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Smallpox: Death of a Disease ...miracle and legacy

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Observations

There has been no greater medical – or humanitarian – miracle in modern times than the eradication of smallpox. It offers a winning blueprint for the great medical challenges to come.

Professor David Oshinsky, 2008 Pulitzer Prize in History

(It) is a testament to the difference the global public health community can make when it truly comes together for a common purpose.

Secretary Thompson, Department of Health and Human Services

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The Presentation -- in brief

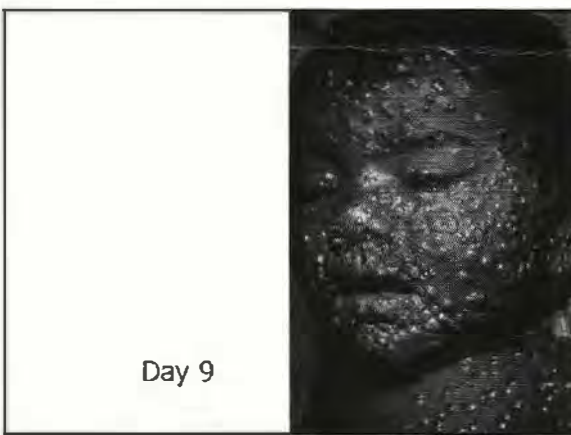
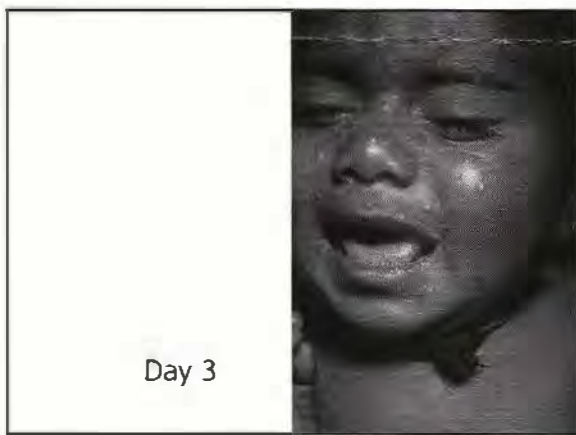
- Clinical features of smallpox, a disease last seen in 1978 *add your own*
- Landmarks of the eradication campaign
- The legacy of the program
- Critical factors intrinsic to its success

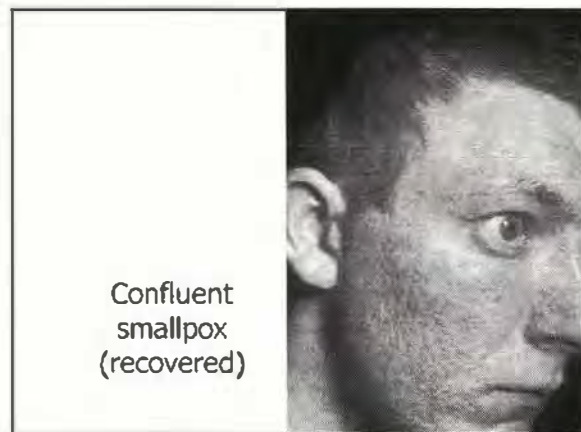
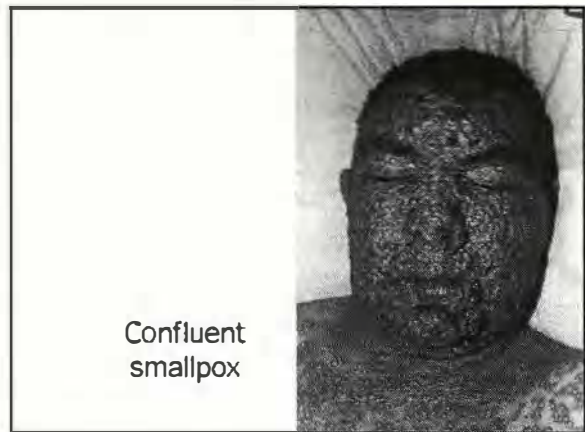
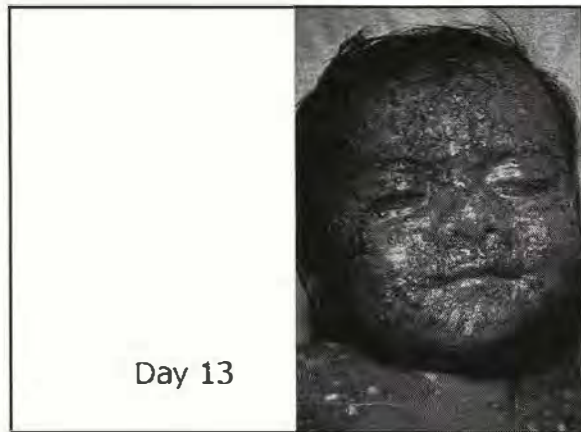
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Smallpox – a unique disease

- Severe febrile disease with rash– death rate of 30%
- Virus transmitted by face-to-face contact
- Man was the only host
 - Chain of infection going back more than 3500 years
 - Only disease with deities – Asia and Africa
- Patient has permanent immunity on recovery but will be disfigured and may possibly be blind
- A very heat-stable vaccine protects with one dose

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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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- Landmarks in smallpox eradication
- World Health Assembly adopted 1959 USSR proposal for a global eradication program
 - 1959 -1966
 - Strategy: mass vaccination (few countries complied)
 - WHO budget of <\$100,000 per year
 - Six WHO staff members
 - Negligible progress in most infected areas
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- A new, intensified eradication program
- Assembly requires DG to submit a plan –1966
 - Strategy
 - Large-scale vaccination
 - Surveillance and containment
 - 10 year goal – WHO budget of \$ 2.4 million/year
 - Objections by delegates
 - Not feasible
 - Demand for no further increases in WHO budget
 - 58 votes for acceptance: 60 voted for approval
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Review Original

Program leadership

- Director General believed program would fail
 - Malaria eradication effort was collapsing
- Demanded an American serve as Director
 - The candidate declines:
 - Just beginning as director of a new CDC program
 - Limited resources – <\$50,000 each for 50 countries
 - Insufficient to buy the vaccine required
 - Lack of support by many potential donors

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The challenge

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

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- = Endemic countries
- = Others with cases

Smallpox 1967

Vaccine supply

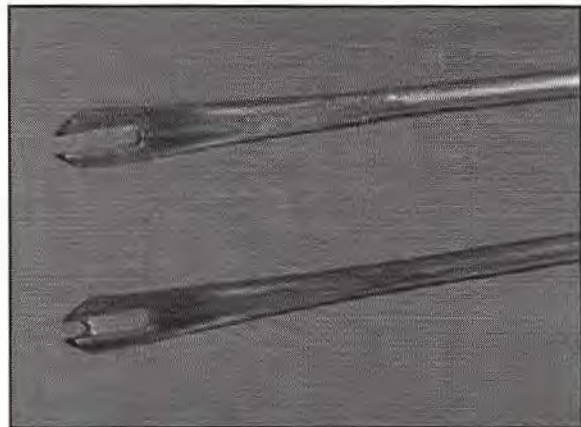
- Heat-stable, potent vaccine was essential
 - Need for >250 million doses/year
 - U.S./USSR committed to 75 million/year
 - 42 labs other labs were producing vaccine
 - International quality control (Netherlands, Canada)
 - Development of national capacity
 - Production manual and research
 - On-site consultant assistance
- By 1973, all vaccine met potency, stability standards

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Vaccination

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

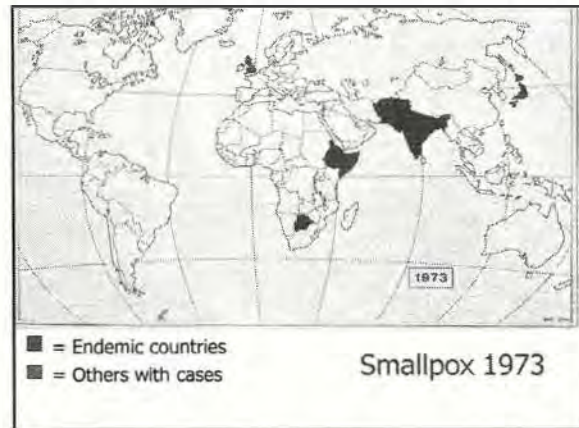
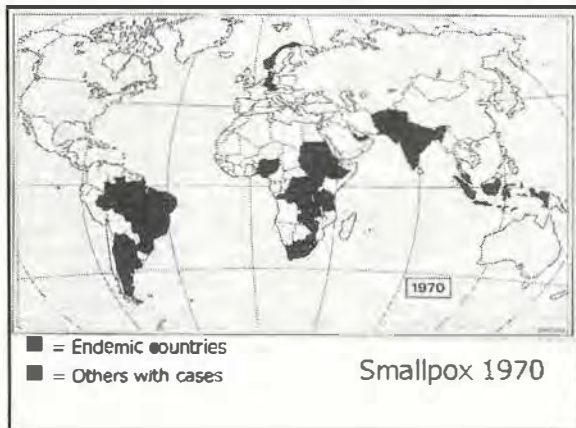
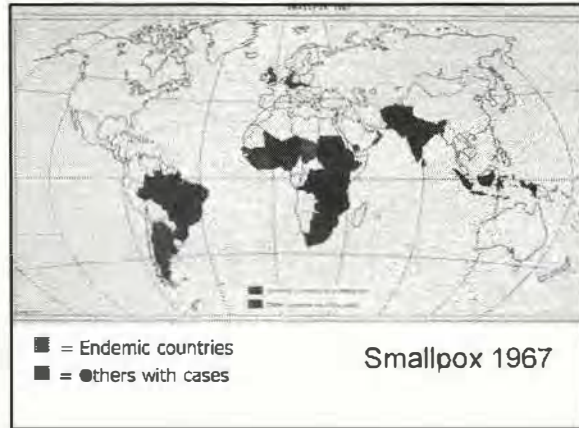
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Surveillance-containment strategy

- Operational plan
 - Surveillance – weekly case report from all health units
 - Teams – to investigate and contain outbreaks
 - Epidemiological research on smallpox
- Strategy evolved to meet the challenges*
 The textbooks prove wrong
 "Smallpox spreads like a prairie fire"
 "Revaccination required 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 for 10 days
 - Results of first search – October
 - Spring 1974 – the darkest days
 - Gas crisis + strikes by airlines, railway, health staff+floods
 - India explodes a nuclear device
 - Emphasis on cases—not number of vaccinations

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Indian Independence Day

August 15, 1975

Prime Minister Indira Gandhi

Saluted India on its 28th Anniversary of Freedom
Announced India's freedom from smallpox for the first time in the nation's written history

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■ = Endemic countries
■ = Others with cases

Smallpox 1976

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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Ali Maalin - 26 Oct 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

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A new era for vaccination

- The genesis was smallpox eradication
 - African teams averaged 500 vaccinations/day
One year: 400,000 vaccinations by a 4 person team
 - Surveillance strategy proved invaluable
 - Nation-wide smallpox eradication programs were workable even in the least developed African countries and even in densely populated Madras State, India
 - WHO agreed to an international meeting on possible global targets for vaccine preventable diseases - 1970

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WHO Expanded Program on Immunization the legacy of smallpox eradication – 1974

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

To some – “the beginning of the Vaccine Era”

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Vaccine coverage (%) – the Americas

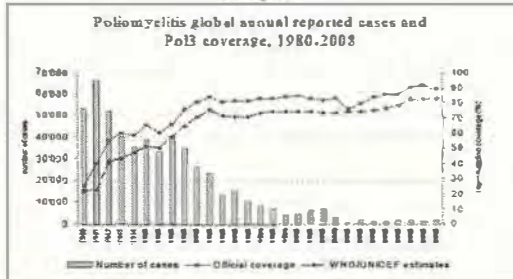
	1980	1990	2000	2008
DTP*	50	74	91	92
Measles	51	80	92	93
Polio*	57	75	90	92
HepB*	—	—	70	88
Hib*	—	—	75	90

* 3 Doses

Transmission interrupted: Polio (1991); Measles (2001); Rubella (2008)

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Poliomyelitis



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Measles



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Factors responsible for the rapidity of eradication

- A continually evolving strategy with an active interplay of Laboratory research
Epidemiology -- surveillance-containment
Dedicated, enthusiastic field staff
- Most important: an inexpensive, easily applied, heat-stable, single-dose vaccine providing durable protection
Vaccine in use into the 1960's -- liquid, calf lymph, inactivated within days, inadequate quality control

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Development of the vaccine and a better vaccination instrument

- 1950s -- Leslie Collier (Lister Institute) developed commercial-scale freeze drying technique for the vaccine
- Five vaccine producers joined to write a standard manual and subsequently trained lab directors
- Production in developing countries rose from 0 to >250 million doses within 5 years
- Labs in Canada and Netherlands regularly tested all vaccines used in the program
- Ben Rubin (Wyeth) invented the bifurcated needle.

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- Are there opportunities for dramatically better control of other diseases with new technologies for better vaccines and alternative methods for delivery?

Polio, pertussis, measles, hepatitis B, dengue, malaria ...?

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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."

