Acknowledgements

• Jeff Wilson
• Kelly Johnston
• Steve Wilson

• Regenstrief Institute, Inc.
• Clement McDonald

• ESRI
GIS in Healthcare

• Geography increasingly recognized
  – Medline “GIS” or “Geographic Information Systems”
    • 2000-2003 = 616
    • 2006-2007 = 627

• Primarily community/regional level analysis
  – Environmental risk / Exposures
  – Disease distributions
Hypotheses

- Adapt GIS techniques from community level to hospital level
- Simplify the linking and interpretation of multiple data sources
A Worsening Problem

• Hospital acquired infections – 2,000,000 / year

• 90,000 patient deaths / year¹

• Increasing Antibiotic Resistance
  – MRSA- Methicillin-Resistant Staphylococcus aureus
  -57.1% of S. aureus isolates in ICUs²

¹MMWR Morbidity and Mortality Weekly Report. 1992;41:783-7
²Am J Infect Control 2003;31:481-498
Combatting the problem

• Infection Control Providers
  – Hand Hygiene
  – Contact Isolation
  – Active Surveillance

  – Outbreak Investigation
CENSUS REPORT For 5N
WISHARD MEMORIAL HOSPITAL

10 AUG 04  10:22AM
19 Patients for : 5N
Total acuity = 57  Avg acuity = 3.16

<table>
<thead>
<tr>
<th>Patient Name</th>
<th>Hosp#</th>
<th>Bed Num</th>
<th>Admit Date</th>
<th>Acuity</th>
<th>Age</th>
<th>Pending Ords</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T</td>
<td>9-0</td>
<td>N/A</td>
<td>4</td>
<td>50yr</td>
<td>Pend disch ord on 09 AUG 04 at 12:17PM</td>
</tr>
<tr>
<td>K</td>
<td></td>
<td>6-7</td>
<td>09 AUG 2004</td>
<td>1</td>
<td>69yr</td>
<td>Pend disch ord on 08 AUG 04 at 09:31AM</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>9-3</td>
<td>N/A</td>
<td>2</td>
<td>60yr</td>
<td>Pend disch ord on 06 AUG 04 at 02:16PM</td>
</tr>
<tr>
<td>D, T</td>
<td></td>
<td>3-2</td>
<td>07 AUG 2004</td>
<td>N/A</td>
<td>54yr</td>
<td>Pend disch ord on 06 AUG 04 at 08:22AM</td>
</tr>
<tr>
<td>M, A</td>
<td></td>
<td>5-0</td>
<td>04 AUG 2004</td>
<td>4</td>
<td>74yr</td>
<td>Pend disch ord on 07 AUG 04 at 12:54AM</td>
</tr>
<tr>
<td>R, L</td>
<td></td>
<td>7-6</td>
<td>05 AUG 2004</td>
<td>3</td>
<td>75yr</td>
<td>Pend disch ord on 07 AUG 04 at 12:54AM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>SOURCE</th>
<th>NAME</th>
<th>MRN#</th>
</tr>
</thead>
<tbody>
<tr>
<td>04/18/1999</td>
<td>URINE</td>
<td>A**** C****</td>
<td>******3</td>
</tr>
<tr>
<td>01/27/1998</td>
<td>URINE</td>
<td>A**** L****</td>
<td>******5</td>
</tr>
<tr>
<td>02/11/1998</td>
<td>RECTAL SWAB</td>
<td>A********* M****</td>
<td>******9</td>
</tr>
<tr>
<td>11/25/2003</td>
<td>URINE</td>
<td>A**** M****</td>
<td>******6</td>
</tr>
<tr>
<td>07/28/2003</td>
<td>URINE</td>
<td>B**** D****</td>
<td>******8</td>
</tr>
<tr>
<td>03/19/2003</td>
<td>URINE</td>
<td>B**** M****</td>
<td>******6</td>
</tr>
<tr>
<td>11/27/2002</td>
<td>URINE</td>
<td>B**** D****</td>
<td>******8</td>
</tr>
<tr>
<td>06/6/1998</td>
<td>BLOOD</td>
<td>B********* B****</td>
<td>******0</td>
</tr>
</tbody>
</table>

LOC: OB/GYN  DR. MARTINIE, MARY K

URINE CULTURE  (UCB860-1)  19-Apr-04  1353
SOURCE(S): urine DCMH
URN ORG: no growth-final

LOC: 4N  DR. PELTE, CHRISTIAN

AFB CULTURE  (TBQ207-6)  12-Apr-04  1330
SOURCE(S): sputum
SOURCE TEXT: #1
AFB SMEAR: AFB none found
TB ORGANISM: no growth-prelim
Data overload?

• Infection control
  – One nurse
  – Most of time spent gathering, sorting and linking paper records
  – Little time to investigate outbreaks and educate staff
A potential solution

• Use a GIS to link disparate data and present data in an intuitive visual format to facilitate tracking of infections, and investigating factors that contribute to outbreaks.
Design

- Feasibility Study
- Retrospective - Three months
- Four wards
Methods

• Existing electronic data sources
  – Hospital Floor Plans (CAD drawings)
  – Microbiology Data
  – Admission/Discharge/Transfer (ADT) Data
  – Electronic Orders (Contact Isolation)

• Cleaned, merged, de-identified (MS Access)

• Imported into a GIS for visual presentation

• Laptop

• ArcMap 9.0 with Tracking Analyst
Example: Patient placement

- 8/42 (19%) MRSA cases
- 67% - No barrier isolation orders
Capturing staff movement

- VitalNet Bedside Computers
- Four Wards
- Date/Time stamped vital signs capture
- Unique nurse logins
- Documented nurse-patient contacts
10:00PM
10:00PM-11:30PM

Watch the activity of practitioner #37
In 35 minutes a single practitioner had documented contact with 9 patients.
Example: Provider movement
Results

• 3 months
• Estimate of 3 minutes for adequate hand hygiene
• 6248 times (14% of all documented contacts) = < 3 minutes between contacts
• Mostly due to nursing aides
Transfer of Vancomycin-Resistant Enterococci via Health Care Worker Hands

Amy N. Duchro, DO; Donald W. Blom, RN; Elizabeth A. Lyle, AB; Robert A. Weinstein, MD; Mary K. Hayden, MD

Background: The roles of the contaminated hospital environment and of patient skin carriage in the spread of vancomycin-resistant enterococci (VRE) are uncertain. Transfer of VRE via health care worker (HCW) hands is assumed but unproved. We sought to determine the frequency of VRE transmission from sites in the environment or on patients’ intact skin to clean environmental or skin sites via contaminated hands of HCWs during routine care.

Methods: We cultured sites on the intact skin of 22 patients colonized by VRE, as well as sites in the patients’ rooms, before and after routine care by 98 HCWs. Observers recorded sites touched by HCWs. Cultures were obtained from HCW hands and/or gloves before and after care. All isolates underwent pulsed-field gel electrophoresis. We defined a transfer to have occurred when a culture-negative site became positive with a VRE pulotype after being touched by an HCW who had the same pulotype on his or her hands or gloves and who had previously touched a colonized or contaminated site.

Results: Health care workers touched 151 negative sites after touching a site that was positive for VRE. Sixteen negative sites (10.6%) became positive after contact. The percentage of times that contact with a site led to a transfer was highest for antecubital fossae and blood pressure cuffs.

Conclusions: Vancomycin-resistant enterococci were transferred from contaminated sites in the environment or on patients’ intact skin to clean sites via HCW hands or gloves in 10.6% of opportunities. Controlling VRE by decontaminating the environment and patients’ intact skin may be an important adjunctive infection control measure.

Arch Intern Med. 2005;165:302-307

• Irrefutable Evidence – EDUCATE!
Limitations

• Associations, not cause/effect
• Generated a LOT of data
Conclusions

• Feasible to use a GIS to merge multiple data sources
• Presentation in this simple visual format made previously undetected trends obvious

Potential Uses

• Outbreak investigation
• Hospital Design
• Resource management
  – E.g. Room assignment
• Questions: Does your location in the hospital make a difference?
  – Safety (Infections, adverse events)
Can I do this at home?

• Yes
• “Events”
• Electronically captured/stored
  – Floor plans
  – Admission, Discharge, Transfer messages (ADTs)
  – Login data
  – Orders/Labs
Related work
Indiana Network for Patient Care (INPC)
Ongoing work

- Within the INPC
- >95% of all inpatient care
- >12,000 MRSA cases
- Geocode all of the known MRSA patients in a city
Summary

- GIS can be a useful tool to pull together disparate data sources *within* the hospital setting.
-Opens up opportunity for quality improvement and research.
Thank you! Questions?

Abel Kho MD, MS
Assistant Professor
General Internal Medicine
Northwestern University
Affiliated Scientist, Regenstrief Institute, Inc
abel.kho@nmff.org