International Conference on Emerging Infectious Diseases: Zoonotic Diseases

Preventing human diseases by altering pathogen transmission in animal reservoirs (AKA “...taking it to the streets...”)

Charles E. Rupprecht
Viral & Rickettsial Zoonoses Branch
ZOONOSIS PREVENTION & CONTROL

RATIONALE FOR TARGETING SUSPECTED RESERVOIRS:

- Basic goals (prevention, control, elimination, eradication, etc.)
- Status (exotic, enzootic, epizootic, etc.)
- Species (domestic, wild, ‘pests’, ‘charismatic megafauna’, etc.)
- Disease ecology (deemed simple or complex; pathogenesis, etc.)
- Methods (practical, feasible, temporal dynamics, etc.)
- Economics (start-up costs, short term benefits, etc.)
- Infrastructure (inter-sectoral cooperation, diagnostics, etc.)
- Society (culture, traditions, religious beliefs, education, community participation, etc.)
QUALITATIVE CONCERNS: VEHICLES* OF TRANSMISSION
*(more than 1 may apply)

Vertebrate Species ABC

Flesh
Hide
Saliva
Blood
Milk
Gametes

Hair
Feces
Urine
Offspring
ZOONOSIS PREVENTION & CONTROL

ORIGINS FOR TARGETING SUSPECTED RESERVOIRS?

Oral/Written History
Religious or Cultural Traditions
Legends: Mythology, Fables, Fairy Tales, Folklore
Common Sense
‘Organized’ Medicine
Modern theory
Gradual rise in the belief about “germs” and their effects in animal populations

- By the mid-to late 19th century, many professional veterinarians throughout Europe were beginning to accept the notion that epizootics were contagions caused by the spread of disease-matter (‘materies morbi’), unlike the majority of their other biomedical colleagues...

- Institution of quarantines, and destruction of obviously ill animals, could serve to impede disease spread.
Professional acceptance of killing vs. healing in large animal veterinary medicine (economy over sentimentality)

- Replacement costs often more timely, less costly than repairs
- More expedient to harvest, before animal values fell further
- Increasing sensibility of slaughter choices in reducing risks
- Appreciation of individual carcass rendering, compared to enmasse disposal during large outbreaks
“Something in the air tonight…”

- Despite their historical distance from so-called “horse doctors” and “veterinary quacks”, many prominent 19th century European physicians held to the conviction that certain diseases were endemic and sporadic, relating to a generalized belief in ‘miasmas’ (‘poisoned airs’), and that overall environmental improvements would gradually prevent the generation and diffusion of such poisons in animal and human populations...
Support for ‘anti-contagionism’ and global markets

- Coupled with the ideals of ‘miasmas’, many supporters of free trade viewed methods such as quarantine, exclusion, import inspection, taxes, slaughtering practices, etc. as an intrusion, nothing more than a nationalistic means of economic protectionism, rather than a prohibition against the potential introduction and exchange of animal pathogens.

- Obviously, history held no monopoly on corruption or incompetence...
ZOOONOSIS PREVENTION & CONTROL

GROSS ENTRY RESTRICTIONS: COARSE-GRAINED

COUNTRY
ABC

X

SPECIES & SOURCE
ABC
ZOOONOSIS PREVENTION & CONTROL

SITE RESTRICTIONS: MEDIUM-GRAINED

SINK
ABC
(e.g. government, university, zoo, private, etc.)

X

SPECIES
ABC
ZOOONOSIS PREVENTION & CONTROL

UTILIZATION RESTRICTIONS: MORE FINE-GRAINED

USE ABC

SPECIES ABC
SELECTED EXAMPLES OF REGULATED ANIMAL USE

- FOOD
- COMPANIONSHIP
  - Vertebrate Species
    - ABC
- LABOR
- FUR
- EDUCATION
- TRANSPORTATION
- SPORT
- RESEARCH
- ENTERTAINMENT
- RITUAL
- INDUSTRIAL PRODUCTS
COMING TO TERMS WITH LETHALITY: “FATAL DISTRACTIONS”

EUTHANASIA

SELECTED CULLING

PREDATOR CONTROL

SANCTIONED BOUNTIES

POPULATION REDUCTION

TEST/SLAUGHTER

OPEN SEASONS

HABITAT DESTRUCTION

‘VERMIN’ REGULATION, ALA SNAKE ROUND-UPS, SHARK HUNTING REDUX’ ‘JAWS’

INTENTIONAL EXTIRPATION

Vertebrate Species ABC
Helminth control: Prevalence of *Echinococcus granulosus* (Gemmell & Roberts, 1998)
Baylisascaris, raccoon latrines, and the great outdoors…

STOP ITINERANT PROCYONID DEFECATION TODAY!
ANTHRAX

Ingested
(grazing/browsing/drinking)
inhaled sometimes? (spore-laden dust)
Fly-bite sometimes?

HERBIVORE
Germination & multiplication
in lymphatics & spleen.
Vegetative forms released
in massive numbers into the
blood in final hours of life

SPORES
Sporulate on
exposure to O₂

VEGETATIVE FORMS
(shed at death in
haemorrhagic exudate
from nose, mouth or anus
or in spilt blood)

Pulmonary
(spore-laden dust)

Gastrointestinal
(infected meat,
contaminated water/vegetables?)

Cutaneous
(via lesion. From
handling infected meat/
contaminated materials.
Fly bite sometimes?

If hygiene poor

MAN

TURNBULL, 1998
BOVINE BRUCELLOSIS

(1) Define area of action

(2) Is Brucellosis present? What type?

YES

(4) Define unit of action

NO

(3) Protect area

Surveillance

Replacement animals

(5) Is surveillance available?

YES

(7) Prevalence/unit in area?

< 1%

1-5%

> 5%

NO

(6) Systematic vaccination

(8) Test and slaughter

< 1%

1-5%

> 5%

Combined

Systematic vaccination

5-10 years

until < 5%

Surveillance

Replacement animals

PLOMMET et al., 1998
Cat Scratch Disease

- Source/breed/temperament
- Selection of older cats
- Claw trimming
- Bite/scratch behavior modification
- Flea control
- Vaccination??
Total Feral Cat Colony Management For a Potpourri of Problems

- Restricted additional members
- Resource control
- Vaccination
- Drug treatment
- Spay/Neuter
- Surgery
- Euthanasia
Rodents & HFRS viruses

- Rodenticides
- Household exclusion
- Habitat modification
- Refuse removal
- Predator promotion
- Pathogen introduction
Defining the problem: the Filovirus reservoir(s)?

WHO
WHAT
WHERE
WHEN
HOW

_________________________ WHY?
Examining the issues: possible zoonosis ‘wannabes’

- Borna disease is a condition of horses and other vertebrates caused by a negative-stranded RNA virus
- Touted as an emerging zoonosis in human affective disorders
- Objective interpretations of serology and PCR data appear related in part to cross-reactivity and contamination
- Any implied methodology to target reservoirs for specific control would be impractical when information in toto suggests alternative explanations...
Xenotransplantation issues

- Rather than focus solely on a short laundry list of known pathogens to screen, proper and rigorous health promotion at the captive animal population level (closed herd, flock, school, etc.) is perhaps the better route...
QUINTESSENTIAL RABIES CONTROL IN ANIMALS

- Quarantine/Restricted Entry
- Population Reduction
- Movement Restriction
- Habitat Modification
- Parenteral Vaccination
- Oral Immunization
This illustration from Daniel's Rural Sports (1807) details operation for removal of "worm" (lyssa) from the tongue, thought for centuries to prevent rabies. At top, lines indicate site of incision. At center, mucous membrane is reflected and lyssa dissected away. At bottom is extracted "worm."

BAER et al., 199
10 February 1831.

**A BILL**

To prevent the spreading of Canine Madness.

---

**Note.**—The Words printed in *Italics* are proposed to be inserted in the Committee.

**Whereas** many of His Majesty's Subjects have suffered from the disease occasioned by the bite of Dogs in a rabid state, and in such cases death hath ensued: And whereas in cases where parties suffer from the bite of Dogs no summary compensation can be had by them for the same, and it is expedient to provide such summary compensation: And whereas mischief to other Animals in which His Majesty's subjects have a property, hath also often ensued from the bite of Dogs: And whereas no summary compensation for such mischief can be had by the owners of such Animals; and it is therefore expedient at all times, when Canine Madness is known to be prevalent, to prevent Dogs from going at large, and to empower Justices of the Peace and others to seize the owners, and if necessary, to cause any Dogs to be destroyed, and also and at all times to make summary compensation to the parties injured by the bite of Dogs, or to the owners of Animals so injured; *Be it therefore* Enacted, by The KING's most Excellent MAJESTY, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the Authority of the same, THAT from and after the passing of this Act, it shall be lawful for any Justice of the Peace, or Chief Magistrate, on information or suspicion of the existence of Canine Madness, to issue a public Notice, requiring all Dogs within any parish, wapentake, division, city, borough, liberty, township, market town, franchise, hamlet, titling, precinct and chapelry, mentioned in such notice, to be kept confined during the time therein stated;

England Muzzling Law, 1831.
VACINE SEU CÃO CONTRA RAIVA
Monthly incidence of animal rabies, Houston–Harris County, Texas, January 1953 to October 1955 (Tierkel, 1956).
SELECTED EXAMPLES OF CANINE RABIES ELIMINATION

- United Kingdom, 1922
- Malaysia, 1955
- Japan, 1956
- Taiwan, 1961
- Portugal, 1961
- Uruguay, 1983
Canine & Human Rabies: Mexico

YEAR

NUMBER OF HUMANS
Humans
Dogs

NUMBER OF DOGS
0 2000 4000 6000 8000 10000 12000 14000
Thailand

Rabies PET

Rabies death

- about 2.6 mill dogs annually vaccinated
- annual costs US$ 6.5 mill

WHO/EMC

Stöhr Mar 97 Gen-Fig. 4
## VAMPIRE BAT POPULATION REDUCTION: ANTI-COAGULANT USE

<table>
<thead>
<tr>
<th>METHOD</th>
<th>PLACE</th>
<th>BITE REDUCTION</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic</td>
<td>Mexico (ir)</td>
<td>90-98%</td>
<td>Thompson et al. 1972</td>
</tr>
<tr>
<td>Tx. Cattle</td>
<td>Mexico (im)</td>
<td>88-97%</td>
<td>Flores-Crespo et al. 1979</td>
</tr>
<tr>
<td>Topical</td>
<td>Mexico</td>
<td>81-95%</td>
<td>Flores-Crespo et al. 1991</td>
</tr>
<tr>
<td>Tx. Bites</td>
<td>Brazil</td>
<td>91-100%</td>
<td>Kverno et al. 1976</td>
</tr>
</tbody>
</table>
A MODEL OF VAMPIRE BAT CONTROL (Massad et al. 2001)

Proportion of Intervention

Annual # Averted Deaths

Bat Control
Vaccination
A MODEL OF VAMPIRE BAT CONTROL (Massad et al. 2001)
Common Bat Entry Points

- Down chimney
- Openings around chimney
- Through vents
- Through open, unscreened windows
- Under loose shingles
- Under eaves
- Under siding
- Under or through open doors
## POPULATION REDUCTION: Alberta, Canada 1952-56 (strychnine baits)

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Number Poisoned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fox</td>
<td>55,889</td>
</tr>
<tr>
<td>Coyote</td>
<td>53,364</td>
</tr>
<tr>
<td>Lynx</td>
<td>10,044</td>
</tr>
<tr>
<td>Wolf</td>
<td>5,461</td>
</tr>
<tr>
<td>Bear</td>
<td>4,130</td>
</tr>
<tr>
<td>Skunk</td>
<td>664</td>
</tr>
<tr>
<td>Cougar</td>
<td>69</td>
</tr>
<tr>
<td>Fisher</td>
<td>18</td>
</tr>
<tr>
<td>Fisher</td>
<td>18</td>
</tr>
<tr>
<td>Badger</td>
<td>4</td>
</tr>
<tr>
<td>Wolverine</td>
<td>1</td>
</tr>
</tbody>
</table>

Ballantyne, 1958
Rabies Cases Europe
1st Quarter 1984
750 cases reported
A FOCUS ON THE RESERVOIR(S) OR A QUESTION OF BALANCE?

- Dairy/beef & bovine tuberculosis?
- Small ruminants & brucellosis?
- Poultry practices & influenza?
- Cannibalistic hoofed stock and TSEs?
- Modern swine production & Nipah?
- Etc.