**Active Surveillance Culture of Asymptomatic Patients as A Strategy to Control MDROs**
**Prof. Anucha Apisarnthanarak, Thammasat University Hospital, Thailand**
**A Webber Training Teleclass**

# Active Surveillance Culture of Asymptomatic Patients as A Strategy to Control MDROs


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NEW ZEALAND

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## Basic Concept when considering Active Surveillance Culture

START BY UNDERSTAND THAT ASC IS A PART OF *"SEARCH"* AND "*DESTROY/CONTAIN"* STRATEGY…

*SEARCH:* SURVEILLANCE, ACTIVE SURVEILLANCE

*DESTROY/CONTAIN:* ALL OTHER INFECTION CONTROL INTERVENTIONS (E.G., HAND HYGIENE, ENVIRONMENTAL CLEANING, ANTIBIOTIC STEWARDSHIP, ETC)

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## IF ASC IS REALLY IMPORTANT, IT MUST FULFILL THESE KEY QUESTIONS

Dose asymptomatic carriage of MDRO increase the risk of infection?

Is carriage associated with transmission?

How long does carriage persist?

Can the carrier state be eradicated or suppressed?

Does eradication or suppression of the carrier state result in decreased risk of infection or transmission?

Detection of MDR GNB at what site?

What are the adverse consequences of decolonization therapy?

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## DOES ASYMPTOMATIC CARRIAGE INCREASE THE RISK OF INFECTION?

Carbapenem-resistant Enterobacteriaceae (CRE)

***- ICU patients***

-27% of asymptomatic carriers developed CRE bacteremia during index hospitalizations[1]

***- Hospital patients***

-8.8 %-17 % of CRE carriers have CRE isolated from a subsequent clinical specimen.[2,3]

-44% of these subsequent positive cultures represented bacteremia.[3]

[2]Calfee DP. Infect Control Hosp Epidemiol 2008;29:966-8
[2] Schechner V. Clin Microbiol Infect 2012; doi 10.1111/j.1469-0691.2012.03888.x
[3] Calfee DP. Unpublished data.

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## IS CARRIAGE ASSOCIATED WITH TRANSMISSION?

In Israeli hospital, the incidence of CRE increased by 0.43 for each hospitalized carrier ($p$<.001).[1]

In two New York City hospitals, the odds of acquiring CRE increased by 15% for every 1% increase in the colonization pressure to which a subject was exposed ($p$=0.01).[2]

[1] Schwaber M. clin Infect Dis 2011;52:848-55
[2] Calfee DP. Unpublished data.

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## HOW LONG DOES CARRIAGE PERSIST?

| MDRGNB | No. of isolates | Duration of colonization, median day (range) |
|---|---|---|
| All species | 52 | 144(41-349) |
| Proteus mirabilis | 15 | 161 (50-279) |
| Klebsiella pneumoniae | 12 | 132 (70-349) |
| Escherichia coli | 8 | 178 (50-259) |
| Proteus stuartii | 7 | 121 (50-322) |
| Morganella morganii | 5 | 103 (41-328) |
| Citrobacter species | 4 | 76 (41-168) |
| Enterobater cloacae | 1 | 133 |

[1] O ' Fallon E. Clin Infect Dis 2009;48:1375-81; Apisarnthanarak A, et al. CID 2009 7

## HUMAN STUDY OF DECOLONIZATION: CARBAPENEM-RESISTANT *K.PNEUMONIAE*

Single center, randomized, double-blind, placebo- controlled study among 40 adult CRKP carriers

- *Subjects had a positive rectal swab within past 7 days.*

- *Treatment consisted of oral gentamicin and polymyxin E gel oral solutions of gentamicin (80 mg) and polymyxin E ($1x10^6$ units) 4 times daily for 7 days.*

Saidel-Odes L. Infect Control Hosp Epidemiol 2012;33:14-9

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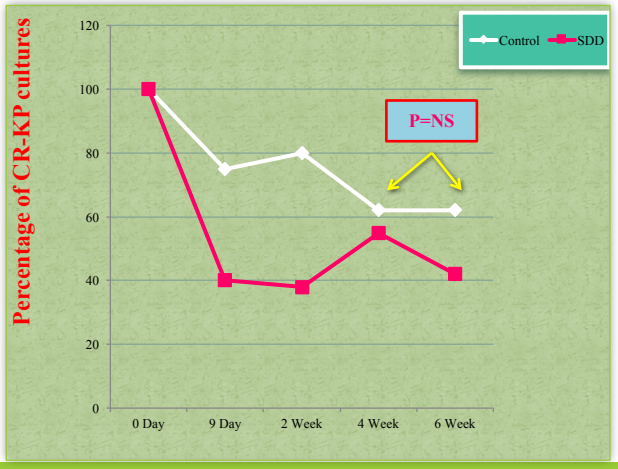
## DECOLONIZATION: CARBAPENEM-RESISTANT *K.PNEUMONIAE*

SDD was associated with a significant reduction in rectal culture positivity at 2 week.

Week 2:39% vs 84% (p=0.002)

At 6 week, the difference was no longer statistically significant

Week 6:42% vs 67% (p=NS)




Saidel- odes L.Infect Control Hosp Epidemiol 2012;33:14-9

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## COLISTIN-RESISTANT *ACINETOBACTER BAUMANNII*: BEYOND CARBAPENEM RESISTANCE

CLIN INFECT DIS. (2015)

ZUBAIR A. QURESHI, LAUREN E. HITTLE, JESSICA A. O'HARA, JESABEL I. RIVERA, ALVEENA SYED, RYAN K. SHIELDS, ANTHONY W. PASCULLE, ROBERT K. ERNST, AND YOHEI DOI

20 unique patients developed colistin-resistant AB.

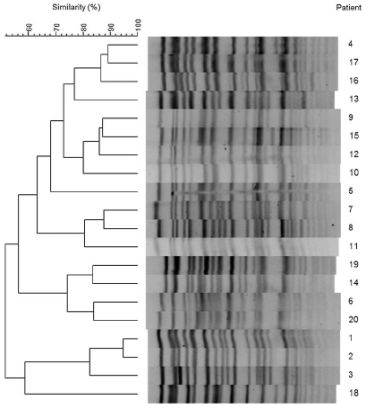
19 pts had previously exposed to colistin.

Colistin susceptible and resistant isolate were highly related by PFGE, but isolates from different pts were not.

By MLST, all isolates belong to International Clone 2

Modification of Lipid A was present in all Colistin-R isolates

Genetic relatedness of colistin susceptibile and resistant AB isolate in each individual patient

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## COLISTIN-RESISTANT *ACINETOBACTER BAUMANNII*: BEYOND CARBAPENEM RESISTANCE

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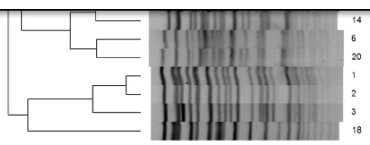
20 unique patients developed colistin-resistant AB.

Genetic relatedness of colistin susceptibile and resistant AB isolate in each individual patient

Similarity (%) Patient

- **Adequacy of colistin dosing to avoid suboptimal use**
- **Colistin should not be used to decolonize asymptomatic CRE carriage**
- **Empirical colistin should be subjected to tight restriction**

Modification of Lipid A was present in all Colistin-R isolates

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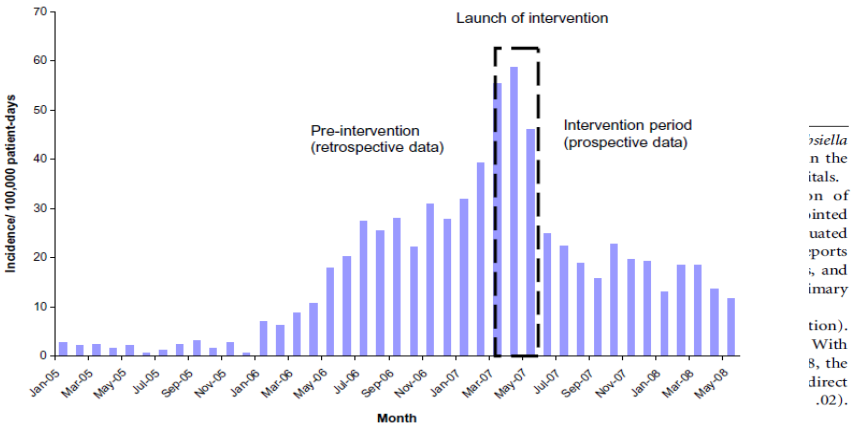
MAJOR ARTICLE

## Containment of a Country-wide Outbreak of Carbapenem-Resistant *Klebsiella pneumoniae* in




*Conclusions.* A centrally coordinated intervention succeeded in containing a nationwide CRE outbreak after local measures failed. The intervention demonstrates the importance of strategic planning and national oversight in combating antimicrobial resistance.

**Table 1. Multivariable Model of Variables Affecting Monthly Incidence of Carbapenem-Resistant Enterobacteriaceae (CRE)**

| Variable | Effect estimate | 95% CI | *P* |
|---|---|---|---|
| CRE carrier prevalence | 0.43 | 0.36–0.50 | <.001 |
| Compliance with dedicated staffing | −.06 | −.11 to −.01 | 0.02 |
| Months of intervention | −1.10 | −1.64 to −0.56 | <.001 |
| Intercept | 12.16 | 7.16–17.17 | <.001 |

**Table 2. Multivariable Model of Variables Affecting Monthly Incidence of Carbapenem-Resistant Enterobacteriaceae (CRE), Including Interaction between Compliance and Prevalence**

| Variable | Effect estimate | 95% CI | *P* |
|---|---|---|---|
| CRE carrier prevalence | 0.56 | 0.43–0.70 | <.001 |
| Compliance with dedicated staffing | 0.01 | −0.07 to 0.10 | .72 |
| Months of intervention | −.99 | −1.54 to −0.44 | .001 |
| Interaction between compliance and prevalence | −.002 | −0.004 to −0.0003 | .03 |
| Intercept | 7.82 | 1.54–14.10 | .02 |

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# KEY QUESTIONS AND "ANSWERS"

Dose asymptomatic carriage of MDRO increase the risk of infection? "Yes"

Is carriage associated with transmission? "Yes"

How long does carriage persist? "Week to months"

Can the carrier state be eradicated or suppressed? "Maybe"

Does eradication or suppression of the carrier state result in decreased risk of infection or transmission? "Unknown"

Detection of MDR GNB at what site? "Unknown for some bugs"

What are the adverse consequences of decolonization therapy? "Yes"

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## Consideration When Using ASC in Asymptomatic Patients in Resource-Limited Settings

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## ESTABLISHMENT OF VRE ENDEMICITY IN HOSPITALS

No VRE → Rare, Sporadic Cases → Monoclonal Outbreak → Polyclonal, Endemic State

Hayden MK CID 2000 31:1058.

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## CONTROL OF MONOCLONAL VRE OUTBREAK

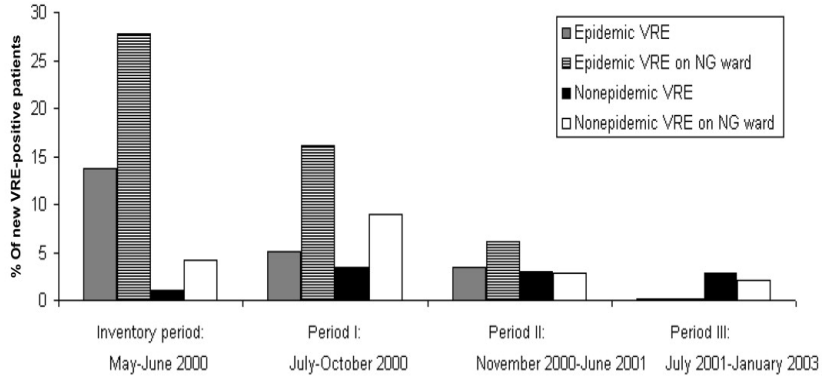
**Table 1. Summary of infection-control measures during the 3 periods of the outbreak.**

| Measure | Period I (June 2000–October 2000) | Period II (November 2000–June 2001) | Period III (July 2001–January 2003) |
|---|---|---|---|
| Cohorting of patients | 4 Cohorts: epiVRE patients, roommates of epiVRE patients, wardmates of epiVRE patients, and newly admitted patients | 3 Cohorts: epiVRE patients, possibly epiVRE patients, and newly admitted patients | No cohorts |
| Cohorting of nursing staff | Cohorted as much as possible into 4 cohorts; for visiting staff, contact isolation of all patients | Cohorted as much as possible into 3 cohorts | No specific measures |
| Isolation of epiVRE patients | Contact isolation in a single room (patients labeled in hospital information system) | Contact isolation in a single room (patients labeled in hospital information system) | Contact isolation in a single room (patients labeled in hospital information system) |
| Isolation of possibly epiVRE patients | For roommates of epiVRE patients, contact isolation in a cohort or single room until 3 negative culture results; for ward contacts of epiVRE patients, treatment in cohort until 3 negative swab test results (no contact isolation) | Preemptive isolation of all patients hospitalized in the NG ward between January and November 2000, regardless of culture results (patients labeled in hospital information system) | None |
| Environmental disinfection | Disinfection of rooms of epiVRE patients after discharge | Disinfection of rooms of epiVRE patients after discharge | Disinfection of rooms of epiVRE patients after discharge |
| VRE screening | Obtainment of swabs from noncolonized and possibly epiVRE patients 3 times weekly | Obtainment of swabs from noncolonized and possibly epiVRE patients once weekly | Obtainment of swabs from noncolonized and possibly epiVRE patients once weekly until September 2001 and once monthly thereafter |

**NOTE.** Patients colonized with an epidemic strain of vancomycin-resistant *Enterococcus faecium* (VRE) were labeled "epiVRE patients." Patients with prior hospitalization in the nephrology/gastroenterology (NG) ward or medical intensive care unit were considered to be "possibly epiVRE patients" until 3 consecutive rectal swab test results were negative for VRE.

Mascini EM et al, CID 2006;42:739-746 17

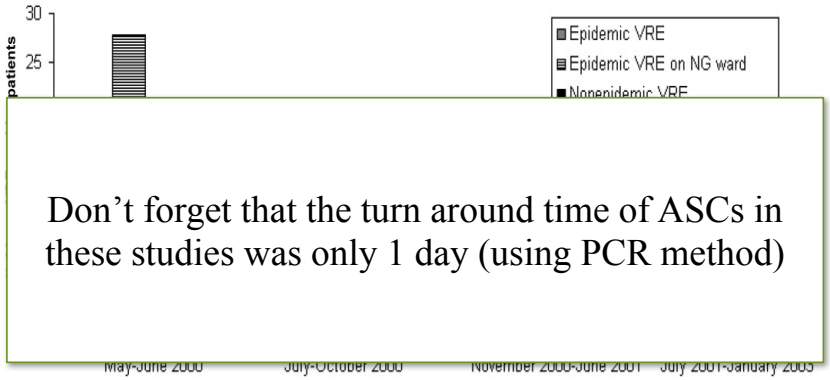
## CONTROL OF MONOCLONAL VRE OUTBREAK




| | | | | |
|---|---|---|---|---|
| Pts screened hospitalwide | 183 | 683 | 810 | 977 |
| Pts screened on NG ward | 47 | 155 | 277 | 661 |

Mascini EM et al, CID 2006;42:739-746 18

## CONTROL OF MONOCLONAL VRE OUTBREAK




Don't forget that the turn around time of ASCs in these studies was only 1 day (using PCR method)

| | May-June 2000 | July-October 2000 | November 2000-June 2001 | July 2001-January 2005 |
|---|---|---|---|---|
| Pts screened hospitalwide | 183 | 683 | 810 | 977 |
| Pts screened on NG ward | 47 | 155 | 277 | 661 |

Mascini EM et al, CID 2006;42:739-746 19

## ESTABLISHMENT OF VRE ENDEMICITY IN HOSPITALS

No VRE → Rare, Sporadic Cases → Monoclonal Outbreak ➡ Polyclonal, Endemic State

Hayden MK CID 2000 31:1058.

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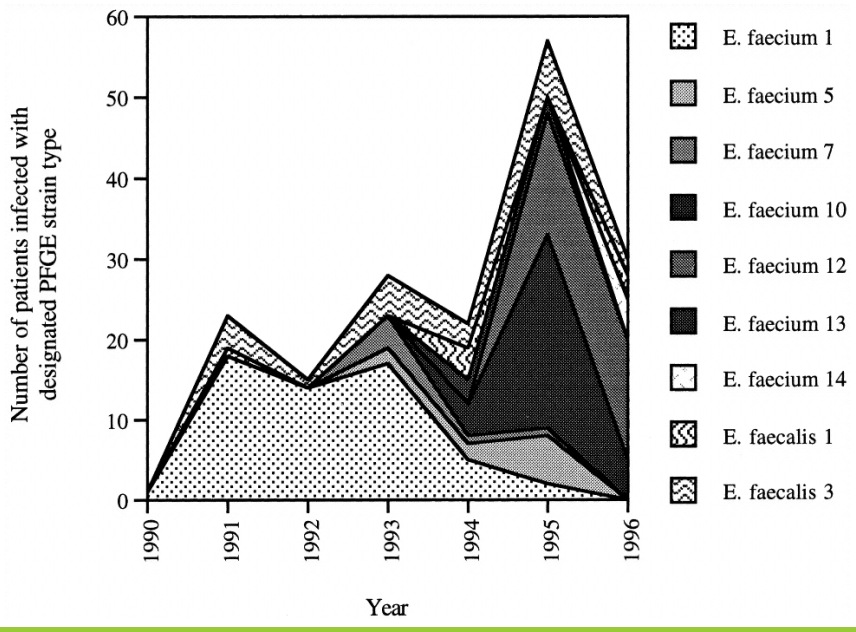


Kim WJ et al JID 1999,179:163 21

## WHY HAVEN'T TRADITIONAL INFECTION CONTROL INTERVENTIONS BEEN MORE EFFECTIVE?

| Intervention | Range |
|---|---|
| Adherence with admission culture | 70% - 98% |
| Adherence with gloving/gowning | 61% - 92% |
| Adherence with hand hygiene | 20% - 100% |
| Sensitivity of single rectal swab culture | 58% - 96% |

Wright M-O et al, ICHE 2004, 25:167. Warren DK et al ICHE 2003, 24:257

Montecalvo M et al Ann Int Med 1999 131:269 Calfee DP et al CID 2003 37:326. 22

## ACTIVE SURVEILLANCE: AT WHAT SITE?

| Colonizaton Sites | No. of Patients (%) (N=129) |
|---|---|
| 1 Colonization Site | |
| Tracheal aspirate | 35 (27) |
| Rectum | 24 (19) |
| Sternal skin | 7 (5) |
| Urine | 4 (3) |
| 2 Colonization Site | |
| Tracheal aspirate, rectum | 38 (29) |
| Tracheal asp | 7 (5) |
| Tracheal asp | (1) |
| Rectum, ster | (8) |
| Rectum, urin | (8) |
| Stemum, urir | (1) |
| 3 Colonization S | |
| Tracheal asp | (15) |
| Tracheal asp | (6) |
| Tracheal asp | (2) |
| Rectum, sternal skin, urine | 6 (4) |
| 4 Colonization Site | |
| Tracheal aspirate, rectum, sternal skin, urine | 10 (8) |
| Total sites | |
| Colonization of the tracheal aspirate | 103 (80) |
| Colonization at rectum | 89 (69) |
| Colonization at sternal skin | 67 (52) |
| Colonization at urine | 32 (25) |
| Detection of CR-A, baumannii at 1 sites (any site) | 70 (54) |
| Detection of CR-A, baumannii at tracheal aspirate and rectum | 97 (75) |
| Detection of CR-A, baumannii at tracheal aspirate ,rectum,strnal skin | 104 (80) |
| Detection of CR-A, baumannii at tracheal aspirate ,rectum,strnal skin, urine | 108 (85) |

"ASC at ≥2 sites that include tracheal and rectal culture had higher yield in detecting CR-AB in our ICU population"

Apisarnthanarak A. Screening site for CR-AB. CID 2012

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## DAILY BATHING WITH CHLORHEXIDINE

**(SUCCESSFUL CONTROL DO NOT NECESSARY NEED ASC)**

3 studies have assessed changes in rates of *Acinetobacter colonization*[1] or clinical culture [2,3] as secondary endpoints.

- *1.0 vs 4.6,*p=0.36*[1]
- *0.36 vs 1.04,* p=0.18*[2] **per 1000 pt-days*
- *0.17 vs 0.68,* p=0.21*[3]

Daily CHG bathing was included as one component of a successful carbapenem-resistant *K.pneumoniae* outbreak control program in a long-term acute care hospital.[4]

[2] Evans HL.Arch Surg 2012;145:240-6
[2] Popovich KJ. Infect Control Hosp Epidemiol 2009;30:959-63
[2] Popovich KJ. Infect Care med 2012;36;854-8
[4] Muniz-Price L. Infect Control Hosp Epidemiol 2012;3-:341

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# Evidence on Control of Colistin-Resistant Gram Negative

PREVENTION AND CONTROL OF COLISTIN-RESISTANT GRAM-NEGATIVE BACTERIA: A SYSTEMATIC REVIEW AND META-ANALYSIS

ASUPON A, ET AL. (UNDER PREPARATION)

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**B. Outbreak setting**

- **Study design:** Observational (pre-post) 17 studies; no RCTs
- **Database searched:** only Pubmed

| Pre-endemic intervention | | | | Post-endemic intervention | | | | | | | | Outcome | Number of studies | Difference between pre- and post-endemic intervention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HH+CP | HH+ENV | HH+CP+ENV | HH+CP+ASC | HH+CP | HH+CP+ASC | HH+CP+ENV | HH+ENV+ASC | HH+CP+ASP+ASC | HH+CP+ENV+ASC | HH+CP+SCT+ASC | HH+CP+ENV+ASP+ASC | | | |
| ✓ | | | | ✓ | | | | | | | | positive | 4 | enhanced |
| ✓ | | | | | ✓ | | | | | | | positive | 1 | add ASC |
| ✓ | | | | | | | | ✓ | | | | negative | 1 | add ASP and ASC |
| ✓ | | | | | | ✓ | | | | | | positive | 1 | add ENV |
| ✓ | | | | | | | | | ✓ | | | positive | 2 | add ENV and ASC |
| ✓ | | | | | | | | | | ✓ | | positive | 1 | add SCT and ASC |
| | | | ✓ | | | | | | ✓ | | | positive | 1 | add ENV |
| | | ✓ | | | | ✓ | | | | | | positive<br>negative | 1<br>1 | enhanced<br>enhanced |
| | ✓ | | | | | | | | ✓ | | | positive | 2 | add CP and ASC |
| | ✓ | | | | | | | | | | ✓ | positive | 1 | add CP, ASP and ASC |
| | ✓ | | | | | | ✓ | | | | | negative | 1 | add ASC |

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# Key Observations

| IC interventions (work) | IC intervention (not work) |
|---|---|
| Enhanced HH + CP | Addition of ASC +/- ASP |
| Addition of ENV +/- ASC | |
| Addition of SCT + ASC | |
| Addition of CP + ASC +/-ASP | |

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INFECTION CONTROL AND HOSPITAL EPIDEMILOGY JULY 2012,VOL.33,NO.7

COMMENTARY

## WHEN SHOULD CONTACT PRECAUTION AND ACTIVE SURVEILLANCE BE USED TO MANAGE PATIENTS WITH MULTIDRUG-RESISTANT ENTEROBATERIACEAE?

JOSHUA T.FREEMAN, MBCHB, FRCPA;[1] DEBORAH A. WILLIASON, MRCP;[1] DEVERICK J.ANDERSON,MD,MPH[2]

## EVALUATE THE ROLE OF IN - HOSPITAL PATIENT – TO – PATIENT MRE TRANSSION

An important starting point when determining the utility of CP and AS for MRE is to ascertain whether rates are stable or whether an outbreak of HAIs caused by MRE is occurring in the hospital. Indeed, because *the rationale is to reduce transmission between hospitalized patients, it follows that CP and AS are likely to yield net benefits only if transmission is actually occurring in the hospital.*

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## SPECIFICALLY CONSIDER THE COST EFFECTIVENESS OF AN ACTIVE SURVEILLANCE PROGRAM FOR MRE

*" Because asymptomatic colonized patients can transmit MRE, the greater the ratio of asymptomatic colonized patients to those infected, the more likely that AS will reduce transmission and be cost-effective.[19] During an outbreak investigation, AS may be helpful to determine this ratio and thus determine whether ongoing AS is likely to be worthwhile……*

*Of note, some data suggest that in endemic (nonooutbreak) setting the use of AS for CRE may not be cost-effective "*

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## SPECIFICALLY CONSIDER THE COST EFFECTIVENESS OF AN ACTIVE SURVEILLANCE PROGRAM FOR MRE

- *" In contrast, generic measures (such as hand hygiene and implementation of evidence-based care bundles) have the advantages of impacting HAIs caused by all potential pathogens and providing benefits to patients regardless of their CRE colonization status .[36,37] Given resource limitations, it is essential to consider the alternative implementation of generic preventative measures."*

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# CONCLUSIONS

*" When evaluating the likely benefits and cost-effectiveness of a CP and AS program for CRE, it is important to investigate the local epidemiology of CRE and to systematically consider key principles……..*

*We suggest that CP and will be most cost-effective and beneficial in the setting of patient-to-patient outbreaks caused by single MDRO strain types, particularly if there is reason to believe that environmental surfaces play a role in transmission. We also suggest that when the strategic merits of CP and AS for CRE are being evaluated, it is important to consider the alternative gains that could be made by channeling the same resources toward implementing generic strategies to reduce HAIs "*

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# BUT…MOST ASIAN HOSPITALS HAVE LIMITED RESOURCES

Success US/EU data

- Single room
- Adequate nurse-to-patient ratio
- Turn around time of ASC is within 24 hours
- ASCs implemented together with other interventions. Thus, attribution of ASC cannot be determined.

- ***Key Messages: Consider your hospital resources before doing it***

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## CONSIDERING ASCS IN RESOURCE-LIMITED SETTING!

| Stages of MDRO transmission | Resource | ASC | IC Measures |
|---|---|---|---|
| Sporadic cases | enough resource for isolation | Do | Do |
| Early outbreak | enough resource for isolation | Do | Do |
| Early outbreak | no enough resource for isolation | No | Do |
| Monoclonal outbreak | enough resource for isolation | Consider | Do |
| Monoclonal outbreak | no enough resource for isolation | No | Do |
| Polyclonal/endemic | enough/no enough resource | No | Do |

Consider = lab turn around time, cost effectiveness, etc.

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## CONSIDERATION IN RLS

Sensitivity low with one site culture
Labor intensive
Benefit will only occur when you have other interventions used simultaneously
Very costly and not cost-effective in resource-limited setting
May need selective plate
Difficult to dealt with administration level
Turn around time
Only work for epidemic

EFFORT SHOULD BE MADE TO IMPROVE BASIC IC (e.g., HH, CP, Environmental cleaning)

*USE OTHER APPROACHES (e.g, horizontal approach) WOULD BE MORE COST-EFFECTIVE*

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*Surveillance cultures for asymptomatic CRE colonization*

- The GDG recognized that information regarding a patient's CRE colonization status does not (yet) constitute routine standard of care provided by health systems. However, in an outbreak situation or situations where there is a high risk of CRE acquisition (for example, possible contact with a CRE colonized/infected patient or endemic CRE prevalence), CRE colonization status should be known. The surveillance culture results for the identification of CRE colonization may not have an immediate benefit to the screened patient, but instead they may contribute to the overall IPC response to CRE. It was also noted that information regarding CRE colonization status could potentially have important beneficial effects on the empiric antibiotic treatment plan for screened patients who subsequently develop potential CRE infection.
- The GDG believes that this recommendation should always apply in an outbreak situation and ideally, also in endemic settings. However, the panel extensively discussed the best approach to surveillance cultures of asymptomatic CRE colonization in a high CRE prevalence (endemic) setting, particularly in low-income settings where resources and facilities are limited and the actual appropriate improvement of IPC infrastructures and best practices may deserve prioritization over surveillance. The panel agreed that there is no one single best approach, but instead the decision should be guided by the local epidemiology, resource availability and the likely clinical impact of a CRE outbreak.
- The GDG believes that surveillance screening should be based on patient risk assessment (that is, patients who are at a higher risk of CRE acquisition and the potential risk that these patients pose to others in their environment). The following **patient risk categories** should be considered:
  - patients with a previously documented history of CRE colonization or infection;
  - epidemiologically-linked contacts of newly-identified patients with CRE colonization or infection (this could include patients in the same room, unit or ward);
  - patients with a history of recent hospitalization in regions where the local epidemiology of CRE suggests an increased risk of CRE acquisition (for example, hospitalization in a facility with known or suspected CRE);
  - based on the epidemiology of their admission unit, patients who may be at increased risk of CRE acquisition and infection (for example, immunosuppressed patients and those admitted to ICUs, transplantation services or haematology units, etc.).
- The GDG noted that surveillance cultures of fecal material were the preferred approach for the identification of CRE colonization. Regarding sample collection, culture of feces/rectal swabs or perianal swabs in rare clinical situations (for example, neutropenic patients) were considered the best methods in descending order of accuracy. However, it was recognized that for practical reasons, rectal swabs were often considered to be the most suitable clinical specimen in many health care situations. A minimum of one culture was considered necessary, although additional cultures may increase the detection rate.
- The GDG noted that surveillance cultures should be performed as soon as possible after hospital admission or risk exposure and that they should be processed and reported promptly to avoid delays in the identification of CRE colonization. The GDG was unable to identify the optimal frequency of testing after admission due to limited and heterogeneous evidence and noted that several studies included a regular screening timetable (for example, weekly or twice-weekly) following the initial on-admission screening.

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**Table 2. Recommendation resource implications and feasibility considerations**

| Recommendation | Resource implications and feasibility considerations |
|---|---|
| 1. Implementation of IPC multimodal strategies<br>**Strong recommendation** | • Multimodal strategies can be complex and require a multidisciplinary approach including executive leadership, stakeholder commitment, coordination, local champions or role models and possible modifications to workforce structure and process. Preventing or controlling the spread of CRE-CRAB-CRPsA should be advocated for as a priority patient safety issue and response to AMR.<br>• Human resource capacity including trained IPC professionals, dedicated IPC budgets and good quality microbiological laboratory support are critical to effective IPC programmes.<br>• Most data on IPC programme implementation come from high- and middle-income countries. However, the panel believed that the resources invested for IPC programmes are worth the net gain, irrespective of context. In settings with limited resources, prioritization should be based on local/regional needs. |
| 2. Importance of hand hygiene compliance for the control of CRE-CRAB-CRPsA<br>**Strong recommendation** | • Practical approaches to hand hygiene improvement and implementation should be considered according to the WHO recommendations (http://www.who.int/infection-prevention/tools/hand-hygiene/) with appropriate local adaptation.<br>• Hand hygiene compliance and the use of alcohol-based handrub are influenced by appropriate product placement and availability. Thus, it is critical to ensure that these adequate resources are in place. |
| 3. Surveillance cultures for asymptomatic CRE colonization and surveillance of CRE infection<br>**Strong recommendation** | • Laboratory testing and identification of carbapenem resistance among potential CRE-CRAB-CRPsA isolates may not be available or routine in limited resource settings. However, given the threat represented by AMR spread, the panel believed that testing for carbapenem resistance in these pathogens should now be considered as routine in all microbiology laboratories to ensure the accurate and timely recognition of CRE-CRAB-CRPsA. For this reason, enhanced efforts and training related to laboratory testing, analysis and interpretation of results may be required.<br>• To support surveillance, enhanced training on epidemiological methods and appropriate data collection and management infrastructure may also be required.<br>• Information regarding a patient's CRE colonization status does not (yet) constitute routine standard of care provided by health systems. However, in an outbreak or high-risk situation, it was determined that CRE colonization status should be known and such information considered an important patient safety issue. This may not have an immediate benefit to the screened patient, but instead it will contribute to the overall IPC response to CRE.<br>• In some limited resource settings, the improvement of IPC infrastructure and best practices may deserve prioritization over surveillance. The panel agreed that there is no one single best approach, but instead the decision should be guided by local epidemiology, resource availability and the likely clinical impact of a CRE outbreak.<br>• The panel noted that although surveillance cultures of fecal material were preferred for the identification of CRE colonization, rectal swabs may be a more practical clinical specimen to collect in many health care situations.<br>• There is growing evidence of the role of genotyping and whole genome sequencing of CRE isolates. Integrating this information into the epidemiological investigation of outbreaks is valuable to decide upon the consequent actions needed for their control. However, some questions remain unanswered, including the criteria that accurately define when a patient is no longer colonized with CRE. The panel believed that at least two consequent negative cultures should be available in order to consider a patient no longer colonized. |
| 4. Contact precautions<br>**Strong recommendation** | • The application of contact precautions involves an increase in workload to health care workers managing these patients, including technical expertise for their overall coordination and programme management.<br>• The application of contact precautions requires an increase in resource usage (for example, gowns and gloves), as well as the cost for their appropriate disposal. It was noted that the use of gloves could occasionally be associated with some occupational exposure issues, such as cutaneous reactions. |
| 5. Patient isolation<br>**Strong recommendation** | • The preference is for colonized/infected patients to be managed in single rooms where possible. Cohorting is reserved for situations where there are insufficient single rooms or where cohorting of patients colonized/infected with the same pathogen is a more efficient use of hospital rooms and resources. However, the panel believed that patient isolation should always apply in an outbreak situation.<br>• The use of dedicated health care workers to exclusively manage isolated/cohorted patients is recommended when feasible, although the panel acknowledged that this may be challenging in limited resource settings.<br>• Patient isolation should be undertaken with care and sensitivity to avoid misunderstanding and increased suffering by some patients. |
| 6. Environmental cleaning<br>**Strong recommendation** | • Strengthening environmental cleaning could have resource implications depending on the type of cleaning product used. Most cleaning products, including hypochlorite, are generally low cost. Some cleaning agents (for example, hydrogen peroxide), while seemingly effective, can be disruptive to hospital workflow and bed utilization given the time and equipment required for their use. Products should be used according to correct instructions to prevent occupational health issues.<br>• There may be an increased workload for hospital cleaners, although their salaries are often relatively low.<br>• Some limited resource settings may face basic WASH challenges. A sufficient and reliable water supply is essential for basic cleaning.<br>• All furniture should be easily cleanable as damaged furniture can prevent adequate cleaning. Environmental cleaning could also potentially lead to the enhanced degradation of some vinyl and other surfaces in hospitals. |
| 7. Surveillance cultures of the environment for CRE-CRAB-CRPsA colonization/ contamination<br>**Conditional recommendation** | • Environmental surveillance cultures may be resource-intensive in terms of human resources and laboratory, information technology and data management infrastructures. The GDG believed that the resources invested are worth the net gain in certain conditions, particularly for CRAB outbreaks.<br>• The collection and microbiological testing of environmental cultures can require a specialized approach necessitating capacity-building, particularly in limited resource settings.<br>• Additional education will likely be required to help standardize the cleaning techniques and surveillance methods. |
| 8. Monitoring, auditing and feedback | • Appropriate training of staff who undertake monitoring of the implementation of multimodal strategies and the feedback of results is crucial.<br>• The GDG agreed that IPC monitoring should encourage improvement and promote learning from experience in a non-punitive institutional culture, thus contributing to better patient care and quality outcomes. |

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### 3.7 Recommendation 7: Surveillance cultures of the environment for CRE-CRAB-CRPsA colonization/contamination

**The panel recommends that surveillance cultures of the environment for CRE-CRAB-CRPsA may be considered when epidemiologically indicated.**
*(Conditional recommendation, very low quality of evidence)*

**Rationale for the recommendation**

- Among the 11 CRE studies, only one included environmental surveillance cultures as part of their assessed intervention and reported a significant reduction in CRE outcomes post-intervention *(55)*.
- Among the five CRAB studies, only one included environmental surveillance cultures as part of their assessed intervention and reported a significant reduction in CRAB outcomes after the intervention *(59)*. In addition, one study monitored environmental contamination after cleaning using an adenosine triphosphate (ATP) bioluminescence assay as part of their intervention and found a significant reduction in CRAB outcomes after the intervention *(50)*.
- Among the three CRPsA studies, two included environmental surveillance cultures as part of their assessed intervention and reported a significant reduction in CRPsA outcomes post-intervention *(60, 61)*.
- The panel noted that environmental contamination with CRE-CRAB-CRPsA is commonly associated with increased rates of patient colonization and infection with these pathogens, particularly CRAB and CRPsA. All studies used environmental surveillance cultures to monitor the efficacy of hospital cleaning, which was one of the key elements of their multimodal IPC interventions.
- The evidence was not uniform, of very low quality, and appeared to be strongest for CRAB and CRPsA, rather than CRE. Thus, the GDG considered surveillance cultures of the environment to be a conditional recommendation.

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Thank you for your attention!

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