Smallpox: Death of a Disease

…its eradication and legacy

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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 – 2006 Pulitzer Prize in History

Smallpox – most feared disease of history

- Virus -- spreads by face-to-face contact during rash
- Man is the only host
  - A chain of infection going back 3500+ years
  - Only disease for which there are deities
- No treatment; death rate = 25 to 30%
- Permanent immunity after recovery

T'ou-Shen Niang-Niang

Pan-chen

Sitala Mata

World's 5 most important historic sites

(from BBC World History Series, Oct. 2012)

- Yellow River, China
- Great African Rift Valley
- Athens, Greece
- Los Alamos, New Mexico
- ?

The Drama of 1796 – Berkeley, England
the world's first vaccine

Cast of characters --1796

Edward Jenner

Blossom

Sarah Nelmes

Jimmy Phipps

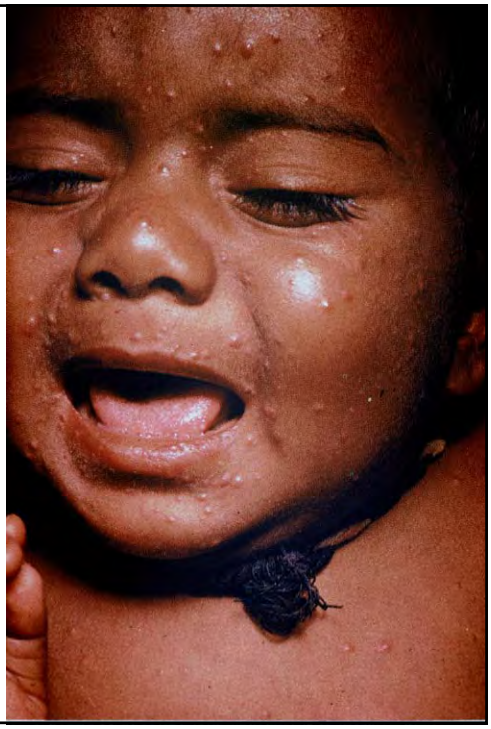
Vaccinia virus transferred from arm to arm until 1870s

- Grown on the flank of a calf or sheep until 2002
- Tissue culture vaccine from 2002

Summary objectives

- To portray the principal clinical features of smallpox, a disease last seen in 1978 but a continuing threat
- To identify the landmarks of the eradication campaign and research contributing to its success
- To highlight the legacies and subsequent opportunities for public health

Day 3

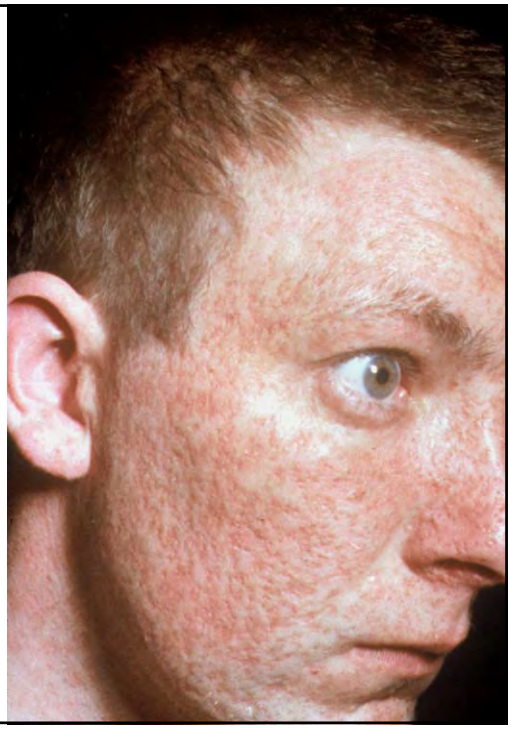


Day 5

Day 9

Confluent smallpox

Confluent smallpox (recovered)



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- ?	29 years +
• Poliomyelitis	1988- ?	27 years +

Global smallpox eradication

- World Health Assembly agrees to a proposal to start some sort of global effort
- 1959 -1966 National programs encouraged
  - Strategy: mass vaccination (few countries complied)
  - Budget of <$100,000 per year
  - Six staff members

The WHO Eradication Program

Assembly requires DG to submit a plan --1966

- Strategy
  - Mass vaccination to reach 80%
  - Surveillance and containment
- 10 year program --budget of $ 2.4 million/year

- Objections by delegates
  - Not feasible
  - Demand for no further increases in WHO budget
- 58 votes needed for approval; 60 voted in favor

Program leadership

- Director General believed program would fail
  (malaria eradication was collapsing)
- Demanded an American serve as Director
  - The candidate reluctantly agreed:
    - Limited resources -- ~$50,000 each for 50 countries
      Insufficient even to buy the vaccine required
    - Not all countries interested in participating

The Challenge

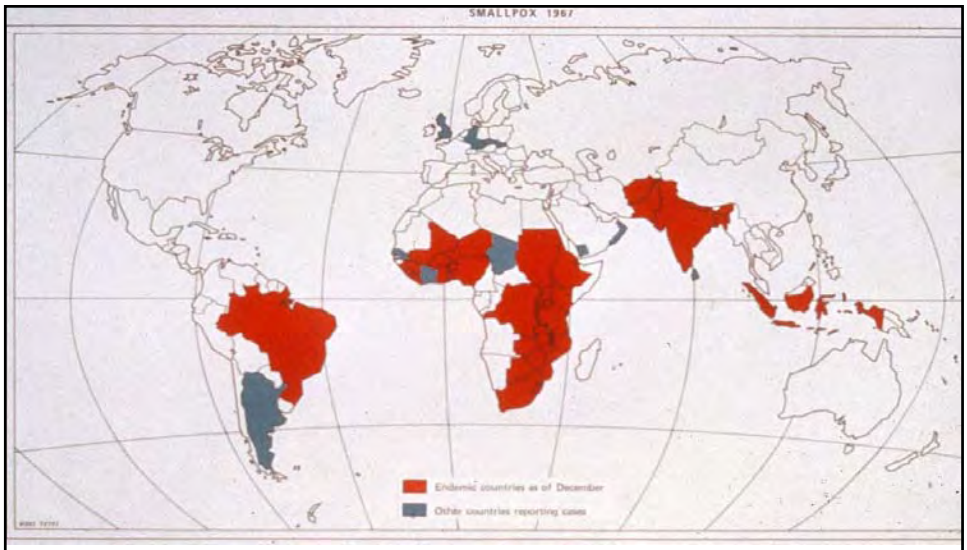
- Status of smallpox – 1967
  - >10,000,000 cases
  - 2,000,000 deaths
  - 43 countries reported cases
- Program staff
  - Headquarters – 5 medical; 5 support staff
  - International staff – never more than 150
- Communication – mail, personal contact

1st major regional smallpox conference

Bangkok – December 1967

- 11 Asian countries
  - Indonesia, India, Pakistan, Malaysia, Afghanistan, Nepal, Philippines, Viet Nam, Laos, Burma, Thailand

- Thailand had become smallpox-free in 1962
  - 1898 survey—95% of teen-agers with scars
  - Smallpox accounted for 90% of all blindness



= Endemic countries

= Others with cases

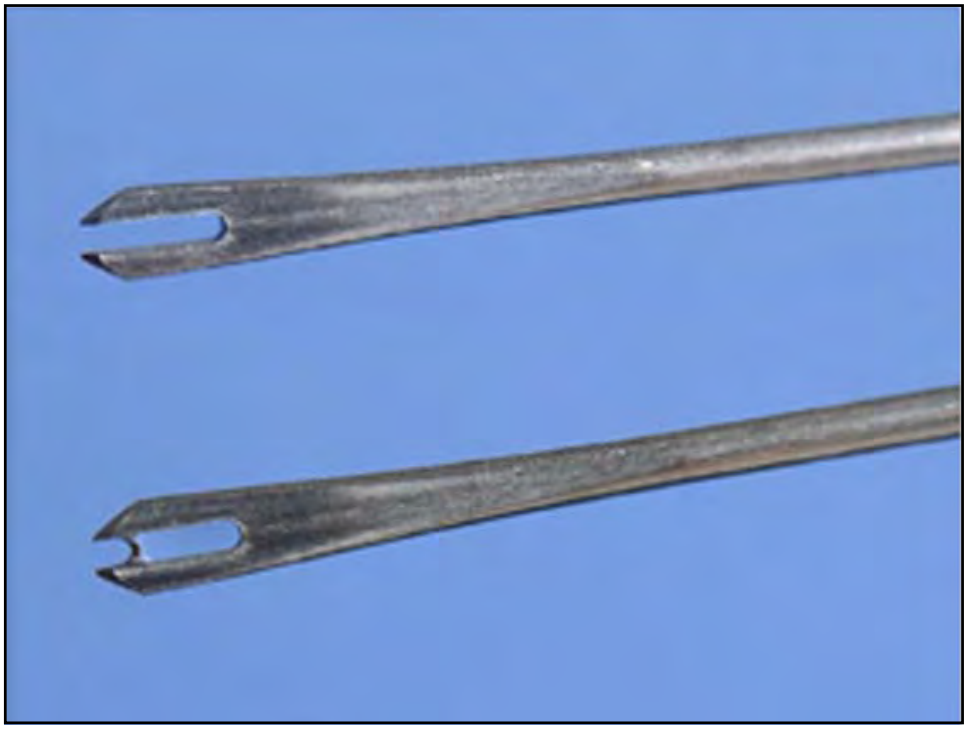
Smallpox 1967

Vaccine Shortages

- Heat-stable, potent vaccine is essential
  - 300 million doses needed annually
  - 42 labs producing vaccine
  - Labs in Netherlands and Canada test vaccine
    Only 10% meets international standards
- National capacity has to be developed
  - Production manual and research
  - On-site consultant assistance

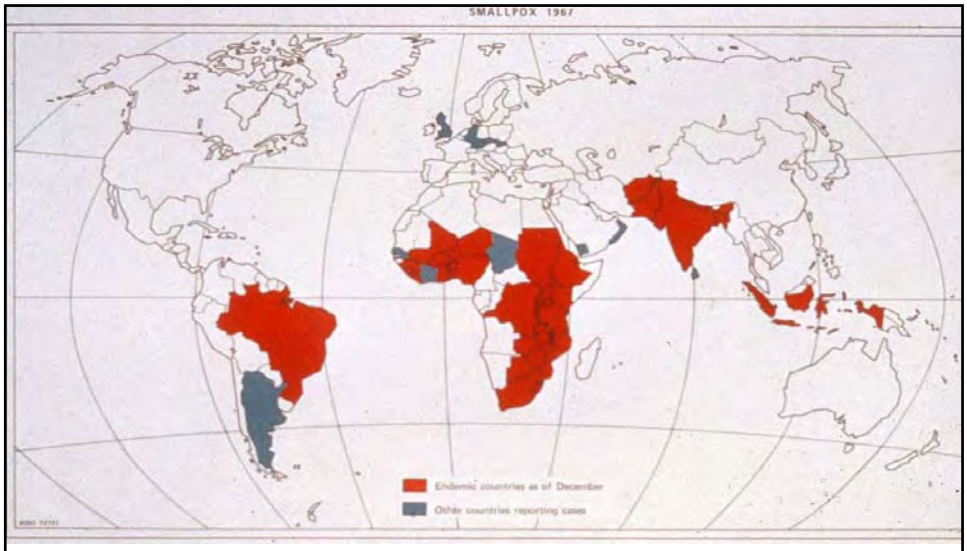
Vaccination methods

- Research to find faster, better methods
  - Bifurcated needle—multiple puncture vaccination
    - One-fourth as much vaccine required
    - Training time -- 15 minutes
    - Easily sterilized and reused
    - Cost -- $5 per thousand
- Target for coverage – 80%
  - Evaluation teams



Surveillance-containment strategy

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



= Endemic countries

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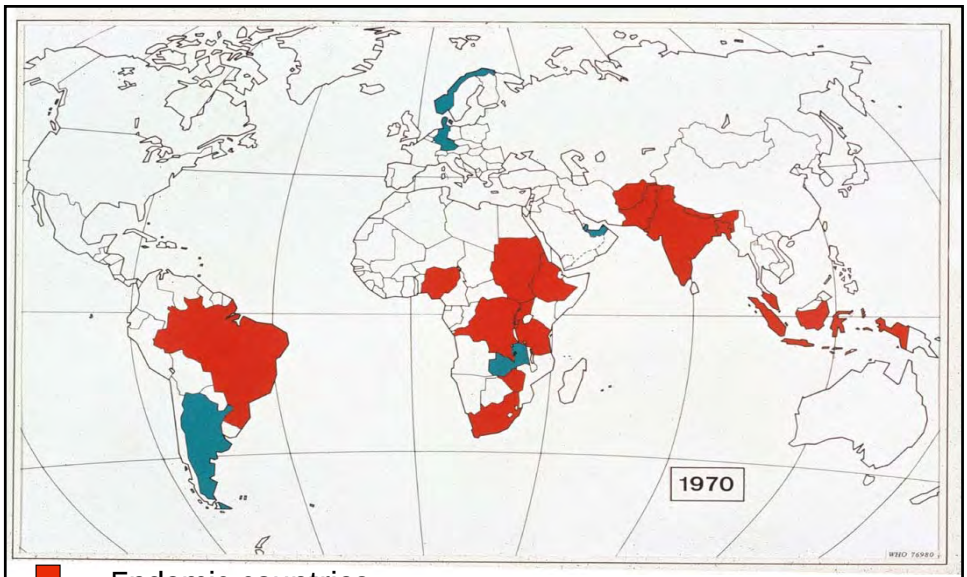
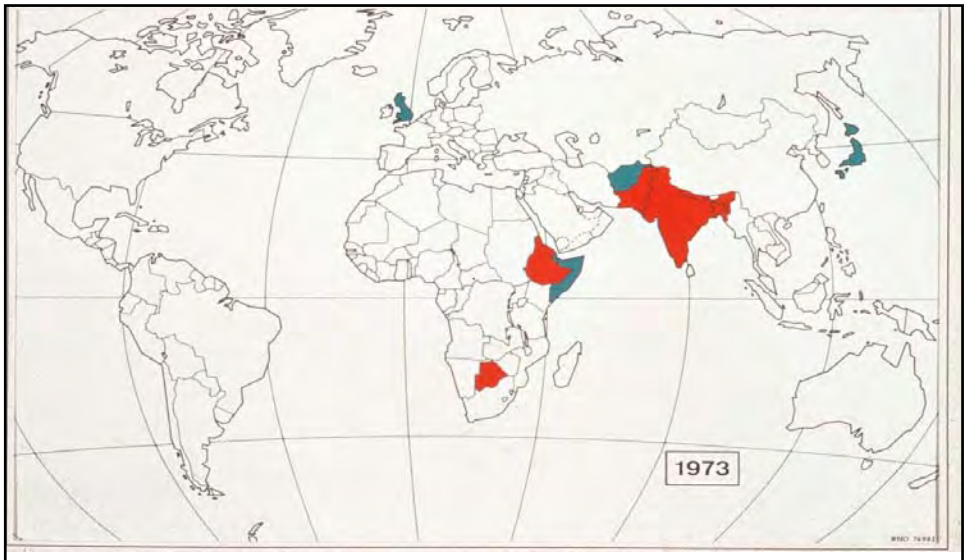
Smallpox 1967



= Endemic countries

= Others with cases

Smallpox 1970



= Endemic countries

= Others with cases

Smallpox 1973

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—later, 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, famine
    - India explodes a nuclear device
  - Containment methods tightened

Indian Independence Day

August 15, 1975

Prime Minister Indira Ghandi

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

= Endemic countries

= Others with cases

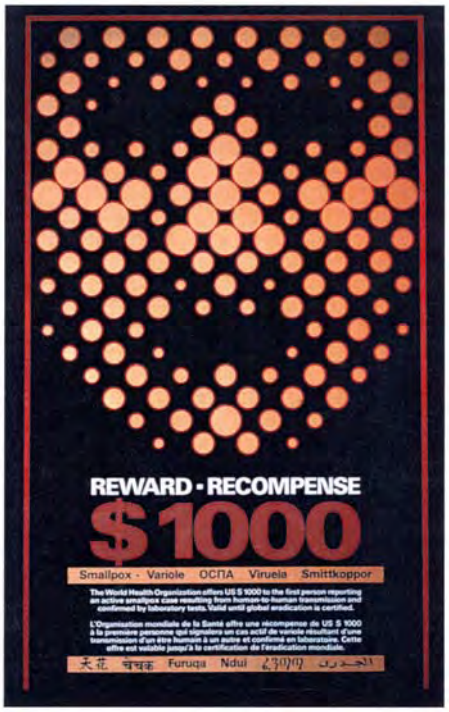
Smallpox 1976

The last strongholds

Ethiopia and Somalia

- Ethiopia
  - Country – about the size of Thailand
    - 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, kidnapping, hostages, famine
- Somalia – the final chapter

Ali Maalin - 26 October, 1977



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*

The legacy – 1974 --the Vaccine Era begins

- The genesis
  - African vaccinators average 500/day with cooperative village leadership

    One year: 4 person team = 400,000 vaccinations
  - Smallpox – the only nation-wide vaccination program in developing countries
  - Smallpox unit sponsors international meeting to advocate for a broadened agenda

Expanded Program on Immunization-1974

- WHO 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

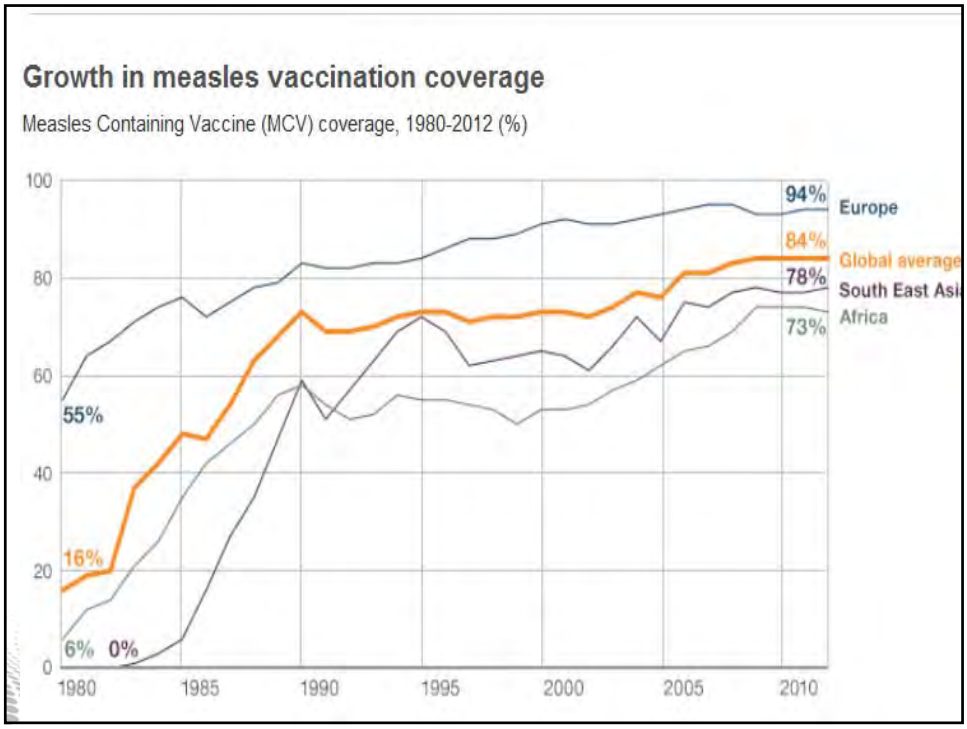
Vaccine coverage (%) -- the Americas

	1980	1990	2000	2008
DTP*	50	74	91	92
Measles-rubella	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)



EPI – 40 years after its beginning

Global vaccine coverage DPT, measles, polio, tuberculosis

1974 – 5%

2014 – 83%

Hepatitis B and H. influenzae – in 190 countries

also: Rotavirus, yellow fever, pneumococcal, rubella

For the future: malaria, AIDS, cervical cancer, Ebola, dengue, tuberculosis, chikungunya, Lassa, Marburg

Surveillance and monitoring

700 laboratories in 184 countries for surveillance of measles and other diseases

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."