

My thanks to the graduate students for inviting me to this interesting symposium
and for opportunity to learn something of your exceptional research program.
Smallpox and Deacons.
1980 - Eradication declared - we celebrated the end of history's most dreaded potential disease
But as I shall relate, the threat of its return is again with us.

Smallpox: the death and resurrection of a virus

Symposium
Duke University Medical Center

D.A. Henderson MD, MPH
November 7, 2003



Ali Maalin - 26 October 1977



Ramses V



Sitala Mata



Sapona

"That disease was the most terrible of all the ministers of death. The horror of the Plague... visited our shores only once or twice within living memory but the smallpox was always present, filling the church yards with corpses...and making the eyes and cheeks of the betrothed maiden objects of horror to the lover."

Macauley

Deaths in the 20th Century

Due directly or indirectly to armed conflict:

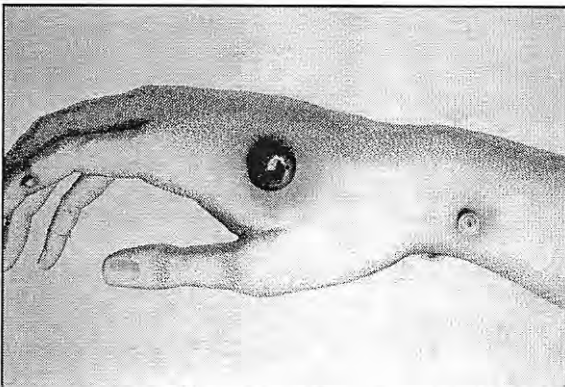
100,000,000

Due to smallpox

300,000,000+



Edward Jenner



Cowpox on the hand of Sarah Nelmes

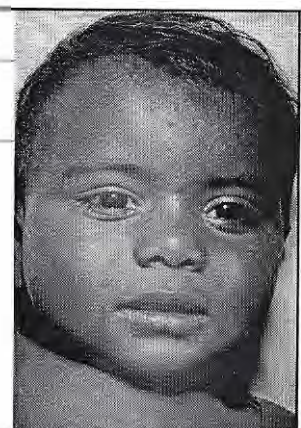
Smallpox -- characteristics

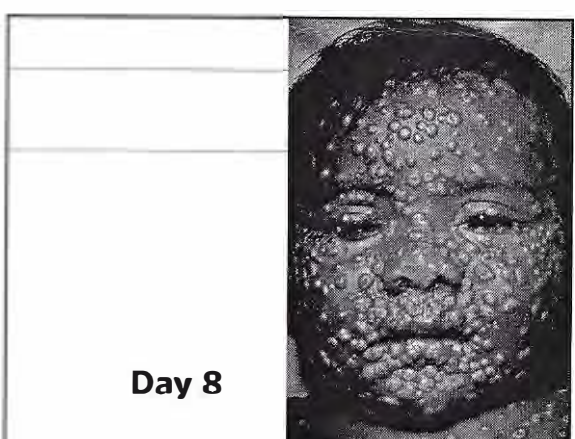
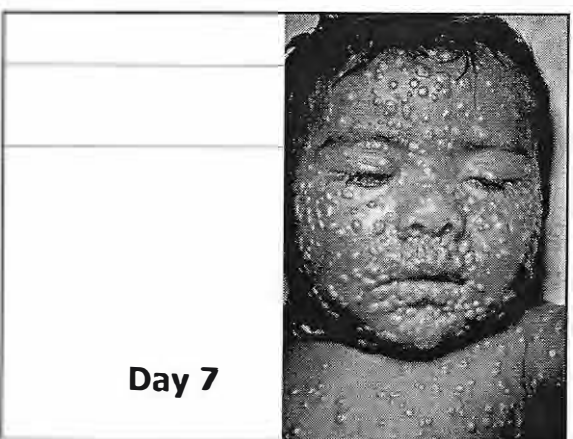
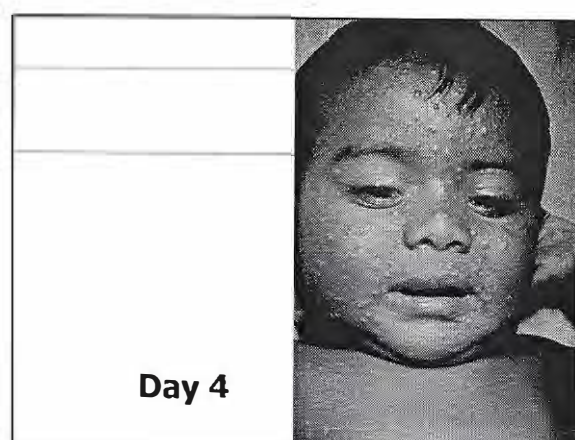
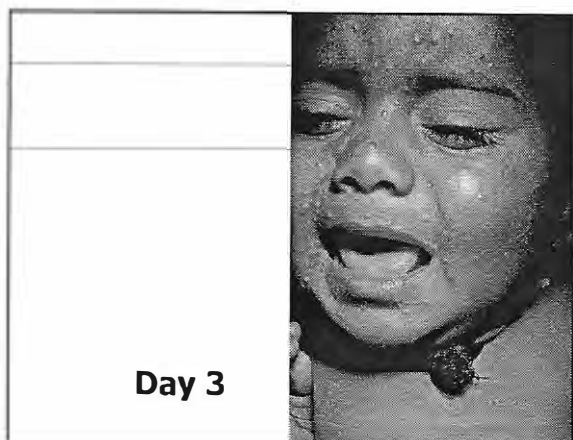
- Incubation period is 10-12 days
- Severe flu-like symptoms then rash
- Case fatality rate --30 %
- No therapy available

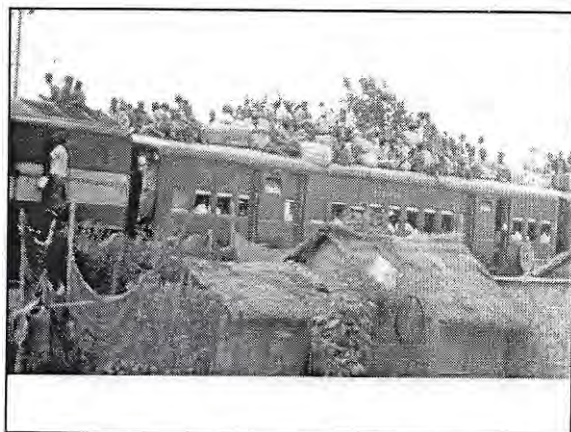
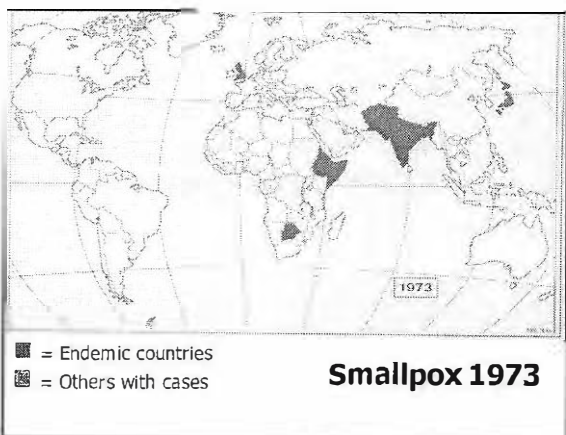
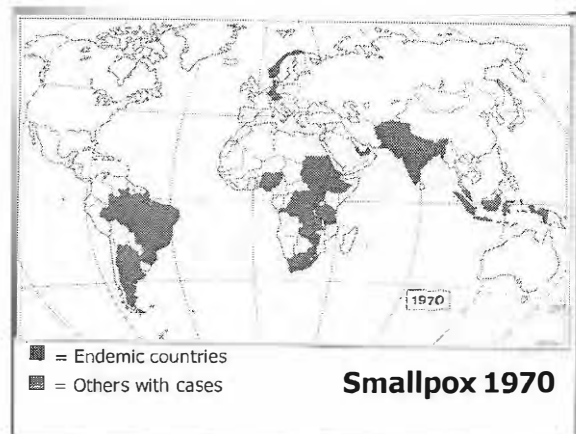
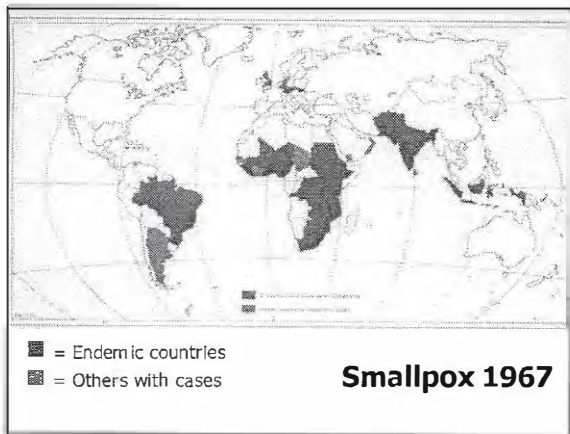
Day 1

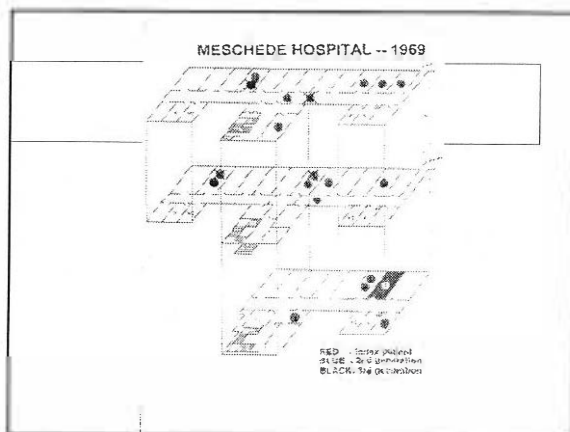
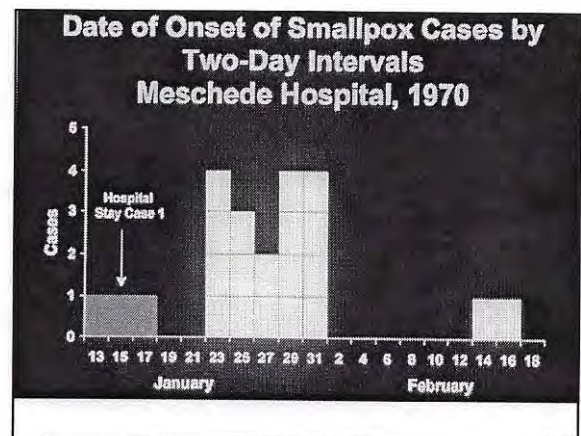
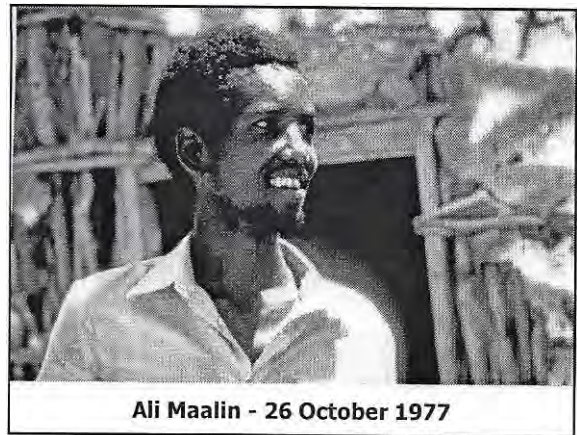
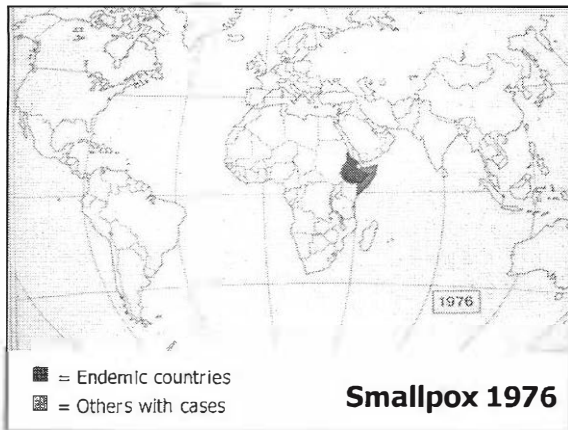


Day 2









"On May 8, 1980, WHO announced that smallpox had been eradicated from the planet... Soon after the WHO announcement, smallpox was included in a list of viral and bacterial weapons targeted for improvement in the 1981-85 Five-Year Plan.... Where other governments saw a medical victory, the Kremlin perceived a military opportunity... the Soviet military command issued an order to maintain an annual stockpile of 20 tons."

Alibek, 1998

Russians

Susceptibility of US Population to Smallpox -- 2003

- Vaccination stopped in 1972
- Few under 32 years of age have been vaccinated -- 45% of population
- Americans successfully vaccinated only once before 1972 have little immunity- 35% of population

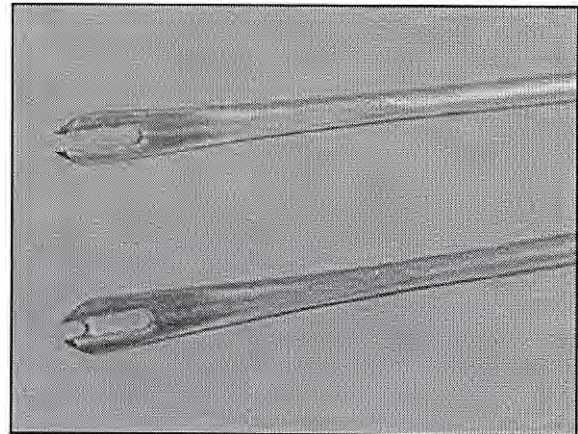
Epidemic Response Capability September 18, 2001

- Vaccine manufacturers
 - U.S. None
 - World None
- Vaccine in storage
 - U.S. 15 million doses
 - World ? 80 million doses
- Ready for emergency shipment
 - 90,000 doses of vaccine
 - Limited quantities -- needles, VIG

Smallpox Vaccine Reserve--2003

	<u>No. of doses</u>
■ Wyeth DryVax	15 million
■ Calf-lymph - 1978	
■ Aventis Pasteur	85 million
■ Calf-lymph - 1958	
■ Acambis/Baxter	209 million
■ Vero cell - 2002	

In emergency -- dilution of vaccine 1:5 is possible



MVA – A Next Generation Vaccine?

- Non-replicating attenuated vaccinia strain (Modified Vaccinia Ankara)
- Vaccination by IM --either 2 doses or 1 dose followed by NYCBH vaccinia
- Contract awarded for development and initial manufacturing
- Phase 1 trials are in progress

Options for Vaccination Before an Event

- Vaccinate no one
- Vaccinate those at highest risk, candidates:
 - Health care workers
 - First responders
 - Truck drivers
 - Essential personnel
- Vaccinate anyone desiring to be vaccinated
 - Recommend vaccination
 - Recommend against vaccination
- Make vaccination compulsory

A Balance of Risks

- Probability that smallpox will be used as a weapon
- Frequency of adverse reactions and public response in 2003
- Likely effectiveness of outbreak control?

Smallpox Vaccine Expected Adverse Events

- **Life-threatening complications (per million)**
 - Post-vaccinal encephalitis (3)
 - Progressive vaccinia (1)
 - Eczema vaccinatum (12)
- **Less serious**
 - Generalized vaccinia
 - Accidental inoculation
 - Rash and fever
- If 100 million vaccinated, 100+ deaths might occur (1960's data)

Smallpox vaccine Military Experience to date*

- Numbers are still small – 493,000
 - None hospitalized; 10 missed 1+days of work
- **Post-vaccinal encephalitis - 1**
- **Progressive vaccinia - 0**
- **Eczema vaccinatum - 0**
- Generalized vaccinia - 33
- Infection in contacts - 29

*Note: September 11, 2003

Smallpox vaccine Cardiac complications

- Myopericarditis 56*
 - Onset 7 to 17 days
 - Fever, chest pain, EKG changes, enzymes increased
 - Recovery
- Ischemic events (civilian) 10*
 - Angina, myocardial infarct
 - Difficult to distinguish from normal background
 - Almost certainly coincidental

*Note: data are provisional

Outbreak control

- Smallpox doesn't spread readily
- Patient transmits only after symptoms
- Vaccine protects even when given 3-4 days after infection

Spread of Infection

Spread of disease is slow

- **Household spread --Secondary attack rates**

Measles	76%
Chickenpox	74%
Smallpox	58%
- **Community spread --measles and chickenpox spread before symptoms; smallpox does not**

Epidemiology of Smallpox

Transmission Patterns in Europe: 1958-1973

- Outbreaks: 34
- Cases: 573
 - Transmission in hospital: 277 (48%)
 - Transmission in home: 143 (25%)
- Hemorrhagic and malignant cases -- a threat to hospitals
 - Bradford, UK (1961) Hemorrhagic smallpox 10 cases
 - Germany (1970) Malignant smallpox 16 cases
 - Yugoslavia (1972) Hemorrhagic smallpox 38 cases
- Seasonal variation
 - Dec to May 24 importations average +45.6 cases
 - Jun to Nov 10 importations average + 0.5 cases

Surveillance and Containment

Steps in Containment -- I

- Isolate patient
- Vaccinate all persons who had been in a room with the patient since he/she became febrile (primary contacts)
- Place primary contacts under surveillance with daily temperatures
 - If contact develops fever, isolate at home or special facility until diagnosed
- Vaccinate all household members of primary contacts (secondary contacts)

Surveillance and Containment

Steps in containment -- II

- Make vaccine available on request to those in the area
- Not generally desirable:
 - Compulsory vaccination
 - Quarantine of city or groups of people
 - Closure of airports, suspension of transport

Preparatory steps -- in progress

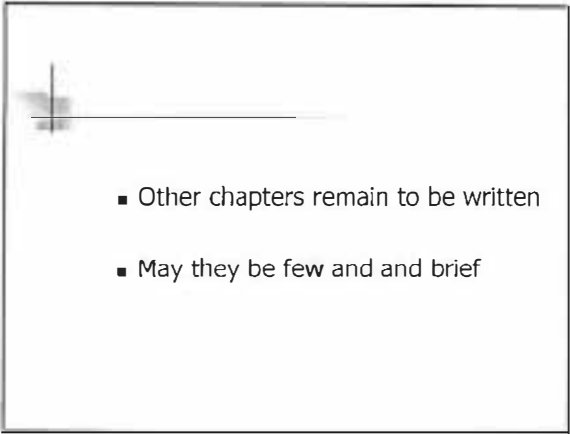
- Vaccine --
 - Stockpiled--available anywhere in 12 hours
- Each metro region to have plan to make vaccination widely available over 7 days
- Each metro region to have plan to accommodate 500+ patients per million pop.
- Every ER to have negative pressure rooms for examining rash and fever patients

Vaccination Program in Transition

Current, erroneous beliefs

- Smallpox is no longer a threat
- Complication rates are very high
- For health care personnel, vaccination after beginning of an outbreak will suffice
- The responsibility for vaccination rests entirely with the government and the individual

- Are we now better prepared than on 9/11 ?
- Are we fully prepared ?
- How long must we sustain our efforts ?

- 
- Other chapters remain to be written
 - May they be few and and brief