J Infect Chemother (2013) 19:1047–1052
DOI 10.1007/s10156-013-0621-x

ORIGINAL ARTICLE

Impact of intensive infection control team activities on the acquisition of methicillin-resistant *Staphylococcus aureus*, drug-resistant *Pseudomonas aeruginosa* and the incidence of *Clostridium difficile*-associated disease

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Received: 24 July 2012 / Accepted: 11 May 2013 / Published online: 29 May 2013

Abstract The transmission of multidrug-resistant organisms (MDROs) is an emerging problem in acute healthcare facilities. To reduce this transmission, we introduced intensive infection control team (ICT) activities and investigated the impact of their introduction. This study was conducted at a single teaching hospital from 1 April 2010 to 31 March 2012. During the intervention period, all carbapenem use was monitored by the ICT, and doctors using carbapenems inappropriately were individually instructed. Information related to patients with newly identified MDROs was provided daily to the ICT and instructions on the appropriate infection control measures for MDROs were given immediately with continuous monitoring. The medical records of newly hospitalized patients were reviewed daily to check previous microbiological results and infection control intervention by the ICT was also performed for patients with a previous history of MDROs. Compared with the pre-intervention period, the antimicrobial usage density of carbapenems decreased significantly (28.5 vs 17.8 defined daily doses/1000 inpatient days; $p < 0.001$) and the frequency of use of sanitary items, especially the use of aprons, increased significantly (710 vs 1854 pieces/1000 inpatient days; $p < 0.001$). The number of cases with hospital-acquired MRSA (0.66 vs 0.29 cases/1000 inpatient days; $p < 0.001$), hospital-acquired drug-resistant *Pseudomonas aeruginosa* (0.23 vs 0.06 cases/1000 inpatient days; $p = 0.006$) and nosocomial *Clostridium difficile*-associated disease (0.47 vs 0.11 cases/1000 inpatient days; $p < 0.001$) decreased significantly during the intervention period. Our study showed that proactive and continuous ICT interventions were effective for reduction of MDRO transmission.

Keywords Multidrug-resistant organism · Infection control · Electronic medical record · Antimicrobial stewardship program

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Introduction

The emergence of multi-drug resistant organisms (MDROs) such as *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus* (MRSA) and drug-resistant *Pseudomonas aeruginosa* (DRP) is a growing problem and infection with these pathogens causes significant morbidity and mortality [1–5]. To control the prevalence of MDROs, guidelines were issued in the United States [6–8] and a position paper on control of multi-drug resistant gram-

negative bacteria was published by the Japanese Society of Environmental Infections in 2011 [9]. The key components for infection control are administrative measures [10, 11], education of health care personnel [12], judicious use of antimicrobial agents [13], surveillance for MDROs [14, 15], environmental measures [16, 17] and appropriate infection control precautions [18, 19]. The high transmission rate of MDROs was a problem in our facility until June 2011. To reduce this transmission, we introduced intensive infection control team (ICT) activities that focused on appropriate antimicrobial use and improvement of compliance with infection control measures. In this study, we investigated the impact of these activities on the incidence of MDRO colonization and infection.

Methods

Infection control team activities and the antimicrobial stewardship program

This study was performed at a single teaching hospital with a tertiary emergency medical center [Tsukuba Medical Center Hospital (TMCH), 409 beds, Tsukuba, Japan] from 1 April 2010, to 31 March 2012. The 2 years were divided into three categories; (1) a pre-intervention period (April 2010–June 2011), (2) a preparation period (July 2011–September 2011) and (3) an intervention period (October 2011–March 2012).

A comparison of infection control activities for MDROs between the pre-intervention and intervention periods is shown in Table 1. In each period, new microbiological results were reviewed daily and ward staff and physicians were informed of the presence of new MDROs (DRP, *C. difficile*, MRSA). DRP was defined as *P. aeruginosa* resistant to more than two classes of anti-pseudomonal agents [carbapenems, fluoroquinolones and an aminoglycoside (amikacin)]. Resistance was defined based on the criteria of the Japan Nosocomial Infection Surveillance System [20]. *P. aeruginosa* with resistance to all three classes of antibiotics was defined as multidrug-resistant *P. aeruginosa* (MDRP). During the pre-intervention period, contact precaution was used for patients with *C. difficile* infection, MRSA infection with sputum, wound exudates and newly detected MDRP. The decision on contact precaution was made by doctors and ward staff in charge of the patients and most infection control measures were not reviewed by the ICT.

During the intervention period, information related to patients with newly identified MDROs was provided daily to the ICT and instructions on the appropriate infection control measures for MDROs were given immediately. In addition to the previous criteria, patients with DRP and MRSA colonization were placed on contact precaution if they had sputum, wound exudate or required assistance during urination or bowel movement. For patients with MDROs who did not meet the contact precaution criteria, standard precautions were recommended. Patients in the perioperative period or patients receiving chemotherapy or immunosuppressive therapy were not allowed to share a room with patients with MDROs.

Medical records of newly hospitalized patients were reviewed daily to check previous MDRO colonization or infection during the intervention period. Patients with a previous history of MDRP detection were placed on contact precaution during hospitalization, regardless of any new microbiological results. Patients with a previous history of MRSA or DRP detection were considered for contact precaution if they had sputum, wound exudate or required assistance during urination or bowel movement. These contact precautions were maintained until improvement of the causative symptom, regardless of any additional microbiological results. For patients with a previous history of MDROs who did not meet the contact precaution criteria, standard precautions were recommended. Patients in the perioperative period or patients receiving chemotherapy or immunosuppressive therapy were not allowed to share a room with patients with a previous history of MDROs as well as patients with newly detected MDROs. Compliance with each infection control measure was reviewed periodically, especially when patients with MDROs underwent in-ward or in-hospital transfer. At TMCH, an electronic medical record system was introduced in 2007 and all previous microbiological information, current clinical data, and in-hospital transfer records were available for review by the ICT.

For appropriate antimicrobial use, carbapenem use was restricted to the treatment of bacterial meningitis, febrile neutropenia, rapidly progressive sepsis, nosocomial onset intra-abdominal infection and infections with highly drug-resistant gram-negative bacteria. Carbapenem use for patients without these conditions, inappropriate long-term use or frequent use in the same patients were not recommended during the intervention period, and the prescribing physicians were individually instructed through daily monitoring by the ICT.

Before introduction of the intensive ICT activities, the prevalence of MDROs at TMCH and the need for the intensive ICT activities were explained to each section chief and to staff through seminars presented in June 2011. After the 3-month preparation period, the intensive ICT activities were fully implemented from October 2011.

Data collection

For comparative analysis of the infection control measures and results between the pre- and intervention periods, the number of inpatient days, ambulances accepted, blood