

# Success for a MRSA Reduction Program: *Role of Surveillance and Testing*

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## Potential COI

- Research Grants
  - Cepheid, ENH, GeneOhm, MicroPhage, Nanosphere, NIAID, Roche, 3M, Washington Square Health Foundation
- Consultations (in conjunction with research projects and new diagnostics)
  - Cepheid, GeneOhm, MicroPhage, Nanosphere, Roche, 3M
- All highlighted are post intervention MRSA plan approval



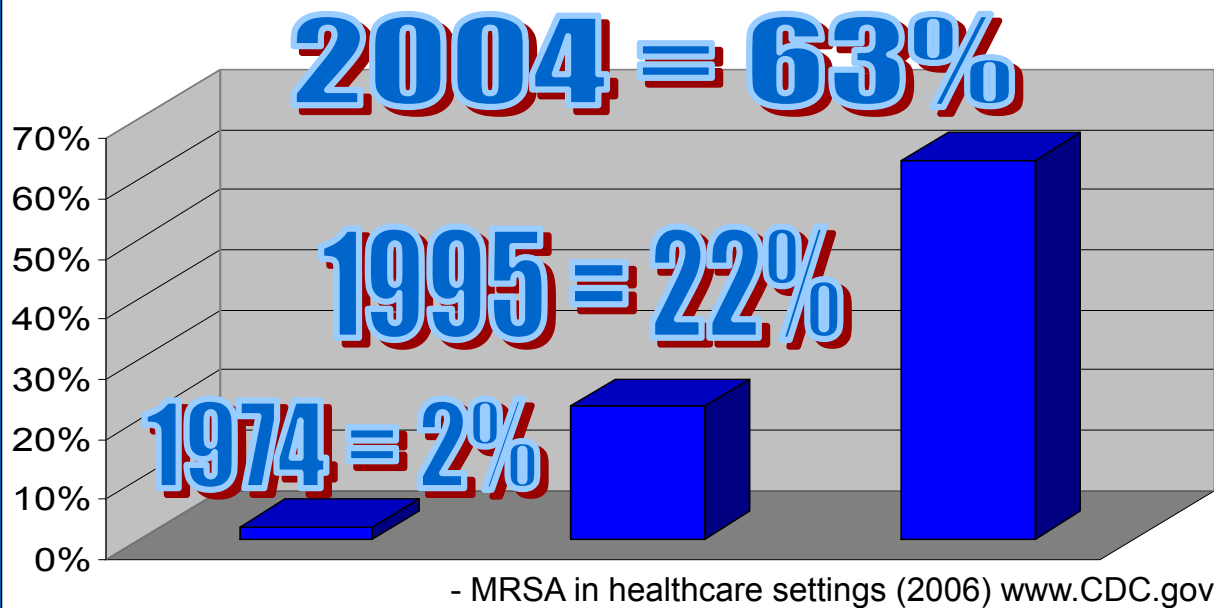
# Goals of the Presentation

- To present the methicillin-resistant *Staphylococcus aureus* (MRSA) pandemic
- To describe the NorthShore infection (MRSA) control program
- To discuss the role of screening (surveillance) and the impact of laboratory testing choice



# Healthcare-Associated MRSA

CDC Data: MRSA as % of Staphylococcal Infections in United States ICUs



## US MRSA Hospitalizations

- Used National Hospital Discharge Survey listing *S. aureus* ICD-9 codes and the rate of methicillin resistance per infection
- During 1999, 126 thousand with MRSA
  - 31,440 for septicemia (blood)
  - 29,823 for pneumonia
  - 64,706 other
  - Accounted for 3.95/1,000 hospital discharges

- MJ Kuehnert et al, Emerg Infect Dis 11:868-872, 2005
- In 2004 there were 8,474 discharges coded for MRSA in Illinois
  - 9,730 in 2005 and 10,579 in 2006

- Illinois Hospital Association, 2007

MRSA may kill more US citizens than HIV -- 335 (7625): 850 -- BMJ - Microsoft Internet Explorer

http://www.bmj.com/lookup/other/northwestern.edu/cgi/content/full/335/7625/850-b

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BMJ 2007;335:850 (27 October). doi:10.1136/bmj.335.7625.850-b

**News**

**Shortcuts from other journals**

**MRSA may kill more US citizens than HIV**

Mediclin resistant *Staphylococcus aureus* (MRSA) is a major public health problem in the US. The incidence of invasive infections such as bacteraemia, pneumonia, and cellulitis reached 31.8 per 100 000 in 2005, according to a population based surveillance programme operating in nine diverse states. The rate of MRSA infection in 2005 was higher than the combined rates of invasive pneumococcal disease (14.1/100 000), invasive group A streptococcus (3.6/100 000), invasive meningococcal disease (0.35/100 000), and invasive *Haemophilus influenzae* (1.4/100 000), says an editorial (p 1803). MRSA was associated with an

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start

NorthShore University HealthSystem

## MRSA in Singapore

- 197 MRSA from 5 hospitals in May 2006
- 34% were EpidemicMRSA-15
  - EMRSA-15 (ST22) first seen locally in 2003
- By first ½ of 2006 EMRSA-15 clone had risen to 25-66% of HA-MRSA

- L-Y Hsu et al. J Med Micro 56:376-9, 2007

- B Spellberg et al, CID (IDSA) 15:155-64, 2008

THE MRSA PANDEMIC

## MRSA Risk Following Colonization

- 24,622 patients had surveillance for MRSA
- 7.4% of asymptomatic MRSA carriers developed MRSA infection over 1 year
- 0.5% of MRSA nasal negative patients developed infection over 1 year
- **Over 10-fold higher risk of disease with MRSA colonization**
  - Highest risk for MRSA infection is nasal carriage ( $p < 0.01$ )

- A Robicsek et al, IDSA 2006

## Infection Control: Screening for MRSA - August 2004



- LR Peterson et al, Jt Com J Qual Pt Safety, 33:732-8, 2007

# MRSA Survey – August 2004

- MRSA prevalence = 8.5%
- 2/3 not previously known
- To find everyone needed to screen all admissions
  - Screening 1/2 of admissions would find 83% of MRSA patients
- Started planning MRSA program

## Developing a Plan



Infection Control  
Administration  
Infectious Disease  
Professional Staff  
Nursing  
Laboratory  
Information Systems  
Medical Informatics  
Pharmacy  
Materials Management  
Finance

# MRSA Screening Program

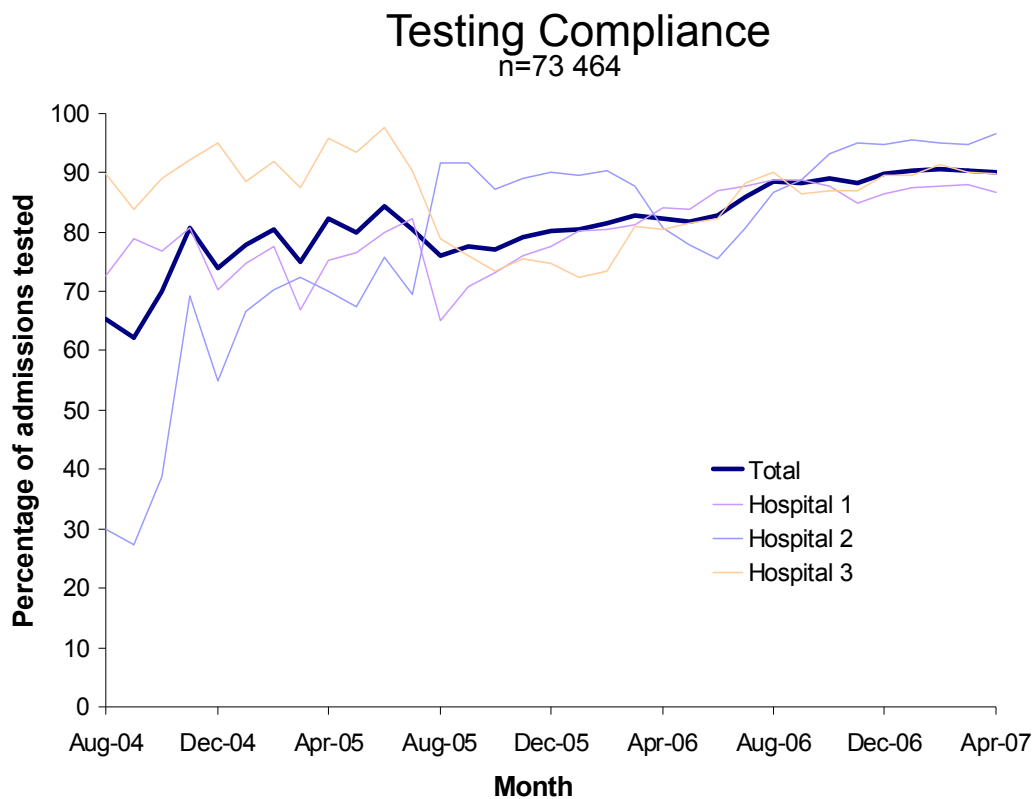
- **Intervention: Admission nasal swabbing and isolation of positives to assure patients we are doing our best so they will not get MRSA**
  - Goal is >90% compliance
- **Intervention: Decolonization as an outreach program**
  - MD responsibility
- **The Process**
  - Admission order set for PCTs and nursing
    - » Admission MRSA Screen
    - » Choice for response either yes or refused
  - Treatment order package (nasal twice daily mupirocin for 5 days with chlorhexidine bathing x 3)
    - » Type in MRSA, and order MRSA Decolonization Panel

# NorthShore Background

- NorthShore – 3 hospitals
  - 47 Intensive Care Unit (ICU) beds (850 total beds)
  - 40,000 to 50,000 annual admissions
  - **August 2004: ICU surveillance**
    - Isolation (gown and glove; cohorting if needed)
    - +/- decolonization
  - **August 2005: Universal Admission Surveillance**
    - Isolation (gown and glove; cohorting if needed)
    - + decolonization recommended
- Statistical analysis
  - Autoregressive integrated moving average model
  - Segmented Poisson regression model (with no first-order autocorrelation demonstrated) using bootstrap resampling techniques, stratified by hospital

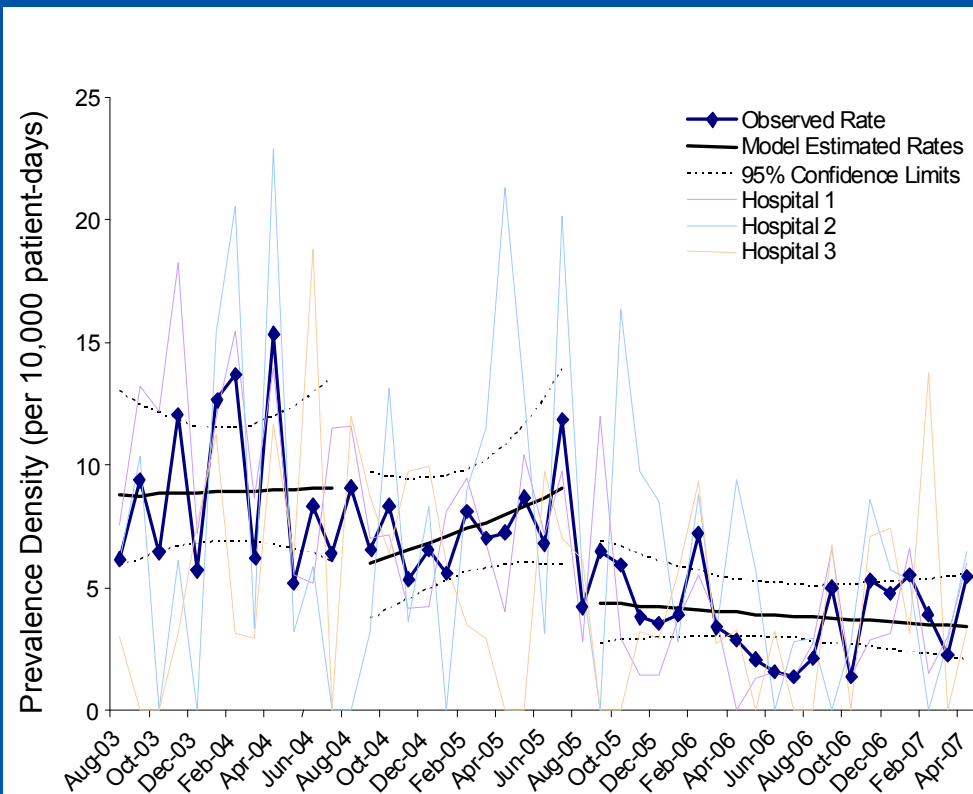
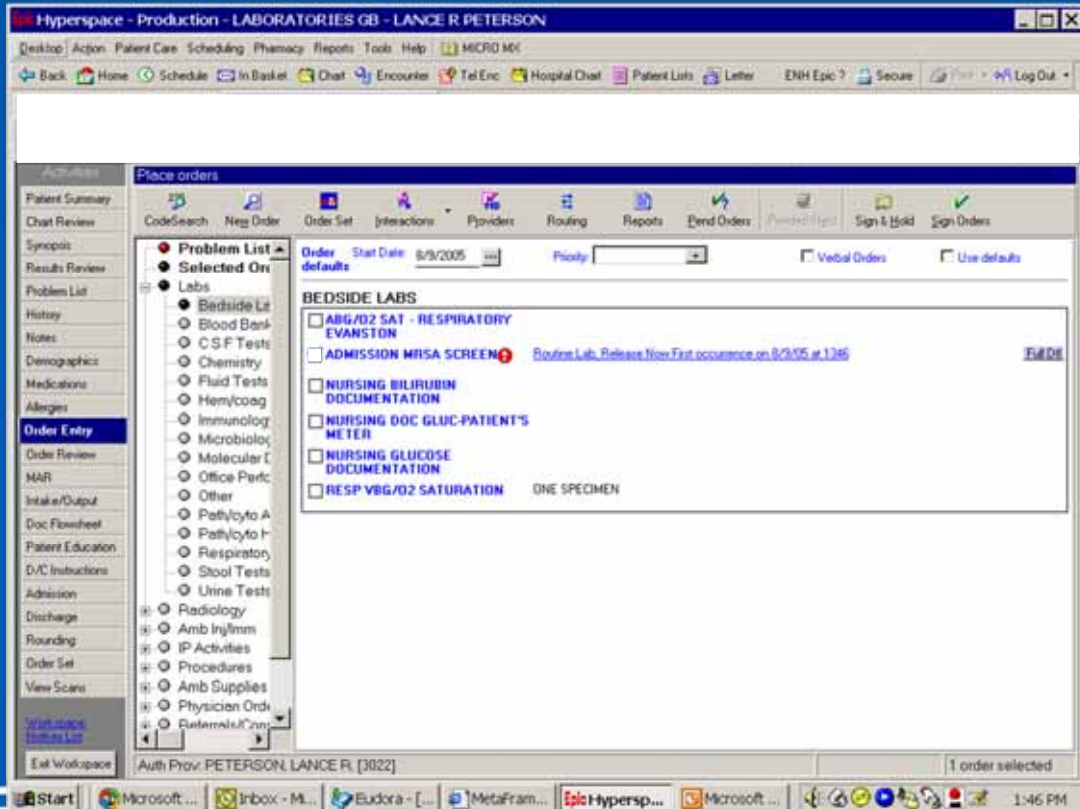
# NorthShore Background

- NorthShore – Now 4 hospitals
  - 60 Intensive Care Unit (ICU) beds (1100 total beds)
  - 55,000 to 60,000 annual admissions
  - August 2004: ICU surveillance
    - Isolation (gown and glove; cohorting if needed)
    - +/- decolonization
  - August 2005: Universal Admission Surveillance
    - Isolation (gown and glove; cohorting if needed)
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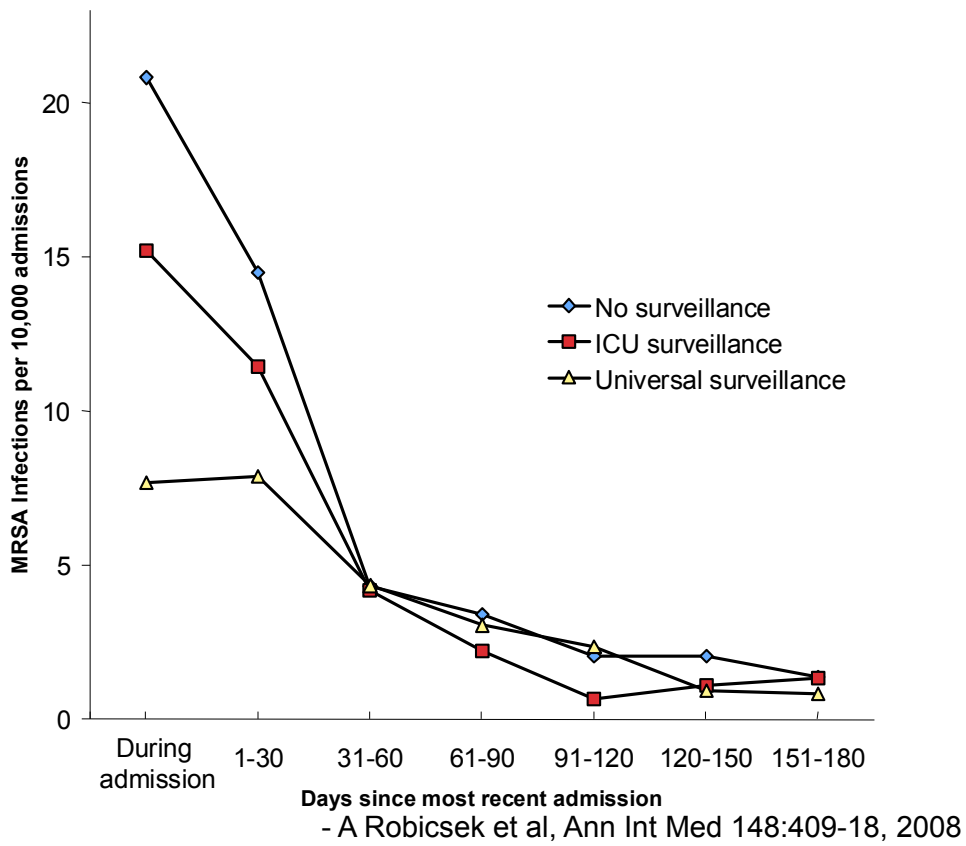




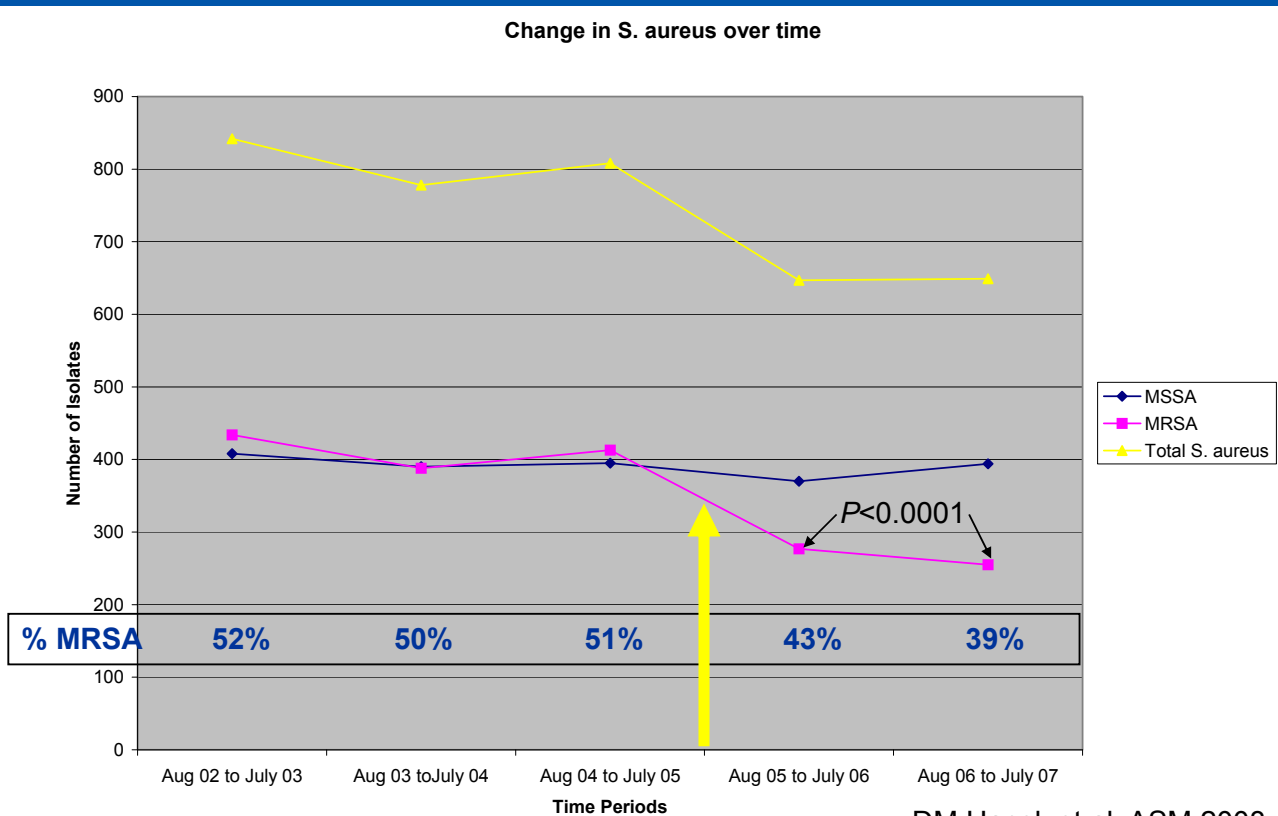
# Medical Record Screens



- A Robicsek et al, Ann Int Med 148:409-18, 2008

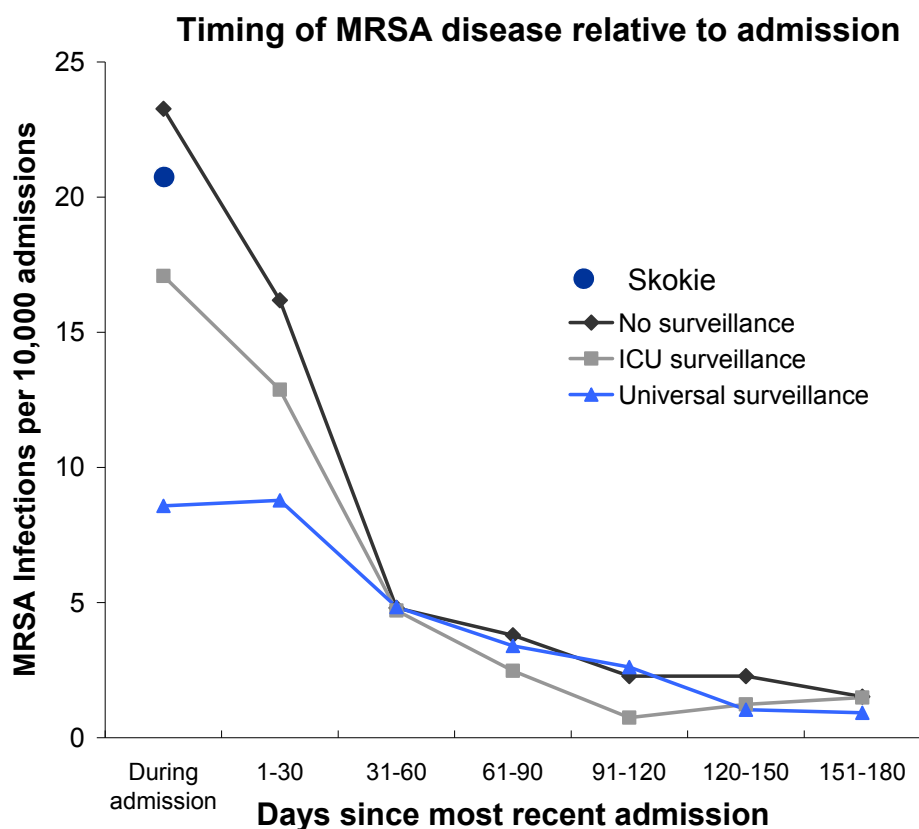


## Change in Total *S. aureus*



# MRSA Survey – August 2004

- MRSA prevalence = 8.5%
- 2/3 not previously known
- To find everyone needed to screen all admissions
  - Screening ½ of admissions would find 83% of MRSA patients
- Started planning surveillance program
- Repeat Prevalence August 2007 = 5.9%
- Skokie Hospital: March 2009
  - MRSA prevalence = 11%



## Why Did the Program Work?

- Transmission rate: 0.14 per non-isolation day, 0.009 per isolation-day
- In 9779 missed isolation days --> 1281 transmissions without isolation, compared to 448 in the setting of universal surveillance
  - For us this implies **62 fewer infections (51-76 actual)**
- If reducing MRSA transmission (*to prevent new MRSA acquisition and lower disease*) is a goal, **some** surveillance needs to be done

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



## ...from the most conservative economic viewpoint

- Cost for Universal Admission Surveillance using molecular diagnostics:

\$600,000

(includes 2 employees - 1.4 used for testing)

How many MRSA HAI would we need to prevent to warrant this cost?

## How Much Does MRSA Healthcare Associated Infection (HAI)/Nosocomial Infection Cost?

	Mean Total Cost	95% CI	Mean Profit/Loss per Patient after Reimbursement	95% CI
No MRSA HAI (n=5796) <b>LOS ≥8d</b>	\$50,013	\$42,363 - \$57,662	-\$25,000	-\$28,883 -\$21,116
MRSA HAI (n=178)	\$73,795	\$63,743 - \$83,847	-\$35,479	-\$42,034 -\$28,923
Excess Cost	\$23,783	\$16,771 - \$30,794	-\$10,479	-\$16,110 -\$4,848

- LR Peterson et al, Jt Com J Qual Pt Safety, 33:732-8, 2007

## How Much Does MRSA Healthcare Associated Infection Cost?

- Cost of MRSA all admission surveillance protocol measured at \$600,000 (really \$200,000)
- Avoided healthcare expenditures
  - 51 infections with >2day definition = \$1,213,000
  - 76 infections with 30day definition = \$1,808,000

## Can We Do It for Less?

- What yield is 'enough' to generate some impact?
- Not known, but some hints
- At NorthShore:
  - Pre-surveillance – captured ~18% of isolation-days
  - ICU-surveillance – captured ~33% of isolation-days
    - ➔ No change in MRSA disease rate
  - Universal surveillance – captured 85% of isolation-days
    - ➔ Large change in MRSA disease rate

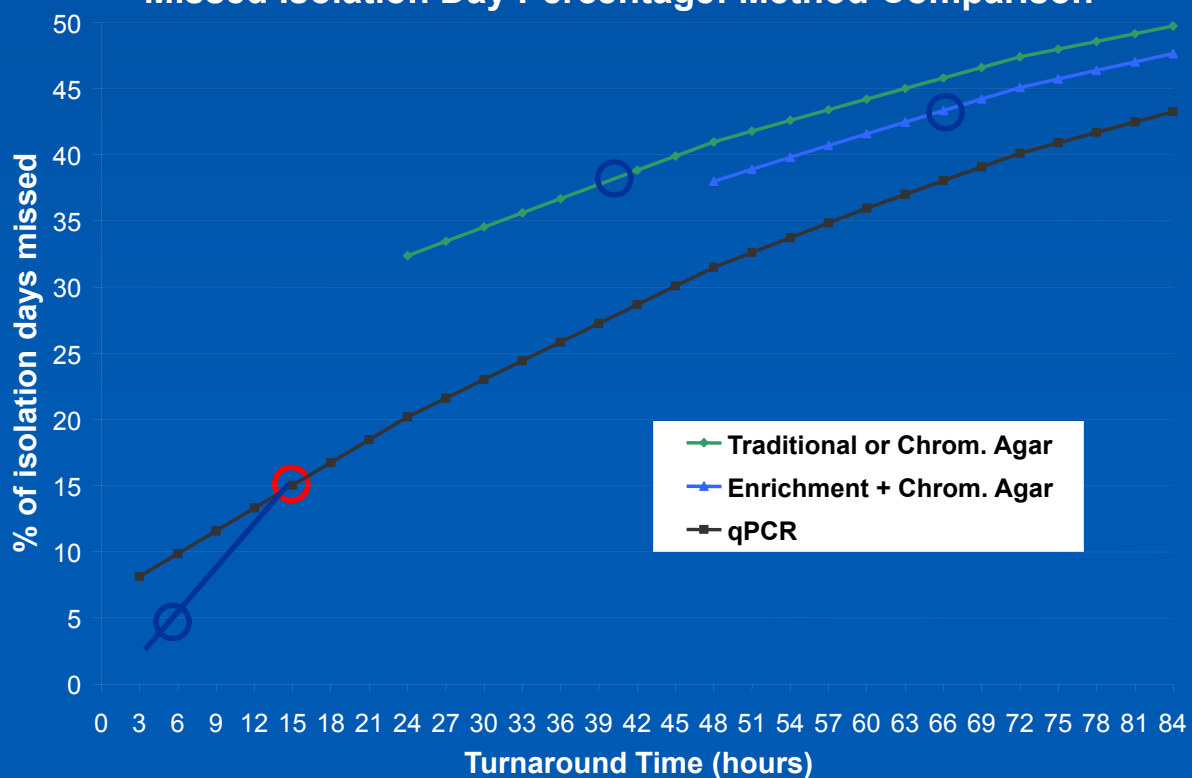
# Test Comparison

- Examined impact of **turnaround time**, **sensitivity**, **specificity** and **MRSA prevalence** on the characteristics of a surveillance program
- Studied **37,179** consecutive MRSA-tested admissions to NorthShore (one year)

-Ari Robicsek, ICAAC/IDSA 2008

- SM Paule et al, Am J Clin Pathol. 131:532-539, 2009

### Missed Isolation Day Percentage: Method Comparison



- Ari Robicsek, ICAAC/IDSA 2008

## Success and Failure of Rapid Surveillance in the ICU

- Compared rapid surveillance and isolation in 2 ICUs
    - Admission prevalence = **6.7%**
    - MRSA test sensitivity and specificity was **84%** and 94%
    - Medical ICU saw benefit of combined 'rapid (**median 23 hours\***)' surveillance and pre-emptive isolation ( $p < .01$ )
    - Surgical ICU saw no benefit of 'rapid (median 21 hours\*)' testing (pre-emptive isolation already in place)
    - Of 35 patients who acquired MRSA in the ICU, 46% developed at least one infection
- S Harbarth et al, Crit Care 10:R25, 2006
- Comments
    - Pre-emptive isolation eliminates the need for rapid testing
    - \* excluded weekends and holidays

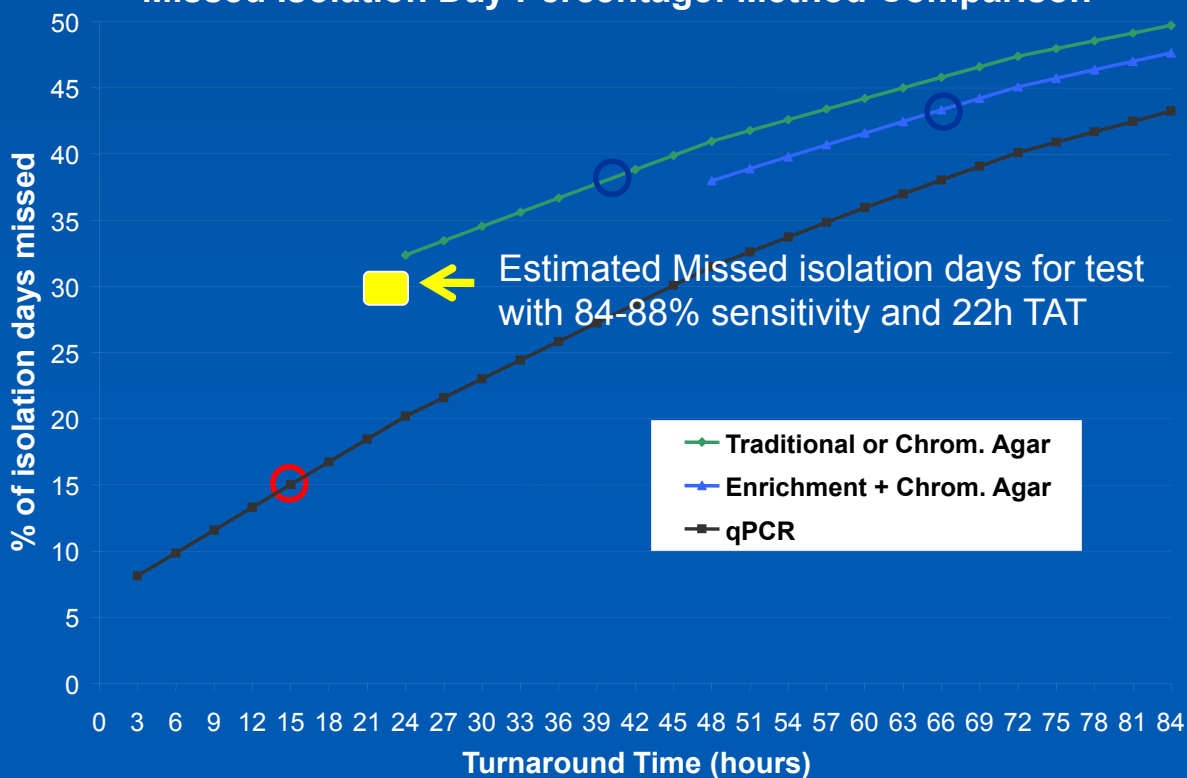
## Failure of Rapid Testing to Benefit MRSA Control Program

	Chicago, IL (N = 153,340)	London, England (N = 6,888)
Design	Historical Control	Cluster Crossover
Turn-around-time	15 hours	22 hours vs 46 hours
Test sensitivity	98% (Nares)	88% (Multiple body sites pooled)
Test Specificity	98%	96%
Admission Prevalence	6.3%	6.7%
Transmission	Not measured	4.9 vs 4.4/1000 days
MRSA acquisition	Approximately 2.2% vs '0'%	3.2% vs 2.8%
Surgical Site Infection	2.83 to 1.63 infections/ 10,000 days	9.43 vs 9.99 infections/ 10,000 days

- A Robicsek et al, An Int Med, 48:409-418, 2008  
- D Jeyaratnam et al, BMJ , 336:927-930, 2008



## Missed Isolation Day Percentage: Method Comparison



- Ari Robicsek, ICAAC/IDSA 2008

## Hand Hygiene Lowers MRSA Disease

- Hand hygiene program improved compliance from 21% to 48%/47% at 12/24 months
- MRSA clinical isolates reduced from 1.39/100 discharges/month to 0.73 ( $P=0.003$ )
- MRSA bacteremia reduced 0.05/100 discharges/month to 0.02 ( $P=0.035$ )

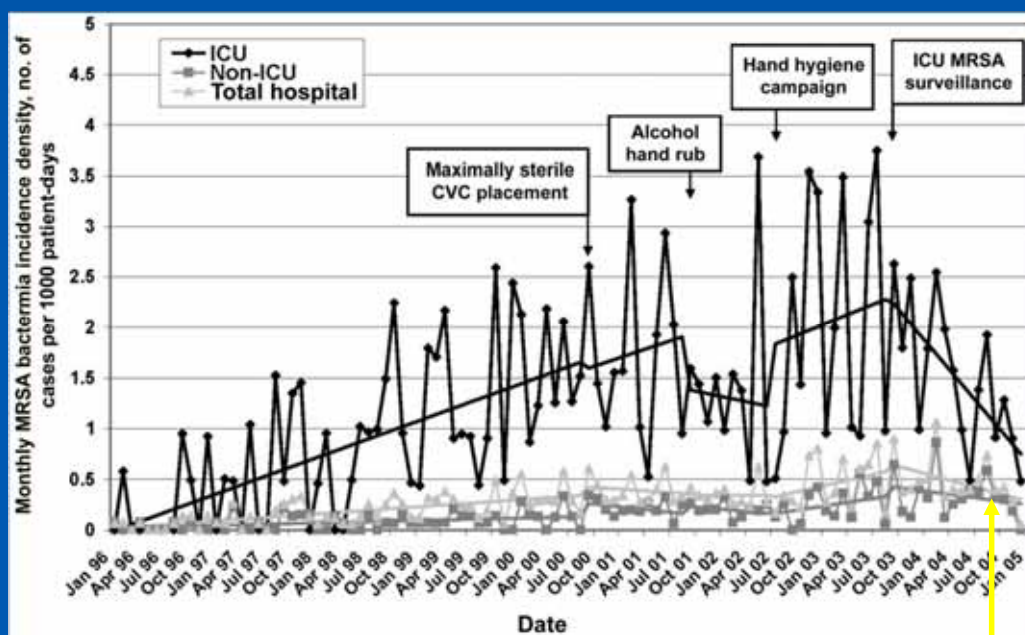
- ML Grayson et al, Med J Aust 188:633-640, 2008

# Hand Hygiene Lowers MRSA Disease

- Hand hygiene program improved compliance from 21% to 48%/47% at 12/24 months
- MRSA clinical isolates reduced from 1.39/100 discharges/month to 0.73 ( $P=0.003$ )
  - Change from 139/10,000 to 73/10,000 discharges
- MRSA bacteremia reduced 0.05/100 discharges/month to 0.02 ( $P=0.035$ )
  - Change from 5 to 2/10,000 discharges

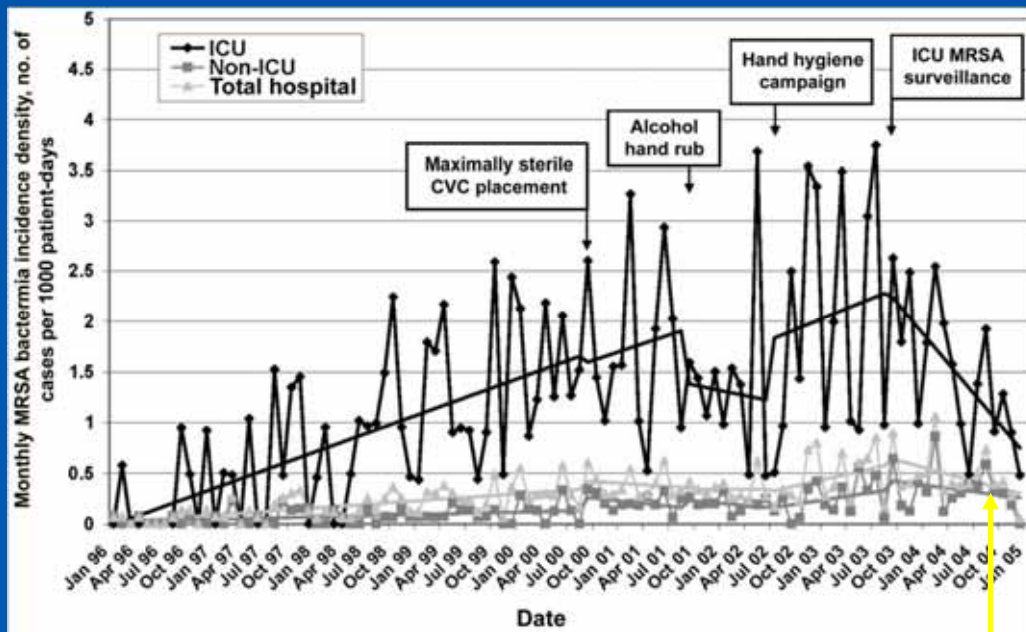
- ML Grayson et al, Med J Aust 188:633-640, 2008

## Effectiveness of Various Strategies



**Hospital-associated MRSA BSI incidence in December 2004:  
Declined from a projected 4.6/1,000 to 1.5/1,000 patients**

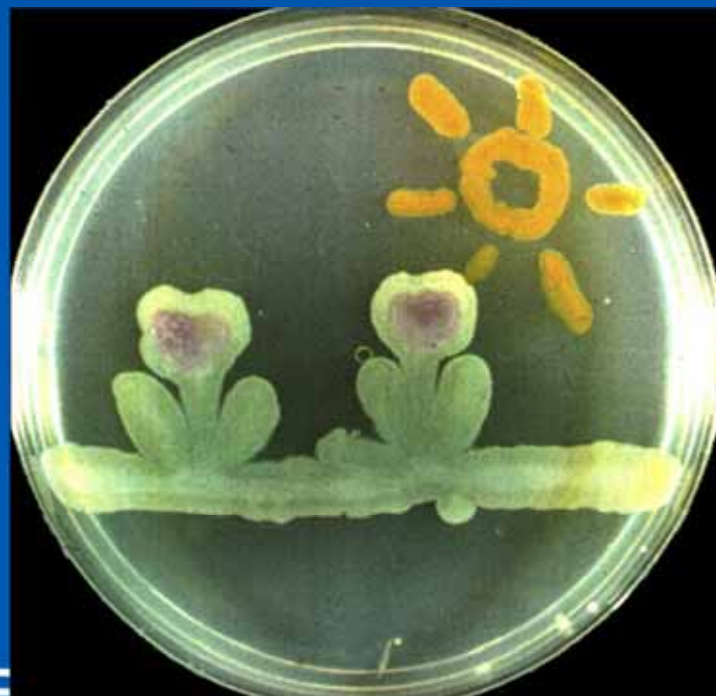
# Effectiveness of Various Strategies



**Hospital-associated MRSA BSI incidence in December 2004:  
Declined from a projected 46/10,000 to 15/10,000 patients**

- SS Huang et al, CID 43:971-8, 2006

# The Role of Test Choice



# BD GeneOhm MRSA Assay

- 250 qPCR positive and 250 qPCR negative samples tested by BD GeneOhm and two Chromogenic media (direct and enriched)
- True Positive = culture positive or MRSA history (n = 186)

	CHROMagar MRSA (Direct)	MRSASelect (Direct)	CHROMagar MRSA (Enriched)	MRSASelect (Enriched)
Sensitivity	80.6%	78.5%	86.6%	90.3%
Specificity	100%	97.4%	99.7%	91.6%

- Past performance showed qPCR to be 98.2% sensitive and 97.5% specific

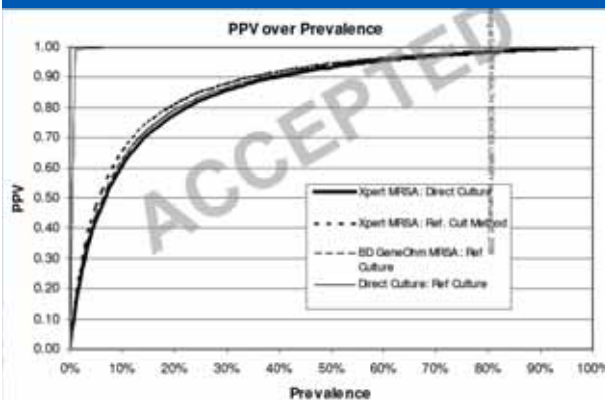
- SM Paule et al, AJCP 131:532-9, 2009  
- SM Paule et al, JCM 45:2993-8, 2007



# Cepheid Xpert™ MRSA Assay

- 1,077 samples from 7 sites in North America
- MRSA prevalence 5.3% to 44%

	Sensitivity	Specificity	PPV	NPV
Xpert vs Chromagar	94.3%	93.2%	73%	98.8%
Xpert vs Enriched	86.3%	94.9%	80.5%	96.6%



Test performance not different from BD GeneOhm

- DM Wolk et al, JCM 47: 758-64, 2009

**NorthShore**  
University HealthSystem



# Roche LightCycler® MRSA Advanced Test

- 1,389 samples from 5 sites in North America
- Culture (direct and enriched) gold standard
- Prevalence = 12.8%

	Sensitivity	Specificity*
Roche	97.2% (95% CI 93-99)	96.5% (95% CI 95-97)
BD GeneOhm	97.2% (95% CI 93-99)	91.7% (95% CI 90-93)

\* P<0.001

- LR Peterson et al, ICAAC 2009



# Do Colonized Patients Spread MRSA?

- Compared 58 patients with MRSA disease to 57 with nasal colonization to determine risk for skin and environmental contamination
  - Skin and environment contaminated 50 vs 47%
  - Various skin sites 38-66% vs 30-63%
  - Various environment sites 27-60% vs 21-63%
- Glove acquisition from skin 14-45% vs 16-38%
- “strategies to limit transmission must address colonized patients”

- S Chang et al, CID 48: ahead of print, 2009

## Summary

- MRSA has reached pandemic levels
- MRSA biology suggests an effective strategy for management and control is possible
  - Surveillance, isolation, and (likely) decolonization
- If MRSA control is desired (to reduce infection), some active surveillance needs to be done
  - Success depends on disease prevalence, scope of surveillance, and rapidity of results reporting

**The Bottom Line:  
An Aggressive Infection Control  
Program Can Lower Cost and  
Improve Patient Safety**





