Deconstructing the Veterans Affairs MRSA Prevention Bundle

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During the 1970s and 1980s, methicillin-resistant Staphylococcus aureus (MRSA) became endemic in hospitals worldwide [1]. By 2007, a large-scale epidemiological study determined that 94,000 cases of invasive MRSA disease and 19,000 MRSA-related in-hospital deaths occurred annually in the United States [2]. Using these estimates, an editorial suggested that the burden of MRSA deaths exceeded that of deaths due to human immunodeficiency virus or AIDS in the United States [3].

The optimal approach to MRSA prevention in hospital settings is debated [4, 5]. In general, 2 epidemiological approaches have been described: (1) “horizontal” programs that broadly attempt to reduce infections from all pathogens and (2) “vertical” programs that aim to eradicate a single pathogen [6]. Horizontal programs include hand hygiene improvement interventions and central-line association bloodstream infection (CLABSI) “bundles.” Vertical programs screen all or selected patients for MRSA colonization by obtaining a nares swab sample and place MRSA-colonized or MRSA-infected patients on contact precautions. Contact precautions include single-bed rooms and patient cohorting and require healthcare workers to wear gowns and gloves for all contacts. Some studies reported benefits of such screening programs [7], some reported benefits when screening was combined with decolonization [8], and some found screening and isolation to be ineffective [9, 10].

After a successful pilot study in the VA Pittsburgh Healthcare System, in August 2006 the Veterans Health Administration implemented a MRSA bundle in 17 US Department of Veterans Affairs (VA) medical centers [11]. The bundle included (1) admission, in-hospital transfer, and discharge active-surveillance swab samples for MRSA; (2) contact precautions for patients known or found to be MRSA carriers; (3) efforts targeting improved hand hygiene; and (4) efforts encouraging culture change [12]. Importantly, and infrequently, mentioned in descriptions of the VA MRSA Initiative, support was also made available for a MRSA prevention coordinator at each site, who was responsible for coordinating implementation of the bundle. Thus, the VA bundle included 1 vertical intervention (swab samples and contact precautions) and 3 horizontal interventions (hand hygiene, culture change, and MRSA prevention coordinator). By October 2007 the bundle was implemented in all acute-care (except mental health) units in 150 of 153 VA medical centers.

By most measures the VA MRSA Initiative was a success. From initiation to June 2010, healthcare-associated MRSA infections declined by 62% in intensive care units (ICUs) and by 45% in non-ICUs. MRSA acquisition declined 17% in ICUs and 21% in non-ICU settings. Interestingly, a subset of hospitals reported healthcare-associated vancomycin-resistant enterococcal and Clostridium difficile infection rates. After the initiative, vancomycin-resistant enterococcal infections were eliminated in ICUs and declined by 73% in non-ICUs. C. difficile infections declined 61% in non-ICU settings, with no change in ICUs [12].

How do we explain the MRSA declines reported by the VA? A nationwide decline in MRSA seen during the study period [13] might have contributed to these in-hospital declines; however, MRSA positivity on admission was relatively flat during the study period, so any outside impact should have been negligible. Importantly, infections declined 2–3 times more than incident colonization, suggesting that factors other than surveillance swab samples and isolation played a role in reduced MRSA infections. Thus, it seems that one benefit of the bundle was to reduce
infections among patients already colonized on admission or who newly acquired MRSA.

Understanding the impact of population-level interventions that target transmissible pathogens, such as the VA MRSA Initiative, requires use of comparative effectiveness methods (alternatives to a randomized, controlled trial) [14]. The options include cluster-randomized trials, quasi-experimental studies, and mathematical models [14]. A recent Institute of Medicine panel highlighted the importance of mathematical models in comparative effectiveness and noted that “when properly constructed and independently validated, these models not only serve as useful tools to identify, set priorities in, or facilitate the design of new trials, but also can be engaged to conduct virtual comparative effectiveness trials” [15].

In this issue of Clinical Infectious Diseases, Gurieva et al provide an excellent example of the utility of mathematical models in assessing population-level interventions [16]. In particular, they noticed that MRSA infections declined more than colonization point prevalence and wanted to determine whether the vertical intervention (eg, screening plus contact precautions) and/or the horizontal intervention (eg, hand hygiene) was responsible for the decline in MRSA infections. To accomplish this, they used 2 mathematical models of MRSA transmission in a hospital setting. The first model assumed that all reductions in MRSA acquisition were attributable to hand hygiene improvements and not contact precautions, which they called barrier precautions. In the second model all benefits were assumed to be due to contact precautions.

Fitting the model to the data from the only published national report of the VA MRSA Initiative [12], Gurieva et al estimated a 16% hand hygiene efficacy in ICUs and a 20% efficacy in non-ICUs. Making some simplifying assumptions as to the speed and accuracy of the MRSA screening test, they estimated the efficacy of contact precautions to be 18%–24% in ICUs and 24%–29% in non-ICUs [16]. They then assumed a constant risk of infection in those colonized with MRSA, meaning that patients newly colonized with MRSA had the same daily rate of infection as those colonized on admission. Under this scenario, they estimated that only a small fraction of the observed decline in MRSA infection rates, 1%–4% in ICUs and 3%–6% in non-ICUs, could have been attributable to the screening, contact precautions, and hand hygiene components of the bundle [16]. Even under largely unrealistic modifications to the models, they were unable to get either transmission prevention component of the bundle to explain more than 50% of the reduction in infections. The reason given for this finding, which seems logical, is that most of the colonized patients were already colonized on admission, so unless contact precautions can reduce the daily risk of infection in patients who were already colonized (or newly colonized during their admission), it would be difficult to attribute more than a small benefit from the screening and isolating component of the bundle.

The study by Gurieva et al is important for several reasons. It provides a systematic evaluation of several of the MRSA bundle components and challenges the conventional wisdom that significant reductions in MRSA infections can only be achieved by preventing transmission. There are several important additional points worth considering. One is that the models assumed the VA was a single aggregate entity because they did not have individual hospital-level data. It is possible that individual VA hospitals had higher transmission rates and/or lower admission prevalence and would see larger reductions attributable to contact precautions or hand hygiene. Additionally, benefits of hand hygiene would extend beyond prevention of patient-to-patient transmission of MRSA. For example, improved hand hygiene would probably reduce MRSA CLABSI infections through catheter-insertion bundles and improved line management. These pathways were not included in the model. Finally, economic evaluation of the bundle or its components will need to wait for a proper cost-effectiveness analysis.

The results of the studies by Gurieva et al and others illustrate the difficulty individual hospital epidemiologists and health systems face when trying to prevent MRSA and other infections. Even in 2012, we have very few high-quality studies available to inform our decision making. Faced with a rising burden of infections, facilities cannot wait for the perfect bundle to be developed and tested. There are several reasons for the lack of high-quality studies, including the financial support required to conduct multihospital, cluster-randomized trials and the limited research funding targeted for infection prevention studies or antibiotic-resistant organisms [17]. Until infection prevention studies are funded at levels equivalent to their current and expected burden of disease, we will be forced to develop bundles and protect patients using interventions that, though imperfect, are the best available. Gurieva et al should be thanked for helping us further understand the epidemiology of MRSA prevention, and the Veterans Health Administration should be congratulated for their success in reducing MRSA infections and protecting their patients.

Notes

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