Surveillance cultures: Can they help our decisions

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Questions about surveillance cultures

– Yes, No and When
– Colonization versus infection
– Prevention options
  ▪ Isolation and barrier precautions
  ▪ CHG
  ▪ Peri-operative prophylaxis
  ▪ Treatment
Why do surveillance cultures?

• Identifies an unknown reservoir or carrier
  – Organism of epidemiologic importance
  – Transmission in the setting of an outbreak
• Enhances infection control and or treatment interventions
• We have always done it
Rationale for active surveillance

- MRSA, VRE and MDR-GNR are an important part of the antimicrobial resistance problem
- Healthcare-Associated MRSA, VRE and MDR-GNR infections are expensive
- Outcomes for MRSA and VRE infection are worse than with infection with sensitive infections
- Healthcare facilities serve as amplifiers of MRSA, VRE and MDR-GNR transmission
- Multifaceted interventions that include active surveillance are often necessary to prevent MRSA and VRE transmission
Does contamination of a prior room increase the risk of acquisition?

<table>
<thead>
<tr>
<th>Study</th>
<th>Pathogen</th>
<th>Likelihood of patient acquiring HCAI based on prior room occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martinez 2003</td>
<td>VRE – cultured w/in room</td>
<td>2.6x</td>
</tr>
<tr>
<td>Huang 2006</td>
<td>VRE – prior room occupant</td>
<td>1.6x</td>
</tr>
<tr>
<td></td>
<td>MRSA – prior room occupant</td>
<td>1.3x</td>
</tr>
<tr>
<td>Drees 2008</td>
<td>VRE – cultured w/in room</td>
<td>1.9x</td>
</tr>
<tr>
<td></td>
<td>VRE – prior room occupant</td>
<td>2.2x</td>
</tr>
<tr>
<td></td>
<td>VRE – prior room occupant w/in previous 2 weeks</td>
<td>2.0x</td>
</tr>
<tr>
<td>Shaughnessy 2011</td>
<td>C. difficile – prior room occupant</td>
<td>2.4x</td>
</tr>
<tr>
<td>Nseir 2010</td>
<td>A. baumannii – prior room occupant</td>
<td>3.8x</td>
</tr>
<tr>
<td></td>
<td>P. aeruginosa – prior room occupant</td>
<td>2.1x</td>
</tr>
</tbody>
</table>

The rationale: “Iceberg” phenomenon

Colonization detected by routine culture

Clinical infection

Asymptomatic Colonization (reservoir)
Who is colonized?

- Asymptomatic colonization >>> infection

- Ability to detect resistant bacteria depends on:
  1. Frequency of obtaining clinical cx’s (ICU>floors)
  2. Sensitivity of site tested (nares, peri-rectal, stool, etc.)
  3. Sensitivity of laboratory methods used (routine cx, enrichment broth cx, molecular tests)
  4. Strategy chosen to identify patients
Higher rates of Vancomycin associated with increased prevalence of VRE

Table 2. Estimated number of incident vancomycin-resistant enterococci (VRE) acquisitions and absolute number and proportion of cases prevented in 1 year with 3 competing infection-control strategies, after 1000 model simulations.

<table>
<thead>
<tr>
<th>Infection control strategy</th>
<th>Average no. of incident VRE acquisitions</th>
<th>Estimated no. of incident cases of VRE colonization/infection prevented, compared with no surveillance strategy</th>
<th>Reduction of cases of VRE colonization/infection, compared with no surveillance strategy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No surveillance</td>
<td>118</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Passive surveillance only</td>
<td>113</td>
<td>5</td>
<td>4.2</td>
</tr>
<tr>
<td>Active surveillance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients isolated after culture results are determined to be positive</td>
<td>72.2</td>
<td>45.8</td>
<td>39</td>
</tr>
<tr>
<td>Immediate isolation and removal of patient after culture results are determined to be negative</td>
<td>41.1</td>
<td>76.9</td>
<td>65</td>
</tr>
</tbody>
</table>

NOTE. Each strategy is compared with a setting where no surveillance is in place.
Monoclonal transmission of HA-VRE bacteremia without active surveillance

<table>
<thead>
<tr>
<th></th>
<th>HOSPITAL A</th>
<th>HOSPITAL B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beds (ICU)/Yearly Admissions</td>
<td>700(68)/35K</td>
<td>683(96)/34K</td>
</tr>
<tr>
<td>VRE bacteremia rate/100K pt days</td>
<td>17.1</td>
<td>8.2</td>
</tr>
<tr>
<td>Mean Vancomycin DDD/1000 pt days/yr (range)</td>
<td>70.3 (64-81)</td>
<td>65.5 (49-72)</td>
</tr>
<tr>
<td>% pts affected by largest clonal types</td>
<td>30%</td>
<td>14.5%</td>
</tr>
<tr>
<td>% pts affected by 4 most predominate clonal types</td>
<td>75%</td>
<td>37%</td>
</tr>
<tr>
<td>Active surveillance &amp; isolation</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>

Active surveillance w/ isolation reduced/eliminated transmission of VRE in 32 health care facilities

Ostrowsky NEJM 2001 May 10;344(19):1427-33

1997 vs 1999 and trend for all 3 yrs highly significant (p<0.001)
Should VRE colonization impact antibiotic choices

- Data are limited
- In normal hosts, VRE colonization should not change antibiotic choice
- In liver and BMT transplant, VRE colonization can be considered in determination of empiric therapy if BSI suspected or in the presentation of severe sepsis until culture information available (48-72 hours), then d/c if no growth
Multiple cx’s were performed on 403 asymptomatic MRSA carriers found:
- 84% positive by initial anterior nares cx
- 38% by perineal cx
- 16% by groin cx
- 10% by axillae cx
- Nares + perineum cx = 93% sensitivity

• 3.4% had MRSA on admission, 19% developed infection
• 3.0% acquired MRSA after admission, 25% developed infection
• 21% had MSSA, 1.5% developed infection
• No colonization 75.4%, 2% developed infection

Impact of ACS on identification of MRSA in ICUs

- Retrospective cohort study - 5 academic medical centers
- Outside of ASC, no change in infection control practices
- Admission prevalence - MRSA: 5-21%, an increase of 30-135%
- 70% of MRSA carriers were identified by surveillance cultures.

Table 3. Average monthly incidence and prevalence measures across all intensive care unit (ICUs).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Excluding surveillance</th>
<th>Including surveillance</th>
<th>Added detection with surveillance (unit range)</th>
<th>Pᵇ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate, % (ICU range)</td>
<td>ICU SDᵃ</td>
<td>Estimate, % (ICU range)</td>
<td>ICU SDᵃ</td>
</tr>
<tr>
<td>Prevalence</td>
<td>8 (2.2–15.9)</td>
<td>1.5–5.8</td>
<td>11.9 (4.5–20.6)</td>
<td>1.9–7.5</td>
</tr>
<tr>
<td>Prevalence density/1000 patient-days</td>
<td>2.9 (1.5–4.4)</td>
<td>0.6–1.4</td>
<td>3.8 (2.2–5.8)</td>
<td>0.6–1.7</td>
</tr>
<tr>
<td>Incidence</td>
<td>2.6 (1.4–5.3)</td>
<td>1.3–4.5</td>
<td>3.4 (2.4–5.7)</td>
<td>1.7–4.6</td>
</tr>
<tr>
<td>Incidence density</td>
<td>6.7 (3.2–16.5)</td>
<td>2.6–10.0</td>
<td>8.9 (4.0–18.2)</td>
<td>3.1–10.1</td>
</tr>
</tbody>
</table>

ᵃ SDs were calculated across all monthly estimates from a given ICU. The range across all ICUs is shown.
ᵇ Paired 2-tailed t test comparing monthly ICU estimates that include and exclude surveillance culture data.
ᶜ Similar results were found when the unit in which routine weekly surveillance was not performed was excluded (overall incidence, 2.4% without surveillance and 3.6% with surveillance [P < .0001]; overall incidence density, 0.3/1000 without surveillance and 0.7/1000 with surveillance [P < .0001]).
Reduction in CABSII and MRSA with Use of Daily Chlorhexidine

- 6 ICUs, academic medical centers
- Cross over design
- Reduced MRSA incident colonizations by 25% (2.59-1.93)

Climo et al. CCM 2009:37; 1858-65
Impact of daily bathing with CHG in ICU patients

- Multicenter, cluster-randomized, non blinded crossover trial
- 7727 patients bathed 2% CHG impregnated washcloths or nonmicrobial washcloths for 6 months
- Poisson regression analysis and incidence rates of MDROs and HAI bloodstream rates

Climo M et al. NEJM. 2013;368:533
CHG skin decontamination in trauma

- Prospective, sequential group, single arm trial compared soap/water baths to cloths impregnated with 2% CHG in 286 severely injured patients
- Single trauma center -312

Evans et al Arch Surg 2010:145 (3);240-6
Decolonization nationally: A cost effective approach

Robatham et al, BMJ 2011; 343:1-13
Decolonization nationally: A cost effective approach

Robatham et al, BMJ 2011; 343:1-13
Decolonization nationally: A cost effective approach

- In an ICU decolonization is likely to be cost effective providing resistance is lacking
- Combining universal screening with decolonization is good value if untargeted screening is unacceptable
- Evidence is insufficient to support decolonization in low prevalence areas
A national approach

Cluster randomized clinical trial in 74 ICUs comparing

• 1. MRSA screening and isolation
• 2. MRSA screening, isolation and decolonization (CHG and mupirocin) of carriers
• 3. MRSA screening, isolation and universal decolonization (CHG and mupirocin)
• Infection control policies standard; hospital and patient characteristics similar

Huang et al, NEJM 2013; 368:2255-65
Decolonization nationally

Huang et al, NEJM 2013; 368:2255-65
Decolonization nationally

- Routine universal decolonization in ICU patients was more effected than targeted screening and decolonization
- 1 BSI prevented for every 54 patients treated
- 7 adverse events related to CHG

Huang et al, NEJM 2013; 368:2255-65
The Limitation(s)

- Most sites were small hospitals
- No data on resistance to either mupirocin or CHG
- Compliance measured at 3 points by hospital nursing supervisors
- Only culture data was used; no definitions applied to laboratory information
- No information about the impact on transmission and guidance for infection prevention interventions such as isolation
Decolonization internationally

Three phased intervention in 13 ICUs

1. Baseline X 6 months
2. Improvement of hand hygiene and CHG bathing X 6 months
3. Cluster randomization of chromogenic versus rapid (PCR) screening for VRE, MRSA, and MDR-GNRs

Derde et al, Lancet 2013 (published on line Oct 23rd)
Decolonization internationally

Table 3: Weekly acquisition of any antimicrobial-resistant bacteria, MRSA, VRE, and HRE

<table>
<thead>
<tr>
<th></th>
<th>Antimicrobial-resistant bacteria</th>
<th>MRSA</th>
<th>VRE</th>
<th>HRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1 trend</td>
<td>1.014 (0.996–1.031; p=0.12)</td>
<td>1.042 (1.010–1.075; p=0.01)</td>
<td>1.000 (0.971–1.030; p=0.99)</td>
<td>1.012 (0.992–1.032; p=0.25)</td>
</tr>
<tr>
<td>Phase 2 step change</td>
<td>0.955 (0.676–1.348; p=0.79)</td>
<td>1.159 (0.654–2.035; p=0.61)</td>
<td>0.884 (0.481–1.626; p=0.69)</td>
<td>0.831 (0.559–1.235; p=0.36)</td>
</tr>
<tr>
<td>Phase 2 change in trend</td>
<td>0.976 (0.954–0.999; p=0.04)</td>
<td>0.925 (0.890–0.962; p&lt;0.001)</td>
<td>0.982 (0.945–1.020; p=0.36)</td>
<td>0.994 (0.968–1.021; p=0.66)</td>
</tr>
<tr>
<td>Phase 3 step change</td>
<td>0.634 (0.349–1.253; p=0.14)</td>
<td>0.755 (0.252–2.257; p=0.62)</td>
<td>0.651 (0.209–2.031; p=0.46)</td>
<td>0.525 (0.263–1.048; p=0.07)</td>
</tr>
<tr>
<td>Phase 3 change in trend</td>
<td>1.015 (0.998–1.032; p=0.09)</td>
<td>1.057 (1.029–1.086; p&lt;0.001)</td>
<td>1.015 (0.984–1.048; p=0.34)</td>
<td>0.991 (0.971–1.011; p=0.35)</td>
</tr>
<tr>
<td>Phase 3 step change (rapid vs conventional screening)</td>
<td>1.696 (1.090–2.638; p=0.02)</td>
<td>1.734 (0.768–3.916; p=0.19)</td>
<td>1.735 (0.711–4.234; p=0.23)</td>
<td>1.691 (1.012–2.828; p=0.05)</td>
</tr>
<tr>
<td>Phase 3 change in trend (rapid vs conventional screening)</td>
<td>0.996 (0.984–1.007; p=0.46)</td>
<td>0.985 (0.966–1.005; p=0.15)</td>
<td>0.993 (0.969–1.018; p=0.59)</td>
<td>1.000 (0.986–1.014; p=0.99)</td>
</tr>
</tbody>
</table>

Data are IRR (95% CI) unless stated otherwise. IRR<1 represents a decrease in acquisition, whereas IRR>1 represents an increase. Cluster effects were accounted for in the analyses, and potential confounding factors (sex, age, month, invasive devices, nurse-to-patient staffing ratio, location before ICU admission, reason for admission, APACHE/SAPS, hospital, and number of days at risk for acquisition) were fitted as covariates. MRSA=meticillin-resistant Staphylococcus aureus. VRE=vancomycin-resistant enterococci. HRE=highly resistant Enterobacteriaceae. IRR=incidence rate ratio. APACHE=Acute Physiology and Chronic Health Evaluation. SAPS=Simplified Acute Physiology Score.

Derde et al, Lancet 2013 (published on line Oct 23rd)
Decolonization internationally: summary and limitations

- HH and CHG bathing not randomized in initial phases
- Not all patients screened on admission—selection bias
- An additional study that does not find screening adds to prevention of transmission

Derde et al, Lancet 2013 (published on line Oct 23rd)
The war of the roses continues

Edgeworth JAC 2011:S41-7
Colonization detected by routine culture

- 3.4% w/ MRSA on admission, 19% developed infection
- 3.0% acquired MRSA after admission, 25% developed infection

Asymptomatic Colonization (reservoir)

Clinical infection

The rationale: “Iceberg” phenomenon

### Meta-analysis of Screening & Decolonization: MSSA & MRSA

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Random Effects OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vancomycin vs. Glycopeptides</td>
<td>0.89 (0.58, 1.38)</td>
</tr>
<tr>
<td>Nasal decolonization: all patients</td>
<td>0.45 (0.32, 0.64)</td>
</tr>
<tr>
<td>Nasal decolonization: S. aureus carriers</td>
<td>0.39 (0.24, 0.65)</td>
</tr>
<tr>
<td>Decolonization + vancomycin of MRSA carriers</td>
<td>0.40 (0.29, 0.56)</td>
</tr>
</tbody>
</table>

M. Schweizer et al. BMJ. 2013 Jun 13;346:f2743. doi: 10.1136/bmj.f2743
Peri-operative prophylaxis: Glycopeptides vs. Beta-lactams

- Protective against Gram+ SSI
- Risk Factor for Gram+

Random Effects OR

M. Schweizer et al. BMJ. 2013 Jun 13;346:f2743. doi: 10.1136/bmj.f2743
Decolonization + Glycopeptide for MRSA Carriers

Walsh
0.26 (0.13, 0.52)

Rao
0.10 (0.01, 0.81)

Kim
0.41 (0.21, 0.80)

Jog
0.56 (0.23, 1.35)

Acebedo
0.42 (0.18, 0.99)

Sporer
0.56 (0.29, 1.09)

Random Effects OR
0.40 (0.29, 0.56)

M. Schweizer et al. BMJ. 2013 Jun 13;346:f2743. doi: 10.1136/bmj.f2743
Control Measures for MDR-GNBs in Studies Performed in Healthcare Settings, 1982-2005

- Contact Precautions or glove use: 20
- Surveillance cultures of patients: 19
- Education of staff, patients or visitors: 19
- Emphasis on handwashing: 16
- Environmental cultures: 15
- Change in Antimicrobial Use: 12
- Extra cleaning & disinfection: 11
- Cohorting of Patients: 11
- Surveillance cultures of staff: 9
- Use of antiseptics for handwashing: 8
- Ward closure: 6
- Other miscellaneous measures: 6
- Dedicated Equipment: 5
- Segregation of cases: 4
- Private Rooms: 4
- Decolonization: 3
- Cohorting of Staff: 2
The Acinetobacter Iceberg

- 4-month prospective pilot study on 5 medical units at JHH
- Admission and weekly surveillance cultures for MDR-ACIN (Axilla, wound, sputum, endotracheal suction)
- 1601 admissions/transfers with 74%-94% compliance
- 7/1240 (0.006%) admission cultures and 5/470 (0.01%) weekly cultures grew MDR-ACIN
- 80% of patients with prior history had + culture

Maragakis, JAMA. 2006
ESBL Klebsiella in a NICU

Tamma et al ICHE 2012;33:631-4
ESBL Klebsiella in a NICU

Cefotaxime as empiric therapy begun

Tamma et al. ICHE 2012;33:631-4
Can We Identify These Cases?

- Carriage of CTX-M found
  - 22% among patients with acute gastroenteritis
  - 7% among elderly Chinese

Table 1. Overview of the Different Colonization Patterns Detected in 133 Patients

<table>
<thead>
<tr>
<th>Pattern</th>
<th>No. of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 colonization site</td>
<td></td>
</tr>
<tr>
<td>Urine</td>
<td>32 (24.1)</td>
</tr>
<tr>
<td>Rectum</td>
<td>11 (8.3)</td>
</tr>
<tr>
<td>Groin</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Throat</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>2 colonization sites</td>
<td></td>
</tr>
<tr>
<td>Urine, rectum</td>
<td>38 (28.6)</td>
</tr>
<tr>
<td>Urine, groin</td>
<td>5 (3.8)</td>
</tr>
<tr>
<td>Urine, throat</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Rectum, groin</td>
<td>6 (4.6)</td>
</tr>
<tr>
<td>Rectum, throat</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Groin, throat</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>3 colonization sites</td>
<td></td>
</tr>
<tr>
<td>Urine, rectum, groin</td>
<td>23 (17.3)</td>
</tr>
<tr>
<td>Urine, rectum, throat</td>
<td>2 (1.5)</td>
</tr>
<tr>
<td>Urine, groin, throat</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Rectum, groin, throat</td>
<td>3 (2.3)</td>
</tr>
<tr>
<td>4 colonization sites</td>
<td></td>
</tr>
<tr>
<td>Urine, rectum, groin, throat</td>
<td>8 (6.0)</td>
</tr>
</tbody>
</table>

Site totals

- Patients with colonization of the urine 110 (82.7)
- Patients with colonization of the rectum 92 (69.2)
- Patients with colonization of the groin 47 (35.3)
- Patients with colonization of the throat 17 (12.8)

Reduced Use of 3rd Generation Cephalosporins Decreases the Acquisition of ESBL-Producing *K. pneumoniae*

Impact of Antimicrobial Formulary Interventions on ESBL *E. coli* and *Klebsiella* spp.

## Multivariate Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted Odds Ratio (OR)</th>
<th>Adjusted OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTCF</td>
<td>8.72</td>
<td>3.77 (1.70–8.37)</td>
<td>.001</td>
</tr>
<tr>
<td>Age*</td>
<td>—</td>
<td>1.04 (1.01–1.06)</td>
<td>.002</td>
</tr>
<tr>
<td>Decubitus ulcer</td>
<td>3.43</td>
<td>4.13 (1.97–8.65)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hospital duration</td>
<td>—</td>
<td>0.97 (0.94–0.98)</td>
<td>.005</td>
</tr>
</tbody>
</table>

*OR reflects the odds associated with each 1-year increase in age: this is equivalent to an OR of 1.44 (95% CI, 1.14–1.81) associated with a 10-year increase in age.

†Days from hospital admission until recovery of an extended-spectrum β-lactamase-producing isolate.

Changes in Antimicrobial Susceptibility After an Antimicrobial Intervention

Experience with KPC’s

- Beginning 2006 in a 10 bed ICU all pts with KPC’s, VRE, MRSA were
  1) Placed in contact isolation
  2) Cohorted in one end of the ICU
  3) Compliance with hand hygiene and cleaning encouraged
  4) Routine rectal swabs for KPCs implemented

- Mean number of patients per 1,000 pt days with KPC’s decreased from 9.7 to 3.7 (P<0.001)

Kochar et al, ICHE 2009:33;447
Experience with KPC’ s

Intervention begins

Kochar et al, ICHE 2009:33;447
Relationship Between Quinolone Consumption and Susceptibility of *Escherichia coli* Isolates from Urine Cultures to Quinolone
Summary

• Surveillance cultures

• In healthcare there is a high prevalence of « unrecognized » MDRO colonization— the Iceberg. Colonization increases the risk of infection.

• For VRE and MRSA, surveillance cultures can facilitate appropriate precautions.

• MRSA in the preoperative patient—should be considered in peri-operative prophylaxis.

• VRE colonization may impact empiric therapy choices in high risk patients.

• In patients with surveillance cultures yeilding MDR-GNR, more information is needed before integrating them into clinical practice.
“There are risks and costs to a program of action. But they are far less than the long-range risks and costs of comfortable inaction”

John F. Kennedy
Free genius results in the capacity for evaluation of uncertain, hazardous, and conflicting information.

Winston Churchill