

# 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

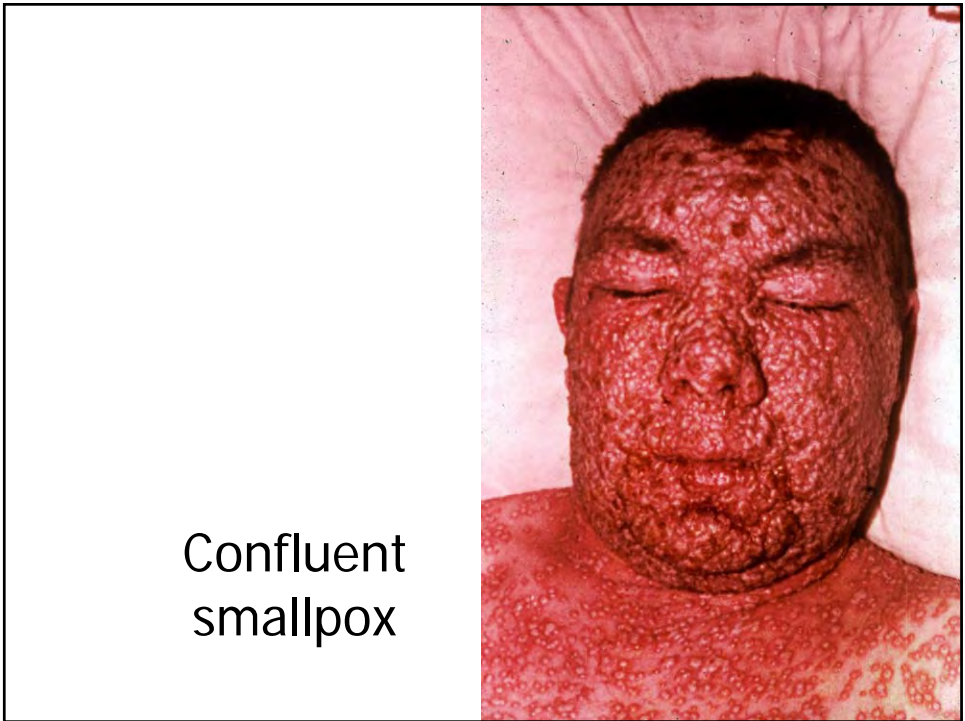
- To portray the principal clinical features of smallpox, a disease last seen in 1978 but a continuing threat
- To identify the landmarks of the eradication campaign and research contributing to its success
- To highlight the legacies and subsequent opportunities for public health

Day 3



Day 5







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        |
| • <b>Smallpox</b>   | <b>1967-80</b> | <b>14 years</b> |
| • 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

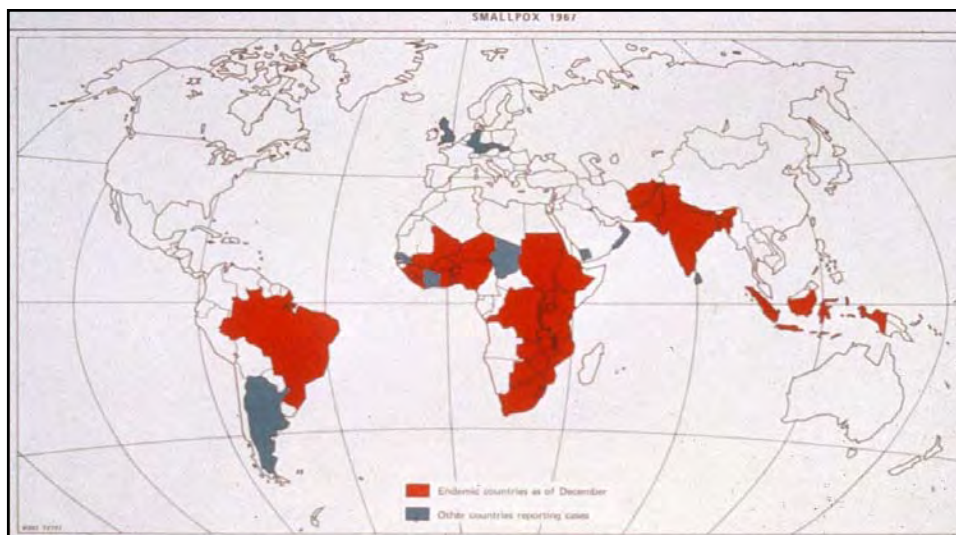
11 Asian countries

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

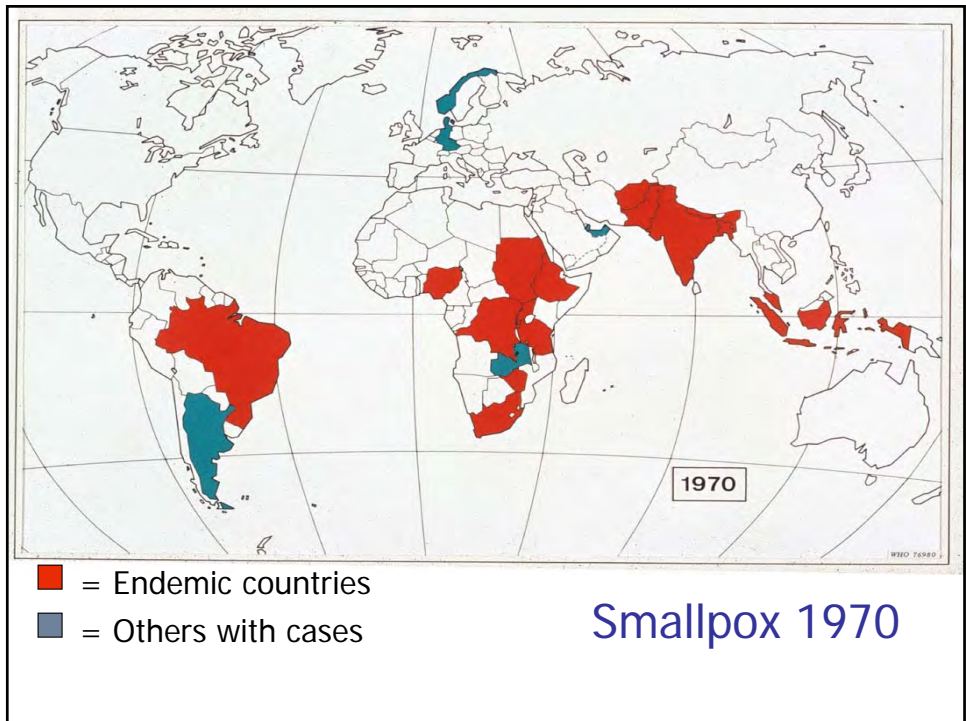
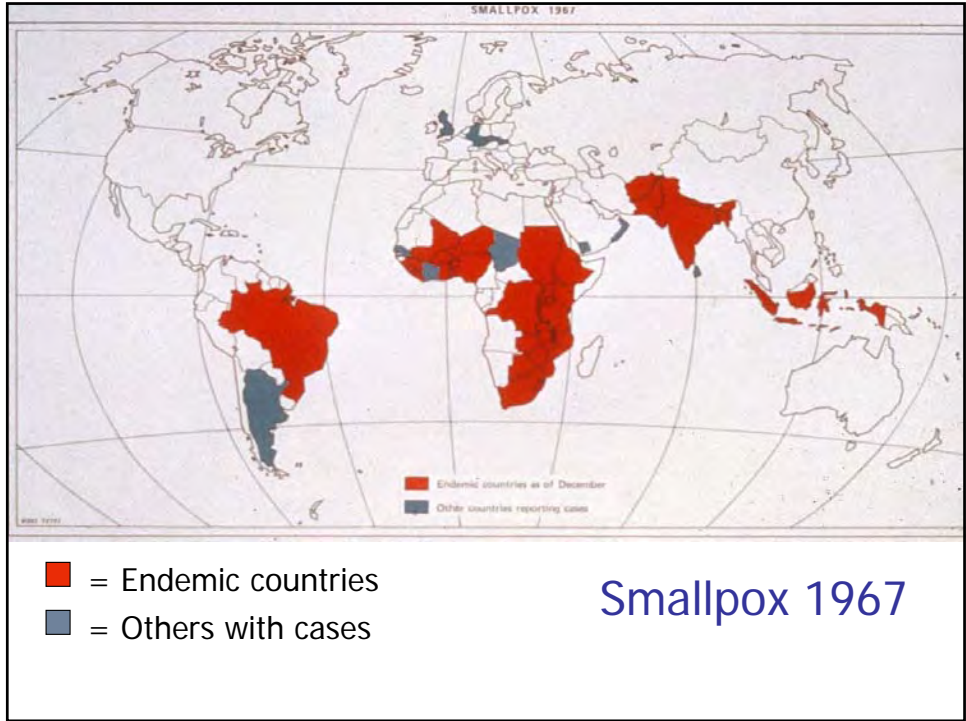
## Vaccination methods

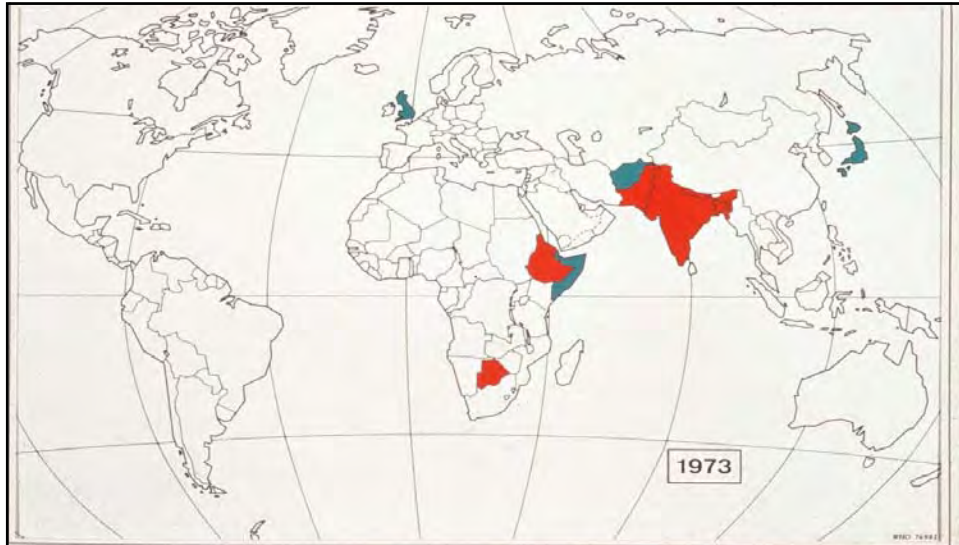
- Research to find faster, better methods
  - **Bifurcated needle—multiple puncture vaccination**
    - One-fourth as much vaccine required
    - Training time -- 15 minutes
    - Easily sterilized and reused
    - Cost -- \$5 per thousand
- Target for coverage – 80%
  - Evaluation teams



## 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
- = 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 Gandhi

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



## 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

**REWARD - RECOMPENSE**  
**\$1000**

Smallpox - Variole OCPA Viruela Smittkoppor

The World Health Organization offers US \$ 1000 to the first person reporting an active smallpox case resulting in a confirmed laboratory diagnosis.

L'Organisation mondiale de la Santé offre une indemnité de US \$ 1000 à la première personne qui signale un cas actif de variole à la suite d'une confirmation de laboratoire.

الجمهورية العربية السورية Furuqa Ndul ٢٠١٧

## 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

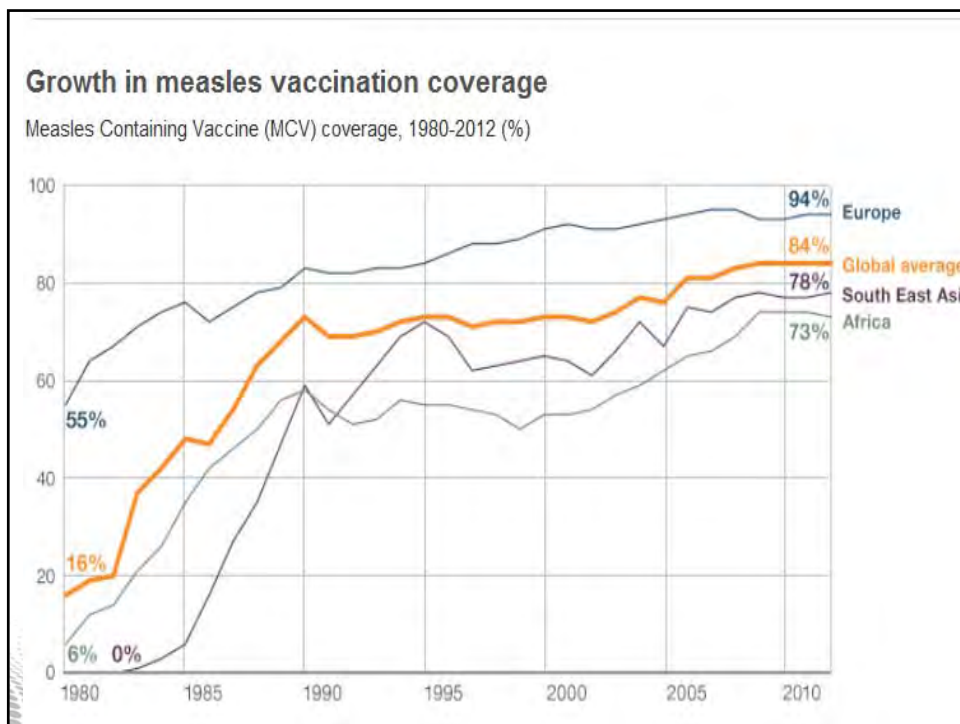
## Vaccine coverage (%) -- the Americas

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2008</u>
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."*

