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Cost-effectiveness of interventions to improve hand hygiene in healthcare workers in middle-income hospital settings: a model-based analysis

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SUMMARY

Background: Multi-modal interventions are effective in increasing hand hygiene (HH) compliance among healthcare workers, but it is not known whether such interventions are cost-effective outside high-income countries.

Aim: To evaluate the cost-effectiveness of multi-modal hospital interventions to improve HH compliance in a middle-income country.

Methods: Using a conservative approach, a model was developed to determine whether reductions in meticillin-resistant *Staphylococcus aureus* bloodstream infections (MRSA-BSIs) alone would make HH interventions cost-effective in intensive care units (ICUs). Transmission dynamic and decision analytic models were combined to determine the expected impact of HH interventions on MRSA-BSI incidence and evaluate their cost-effectiveness. A series of sensitivity analyses and hypothetical scenarios making different assumptions about transmissibility were explored to generalize the findings.

Findings: Interventions increasing HH compliance from a 10% baseline to ≥20% are likely to be cost-effective solely through reduced MRSA-BSI. Increasing compliance from 10% to 40% was estimated to cost US$2515 per 10,000 bed-days with 3.8 quality-adjusted life-years (QALYs) gained in a paediatric ICU (PICU) and US$1743 per 10,000 bed-days with 3.7 QALYs gained in an adult ICU. If baseline compliance is not >20%, the intervention is always cost-effective even with only a 10% compliance improvement.

Conclusion: Effective multi-modal HH interventions are likely to be cost-effective due to preventing MRSA-BSI alone in ICU settings in middle-income countries where baseline compliance is typically low. Where compliance is higher, the cost-effectiveness of

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interventions to improve it further will depend on the impact on hospital-acquired infections other than MRSA-BSI.

Introduction

Hospital-acquired infections (HAIs) are a major cause of morbidity and mortality among hospitalized patients [1]. HAIs are also associated with a substantial economic burden due to longer hospital stays and additional antibiotic costs [2]. The risk of infection in developing countries is two to 20 times higher than in developed countries [3]. In Thailand, among hospitalized patients, the point prevalence of nosocomial infection has been estimated at 6.5% and ~250,000 patients are believed to have an HAI each year [4].

Direct patient contact with healthcare workers (HCWs) transiently contaminated with nosocomial pathogens is believed to be the primary route of transmission. Improving HCW hand hygiene compliance can minimize the impact of this transmission route and reduce the incidence of nosocomial infection [5]. A multi-modal intervention including system change, training and education, observation and feedback, reminders, and a hospital safety climate has been developed and promoted by the World Health Organization (WHO). This campaign (referred to as WHO-5) has been shown to be effective in increasing hand hygiene compliance [5,6]. Hand hygiene promotion is also relatively easy to implement and requires a modest level of investment. Nevertheless, in many healthcare settings, particularly in low- and middle-income countries, compliance remains poor and reports of rates of <10% may be typical [7–9].

Transmission dynamic models are useful tools to help understand the likely impact of interventions to control communicable diseases. Moreover, their use in health-economic evaluations of interventions that reduce transmission is essential to fully capture intervention benefits. However, whereas several studies have used dynamic models to consider hospital infections [10,11], economic evaluations of hand hygiene interventions have used only static models and have largely neglected developing countries where the need for appropriate investment is greatest [12–16]. Whereas one previous cohort study in Vietnam concluded that a hand hygiene intervention was cost-saving (i.e. the reduction in costs from HAIs averted exceeded the intervention cost), there have been no systematic attempts to quantify the levels of investment in hand hygiene promotion under which it remains cost-effective or to explore how appropriate levels of investment depend on pre-intervention levels of hand hygiene compliance [16].

The aims of this study are to develop a dynamic model-based framework for evaluating the cost-effectiveness of hand hygiene promotion interventions and use it to evaluate the cost-effectiveness of such interventions in a middle-income country. Our analysis is informed by data from a typical regional hospital in Thailand, a middle-income country with a gross domestic product (GDP) per capita approximately equal to the world median. We focus on MRSA-BSI as this is one of the most serious and best-studied types of infection in ICU patients, there is clear evidence of frequent patient-to-patient transmission of MRSA, and evidence that such transmission can be interrupted by improved hand hygiene [17–19]. Hand hygiene interventions should also reduce other types of MRSA infections and infections with other organisms. However, since these are harder to quantify, we take a conservative approach by focusing on MRSA-BSI alone and are therefore likely to underestimate the true health benefits of the intervention [20].

Methods

Overall description

Transmission dynamic and decision analytic models were combined to simulate the transmission dynamics and evaluate the impact and cost-effectiveness of hand hygiene interventions. Two ICU settings were considered: a paediatric intensive care unit (PICU) and an adult intensive care unit (adult ICU). Epidemiological and economic parameters were derived from detailed local data from a typical tertiary hospital in Northeast Thailand. Information about catchment area, staff:patient ratios, and further details about the ICUs have been described elsewhere [21,22]. Incidence of hospital-acquired and healthcare-associated BSI from this and other hospitals in the same region have also been reported in previous studies [22,23].

Transmission dynamic model

A previously described deterministic host–vector model was constructed to simulate MRSA transmission dynamics in an ICU (Figure 1) [24]. Patients can be admitted to the ICU either uncolonized or colonized with MRSA. Uncolonized patients can become colonized or infected by contact with transiently colonized HCWs. HCWs can be decolonized by performing hand

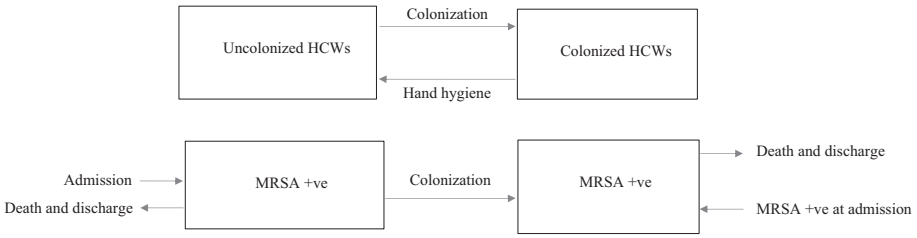

Figure 1. Model structure.

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