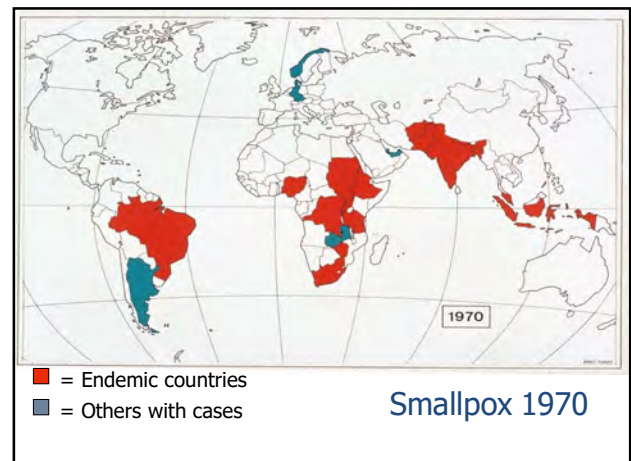
Surveillance-containment strategy

- Operational plan
 - Surveillance – weekly report from all health units
 - Teams – to investigate and contain outbreaks
 - Epidemiological research on smallpox
 - The textbooks prove to be wrong
 - “Smallpox spreads like a prairie fire”
 - “Revaccination is needed every 3 to 5 years”

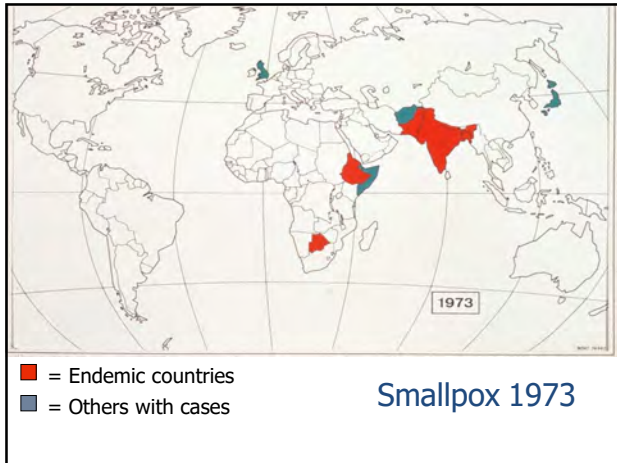
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India -- the pivotal challenge

1973-75

- India – the “home of smallpox”?
 - Population – 550,000,000
 - Surveillance-containment strategy--not working
 - June 1973 – search every village> every house
 - 130,000 health staff in 10 days
 - Results of first search – October
 - Spring 1974 – the darkest days
 - Gas crisis + strikes by airlines, railway, floods
 - India explodes a nuclear device

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Indian Independence Day

August 15, 1975

Prime Minister Indira Gandhi

- Salutes India on its 28th Anniversary of Freedom
- Announces India's freedom from smallpox for the first time in its written history

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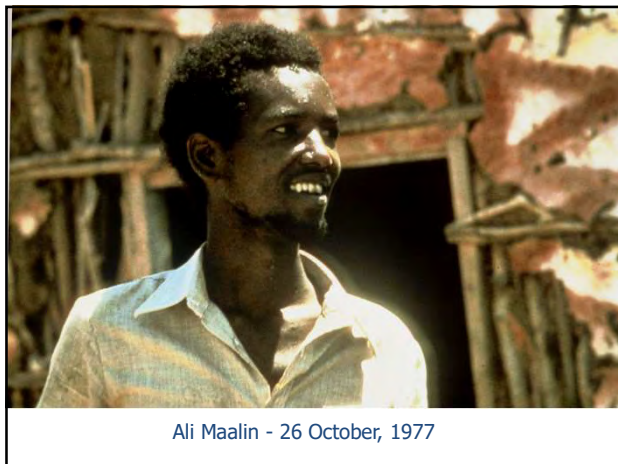
The last strongholds

Ethiopia and Somalia

- Ethiopia
 - Country – twice the size of Texas
 - Largely highland –over 5000 feet
 - Health facilities serve 5% of 30 million people
 - Travel largely by donkey and on foot
 - Emperor is assassinated; Marxist take-over
 - No foreign staff outside of Addis except smallpox teams
- Civil war, floods, famine, kidnapping, hostages
- Somalia – the final chapter

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World Health Assembly --1980

- Declares solemnly that the world and all its peoples have won freedom from smallpox
- Smallpox vaccination should be discontinued in every country

» Thirty-third World Health Assembly, 8 May 1980

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The legacy – beginning of the Vaccine Era

- The genesis -- 1970
 - African vaccine teams average 500/person/day with cooperative village leadership
 - One year = 400,000 vaccinations/4 person team
 - Smallpox – the only nation-wide vaccine program in developing countries
 - Smallpox unit sponsors international meeting on strategies and targets - 1970

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Expanded Program on Immunization-1974

- A global program for vaccination for all children --smallpox, measles, DPT, polio
- Surveillance of vaccine-preventable diseases
- UNICEF and Rotary make this a high priority
- Target: 1990 – 80% coverage

Vaccine coverage (%) -- the Americas

	1980	1990	2000	2008
DTP*	50	74	91	92
Measles	51	80	92	93
Polio*	57	75	90	92
HepB*	--	--	70	88
Hib*	--	--	75	90

* 3 Doses

Transmission interrupted:

Polio (1991); Measles (2001); Rubella (2009)

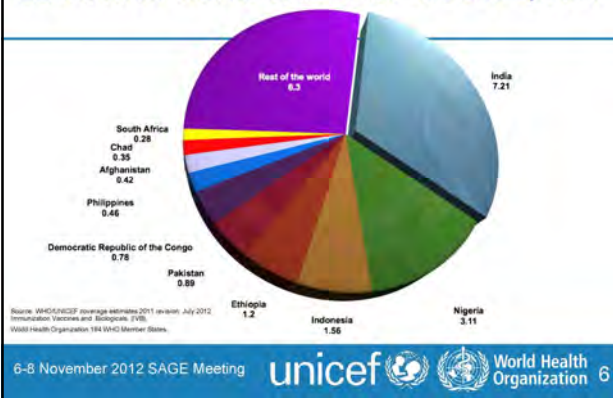
Global coverage estimates, 1980-2011 DTP3, Measles, HepB3, Hib3, PCV3 and Rota



Disease eradication?

- Smallpox eradication was comparatively easy;
 - No other disease comes close
 - serious problem for all countries
 - feared by all in the population
 - high case-fatality rate and frequent sequelae
 - no sub-clinical cases
 - vaccine – protects 95% with one dose
 - vaccine is heat stable – one month at 100° F.

22.4 million infants did not receive DTP3, 2011



Keynote address: Sept. 1980

First Conference on Eradication

Regarding candidate human diseases for eradication

“...There is no other disease which possesses so many characteristics favorable to eradication and for which we now have available, effective, simple, and inexpensive measures for prevention or treatment.”

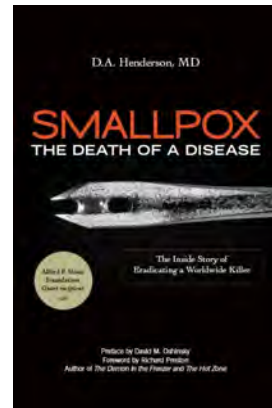
D.A.Henderson, F. Fenner

Coda

- From *Smallpox: death of a Disease*:

“We are only beginning to realize the potential of public health...It is a field begging for fresh, resourceful ideas and a new generation of professionals who are not constrained by ‘knowing’ what can’t be done. So it was with so many who contributed so much to making smallpox eradication a possibility.”

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