Controlling MRSA & VRE
Presented by Dr. Barry Farr
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Should We Try To Prevent Healthcare-Associated MRSA & VRE Infections?

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Why Control Nosocomial MRSA?

- MRSA doesn't just replace MSSA in an ecologic niche, but adds to total burden of illness.
- MRSA colonization has been associated with a higher infection rate than MSSA.
- MRSA infection is significantly more deadly than MSSA infection.
- MRSA infection is significantly more costly than MSSA infection.
- Virtually all patients with MRSA infection have to acquire it by spread.
- Isolation works as documented in > 45 epidemiologic studies (i.e., MRSA infection preventable).

Why Control Nosocomial VRE?

- VRE infection is significantly more deadly than VSE infection.
- VRE infection is significantly more costly than VSE infection.
- Virtually all patients with VRE infection have to acquire it by spread.
- Isolation works as documented in > 25 epidemiologic studies (i.e., VSE infection preventable).
- Allowing high rates of spread of vancomycin resistance genes will increase the probability of both creation and spread of VRSA.
- VISA strains significantly more deadly than MRSA.

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MRSA Infection Attributable Mortality

- Higher mortality with MRSA vs MSSA BSI (OR=1.9, 95% CI, 1.5,2.4, $p < 0.001$) after adjustment for severity of illness.[1]
- Adjusted attributable mortality 23.4% for MRSA BSI vs only 1.3% for MSSA BSI .[2]
- Higher mortality with MRSA vs MSSA SSI *(adjusted* odds ratio, 3.4; 95% confidence interval, 1.5-7.2).[3]

1Cosgrove SE. CID 2003; 36:53-59.

2 Blot SI. Arch Intern Med. 2002 28;162:2229-35.

3 Engemann JJ, et al. CID 2003;36:592-8.

Outcomes Associated With Vancomycin-resistant Enterococci: a Meta-analysis

In 13 studies, pooled VRE bacteremia case-fatality rates were significantly higher than for VSE (48.9% vs 19%; RR, 2.57; CI95, 2.27 to 2.91; attributable mortality = 30%). In 5 studies when bacteremia was the direct cause of death, VRE was more deadly than VSE (39.1% vs 21.8%; RR, 1.79; CI95, 1.28 to 2.5; attributable mortality = 17%). Four multivariate analyses found significant increases in case-fatality rates (OR, 2.10 to 4.0), 3 showed trends toward increase (OR, 1.74 to 3.34 with wide confidence intervals), and 3 with low statistical power found no difference. VRE BSI recurred in 16.9% versus 3.7% with VSE ($P < .0001$). Three studies reported significant increases in LOS, costs, or both with VRE.

Salgado, CD. ICHE 2003;24:690-698.

Attributable Mortality of VRE Bacteremia

- Association with death was 2.52-fold higher for VRE bloodstream infections than for VSE BSI (95% CI= 1.9-3.1, $p < 0.001$) after adjustment for severity of illness in a meta-analysis of 9 studies providing data allowing adjustment for severity of underlying illness. A second meta-analysis excluded studies of selected populations and found similar results in the 7 remaining studies (OR=2.32, 95% CI,=1.7-2.96).

Diazgranados CA et al. IDSA 2003; abstract 491, p. 45.

Attributable Mortality Of VRE Infection

- VRE infection associated with significant increases in attributable adjusted mortality (OR=2.5,p=0.05) as compared with patients with infection due to vancomycin susceptible enterococci.

Kaye KS et al, ICAAC 2002 http://www.asm.org

Epidemiological and Microbiological Characterization of Infections Caused by Staphylococcus Aureus With Reduced Susceptibility to Vancomycin, United States, 1997-2001

VISA infected patients were more likely to die than patients with MRSA infections with full susceptibility to vancomycin in a case-control analysis.

This remained true in stepwise, multiple logistic regression after adjustment for other known predictors of hospital death.

Fridkin SK, Clin Infect Dis. 2003 Feb 15;36(4):429-39.

Infection With Vancomycin-Resistant Staphylococcus Aureus Containing The Vana Resistance Gene

PFGE showed that patient's VRSA was identical to patient's MRSA strain that was susceptible to vancomycin and to an MRSA isolate from her friend. PCR revealed only *van*A and sequencing showed that the *van*A in the VRSA was identical to the *van*A in patient's VRE, which was also identical to the *van*A sequence in transposon Tn1546. The VRSA isolate's MIC for vancomycin was 1024. The authors conclude that "this finding underscores the importance of extending efforts to prevent and reduce the spread of MRSA."

Chang S et al, NEJM 2003;348(14):1342-7.

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Excess Cost of MRSA Infection

MRSA infections cost significantly more than MSSA infections.

Engemann JJ et al, CID 2003; 36:592-598.

Kaye KS et al, ICAAC 2002 http://www.asm.org

Cosgrove SE et al, ICAAC 2001 abst. K-1221, p. 415.

Abramson, *ICHE* 1999;20:408.

Wakefield, *AJIC* 1988;16:185-192.

Cheng, *J Hosp Infect* 1988;12:91-101.

Costs Of VRE Bacteremia

- VRE bacteremia associated with significant increases in length of stay (p=0.004), and hospital costs (more than $27,000 per episode, p=0.04) as compared with VSE bacteremias.[1]
- VRE BSI associated with 19-day increase in length of stay (p<0.001), and increased hospital costs ($79,589 per episode, p<0.001) as compared with matched, uninfected controls.[2]

1) Stosor V, *et al., Arch Int Med* 1998;158:522.

2) Song X, et al, *ICHE* 2003;24:251-256.

Mechanisms Of Developing Antibiotic Resistance

1. Random genetic mutation.
2. Plasmid swapping during conjugation.
3. Movement of transposons to plasmids/chromosomes.
4. Transduction by bacteriophages.
5. Transformation (acquisition of resistant genes from a recently killed cell and incorporation into a chromosome or plasmid).
6. Binary fission (replication) can share any of the above.

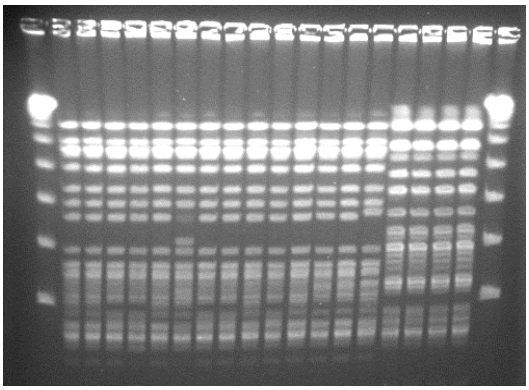
Mechanisms Of Developing Antibiotic Resistance

Natural Selection

Darwin C. *On the Origin of Species by Means of Natural Selection*, London, 1859.

Prevalence of Antibiotic Therapy in U.S. Hospitals In Recent Surveys

- A quarter to a half of all patients
- Almost all ICU patients



Byers KE, *et al. ICHE* 2001;22(3):140-147.

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Clonal Spread Of Methicillin-Resistant Staphylococcus Aureus In A Large Geographic Area Of The United States

MRSA isolates mostly from blood were studied from 12 hospitals in 7 states. Using different molecular techniques for MRSA typing, we verified that two unique epidemic clones are spread over a large geographic area in the US (51% were clone A, 9% strains closely related to A, and 20% clone W). Clone A infected patients in all 12 hospitals accounting for 17-78% of all MRSA infections in the 12 hospitals. Clone W caused infections in 10 of the 12 hospitals. In addition, we showed that a previously described MRSA clone type, the New York clone (I::A:A), is widely spread beyond the New York frontiers.

da Silva Coimbra MV et al, JHI 2003;53(2):103-10.

Possible Control Measures

1) Antibiotic control
2) Prevention of spread
   a) hand hygiene for all patient contacts (Universal/Standard Precautions)
   b) identify colonized patients with active surveillance cultures and use barrier precautions to prevent spread

Risk of Acquiring MRSA from an MRSA Colonized Roommate

- **Patients with an MRSA-positive roommate were significantly more likely to be found positive for MRSA as compared with other high-risk hospital patients without known exposure to an MRSA-positive roommate.**
  - **8.1% vs. 4.7%, RR=1.73 95%CI 1.02-2.94, p=0.042)**
  - **The entire group of exposed patients were hospitalized a mean of 6.7 days before their follow-up culture.**
  - **The control "high-risk" patients had been hospitalized for a a mean of 6.8 days before their follow-up culture.**

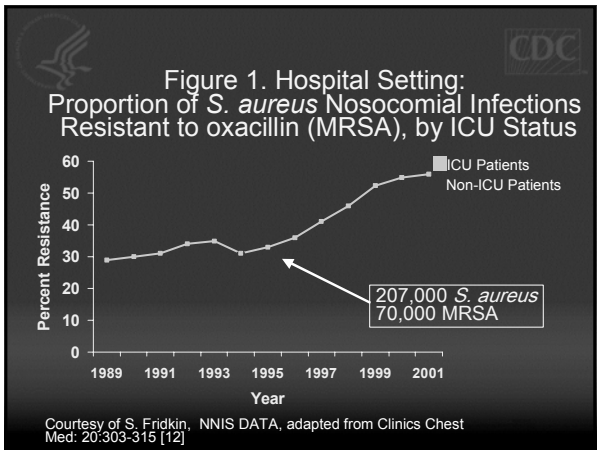
CD Salgado, et al. SHEA 2003; abstract 248, p. 109.

Risk of Acquiring MRSA from an MRSA Colonized Roommate

- **10 (71.4%) of the 14 roommate pairs were found to carry MRSA with identical antibiograms:**

AB type (percent of time it occurs among all MRSA)	Roommate pairs with the AB	Probability of occurring by chance alone
R to CC,Cip,E (38.8%)	6	3.41×10^{-3}
R to Cip,E (22.8%)	1	2.28×10^{-1}
R to CC,Cip,E,STX (15.3%)	2	2.34×10^{-2}
R to CC,Cip,E,STX,Tet (3.5%)	1	3.50×10^{-2}
Total	**10**	6.37×10^{-7}

AB=antibiogram, R=resistant, CC=clindamycin, Cip=ciprofloxacin, E=erythromycin, STX=sulfamethoxazole, Tet=tetracycline



Quinolone Exposure Preferentially Selects for MRSA Carriage.

Weber SG, et al. ICAAC 2002 abstract.

Hori S et al. J Hosp Infect 2002; 50:25-19.

Harbarth S et al. Clin Infect Dis 2001; 33:1462-1468.

Campillo B et al. Epidemiol Infect 2001; 127:4430450.

Dziekan G et al. J Hosp Infect 2000; 46:263-270.

MRSA Control Via Antibiotic Control

•4 studies have reported decreased MRSA following reductions in usage of certain antibiotics, but in three new measures to block spread were simultaneously implemented:

1) switching from a third to a first generation cephalosporin for perioperative prophylaxis; 2) major reductions in the use of third generation cephalosporins and clindamycin; 3) restriction of both ceftazidime and ciprofloxacin as well as cycling of other beta-lactams; 4) MRSA declined in the first year of an antibiotic control program but then rose again despite continuation of the program.

1) Fukatsu K et al, Arch Surg 1997; 132:1320-1325. 2)Landman D et al, CID 1999; 28:1062-1066. 3) Gruson D et al, Am J Respir Crit Care Med 2000; 162:837-843. 4) Frank MO et al, CPQHC 1997; 5:180-188. 5) Batteiger BE. Indiana University, Indiana, personal communication. 2001

Failure To Prevent MRSA Spread

• Thompson *et al.* found that despite isolation of patients known to have MRSA from clinical cultures, the prevalence of MRSA infection continued to increase.

	1977	1979	1980
Pneumonia	0%	19%	24%
Blood stream infection	0%	13%	40%
Surgical site infection	0%	27%	49%

Thompson RL, *Ann Intern Med* 1982;97:309

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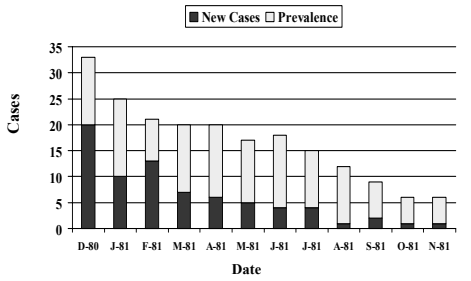
Control of MRSA Using Active Surveillance Cultures and Isolation of Colonized Patients



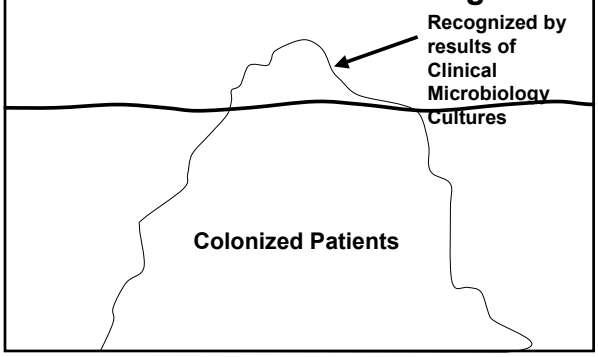
Incidence ($p < 0.002$) and Prevalence ($p < 0.001$)

Thompson RL, *Ann Intern Med* 1982;97:309.

MRSA (which had been out of control for 2.5 years) Was Completely Eradicated from the Hospital

- Within 1.5 years
- This was done with no antibiotic control effort of any kind.
- There was also no campaign to increase hand hygiene.

Reservoir for the Spread of Antibiotic Resistant Pathogens

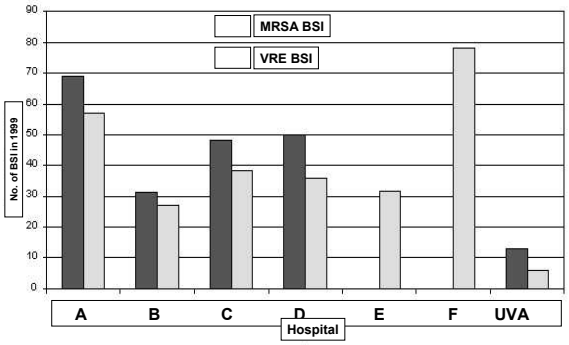


Sensitivity of Using Clinical Microbiology Cultures To Detect MRSA-Colonized Hospital Patients

- Of 437 patients found to be colonized with MRSA on hospital admission, 66 had positive clinical microbiology cultures for MRSA during the hospital stay (15%, 95%CI 11.9-18.8%).
- 306 (70%) had 1,238 clinical microbiology cultures done during their admission and 98 (7.9%, 95%CI 6.5-9.6%) were positive for MRSA.

Salgado CD et al. SHEA 2003 abstract 28, p. 61.

VRE and MRSA Bacteremias at Hospitals of Comparable Size and Complexity, 1999



Calfee DP, et al. ICHE 2002;23:407-410.

Rates of MRSA Transmission

	Source	
	Isolated	Unisolated
Transmissions	5	10
Patient-days	558	71.5
Rates	0.009	0.140

RR=15.6, 95% CI=5.3-45.6, p<0.0001

Jernigan, *et al. Am J Epi* 1996;143:496-504.

Follow-up After Control of MRSA Outbreak in NICU

No MRSA in any patient during the next 10 years and about 100,000 patient-days.

This long term control suggests a low frequency of *de novo* development of methicillin resistance despite prolonged hospital stay and frequent antibiotic therapy in the NICU.

It also suggests a very low rate of MRSA colonization among healthcare workers and mothers in central Virginia.

Risk of MRSA Transmission from Unisolated, MRSA-Colonized NICU Patients Using Standard Precautions

	Source	
	Unisolated	Isolated
Transmissions	7	5
Patient-days	58.5	497
Rates	0.12	0.01

RR=11.9, 95%CI=3.25-47.5, $p=1.4 \times 10^{-4}$

Geffers C et al. Unpublished data

Jernigan JA, *et al. Am J Epi* 1996;143:496-504.

Rates of Clonal MRSA Transmission

	Unisolated	Isolated
Transmissions	38 *	1^
Assumed person days at risk	X	X

*= # acquiring MRSA clone from 3 unisolated ICU patients (i.e., 23 patients and 15 HCWs)

^= # acquiring MRSA clone from 3 isolated ICU patients

RR=38.0, 95% CI=6.4-1539.9, $p<10^{-6}$

Vriens MR, et al, ICHE 2002; 23:491-494.

Secondary infection with MRSA in Dutch hospitals, 1994-1996

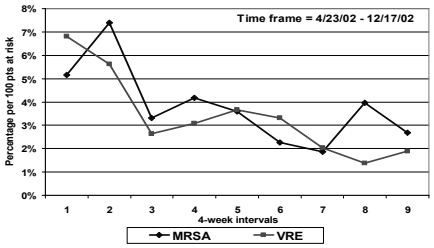
231 hospitals had MRSA index cases and responded to survey, allowing 2- year retrospective cohort study.

Isolation cohort (for which index cases were isolated on hospital admission as per Dutch guidelines):4 of 73 gave rise to secondary transmission to one or more.

Non-isolation cohort (patients not suspected and thus not put into isolation on admission):19 of 95 gave rise to secondary transmission to one or more.
Odds ratio= 4.3 (95% CI=1.3-18.2)

Esveld MI et al, Ned Tijdschr Geneeskd. 1999;143(4):205-8.

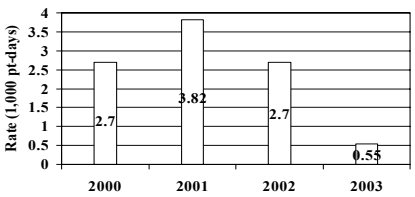
Incidence of Colonization Since Initiation of Active Surveillance



Chi-sq for Trend : MRSA p = 0.003, VRE p < 0.0001

Karchmer TB et al, SHEA 2003 abstract 257.

Results –MICU MRSA infection rates



- Isolating the large influx of MICU AMSC + patients and the newly acquired cases (WMSC +) resulted in a 83.7% reduction of MICU MRSA HAI
  - 3.53/1,000 PT days in 2001 vs 0.55 in 2003
- This was a significantly lower rate (OR 6.6 CI 2.2-22.3 p=0.001).

Blank MK et al, SHEA 2003 abstract 253 (updated)

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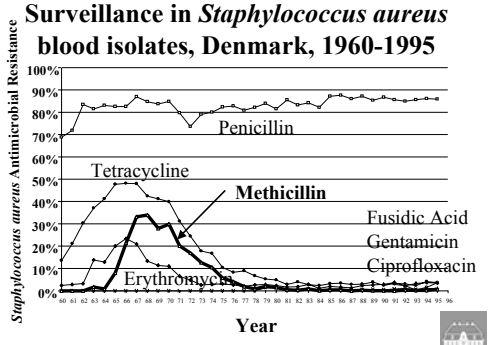

Source: DANMAP Report, 1997.

Criteria for Causal Inference

1. Strength of association
2. Consistency of evidence
3. Temporal relationship
4. Biological gradient
5. Reversibility
6. Specificity
7. Coherence of evidence

Hill AB. A Short Textbook of Medical Statistics **(11th ed.), p. 273. London, UK: Unibooks. 1984.**

Studies Reporting Control of MRSA Using ASC & CP

Law MR, et al. Epidemiol Infect 1988; 101:623-629.

Murray-Leisure KA, et al, ICHE 1990; 11:343-350.

Nicolle LE, et al ICHE 1999; 20:202 -205.

Cantey J, et al. SHEA. 2002; Abstract 36:49.

Croyle K, et al, SHEA. 2002; Abstract 35:49.

Kotilainen P, et al. Arch Intern Med 2001; 161:859-863.

Nouer A, et al ICAAC 2002; K-97: 97.

Horcajada J, et al ICAAC 2002:K-98.

Gerard M, et al ICAAC 2002:K-99.

Verhoef J, et al. Eur J Clin Micro Infect Dis 1999; 18:461-466.

Cooper CL et al, ICHE 2002;23:483-484.

Adverse Effects of Isolation in Unrandomized Study

MRSA isolation patients were twice as likely to have adverse events (31 vs. 15 per 1000 patient days, $p<0.001$). These prominently involved falls, pressure ulcers, and fluid/electrolyte disorders. Nurses recorded vital signs and physicians wrote progress notes less frequently. There were no significant increases in diagnostic, operative, anesthetic, medical procedure or adverse drug events nor in mortality. The authors said these findings would require confirmation from further studies in other populations.

Stelfox HT et al. JAMA 2003;290:1899-1905.

51-Month MRSA NICU Outbreak

40-50% of all neonates colonized by outbreak strain of MRSA

75 MRSA bacteremias

14 (18.6%) with MRSA bacteremia died

Haley RW et al, JID 1995;171:614-624.

Genome and Virulence Determinants of Virulent Community-acquired MRSA

The whole genome of MW2, a strain of community-acquired MRSA, was sequenced by shotgun cloning/ sequencing. MW2 caused fatal septicaemia and septic arthritis in a 16-month-old girl in North Dakota, USA, in 1998. Nineteen additional virulence genes were recorded in the MW2 genome.

Baba T, et al. Lancet. 2002;359:1819-27.

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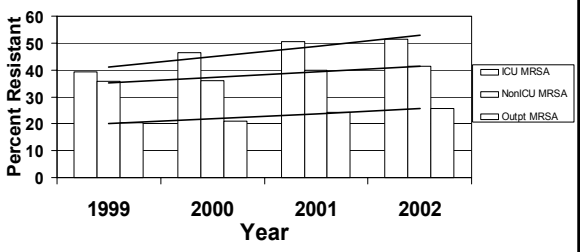
MRSA Continues to Increase



Prevalence of MRSA Carriage Among the General Population

Two recent, large prevalence studies focusing on children, because of frequent reports of community acquired MRSA in children, both found a prevalence of 0.2%.[1, 2] A third found a higher rate among homeless adults , but of those without healthcare contacts it was 0.2%.[3]

[1]Sa-Leao R et al, Microbial Drug Resistance 2001; 7:237-245.

[2]Shopsin B et al, JID 2000; 182:359-362.

[3]Charlebois E et al, CID 2002;34:425-33.

[4]National Health and Nutrition Examination Survey (NHANES).

Prevalence of Methicillin-resistant Staphylococcus Aureus Nasal Carriage in the Community Pediatric Population

Nasal swabs were collected from 500 children at well-child visits in Nashville, TN. Cultures were plated onto selective staphylococcal media, with or without oxacillin. isolates were confirmed by coagulase tube testing. PFGE was used to evaluate epidemiologic relatedness. 4 patients (0.8%) had MRSA. Only having a household member employed in a hospital was associated with a greater risk of MRSA nasal carriage (odds ratio, 9.6; P= 0.008).

Nakamura MM, et al. Pediatr Infect Dis J. 2002 Oct;21(10):917-22.

Spread of MRSA To Household Contacts of Individuals with Nosocomially-Acquired MRSA

MRSA was isolated from 25 (14.5%) of 172 individuals. Among the contacts to index cases who had at least one MRSA-colonized contact, those with close contact to the index case were 7.5 times more likely to be colonized (53% versus 8%, 95% CI 1.1-50.3, p=0.002). Analysis of antimicrobial susceptibility and DNA fingerprint patterns suggested person-to-person spread.

Calfee DP et al, ICHE 2003;24:422-426.

Nottingham Staphylococcus Aureus Population Study: Prevalence of MRSA Among Elderly People in the Community

The sample (1% of people ≥ 65) found nasal MSSA in 257 people (26.7%, 95% confidence interval 24.1% to 29.8%) and MRSA in 8 (0.8%, .3-.14%). MRSA was associated with hospital admission in the prior six months (adjusted odds ratio 13.0, 2.5-68.2) and diabetes (6.8, 1.33 to 34.3). All MRSA isolates were the epidemic MRSA type 15 widely prevalent in English hospitals and also the most common MRSA strain in the two major hospitals in Nottingham at the time of investigation.

Grundmann H, et al. BMJ. 2002 Jun 8;324(7350):1365-6.

Population-based Prevalence Study in an American Indian Population, Washington, 2001

After CO-MRSA rates increased significantly in 2000, MRSA accounted for 34% of all CO-S. aureus infections.

128 (27.3%) of 469 participants had *Staphylococcus aureus.* Nine (2.1%) of 469 had MRSA carriage; of these, five had CA-MRSA (5/469, overall CA-MRSA carriage rate: 1.1%). MRSA carriage was associated with antimicrobial use in the previous year (RR 7.2, p=0.04) and residence in a household of >7 persons (RR 4.5, p= 0.03).

Leman R et al, ICHE 2004;25:In press.

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Healthcare Spread of and Infections by mec IV MRSA Strains

Associated with community spread, thes strains have also been associated wit spread and virulent infections in th healthcare setting. They also can acqui additional co-resistances and can be difficu to separate from mec types I-III without DN typing.

Saiman L et al, CID 2003;37:1313-1319.
Naimi TS et al JAMA. 2003; 290(22): 2976-84.
Said-Salim B, et al. ICHE 2003;24:451-5.
Tenover F. IDSA 2003

Fatal pneumonia in an adolescent due to community-acquired methicillin-resistant Staphylococcus aureus positive for Panton-Valentine-leukocidin

A 15-year-old girl developed a severe S. aureus pneumonia following influenza. The patient was admitted to a PICU but died despite aggressive therapy on the third day after admission with hypoxic-ischaemic encephalopathy. PCR-based methods demonstrated that the isolate possessed the Panton-Valentine-leukocidin (PVL) gene, an exotoxin associated with fulminant, necrotizing pneumonia.

van der Flier M, et al.
Ned Tijdschr Geneeskd. 2003 May 31;147(22):1076-9.

Recent Recommendations on MRSA Infection Control

"Application of known prevention measures should be our highest priority. This should include active surveillance cultures and contract isolation in healthcare facilities. These measures have been documented to reduce or eliminate MRSA transmission in healthcare facilities and do not require advanced genotyping capacity to accomplish. It should be remembered that the majority of MRSA … is healthcare-related, as the current prevalence of MRSA in the community population is <1%. "

Jarvis WR, et al. ICHE 2003;24(6):392-6.

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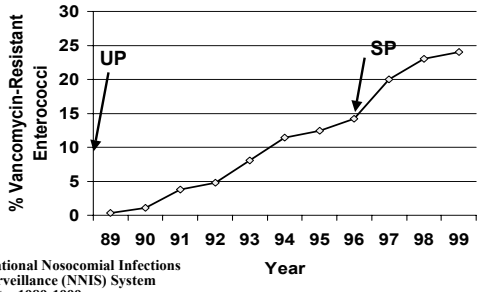
Percentage of Nosocomial Enterococci Reported as Resistant to Vancomycin, by Year



*National Nosocomial Infections Surveillance (NNIS) System Data, 1989-1999.

Effect Of Vancomycin and 3rd Generation Cephalosporins On VRE Rates In 126 ICUs

- Higher rates of vancomycin or third-generation cephalosporin use were associated with increased prevalence of VRE, independent of other ICU characteristics and the endemic VRE prevalence elsewhere in the hospital.
- Decreasing the use rates of these antimicrobial agents could reduce rates of VRE in ICUs.

Fridkin SK et al, Ann Intern Med 2001;135:175-83.

VRE Control Via Antibiotic Control

1&2) 2 studies have reported that greatly reducing or stopping the use of ceftazidime and switching to pip-tazo was associated with a 2/3 relative reduction in VRE. Both made multiple changes at once, including new measures to prevent spread, making it hard to see the effect of each measure. 3) 3rd study suggested vanco restriction in ICUs was associated with a modest decline in VRE (7.5% decrease vs. 5.7% increase in ICUs not doing this over the 1.25-year study). 4) 4th study reported declines in C diff and VRE but not MRSA. 5) Another recent study reported that VRE continued to increase despite 85% relative reduction in the usage of 3rd gen cephalosporins.

1) Quale J et al, CID 1996; 23:1020-1025. 2) Bradley SJ et al, JAC1999; 43:261-266. 3) Fridkin SK et al, Emerg Infect 2002; 8:7. 4) Carling P et al, ICHE 2003;24:699-706. 5) Lautenbach E et al, CID 2003; 36:440-446.

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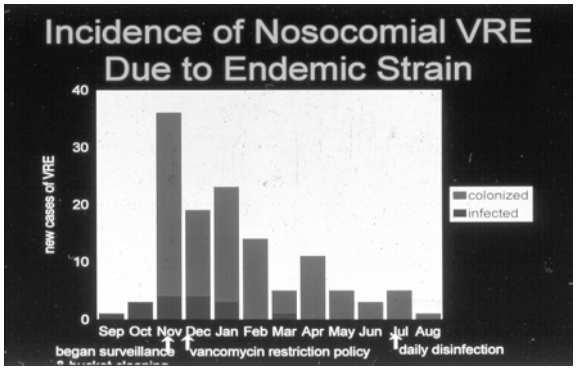


Byers KE et al. ICHE 2001;22:140-7.

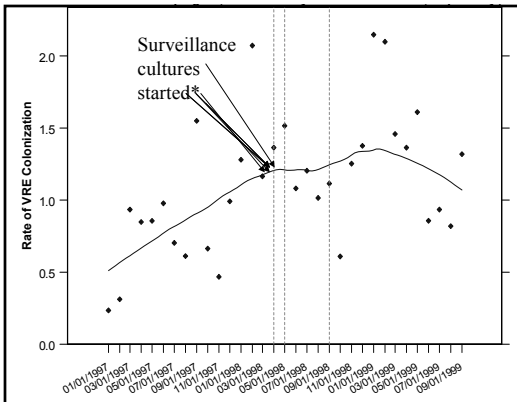
Conditional Logistic Regression Analysis

Variable	OR	P
Proximity to unisolated VRE patients	2.04*	0.0014
History of major trauma	9.27	0.020
Metronidazole therapy	3.04	0.040

•Per exposure-unit

Proximity to isolated VRE patients was not associated with increased risk.

Byers KE et al. ICHE 2001;22:140-7.



* p=0.0321 in Poisson regression after adjusting for new colonizations. Calfee DP, Clin Infect Dis. 2003;37(3):326-32.

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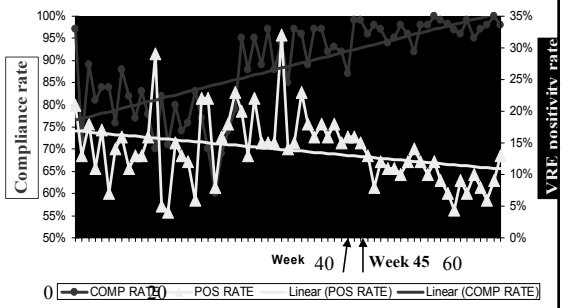
VRE compliance and positivity rates



Muto CA, et al. IDSA 2001, abstract 210, p. 75.

VRE Prevalence in 30 Healthcare Facilities, Siouxland, 1997 vs 1999

Facility	Number (%) VRE-Colonized 1997	1999	Relative Risk	p-value
All	40 (2.2)	9 (0.5)	0.23	<0.001
Acute Care	10 (6.6)	0	0	<0.001
Long-Term Care	30 (1.8)	9 (0.5)	0.31	0.001

Ostrowsky BE, *et al.*, NEJM 2001;344:1427-1433.

Incidence Densities of VRE BSI in Two Neighboring Hospitals With Comparable Patient Populations

Surveillance Cxs	VRE BSI	Pt.-days
No –Hospital A*	218	1,271,715
Yes-Hospital B	72	875,730

BSI RR=2.1, 95%CI, 1.59-2.76

***Most Hospital A isolates were clonal with 4 clones accounting for >75% of BSI and most common clone accounting for 30% as compared with 37% and 14.5% at Hospital B, respectively.**

Price CS et al. CID 2003;37:921-928.

Studies Reporting Control of VRE Using ASC & CP

Comparison	Incidence Rate Ratio	95% CI	P value
2 vs 1	0.63	0.38–1.05	0.078
2 vs 3	0.36	0.23–0.55	<0.0005
4 vs 3	0.68	0.54–0.85	<0.0005

Siddiqui AH, et al. AJIC 2002; 30:40-43.

Studies Reporting Control of VRE Using ASC & CP

Boyce JM, et al, ICHE 1995; 16:634-637.

Boyce JM, et al. J Clin Microbiol 1994; 32:1148-1153.

Livornese LL, et al. Ann Intern Med 1992; 117:112-116.

Byers KE, et al, ICHE 2001; 22:140-147.

Ostrowsky BE, et al. N Engl J Med 2001; 344:1427-1433.

Calfee DP, et al, ICHE 2002; 23:407-410.

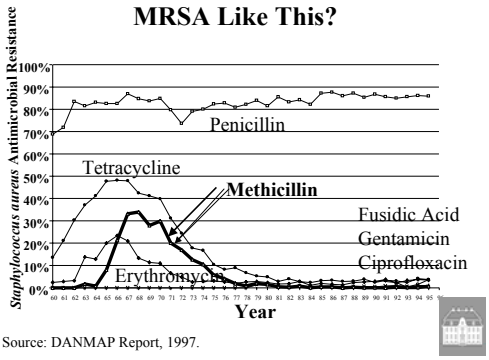
Karanfil LV, et al, ICHE 1992; 13:195-200.

Montecalvo MA, et al. Antimicrob Agents Chemother 1994; 38:1363-1367.

Dembry L, et al, ICHE 1996; 17:286-292.

Rupp ME, et al, ICHE 2001; 22:301-303.

Could Hand Hygiene Alone Control MRSA Like This?



Source: DANMAP Report, 1997.

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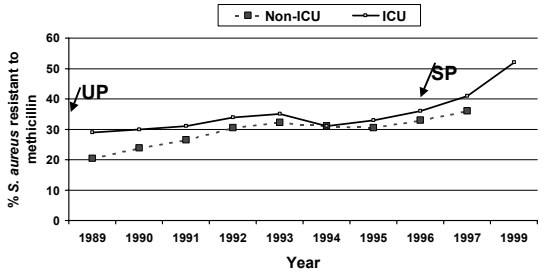
MRSA Isolates From ICUs vs Non-ICUs



ICU=intensive care unit

Fridkin. *Clin Chest Med*. 1999;20(2):303.

Studies Reporting Failure of Standard Precautions to Control MRSA or VRE

Wernitz MH, et al, Emerg Infect Dis. 2004. In press.

Herrera OF et al, IDSA 2003 abstract 565, page 119.

Saiman L et al, ICHE 2003; 24:317-321.

Marshall C et al, ICHE 2003; 24:322-326.

Price CS, et al, CID 2003; 37:921-928.

Calfee DP, Clin Infect Dis. 2003;37(3):326-32.

Vriens MR, et al, ICHE 2002; 23:491-494.

Muto CA, et al, abstract 164, SHEA 2002, page 80.

Studies Reporting Failure of Standard Precautions to Control MRSA or VRE

Calfee DP, et al, ICHE 2002; 23:407-410.

Siddiqui AH, et al. AJIC 2002; 30:40-43.

Byers KE, et al, ICHE 2001; 22:140-147.

Ostrowsky BE, et al. N Engl J Med 2001; 344:1427-1433.

Esveld MI et al, Ned Tijdschr Geneeskd. 1999;143(4):205-8.

Jernigan JA, et al. Am J Epidemiol 1996; 143:496-504.

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ISOLATION GOWNS PREVENT HCWs FROM CONTAMINATING THEIR CLOTHES/HANDS

14 (40%) of 35 HCWs' gowns were culture (+) for MRSA and ARE on exiting room (2-200 colonies recovered). Clothing underneath was culture (-). 11 (69%) of 16 HCWs wearing freshly laundered white coats had detectable contamination. 3 of 11 developed (+) hand cultures after touching the white coat.

Boyce, *et al.* SHEA 1998, Abstract S74.

CONTAMINATION OF GOWNS, GLOVES AND STETHOSCOPES

- **Two thirds of examinations of VRE patients resulted in VRE contamination of gown, gloves and/or stethoscopes.**
- **Same rate of contamination whether the patient was infected or merely colonized.**

Zachary KC et al. *ICHE* 2001; 22:560-564.

Importance of Gowns for Controlling Contact Transmission of VRE

	Gloves	Gown & gloves
VRE Rate per 100 patient-days	3.78	1.8
	p=0.04	

In a proportional hazards model adjusted for length of stay, 'gloves only' precautions were associated with a hazard ratio of 2.5, p=0.02, 95%CI=1.2-5.3)

Srinivasan A, et al, ICHE 2002; 23:424-428.

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Importance of Gowns for Controlling Contact Transmission of VRE

	Gloves	Gown & gloves
VRE Rate per 1000 patient-days	19.6	9.1

p<0.01

In a logistic regression analysis, 'gown and gloves' precautions were associated with an adjusted odds ratio of 0.43, p=0.02, 95%CI=0.27-0.68)

Puzniak LA, et al, Clin Infect Dis 2002; 35:18-25.

Environmental MRSA Contamination

- 70% of rooms had environmental contamination when the patient was colonized or infected and 42% of nurses' gloves were contaminated after touching environmental surfaces without touching patient.[1]
- 7% of stethoscopes were contaminated with MRSA[2]
  - Wiping with 70% isopropyl alcohol significantly reduced colony counts on stethoscopes ($p < 0.02$).[3]
- Contaminated surfaces include patient's gowns, floor, bed linens, blood pressure cuffs, overbed tables, stethoscopes, etc.[1]

[1] Boyce. *Infect Control Hosp Epidemiol.* 1997;18:622.

[2] Cohen. *Fam Pract.* 1997;14:446

[3] Marinella. *Arch Intern Med.* 1997;157:786.

Rates of Persistent Environmental VRE Contamination

Conventional	60/376 = 15.9%
Bucket	0/135 = 0%

Chi Square = 25.7

p < 0.001

Byers KE et al. ICHE 1998;19:261-4.

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Studies Reporting Long Term MRSA or VRE Control Using ASC & CP

Jernigan J et al, ICHE 1995; 16:686-696.

Verhoef J, et al. Eur J Clin Micro Infect Dis 1999; 18:461-466.

Salmenlinna S, et al. Euro J Clin Micro & Infect Dis 2000; 19:101-107.

Vriens MR, et al, ICHE 2002; 23:491-494.

Farr BM, et al, Lancet Infect Dis. 2001;1:38-45 (provides 9-year F/U for Jernigan JA, et al. Am J Epi 1996; 143:496-504.)

Calfee DP, et al, ICHE 2002; 23:407-410.

Calfee DP, Clin Infect Dis. 2003 Aug 1;37(3):326-32.

Price CS, et al, CID 2003; 37:921-928.

Significantly Lower Rate of MRSA & VRE Among Patients Transferred from Nonacademic Hospital A Using ASC/CP

	MRSA		VRE	
	+	-	+	-
Hospital A	12 (1.3%)	948	3 (0.4%)	724
Others	189(4.8%)	3731	75 (2.7%)	2752
	RR=0.26, 95%CI=0.15-0.46 $p=1.0X10^{-6}$		RR=0.16,95%CI=0.05-0.49 $p=4.1X10^{-4}$	

Unpublished data, Calfee DP, Farr BM

Studies Reporting Control of MRSA & VRE in Nonacademic Settings Using ASC & CP

Green K, et al ICAAC 2002: abstract K661.

Ostrowsky BE, et al. N Engl J Med 2001; 344:1427-1433.

Salmenlinna S, et al. Euro J Clin Micro & Infect Dis 2000; 19:101-107.

Esveld MI et al, Ned Tijdschr Geneeskd. 1999;143(4):205-8.

Armstrong-Evans M, et al, ICHE 1999; 20:312-317.

Jochimsen E, et al, ICHE 1999; 20:106-109.

Verhoef J, et al. Eur J Clin Micro Infect Dis 1999; 18:461-466.

Kotilainen P, et al. Emerg Infect Dis. 2003 Feb;9(2):169-75.

Silverblatt FJ, et al, J Am Geriatr Soc 2000;48:1211-1215.

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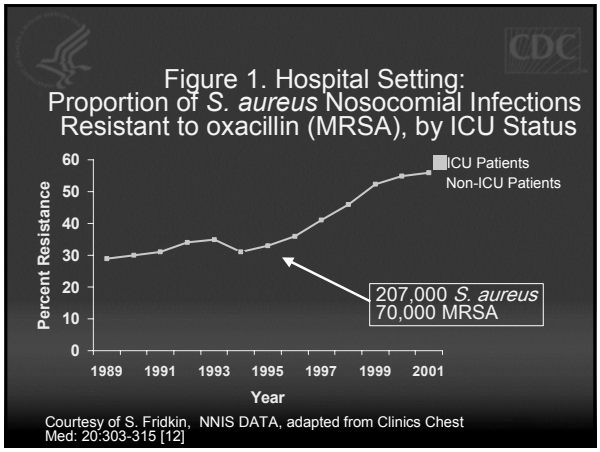

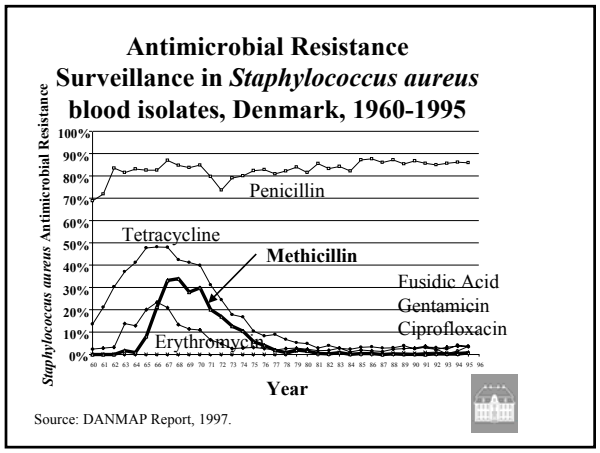

CDC Guideline for Isolation Precautions

- **The CDC guideline for isolation precautions recommends contact isolation for "patients known or suspected to be colonized or infected with epidemiologically important" antibiotic-resistant microorganisms.**

Garner, *et al. ICHE* 1996;17:53.

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SHEA Guideline for Preventing Nosocomial Transmission of Multidrug-resistant Strains of Staphylococcus aureus and Enterococcus

This guideline recommends that all healthcare facilities try to control MRSA & VRE by identifying colonized patients with active surveillance cultures so they can be cared for using contact precautions. It is posted on the 'Position Paper' section of the SHEA website (http://www.shea-online.org/PositionPapers.html). This site is accessible to nonmembers who are welcome to print a personal copy.

Muto et al, ICHE 2003;24:362-386.

Studies Showing Cost Benefit of ASC & CP for Controlling MRSA & VRE

Jernigan JA, *et al. ICHE* 1995;16:686.

Papia G, et al. ICHE 1999;20:473-477.

Chaix, *et al. JAMA* 1999;282:1745.

Montecalvo MA, *et al. ICHE* 2001 July;22:437-42.

Bronstein M, et al. SHEA 2002 abstract 47, page 51.

Karchmer TB et al, *J Hosp Infect* 2002;51:126.

Muto CA et al, *ICHE* 2002;23:429-435.

Calfee DP, et al. *ICHE* 2002;23:407-410.

Lucet J et al. *Arch Int Med* 2003;163:181-88.

Cost-benefit Analysis of Detecting and Isolating MRSA Colonized Patients on ICU Admission

- A prospective study in 14 French ICUs for 6 months found that only universal screening detected MRSA carriage with acceptable sensitivity. A cost-benefit analysis confirmed that universal screening and preventive isolation saved money.

Lucet JC et al. Arch Intern Med. 2003;163:181-8.

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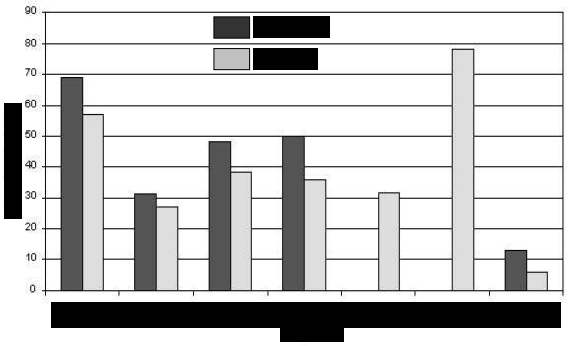
VRE and MRSA Bacteremias at Hospitals of Comparable Size and Complexity, 1999



Calfee DP, et al. ICHE 2002;23:407-410

A Recent Study Reporting Cost Effectiveness of Active Surveillance Cultures and Contact Precautions for Controlling MRSA Spread

	Baseline	ASC & CP
MRSA Rate per 1000 patient-days	5.4^	1.8^
Gown usage per patient-day	6.9*	4.6*

^p=0.10, *p<0.001

Gown costs decreased from $18,941 to $11,877.

Bronstein M, et al. SHEA 2002 abstract 47, page 51.

UVA Named 'Top 100' US Hospital 5 Consecutive Years, 1998-2002

1. Risk adjusted mortality rates
2. Risk adjusted complication rates
3. Severity adjusted length of stay
4. Expense per adjusted discharge (for case mix and local wages)
5. Profitability
6. Index of outpatient activities
7. Index of total facility occupancy
8. Long-term growth in equity
9. Productivity (net patient revenue / total assets)

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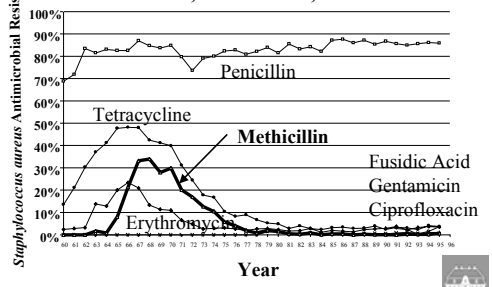
Antimicrobial Resistance Surveillance in *Staphylococcus aureus* blood isolates, Denmark, 1960-1995



Source: DANMAP Report, 1997.

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