The Global Eradication of Smallpox:
what should we have learned

John C. Cutler Memorial Lecture

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The tale of smallpox eradication

- The beginning -- January 1967
  The target -- December 1976
  - Last case – October 26, 1977
- A program that almost wasn't launched,
  was forecast to fail,
  but miraculously succeeded

Efforts to eradicate a human disease

- Hookworm 1909-23 14 years
  Treatment, latrines
  52 countries
- Yellow fever 1915-32 17 years
  Aedes aegypti control
- Yaws 1948-66 18 years
  Penicillin
- Malaria 195573 18 years
  DDT

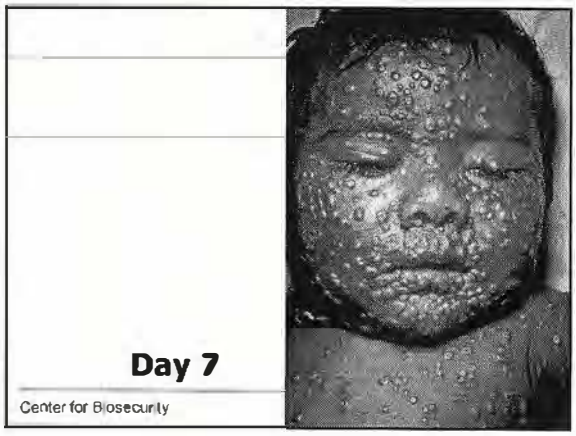
Common features: No surveillance; no research program

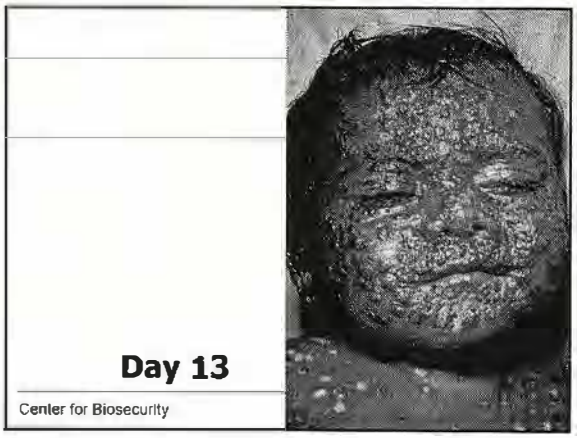
Characteristics of Smallpox Favoring Eradication

- Man -- the only host
- Virus spread -- during rash only
  -- face-to-face contact
- Permanent immunity after recovery
- Highly stable vaccine requiring one dose

Day 3

Day 5





Smallpox as a target

- 1953 – Director General proposal to the World Health Assembly

  "...a practical world program, of importance and value to every country...demonstrating the importance of WHO to every Member State"

Rejected as being uneconomical and unfeasible

Prominent in opposition – U.K. and U.S.

Global eradication program approved

- 1958 USSR Vice-Minister Victor Zhdanov

  Proposed a program of mass vaccination to achieve global eradication

- 1959 -1967
  - Budget of <$100,000 per year
  - One staff member in HQ and 5 in the field

WHO's "intensified" program - 1967

- Director-General to submit plan for an "intensified" program-1966
- Plan- 10 year program; budget of $US 2.4 million/year
- Objections by delegates
  - Not feasible
  - Demand for no further increases in WHO budget
- 58 votes needed to accept the proposal; 60 votes received

Program leadership

- Director General -- confident that program will fail with loss of credibility in WHO
- Demand for an American Director
  - The identified candidate declines:
    - Major responsibilities for new CDC African program
    - Budget too small to purchase vaccine needed
    - Only <$50,000 each for 50 countries
  - The appointment

The Challenge

- Global status of smallpox – 1967
  - 10,000,000 – 15,000,000 cases
  - 2,000,000 deaths
  - 43 countries reported cases
  - Population of endemic areas > one billion
- Program staff
  - Headquarters – 4 medical, 2 admin, 3 secretaries
  - Regions – one each in 4 WHO Regions
  - International staff – never more than 150

The Strategy

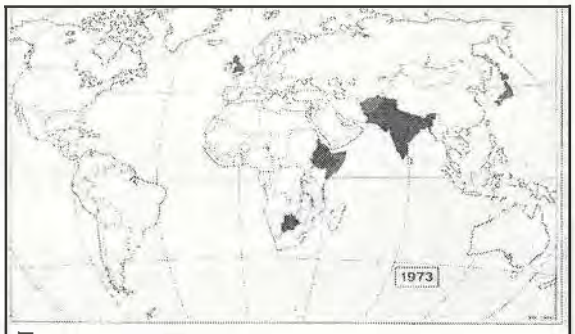
- Vaccination
  - Target – 80% of population
  - Quality control
- Surveillance-containment
  - Surveillance – weekly report from every health center and hospital
  - Containment teams to do "ring vaccination"
  - Quality control

= Endemic countries
= Others with cases

Smallpox 1967

= Endemic countries
= Others with cases

Smallpox 1970



■ = Endemic countries
■ = Others with cases

Smallpox 1973

Center for Biosecurity

Critical final challenges

- India- 1973
  - National search and containment
  - Many staff for 3 to 6 month assignment
- Bangladesh – August 1975
  - Only remaining area with variola major
  - Civil war, floods, and famine
  - Health services are reorganized
  - President and family are assassinated

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Critical final challenges

- Ethiopia—1974-75
  - Marxist revolution
  - Civil war in three areas
  - Few roads and limited staff
- Somalia – Summer 1977
  - The only remaining endemic country
  - Nomadic, minimal health infrastructure
  - Variola minor patients readily able to move about
  - The time of the Haj was approaching

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■ = Endemic countries
■ = Others with cases

Smallpox 1976

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Ali Maalin - 26 October, 1977

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Critical components of international programs

what I believe we learned

- Surveillance and containment
  - Surveillance – epidemiology in action
    - Incidence – indicator of progress
    - Identification of groups or areas at risk
    - How disease spreads
    - Continuing adaptation of tactics to circumstances
  - Containment
    - Targeted control where disease occurs

Played no role in past failed eradication programs

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Critical components of international programs
what I believe we learned

- Research
  - Field- epidemiology, operations, social sciences
  - Manufacturing
  - Laboratory
  - Continuing questions
    - What would make the task easier, faster, less costly, more certain of success

Why have public health professionals been so resistant to research?

Critical components of international programs
what I believe we learned

- Quality control is an intrinsic part of an effective program
  - Vaccines, pharmaceuticals, bed nets, etc
  - Success in obtaining adequate distribution

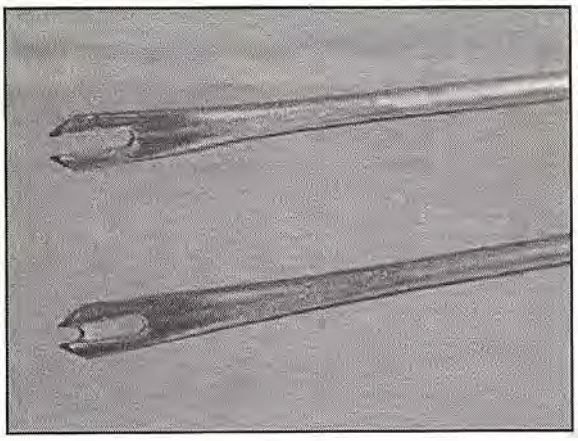
One of the most ignored precepts in program operations

Wrong assumptions - vaccine

- Available supplies would be adequate
- Quality of vaccine is essential
  - Quality control labs (Canada and Netherlands)
  - Less than 10% met accepted standards
  - Budget-too small to permit vaccine purchase
- Development of vaccine production
  - Research to do manual and training

Solutions for the vaccine problem

- Change vaccination procedures to use less vaccine - Research
  - Jet injector gun
  - Bifurcated needle
    - One-fourth as much vaccine required
    - Training time-15 minutes
    - Vaccinations successful in 95%+
    - Needles can be easily sterilized and reused
    - Cost -- $5 per thousand



Wrong assumptions

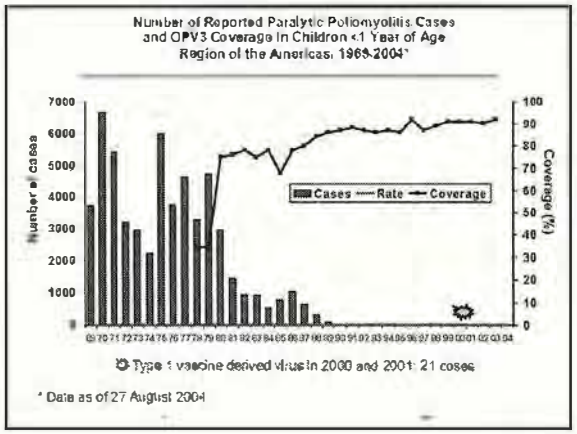
- Revaccination required every 5 to 10 years
  - Surveillance shows almost all cases are unvaccinated
- Smallpox spreads "like a prairie fire"
  - Surveillance shows a patient usually infects few others
  - From onset, most patients are sick and go to bed

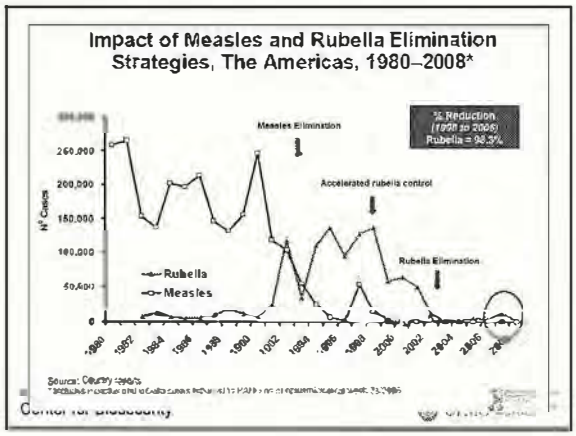
A legacy of smallpox eradication Expanded Program on Immunization EPI

- WHO international conference-PAHO 1970
  - Wards full of children with vaccine-preventable diseases
  - High productivity of smallpox vaccination teams
- Expanded Program on Immunization adopted by World Health Assembly -- 1974
  - Smallpox, DTP, measles, polio
- Special support by UNICEF and Rotary
  - *Target: 80% coverage by 1990 (~5 % in 1975)*

Immunization in the Americas

- 1977 EPI began – Director, Ciro de Quadros
- 1985 PAHO– Polio eradication
  - Development of a surveillance network
  - Development of a lab network
- 2008 – Ten antigens
  - >90% coverage -- DPT, polio, BCG, measles, rubella, H. influenzae b, hepatitis B, (rotavirus)
  - Yellow fever in endemic and at-risk areas
- Vaccine expenditures/ year –
  >$2,000 million – 95 % from national budgets





What we should have learned.....

- Commitment of countries before programs begin
  - Strategy
  - Plan and budget
  - Practical demonstration of efficacy
- Surveillance system
- Systems for quality control of vaccines or drugs and success in delivery
- Research program