Implementing a GIS to investigate nosocomial Salmonella infections in a veterinary teaching hospital

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Salmonellosis
Salmonella Timeline

Jan
Surveillance program begins – all horses physically in ICU

Apr
Enteric precautions ward developed. Surveillance expanded to include ICU, SX and IV fluid patients

May
Last Salmonella Anatum isolated

Feb 25
Salmonella Javiana first appears

Jan 29
Institute new RED ZONE protocol

Mar
Hospital closure – Salmonella Anatum

Jan
Stall scrubbing protocol instituted

Jan
Surveillance of all patients begins

Jan 8
Hospital closure due to Salmonella Javiana
Biosecurity Protocols

- Boot wash stations
- Restricted access
- Cleaning protocols
- Isolation facilities
- Sealant for walls
- Glove rules
- Hand foam
- Environmental cultures
We must be missing something
Hypotheses

GIS will be a useful tool to
• visualize patterns of nosocomial transmission of Salmonella organisms
• determine environmental factors that contribute to the spread
Salmonella Surveillance

- Since 2000.....
  - Selected groups
- Since 2004 ....
- **All** hospitalized horses
- Days 1-5, then weekly
- **Stall location recorded**

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**Stamp card with patient information**

<table>
<thead>
<tr>
<th>CLINICIAN: EADES</th>
<th>STUDENT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMISSION DATE:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STALL #: _______</th>
<th>FECAL SPECIMEN#: (1-5): ______</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIMEN COLLECTION DATE:</td>
<td></td>
</tr>
<tr>
<td>ADMISSION DATE: ______</td>
<td>DISCHARGE DATE: ______</td>
</tr>
<tr>
<td>PRIMARY DIAGNOSIS (REASON FOR ADMISSION):</td>
<td></td>
</tr>
<tr>
<td>SYSTEMIC ANTI BIOTICS: ☐ YES ☐ NO</td>
<td>SURGERY: ☐ YES ☐ NO</td>
</tr>
<tr>
<td>LEUKOPENIA: ☐ YES ☐ NO</td>
<td>FEVER: ☐ YES ☐ NO</td>
</tr>
<tr>
<td>OTHER HISTORY:</td>
<td></td>
</tr>
</tbody>
</table>

**RESULTS:**

| ORGANISM ISOLATED: | |

**ANTIBIOTIC RESISTANCE:**

- Ampicillin
- Erythromycin
- Nitrofurans
- Amikacin
- Gentamicin
- Sulfonamides
- Cephalothin
- Oxacillin
- Tetracycline
- Ceftiofur
- Penicillin
- Ticarcillin
- Ceftazidime
- Neomycin
- Tribrissen

**GIVE THE PINK COPY TO DR. EADES BEFORE SUBMISSION TO LAVMDL**

Susan Eades, countless students and house officers
Salmonella Culture Results

- Positive/Negative
- Serotypes -> Nat An Disease Lab
- Antibiograms
- 1st positive per animal only

Keith Neal, Alma Roy, LADDL
January 2000-March 2009

- 13,137 fecal cultures
- 3,572 hospitalized patients
- 1,111 positive cultures
- 46+ serotypes isolated

- 54 stalls
- 197,100 stall days (~ 10 years)
- ___ hospitalization days

? #_
Linking cultures to location (in progress)

Jenuine Parker and Heather McKay
Preliminary Observations

• Major outbreaks
Major outbreaks

<table>
<thead>
<tr>
<th>Date</th>
<th>DL Sample ID</th>
<th>Other Information</th>
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<tbody>
<tr>
<td>2002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
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</tbody>
</table>
Preliminary Observations

• Major outbreaks
• ‘Mini-outbreaks’; temporal clustering
• Several different serotypes
• Same serotype several times
Mini-outbreaks
Patient Demographics

IDEXX Cornerstone®
Powered by IDEXX SmartLink™ Technology

Amy Grooters
Cornerstone Medical Records

- Signalment (age, breed, sex, color)
- Admission/discharge dates
- Zip code of origin

- Invoice items
  - ICU level
  - Therapeutic agents
    - Antibiotics
    - Non-steroidal anti-inflammatory
    - Anti-ulcer medication
    - Surgery
    - Anesthesia
Next step....
putting things into a GIS

• ‘Small area’ GIS
• Spatial aspects of ‘outbreaks’
• Temporal aspects of ‘outbreaks’
• ArcGIS 9.3
• Tracking Analyst Extension
Base map of LAC
Floor drains
Stall usage
Water faucets
Bird perches
Bird perches
Red zone
Current Composite
Other players?

Dr. Rhett Stoutt
Spatial analysis

Fig 1. A patient infected with methicillin-resistant Staphylococcus aureus placed into a shared room.
Temporal analysis

Fig 2. A nursing aide checking vital signs on 9 patients within a time span of 33 minutes.
Project Summary

• Data acquired
• Linking culture data to location
• Sorting culture ‘outbreak' information
• Developing spatial maps
Prospective plans

- Expanded environmental cultures
- Feed samples archived
- Flooring renovation planned
- Farm animal surveillance