Lessons of Disease Eradication Efforts for Invasive Mussel Control

Jim Koopman MD MPH, Professor Emeritus
Talk Organization

• Antecedents to Smallpox Eradication philosophy
  – Yellow fever and Malaria
• Smallpox, why and how it was eradicated
• Polio eradication, why we are in year 28 of a 12 year program and consuming annually a billion dollars a year more than the total original program was to cost
• Collaborative modeling to set and achieve goals
Fred Soper’s Quest to Eradicate Aedes Agypti for Yellow Fever Control

Rockefeller Foundation
First Director of PAHO
First Major Public Health Leader to Espouse Eradication
Yellow Fever Eradication Program

• Successes in Aedes aegypti control and discovery of monkey hosts changed program objectives from yellow fever eradication to Aedes aegypti eradication

• Focus was on rigid program implementation without much exploration of new approaches or scientific investigation of the biological or social processes that led to success or failure

• Philosophy was almost all resources had to be put into field work with checking on the work of all field workers
Map 1—Status of the Aedes aegypti Eradication Campaign, June, 1961

*Eradication carried out according to the standards established by the Pan American Health Organization.
In the late 80s, after dengue reinvaded the Americas (because USA did not do its job according to Latin Americans), and after epidemics of severe dengue in Cuba, Cuba supposedly once again eradicated dengue and Aedes Aegypti.

But brave field workers reported on the internet that there in fact had not been eradication and that their reporting of cases of dengue was suppressed.
What the World Learned From Yellow Fever

• Strong, thorough, meticulous, detailed (dictatorial) leadership can knock down health threats

• Lack of knowledge about transmission routes and dynamics can lead one to pursue a fools errand
  – Monkey host made eradication unpalatable
  – Mosquito population dynamics allow Aedes to spring back full force from undetectable levels of infestation (Concept of stable vs. unstable eradication)
What the World Needed to Learn

• Initial empirical success is a weak base on which to build an eradication program
• Eradication programs need a wide community of scientists to work openly on understanding what is involved in successes and failures
• Basic science and technological innovation should be built into big eradication programs
• Programs should be prepared to shift from eradication to control objectives in a manner that maintains progress
CDC is Founded on Malaria Elimination Success

DDT

Chloroquine
The First Malaria Eradication Effort

- 1955 WHO begins a Global Malaria Eradication Campaign based on DDT spraying & chloroquine Rx
- Same philosophy of putting all resources into fieldwork and evaluation of fieldwork quality
- Success in developed countries & India but by 1969 resistance to DDT and Chloroquine lead to surrender
- Reasons for failure were never completely understood
  - Inadequate understanding of biology (esp. gametocytes)
  - Inadequate efforts to understand transmission dynamics:
    - Effects of simplifying model assumptions never fully explored
    - Little modeling of evolution of resistance
    - WHO modelers involved, but modeling was underdeveloped in 1955
A knowledge gap that deserves more attention is the frequency and causes of asymptomatic gametocytemia.
Melinda Gates Revives Malaria Eradication

• Some effort to make data more available to a wide community of collaborative scientists but data is still too restricted to attract a broad community of modelers
• Some successes with insecticide impregnated bednets
• Search for key technical innovations that will make rigid program implementation successful
• Vaccine faces very fast waning of immunity problems
• Gates establishes company to do the needed modeling
• Still not enough basic science to understand how problems will arise as program changes transmission dynamics
Smallpox eradication

- Administrative structure similar to yellow fever & malaria
  - WHO maps made for malaria serve smallpox
  - DA focuses all efforts outside WHO to skirt bureaucracy
- A flexible leadership changes directions
- A grand success on an easy target
- Rudimentary modeling was enough to guide decisions
- Morally questionable decisions helped success
Flexible Leadership

• Believed initially
  – that infection was highly contagious, vaccine immunity was short lived, high coverage needed reach transmission threshold
• Discovered that
  – 150% vaccine coverage was insufficient in places due to counting repeat vaccinations as new vaccinations, transmission was very slow, vaccination lasted
• Program initially based on mass vaccination but lack of vaccine led to discovery that a few key vaccinations could stop transmission
• Logic of simple model convinced leadership to change to ring vaccination
An Easy Target

- Usually just looking at a face is enough to diagnose
- Vaccination after exposure to a case can prevent an infection and a subsequent transmission
- Vaccination is easy
- Lyophilized vaccine stable
- Two weeks to find exposed individuals
- Rewards for reporting cases highly effective
Only Rudimentary Modeling Needed

- Mostly mathematicians doing modeling back then
- Modeling was highly disparaged
- Bill Foege did thought experiment
  - After stumbling on low vaccine use strategy
- Foege leadership: know and inspire workers
Choose a virulent vaccine just to better insure success

- Russian vaccine had much higher complication rate but also a little higher take rate.
1988 -- 350,000 cases
Eradication Program Begins
Polio Eradication

- The greatest global communitarian effort ever
- Year 28 of a 12 year program consuming every year more than original 12 year program was to cost
- Success needed now so we can pursue easier targets
- Biggest problems I see are
  - Lack of understanding of transmission dynamics
  - Program data constrained to 3 modeling groups
    - Theorists who could best use data don’t get data
    - No local theorists generating new approaches
- The Taliban and Boko Haram blamed for failure
  - True, but we could have eradicated by now despite their actions
Program organization

• Inherited from yellow fever, malaria, smallpox
• More research but
  – mainly implementation operations research and vaccine research. Not transmission dynamics
• WHO, UNICEF, CDC, Rotary International form GPEI
• Gates Foundation joins
  – New diagnostic, monitoring, mapping, and modeling tools are allowing faster and more accurate tracking of polio cases and transmission patterns
  – But basic science on transmission dynamics not pursued
The Polio Endgame Problem

• High transmission countries that quickly reached high vaccination levels eradicated quickly
  – Helped by transmission of the vaccine boosting immunity
• Those who took a long time let immunity wane in older age groups let older age groups maintain transmission
• WHO and the GPEI have so longed stressed that only children need to be vaccinated that they fear changing their story
The Global Polio Eradication Initiative Strategy

Only in the polio game the mole gains an ability to pop up and spread unseen as time passes.
Ways for invasive mussel control to avoid mistakes made controlling epidemics

• Get modelers, program people, & outside groups working together so they are continually mapping what we do and do not know while they are mapping mussels
• Use collaborative modeling software like Nova (Numerus) modeler
• Involve citizen scientists not only in gathering data, but in conceptualizing spread and control
• Make all data open so that smart people are attracted to analyze it
Thank You