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Original Article

Implementation and outcomes of hospital-wide computerized antimicrobial approval system and on-the-spot education in a traumatic intensive care unit in Taiwan

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Abstract *Background/purpose:* Inappropriate prescribing of antibiotics is a major health-care problem in intensive care units (ICUs). This study evaluates the impact of a direct hospital-wide computerized antimicrobial approval system (HCAAS) and on-the-spot education for practitioners in a neurosurgical ICU in Taiwan.

Methods: We retrospectively analyzed the medical records monthly of patients who were admitted to the neurosurgical ICU during a period of 7 years and 7 months. A pretest-post-test time series analysis, comparing the three periods: period I (no infectious disease (ID) physician), period II (part-time ID physicians), and period III (full-time ID physician). Antimicrobial consumption and expenditure, incidence of hospital-associated infections, prevalence of healthcare-associated bacterial isolates, in-hospital mortality rates, and indication of antibiotics usage were analyzed.

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Results: Full-time ID physician can increase the consumption of narrow-spectrum antimicrobials (cefazolin, and cefuroxime), and decrease the consumptions of broad-spectrum antimicrobials (ceftazidime, cefepime, and vancomycin) compared to part-time ID physicians. From period I to period III, the expenditure of antimicrobials, incidence of hospital-associated pneumonia, and the in-hospital mortality rates (crude, sepsis-related, and overall infection-related mortality) decreased statistically. The prevalence of extended-spectrum β -lactamase-producing *Escherichia coli* and *Klebsiella pneumoniae*, and Carbapenems-resistant *Pseudomonas aeruginosa* remained at low level after HCAAS implementation. From 2007 to 2009, the rational antibiotics usage continued to increase, resulting from to more prophylaxis and appropriate microbiologic proof, but less empiric antimicrobial therapy.

Conclusion: Implementation of HCAAS and long-term on-the-spot education by full-time ID physician can reduce antimicrobial consumption, cost, and improve inappropriate antibiotic usage whilst not compromising healthcare quality.

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Introduction

About 17%–64% of hospitalized patients receive antimicrobial therapy,^{1–3} and 42%–71% of patients receive antibiotics in intensive care units (ICUs).^{4–7} Previous research has indicated that total antibiotic consumption is approximately 10 times greater in ICUs than in general hospital wards.⁷ Inappropriate antibiotics use is increasing worldwide in hospital settings by around 36%–54% globally,^{1–3,8,9} and up to 47%–66% of ICU patients receive inappropriate antibiotics therapy.^{5,10} In ICUs, inappropriate antibiotic usage was higher in patients undergoing surgery,⁵ while 5%–57% of patients develop nosocomial infections.^{7,11} Multidrug resistant (MDR) bacteria, both gram positive cocci and gram negative bacilli (GNB), are increasingly widespread processes in hospital settings.^{12,13}

The hospital-wide computerized antimicrobial approval system (HCAAS) was developed in September 2004 at Chang-Gung Memorial Hospital (CGMH), and the implementation of an online antibiotic control program was first reported at CGMH-Taoyuan in Taiwan in 2011.¹⁴ The aim of the study is to evaluate and report the impact of HCAAS and on-the-spot education by infectious disease (ID) physicians in a trauma ICU at CGMH-Chiayi. This study examined the effects of HCAAS on antimicrobial consumption and expenditure, clinical outcomes, antimicrobial resistance of major healthcare-associated bacterial isolates before and after implementation of the system. We also analyzed rates of appropriate antibiotics and indication of antibiotic usage after implementation of the system.

Methods

Study design and setting

The CGMH-Chiayi is a 1300-bed tertiary hospital providing acute and chronic care service in Southern Taiwan. This hospital provides all major services, including medical and surgical subspecialties. Our neurosurgical ICU (NSICU) has twenty hospital beds, which provided for trauma or surgical

critical patients. This ICU has been in service since June 2002, however no ID physicians served CGMH-Chiayi until January 2006. HCAAS started in January 2006, with four rotating ID physicians from CGMH-Taoyuan served 12 months (since January 2006 to December 2006). One full-time ID physician has undertaken the work since January 2007 to February 2010. This retrospective study was approved by the Institutional Review Board (Ethics Committee) of CGMH (Document no. 97-1073B and 99-1123C).

All data of patients who were admitted to NSICU from June 2002 to December 2009 were retrospectively reviewed monthly. A pretest-post-test time series analysis, comparing the three periods: period I (no ID physician period, June 2002 to December 2005), period II (part-time ID physicians period, January 2006 to December 2006), and period III (full-time ID physician period, January 2007 to December 2009).

The data included age, sex, duration of ICU stay, incidence of hospital-associated infections (HAIs), prevalence of the major healthcare-associated bacterial isolates, parenteral antimicrobial consumption and cost, rates of appropriate antibiotics, indication of antibiotic usage, and major underlying diseases, but excluded cerebrovascular disease, which was not analyzed.

HCAAS and on-the-spot education by ID physicians

The HCAAS is an intranet-based application, built under the Health Information System, and is linked to the comprehensive electronic medical records.^{10,14,15} Each ID physician was notified when a restricted antimicrobial agent was being prescribed in his pre-assigned region (wards and ICUs). All of the above information was automatically processed in the HCAAS. The prescribing physician was required to provide necessary clinical supporting data that includes clinical history, laboratory reports, culture results, and images for an online review of the ID physicians. After review, the ID physicians briefly discussed the case with the physicians-in-charge prior to making a decision. If a prescription was disapproved, the antimicrobial agent was discontinued by the pharmacy's unit-dose delivery system

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