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Major article

Trend of methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia in an institution with a high rate of MRSA after the reinforcement of antibiotic stewardship and hand hygiene

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Key Words:

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Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) infections are a concern across the worldwide.

Methods: Antibiotic stewardship and hand hygiene programs were reinforced in a 2,000-bed tertiary hospital in South Korea where the methicillin resistance rate of *Staphylococcus aureus* is about 65%. The computerized prescription restriction was implemented in August 2008. “Hand hygiene program,” consistent with World Health Organization guideline, was reinforced in December 2008. We assessed the effect of the infection control programs on the incidence of MRSA bloodstream infection (BSI) from January 2006 through November 2011.

Results: Incidence of MRSA BSI was reduced from 0.171 per 1,000 patient-days in 2009 to 0.116 per 1,000 patient-days in 2011 ($P = .009$). Monthly mean antibiotic consumption decreased from 690.54 ± 28.33 defined daily dose per 1,000 patients-days in 2008 to 652.47 ± 20.77 ($P = .015$) in 2011. The rates of performance in hand hygiene increased from 43% in 2008 to 83% in 2011 ($P = .043$).

Conclusion: Although we did not implement all components of “MRSA bundle,” efforts to reinforce antibiotic stewardship and hand hygiene program for 3 years had beneficial effects on the decrease in MRSA BSI in this institute with high rate of MRSA.

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Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the most prevalent organisms that cause health care-associated infections. Incidence of MRSA infection has increased across the world and is associated with an increased mortality.^{1–3} Successful efforts to reduce MRSA infection have been investigated, and the implementation of a “MRSA bundle” comprising universal active surveillance, contact precautions, hand hygiene, and change in the institutional culture is linked to significant declines in health care-associated MRSA infections in large health care systems.^{4–13}

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The methicillin resistance rate of *S aureus* in South Korean hospitals has rapidly increased since 1980 and remained at 65% to 70% during the past several years.^{14–16} MRSA is a major pathogen isolated from patients with health care-associated infections in South Korea¹⁷ and is a national priority for disease control. However, because MRSA is now endemic in many Korean hospitals and the implementation of all components of the “MRSA bundle” requires excessive costs and facilities, the full control of MRSA may be beyond execution for many Korean institutes.

Since 2008, 2 infection control programs were reinforced to decrease multidrug-resistant organisms in a tertiary care teaching hospital in South Korea. They were an “antibiotic stewardship program” and a “hand hygiene program.” The “antibiotic stewardship program” was reinforced starting in May 2006 and associated bylaws were created in March 2007. The policy was intensified by

use of a computerized prescription restriction of inappropriate prophylactic antibiotic use for surgery, inappropriate antibiotic combinations, and inappropriate antibiotic use from August 2008. From December 2008, the “hand hygiene program” was reinforced because of the poor performance rates. The performance rates were investigated each quarter, and hospital-wide efforts were implemented to improve hand hygiene performances.

It is known that hand hygiene and antibiotic stewardship are associated with the prevention of transmission and infections of resistant organism, including MRSA.^{18–20} We hypothesized that our efforts to reinforce the hand hygiene and antibiotic stewardship programs would affect the incidence of MRSA bloodstream infections (BSI). In this study, we evaluated the epidemiologic characteristics of MRSA BSI and the trend of MRSA BSI incidence from January 2006 through November 2011 and analyzed the effect of the infection control programs.

METHODS

Hand hygiene program

Hand hygiene was reemphasized because of the poor rates of performance, and a reinforced program was implemented to promote hand hygiene beginning in December 2008. Contents of program were consistent with the World Health Organization (WHO) guidelines.²¹ We educated each department in the hospital on the contents and importance of hand hygiene. Hospital-wide monitoring of hand hygiene practice was conducted. The entire hospital was classified by special care units, and their performance rates were investigated by professional groups every quarter. The results were recorded in the hospital newsletter, which was mailed to all hospital workers. We did several internal campaigns and publicized the infection control program through posters, large sized electronic displays, and screen savers.

Antibiotic stewardship program

There had been some efforts regarding antibiotic stewardship because of concern over the role of antibiotic overuse and overgrowth of multidrug-resistant organisms in the hospital since May 2006. Associated bylaws were created in March 2007, which aimed to limit inappropriate prophylactic antibiotic use for surgery, inappropriate antibiotic combinations, and inappropriate antibiotic use. The policy was reinforced by way of computerized prescription restriction of third-generation cephalosporin and aminoglycoside for surgery starting in August 2008. Inappropriate antibiotic combinations such as redundancy in antimicrobial coverage were also restricted using the computerized prescription system from August 2009. Exceptions and clinical indications were agreed on by a group of infection specialists. The amount of antibiotic consumption was analyzed by antibiotic stewardship committee every quarter. The results were mailed to the relevant departments.

Amount of antibiotic consumption and rate of hand hygiene performance

The manager in the department of pharmacy aggregated the data for monthly prescribed antibiotics for monitoring consumption of drugs. To evaluate the amount of antibiotic use, prescribed antibiotics were classified by generic names and according to the WHO Anatomical Therapeutic Chemical Classification.²² Defined daily dose (DDD) was used as a unit to calculate the total antibiotics prescribed. The amounts of antibiotic used were expressed as a monthly mean (\pm standard deviation) DDD per 1,000 patient-days.

Hand hygiene performance was monitored by direct observation following the WHO guidelines.²¹ Direct observations by trained and validated observers were used for monitoring hand hygiene compliance. Observed locations, times, and health care workers (HCWs) were randomly identified to avoid selection bias. The rate of hand hygiene performance was calculated by dividing the number of observed hand hygiene actions performed when an opportunity occurs by the total number of opportunities.

Study population and data collection

From January 2006 through November 2011, 515,703 patients were admitted to the hospital. All patients were eligible to be part of the hospital-wide infection control programs. We collected retrospective data, including age, sex, prior antibiotic use, predisposing factors, comorbid conditions, attributable unit for infection, route of admission, epidemiologic type of infection, and primary focus of infection, from patients identified as positive for MRSA BSI using the hospital database. Antimicrobial susceptibilities were determined using disk-diffusion methods or a VITEK-2 P600 card (bioMerieux, Hazelwood, MO). The results were interpreted using the Clinical and Laboratory Standards Institute guidelines.²³

Definitions

A MRSA BSI episode was defined by a positive blood culture for the first time.²⁴ MRSA BSI was classified as community acquired (CA), health care associated (HCA), or hospital acquired (HA). HA BSI was defined by a positive blood culture from a patient who had stayed more than 48 hours in the hospital or was discharged from an acute care unit within the past 10 days. A positive blood culture within 48 hours after admission was defined as HCA BSI, if more than 1 of the following conditions was satisfied: a history of more than 2 days of hospitalization within the past 90 days, receipt of hemodialysis, receipt of intravenous therapy or specialized wound care within the past 30 days, or residence in a long-term care facility or nursing home. CA BSI was defined by a positive blood culture within 48 hours after admission, if the episode did not meet the HCA BSI criteria.²⁵

Prior antibiotic use was defined as use of any antimicrobial agent for more than 3 days in the previous 30 days. Predisposing factors to infection included neutropenia, steroid therapy, chemotherapy, radiotherapy, and other immunosuppressive therapy. Neutropenia was defined as an absolute neutrophil count less than 500/mm³ in the previous 30 days. Steroid therapy was defined as the daily receipt of the dose equivalent to 30 mg of prednisone for 7 days or 20 mg for 14 days. If other immunosuppressive therapy, chemotherapy, or radiotherapy were used in the 30 days before MRSA BSI, each therapy was considered to be a predisposing factor to infection. All comorbid medical conditions were identified through a medical record review and defined according to ICD-10. We defined primary BSI including intravenous catheter-associated infection according to the National Nosocomial Infections Surveillance System and classified any other primary focus of infection according to the Centers for Disease Control and Prevention/National Healthcare Safety Network surveillance criteria.^{26,27} Units attributable for infection were determined to be places occupied for more than 48 hours prior to the BSI.

Statistical analysis

A general linear model was used to determine the trend of the amount of antibiotic consumption. Incidence of MRSA BSI was expressed in annual episodes per 1,000 patient-days. Data for yearly percent change of incidence of MRSA BSI are reported with

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