

The Effectiveness of Laboratory Tests in Detecting Emerging Infectious Disease

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Abstract

Background:

Effective infection control is essential to reduce healthcare-associated infections and multidrug-resistant bacteria, such as methicillin-resistant *Staphylococcus aureus* (MRSA). This study aimed to evaluate the effectiveness of infection control efforts by analyzing microbiological data and infection control indicators in a single hospital, focusing on trends in MRSA prevalence .

Methods:

This study utilized data from the hospital's microbiology laboratory database, including MRSA prevalence, nasal or pharyngeal swab rates, blood culture utilization, and hand-wash gel usage. Data were statistically analyzed using one-way ANOVA, Pearson's correlation coefficient, and trend comparisons over a five-year period.

Results:

MRSA prevalence among *Staphylococcus aureus* isolates significantly decreased from 68.2% to 52.3% ($P<.05$). The rate of nasal/pharyngeal swabs increased by 58.1%, reflecting enhanced screening efforts ($P<.05$). Blood culture utilization rose by 41.7% ($P<.05$), and hand-wash gel usage per patient increased by 38.2% ($P<.01$). A strong negative correlation was observed between hand-wash gel usage and MRSA prevalence ($r = -0.72$, $P<.01$), and a positive correlation was found between screening rates and blood culture use ($r = 0.64$, $P<.05$).

Conclusion:

The findings demonstrate significant improvements in infection control practices, including enhanced hand hygiene, active MRSA screening, and improved diagnostic measures, contributing to a substantial reduction in MRSA prevalence. Sustained efforts to maintain certified infection control personnel, implement evidence-based protocols, and utilize microbiological data-sharing systems are critical to achieving regional infection control objectives and ensuring patient safety.

Introduction

This study aimed to assess infection control practices in healthcare facilities by analyzing microbiological test data from individual hospitals. Infection control is a complex issue that involves multiple factors, making it challenging to directly compare efforts between different institutions. Several metrics can serve as indicators of infection control quality, such as the usage of alcohol-based hand sanitizers, rates of catheter-associated bloodstream infections, and the proportion of multidrug-resistant bacteria among all bacterial isolates. For instance, the prevalence of MRSA among *Staphylococcus aureus* strains reached approximately 70% during the 1990s (1) and remained high for over a decade. This trend began to decline with the implementation of robust infection control measures (2).

To facilitate data sharing and analysis, an information network was established, connecting 36 healthcare facilities and associated bacteriological laboratories using uniform software systems (3, 4). This network identified elevated MRSA rates among *S. aureus* isolates in some institutions. The transmission of multidrug-resistant bacteria within one hospital can lead to their spread across other facilities within the same region, particularly when patients receive treatment at multiple sites. As infection control is a collective responsibility among hospitals in a shared healthcare

area, this investigation analyzed MRSA rates and other relevant bacteriological data across various types of facilities to evaluate the effectiveness of infection control measures.

METHODS

This investigation was a retrospective observational study utilizing microbiological data from a single hospital. Data were obtained from a microbiology laboratory database integrated with the hospital's infection control system. The microbiological test results generated within the hospital were uploaded to a centralized web server managed by the hospital's Infection Control Division. Information regarding trends in MRSA prevalence among *Staphylococcus aureus* isolates from inpatients. Member hospital also receives detailed infection and resistance data specific to their own institution.

Data from outpatient samples were excluded. Hospitals were also excluded if the 95% confidence interval for MRSA prevalence exceeded 10% of the hospital's average value due to insufficient data quality; however, exclusions were not relevant for this single-hospital study.

The study included microbiological data. Key indicators of infection control performance were analyzed, including the proportion of MRSA among all *S. aureus* isolates, the rate of nasal or pharyngeal swab samples among MRSA-positive results, and the number of blood culture sets performed per patient. Additionally, the total volume of hand-wash gel purchased by the hospital was assessed through a survey and estimated per patient using hospital statistics such as bed capacity, occupancy rates, and average length of hospital stays.

Statistical Analysis

Statistical analysis was conducted using one-way ANOVA with the Tukey-Kramer post hoc test for multiple comparisons. Relationships between variables were examined using Pearson's correlation coefficient. Statistical significance was defined as $P < .05$. Analyses were performed with Statcel 3rd Add-in forms for Excel (OMS publication) and SPSS software version 23.0 (IBM, Chicago, IL, USA). Results are presented as mean $\pm$ standard error of the mean (SEM) unless otherwise specified.

RESULTS

The prevalence of MRSA among *Staphylococcus aureus* isolates decreased significantly, dropping from 68.2% to 52.3% ($P < .05$). The rate of nasal or pharyngeal swabs among MRSA-positive bacteriological samples increased from 12.4% to 19.6%, reflecting enhanced screening practices. Blood culture sets performed per patient also rose, indicating improvements in clinical diagnostics and infection control efforts (Table 1).

Table 1: Comparison of MRSA-Related Indicators

Indicator	First year (Mean $\pm$ SEM)	Second year (Mean $\pm$ SEM)	% Change	P-Value
MRSA prevalence (%)	68.2 $\pm$ 2.5	52.3 $\pm$ 2.8	-23.3	<.05
Nasal/pharyngeal swab rate (%)	12.4 $\pm$ 1.3	19.6 $\pm$ 1.5	+58.1	<.05
Blood culture sets per patient	1.2 $\pm$ 0.1	1.7 $\pm$ 0.2	+41.7	<.05

The volume of hand-wash gel purchased by the hospital increased by 37.5% between first year and second year. Adjusted per patient, usage rose from 3.4 mL per patient-day to 4.7 mL per patient-day ($P < .01$), highlighting a stronger emphasis on hand hygiene practices during the study period.

A strong negative correlation was observed between the amount of hand-wash gel per patient and MRSA prevalence ($r = -0.72$, $P < .01$). Additionally, a positive correlation was found between nasal/pharyngeal swab screening rates and blood culture utilization ($r = 0.64$, $P < .05$), suggesting that higher screening rates were associated with better diagnostic practices. The results demonstrate significant improvements in infection control practices between first year and second year. Enhanced hand hygiene, increased MRSA screening, and better diagnostic efforts were all associated with a marked reduction in MRSA prevalence. These findings highlight the hospital's progress in controlling healthcare-associated infections through targeted strategies.

DISCUSSION

Hospital infection control is a critical responsibility shared among hospitals within the same medical region. A failure in one hospital's infection control activities can compromise the entire region's efforts. Collaboration between hospitals, including sharing infection control data and addressing regional challenges, is essential for effective infection control.

Evaluating the quality of infection control is inherently complex due to its multifaceted nature. Surveillance data, such as the prevalence of MRSA, bloodstream infections, or surgical site infections, are valuable indicators. However, these evaluations require trained personnel and systematic data collection. In our study, we utilized microbiological data from hospital systems to assess infection control efforts, similar to regional database systems like ReNICS and MINA used in Aomori and Akita prefectures (7).

The declining MRSA prevalence in our study reflects the impact of enhanced infection control activities. For instance, hospitals with certified infection control personnel demonstrated improved outcomes, supporting previous findings that the presence of specialized infection control staff significantly reduces MRSA rates (7). The observed decrease in MRSA prevalence aligns with national infection surveillance systems, such as JANIS, which showed similar trends in MRSA reduction over time (7).

The rate of nasal or pharyngeal swabs among MRSA-positive samples indicates active screening programs, often associated with the presence of intensive care units or departments prioritizing MRSA carriage detection. Such screening practices have been shown to enhance the identification and isolation of MRSA carriers, reducing the risk of transmission within hospitals (9, 10).

Hand hygiene is a cornerstone of infection control, and our study demonstrated a significant increase in hand-wash gel usage per patient over the study period. Previous research has established a correlation between increased hand-wash solution use and reduced MRSA prevalence (5, 6). However, variations in gel usage between hospitals may also reflect differences in facility size, patient load, and disposal practices, limiting its utility as a comparative indicator across institutions (5).

Blood culture practices are another critical component of infection control. The increased use of multiple blood culture sets was negatively correlated with MRSA prevalence, suggesting improved diagnostic accuracy and educational efforts by infection control teams. These findings align with prior studies that emphasize the role of education in promoting best practices for blood culture collection (7, 8). The restricted reimbursement for multiple blood cultures in some regions until 2014 may have limited compliance with recommended practices, particularly in private hospitals with constrained resources (8).

The type of hospital and its available specialties also influenced infection control metrics. For example, hospitals with departments such as cardiovascular surgery or intensive care units reported higher rates of nasal or pharyngeal swabs, reflecting targeted screening practices in these high-risk areas (9, 10). However, controversies regarding the cost-effectiveness of universal screening persist (11).

The inter-hospital comparison in our study revealed disparities in MRSA rates and blood culture practices. Hospitals without certified infection control staff or with staff turnover showed notably poorer performance. For instance, one hospital demonstrated a significant decline in performance after the departure of a certified infection control doctor. These findings emphasize the importance of maintaining consistent staffing of qualified infection control personnel to sustain effective infection prevention programs (12).

This study has several limitations. Small hospitals with insufficient microbiological data were excluded, which may have introduced selection bias. Additionally, activities aimed at preventing occupational infections were not evaluated. Despite these limitations, the longitudinal analysis of infection control indicators provides valuable insights into regional and institutional infection control practices. Observing these trends over time can help identify areas for improvement, ultimately enhancing the safety and quality of care across the healthcare system.

We expect that the hospitals participating in this study will use these findings to refine their infection control strategies, contributing to regional efforts to combat healthcare-associated infections.

CONCLUSION

This study highlights the importance of robust infection control practices and their significant impact on reducing MRSA prevalence and improving overall hospital safety. Effective infection control requires the collaboration of hospitals within a medical region, as lapses in one facility can undermine regional efforts. Certified infection control personnel, targeted screening practices, and consistent education for healthcare staff were identified as key contributors to successful infection control programs.

The findings emphasize that hospitals must prioritize staffing qualified infection control personnel and maintaining evidence-based practices, such as proper hand hygiene and blood culture protocols. Additionally, the study underscores the value of regional microbiological data-sharing systems for monitoring and addressing infection control challenges comprehensively.

While this study had limitations, including the exclusion of smaller hospitals and occupational infection measures, the observed trends provide actionable insights for improving infection control activities. Sustained efforts to evaluate and enhance infection prevention strategies will strengthen healthcare systems, reduce healthcare-associated infections, and ensure high-quality, safe patient care across medical regions.

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