A Multidisciplinary Approach to Reducing Outbreaks and Nosocomial MRSA in a University-Affiliated Hospital

Maryam Salaripour, Pat McKernan, Roslyn Devlin
and the Infection Prevention and Control Team

Abstract

Endemic MRSA (methicillin-resistant *Staphylococcus aureus*) colonization and infection has been shown to increase morbidity, length of stay and hospital cost. Prevention of transmission demands innovative approaches.

Descriptive statistics were used to determine high-incidence units. On admission, patients with a history of previous admission to a healthcare institution within the past six months were screened for MRSA. Point prevalence studies were carried out on units with more than two nosocomial (hospital-acquired) MRSA patient isolates within a four-week period. A multidisciplinary team from Infection Control and clinical units determined potential contributing factors. Recommendations included increased organism-specific education for staff, environmental cleaning and elimination of sources of transmission. Control charts to monitor nosocomial incidence rates were provided to those units that historically had a high prevalence of MRSA infections and colonization. Compliance with the infection control isolation guidelines and screening guidelines was monitored by the service.

There was a 60% decrease in nosocomial MRSA between 2000 and 2001. Unit feedback was extended throughout the hospital. This decrease has been sustained since 2001 with annual rates per 1,000 patient-days of 0.61 for 2000, 0.21 for 2001, 0.24 for 2002, 0.25 for 2003, 0.35 for 2004 and 0.19 for 2005.

Introduction

Healthcare-associated infections (HAIs) represent a major source of avoidable morbidity and mortality. A recent survey identified the need for a focus in infection control strategies as one of the top 10 strategic issues/challenges facing acute care hospitals in Ontario (Adalsteinn et al. 2005).

Canadian data published by Zoutman et al. (2003) estimated over 220,000 cases of HAIs per year in healthcare settings, resulting in more than 8,000 deaths. Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major cause of nosocomial (hospital-acquired) infection and colonization, resulting in substantial morbidity and mortality (Cosgrove et al. 2003), and costing the Canadian healthcare system an estimated $42 million to $59 million annually (Kim et al. 2001). Although the rate of MRSA isolates in Canada is significantly lower than in hospitals in the United States (40%), Japan (80%) and some European countries (Verhoef 2001), a significant and steady rise in the percentage of *Staphylococcus aureus* isolates resistant to methicillin has occurred, increasing from 0.95% in 1995 to 10.39% in 2003 (Public Health Agency of Canada 2005).

The Canadian Infectious Diseases Society and the Canadian Association of Medical Microbiologists have outlined best practices for treatment, surveillance and infection control strategies (Simor et al. 2004). Cooper et al. (2004) agreed that the appropriate practice of infection control protocols is associated with reduction of nosocomial transmission of MRSA. However,

they identified the need for more research in recognizing the individual value of each preventive intervention to decrease nosocomial MRSA. Other studies have called for a multidisciplinary and strategic collaborative effort in identification, and institution of prevention and control measures such as appropriate use of antibiotics, screening on admission, active surveillance and concentrated control measures (Struelens 1998).

However, the application of techniques used regularly in quality improvement strategies, such as statistical process control charts and feedback, and their effect on nosocomial rates of MRSA, has not been frequently reported. Recently, a tripartite group, representing the British Society of Antimicrobial Chemotherapy, the Hospital Infection Society and the Infection Control Nurses Association, recommended surveillance for MRSA with feedback to staff and hospital administration as one of the cornerstones of an effective program to control and prevent nosocomial MRSA infection (Coia et al. 2006).

In 2001, after a comprehensive risk assessment and review of infections due to MRSA as well as colonization rates at St. Michael's Hospital, the Infection Prevention and Control Service (IP&C) made a strategic decision to align intervention strategies to prevent the spread of MRSA with the long-term strategic risk management goals of the organization. We examined, designed and implemented three major risk response options: preventing risk, controlling risk and risk financing. However, the major focus was on the concept of risk communication and exchanging findings with stakeholders. We utilized a risk management conceptual framework (Figure 1) for developing the strategic plan to reduce the rate of MRSA infection and colonization adapted from the risk management process steps detailed originally in the Australia/New Zealand Standard in risk management (National Health Service 1999). We also incorporated strategies from the quality improvement literature, such as those described by Langley et al. (1996), that emphasized the continuous nature of improvement. The major innovation to standard infection control strategies was structured communication with frontline workers, senior administration and other stakeholders of quantitative data with respect to care outcome, practice standards, the role of the environment and economic impact on a regular basis. The effect of surveillance and timely reporting as an agent of reduction of HAIs was confirmed in the literature as we moved into the second year of this plan (Curran et al. 2002).

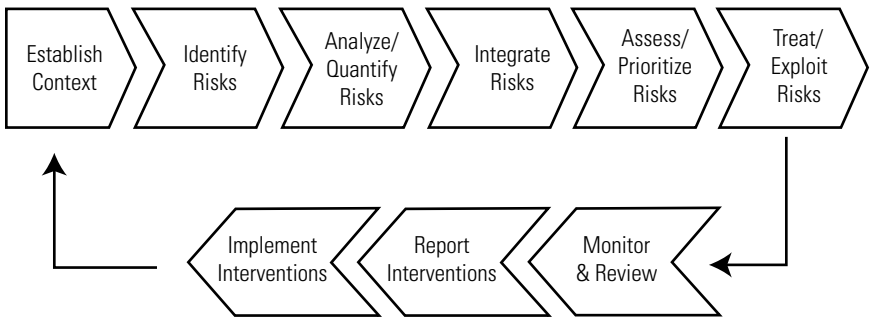
A problem-solving paradigm based on an educational model (Bagayoko et al. 2000) was used to plan out the roadmap against the risk management strategies. This paradigm considers the following five factors as major contributors to developing proficient problem-solving analyses: (1) knowledge base – understanding the knowledge level and disseminating a standard and evidence-based knowledge, (2) skills base – the capability in translating the knowledge into actions, (3) resource base – human and material were both considered, (4) strategy or experience base – the translation and the order in which the tasks were operationalized, (5) behaviour base – defined as the self-discipline that encourages the knowledge and the skills.

Methods

The high-risk and high-incidence units were initially identified by retrospectively analyzing patients identified as being colonized or infected with MRSA utilizing the Microbiology Laboratory reports and Infection Prevention and Control surveillance data. Nosocomial cases were defined as cases identified by culture taken more than 72 hours after admission. Patients that were identified as having MRSA within 72 hours of admission were termed as having MRSA POA (present on admission). We interpreted MRSA POA cases as representing the burden of disease for each unit and the risk management challenge facing units when preventing nosocomial cases.

The incidence rates per 1,000 patient-days were calculated by unit, and a hospital-wide comparison was done in order to benchmark similar units against each other as well as externally. We identified those units with a high rate of nosocomial MRSA as well as units with high number of MRSA positive patients on admission. Unit-specific extracted data were next evaluated for special or common-cause variations using Statistical Process Control Charts. Risk management quarterly reports were initiated and sent electronically to all patient-care-area managers and medical leadership commencing in January 2001. Unit-specific discussions to identify special or common sources for nosocomial spread were initiated by the IP&C. A multidisciplinary team, including the Medical Director of the unit affected, the Clinical Leader Manager, the Program Director, a senior frontline

Figure 1. Risk Management conceptual framework to decrease the incidence of MRSA at St. Michael's Hospital



nurse, housekeeping and environmental hygiene services, an Infection Control Practitioner (ICP), the Medical Director of IP&C, the Director of Risk Management & Quality Improvement, the microbiology laboratory, and representatives of engineering/planning (when applicable), identified root causes, intervention measures and long-term preventive actions. When outbreaks occurred, trends of transmission were mapped on a floor plan of the affected unit to better understand the possible common sources and reservoirs.

The following interventions were introduced as a result of these meetings:

- Routine screening of all patients with a history of admission to a healthcare facility within the previous six months (this was later extended to 12 months) for MRSA (and vancomycin-resistant enterococci [VRE]) within 72 hours of admission.
- Assignment of an Infection Control Assistant to generate a daily list of new admissions and call the clinical units to remind them to culture the high-risk patients for MRSA and VRE.
- Active surveillance for patients with MRSA delegated to one Infection Control Professional (ICP) in order to provide an organization-wide picture of the incidence of MRSA and trends of admission in real time.
- Early identification of the contacts of a positive case and screening of those cases for MRSA twice, at least one week apart.
- Point prevalence studies conducted in units with three or more nosocomial cases in a four-week period or two or more nosocomial cases in a four-week period in an open-concept unit (defined as outbreak condition).
- Revamping of the MRSA policy and procedures related to it, including entering and exiting the patients' rooms under precautions, the environmental cleaning protocol and a transport policy.
- Development of a decolonization/eradication protocol for colonized patients. This was formulated by a team consisting of infectious disease specialists, a pharmacist, an internal medicine specialist from a high-incidence unit, the Medical Director of IP&C and an infection control practitioner. The protocol included both local and systemic antibiotics, bathing with antiseptic soap and follow-up cultures to ensure eradication of MRSA.
- Knowledge transfer and targeted education of staff about the prevention and control measures to limit the spread of this organism in the environment. These sessions were designed to pass on organism-specific information in a short (30-minute) face-to-face format. During the educational sessions skills and behavioural concerns were addressed and a practical demonstration of the use of personal protective equipment was conducted.
- Education of both patients and family members to prevent the spread of the organism.
- Development of visual aids and signage to remind healthcare workers at the site of the isolation about the precautionary measure.
- Prevention of transient carriage of MRSA through a hospital-wide hand hygiene campaign. This included updating and redesigning the hand hygiene signage, installing more waterless hand sanitizers in the patient care areas and hand hygiene demonstrations.
- Providing a daily electronic list of rooms of the patients under precautions to the housekeeping supervisors in order to emphasize the cleaning resources to be assigned to those areas.

Figure 2. Identification of the high-risk/high-incidence units at St. Michael's Hospital

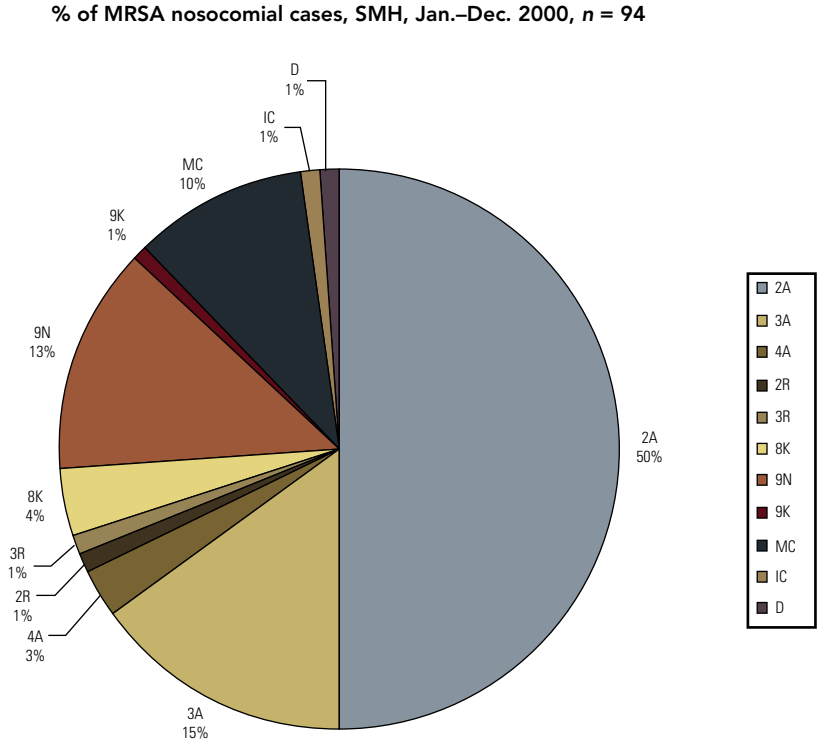
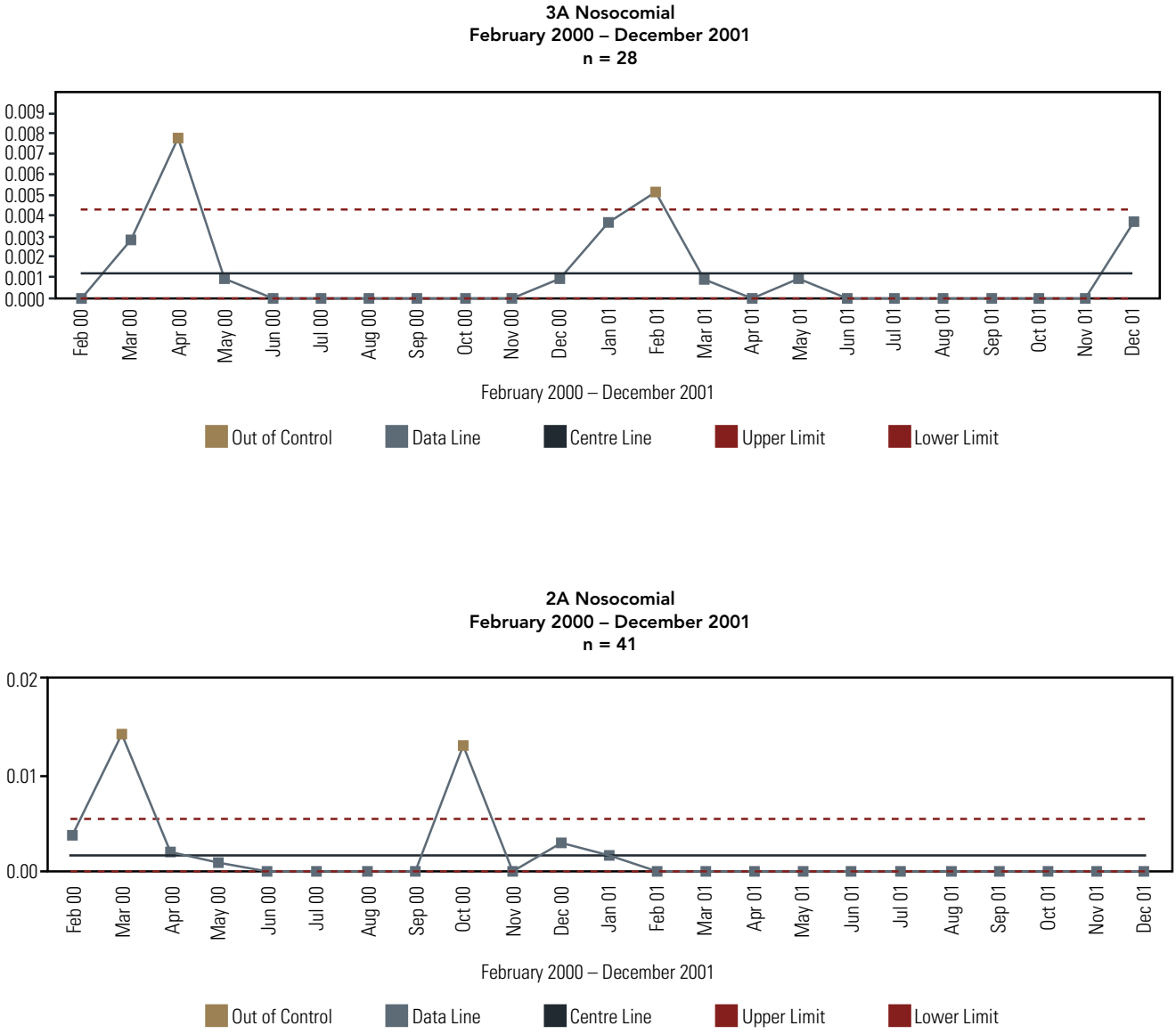


Figure 3. Use of statistical process control charts to identify special or common-cause variation in high-risk/high-incidence units at St. Michael's Hospital



- Provision to stakeholders of the estimated costs of a patient colonized or infected with MRSA as calculated by Kim et al. (2001).

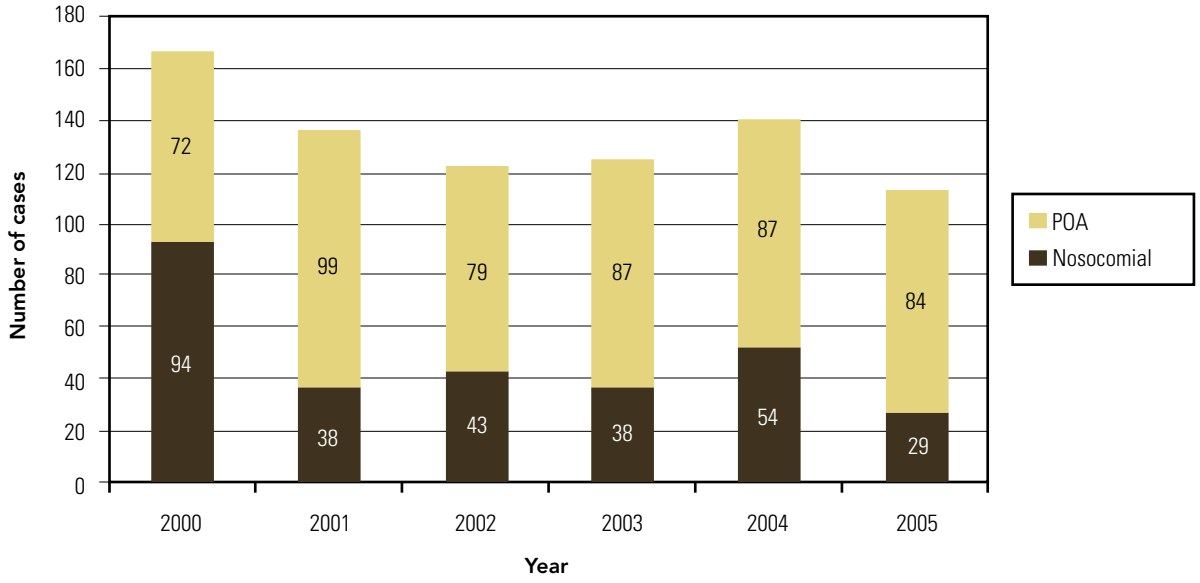
This approach was enhanced by the implementation of an Infection Prevention and Control Competency-Based Certification program in 2003. The goal of the program was to enhance patient and staff safety and facilitate the continuous development of infection control competence, and to practise compliance among all healthcare providers (Salaripour et al. 2004).

We utilized the Z-test with approximation to determine the significance of the decrease in the rate of MRSA both over time and in comparison to the benchmark.

Results

In March 2001 a hospital-wide impact analysis of the burden of MRSA was conducted. Both nosocomial cases and those

Figure 4. Comparison of the total nosocomial and POA cases of MRSA from 2000–2005 at St. Michael's Hospital



considered POA were identified; units with a high rate of nosocomial transmission were also identified (Figure 2). Data for the two highest-risk units were further assessed using statistical process control charts (SPC) to detect special or common-cause variation (Figure 3). Nosocomial transmission on high-risk units was outside the control limit, set at 2 standard deviations from the mean, during the periods February–March 2000, October–November 2000, and February–March 2001.

During the first year of the implementation of this strategy, a 60% hospital-wide drop in the incidence of nosocomial transmission was noticed, decreasing from 0.61 per 1,000 patient-days for the year 2000 to 0.21 per 1,000 patient-days in 2001. The number of isolates detected on admission increased by 38% in the first year (Figure 4) as a result of the screening and detection procedures implemented. Despite the fact that no outbreaks were noticed during the first 13 months after the institution of this feedback methodology, the majority of cases still originated in the high-risk units (identified as 2A and 3A on Figure 2). Continuous use of the policies and procedures described above coupled with quarterly feedback to all units has successfully sustained the decrease in the rate of nosocomial transmission across the hospital.

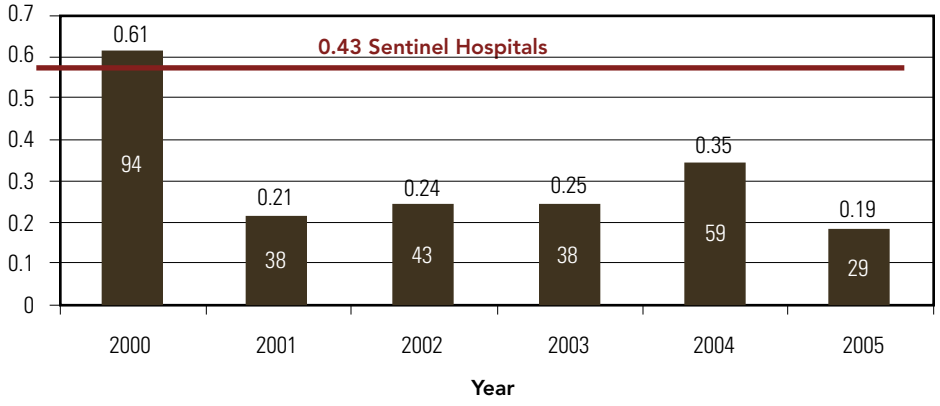
The rate per 1,000 patient-days of nosocomial MRSA was 0.61 for year 2000, 0.21 for year 2001, 0.24 for year 2002, 0.25 for year 2003, 0.35 for year 2004 and 0.19 for 2005 (Figure 5). The rates in each year from 2001 to 2005, at 0.43 per 1,000 patient-days, were significantly lower than the target ($p < 0.01$) (Simor et al. 2001, Table 1) and significantly lower than the internal benchmark rate of 0.61 in 2000 ($p < 0.001$).

Over time, the high-risk units were merged, and the one combined unit has become one of our success stories, with a nosocomial MRSA rate of 0.01 as against the hospital rate of 0.19 and the benchmark rate of 0.4 per 1,000 patient-days. This unit still has the largest burden of patients considered POA MRSA.

Discussion

Establishing a systematic method of feedback and follow-up is sometimes more challenging than the intervention. However, only by doing so is effective information constantly provided to both frontline workers and leadership (Gandhi et al. 2005). Curran et al. (2002) demonstrated that the use of statistical control charts and monthly feedback to medical staff, ward managers, senior managers and hotel services resulted in a 50% reduction in the overall MRSA rate and an associated decrease in variability within departments. Our findings supported this observation by demonstrating a sustained decrease in the rate of nosocomial transmission within our institution. It became apparent that senior administrators of the high-risk units were unaware of the severity and depth of the problem as it related to their units. There was a misconception among administrators and health workers that the rate of infection was the same for all clinical units. Our first unit breakdown presentations raised many questions and the senior administration of the units became fully supportive of efforts to decrease their incidence levels. These presentations also highlighted the risk financing aspect of the MRSA problem at the unit level. A special commitment to early identification and adherence to the admission screening policy was noticed in high-risk units. This

Figure 5. Demonstration of decrease in rate/1,000 patient-days of MRSA from 2000–2005 at St. Michael's Hospital



was supported by delegating the task of reminding units of the need for admission screening based on the daily new admission list to an infection control assistant.

The success of our program was due, in large part, to unit-specific short in-services that were customized to attract the interest of each clinical unit on the basis of the culture of the service. These educational sessions were designed to emphasize the practical aspects of the prevention and control measures, appealing to the ethical commitment of the healthcare workers and their role in advocating a safe practice as well as a review of evidence-based standards and the latest literature. In July 2003, our hospital made it a mandatory requirement for all staff to be certified in infection control through a competency-based program for infection control practices. A survey of staff revealed that those who have gone through the certification felt more confident when caring for patients under precautions (Salaripour et al. 2004). Other workers have examined the use of process feedback rather than outcomes feedback. MacDonald et al. (2004) demonstrated a decrease in the MRSA rate from 1.9 to 0.9% using performance feedback of hand hygiene. Cromer et al. (2004) examined the impact of implementing a method of feedback and accountability related to contact precautions compliance and showed a reduction in facility acquired MRSA from 0.69 per 1,000 patient-days in 2001 to 0.478 in 2003. Notably, neither of these methods achieved the low levels achieved at St. Michael's Hospital using a multifaceted approach that incorporates feedback to clinical units.

Access to the microbiology laboratory and a short turnaround time for specimen processing was another contributing factor that led to our success. Effective use of the microbiology laboratory in assisting the IP&C programs for surveillance and efficient epidemiological interpretations and investigations is an essential tool required to build a solid foundation for an IP&C program (Emori and Gaynes 1993; Franklin et al. 2004).

One of the deficiencies of our method was the lack of segregated and intervention-specific measurements. Studies to evaluate the effect of each intervention may help assist prioritizing the future selection of action plans. However, similarities between our results and those of Pittet provide evidence that the complexities tied into a change process require implementation of multimodal and multidisciplinary approaches to effectively achieve a culture change (Pittet 2001). Despite the lack of outbreaks in the high-risk units that historically have had increased nosocomial transmission, sporadic clusters have been noticed in the recent years, mostly in the open-concept units. Our next step will be to focus our efforts on effective infection prevention and control practices in such units. The comprehensiveness and interactive nature of our multipronged strategy that demands active multidisciplinary participation of all stakeholders is considered key to our sustained and successful achievement.

About the Authors

Maryam Salaripour is Manager of Infection Prevention & Control, Department of Risk Management & Quality Improvement, St. Michael's Hospital.

Pat McKernan is Director of Risk Management & Quality Improvement, St. Michael's Hospital.

Roslyn Devlin is Medical Director of IP&C and the Microbiology Laboratory, St. Michael's Hospital.

Other members of the Infection Prevention & Control Team are Brigette Boaretto, Lisa Bunn, Anjum Khan, Mariantia Lampitoc, Bryan Morales, Shamim Nanji and Diana Petrusic.

Please direct correspondence to: Maryam Salaripour, Manager of Infection Prevention & Control Service, St. Michael's Hospital, 30 Bond St., Toronto, ON M5B 1W8. Tel: 416-864-5697. Fax: 416-864-5932. E-mail: salaripourm@smh.toronto.on.ca.

Acknowledgments

We would like to thank Sister Barbara Wells, who began this work, and all the frontline and management staff at St. Michael's Hospital who worked so hard to make this all happen. We would also like to thank Jianli Li for statistical analysis of our data.

References

Adalsteinn, D.B., L.M. Alikhan, G.A. Sandoval, N. Seeman, G.R. Baker and G.H. Pink. 2005. "Acute Care Hospital Strategic Priorities: Perceptions of Challenges, Control, Competition and Collaboration

in Ontario's Evolving Healthcare System." *Healthcare Quarterly* 8(3): 36–47.

Bagayoko, D., E.L. Kelley and S. Hasan. 2000. *College Teaching* 48(1)(Winter 2000): 24–27.

Cockerill, F.R. III and T.F. Smith. 2004. "Response of the Clinical Microbiology Laboratory to Emerging (New) and Reemerging Infectious Diseases." *Journal of Clinical Microbiology* 42(6): 2359–65.

Coia, J.E., G.J. Duckworth, D.I. Edwards, M. Farrington, C. Fry, H. Humphreys, C. Mallaghan and D.R. Tucker. 2006. "Guidelines for the Control and Prevention of Methicillin-Resistant *Staphylococcus aureus* (MRSA) in Healthcare Facilities." For the Joint BSAC/HIS/ICNA Working Party on MRSA. *The Journal of Hospital Infection* 63(S1): S1–S44.

Cooper, B.S., S.P. Stone, C.C. Kibbler, B.D. Cookson, J.A. Roberts, G.F. Medeley, G. Duckworth, R. Lai and S. Ebrahim. 2004. "Isolation Measures in the Hospital Management of Methicillin Resistant Staphylococcus aureus (MRSA): A Systematic Review of the Literature." *British Medical Journal* 329: 533–39.

Cosgrove, S.E., E.N. Sakoulas, E.N. Perencevich, M.J. Schwaber, A.W. Karchmer and Y. Carmeli. 2003. "Comparison of Mortality Associated with Methicillin-Resistant and Methicillin-Susceptible Staphylococcus aureus Bacteremia: A Meta-analysis." *Clinical Infection Diseases* 36: 53–59.

Cromer, A.L., S.O. Hutsell, S.C. Latham, K.G. Bryant, B.B. Wacker, S.A. Smith, H.A.G. Bendyk, G.T. Valainis and M.C. Carney. 2004. "Impact of Implementing a Method of Feedback and Accountability Related to Contact Precautions Compliance." *American Journal of Infection Control* 32(8): 451–55.

Curran, E.T., J.C. Benneyan and J. Hood. 2002. "Controlling Methicillin-Resistant Staphylococcus aureus: A Feedback Approach Using Annotated Statistical Process Control Charts." *Infection Control and Hospital Epidemiology* 23(1): 13–18.

Emori, T.G. and R.P. Gaynes. 1993. "An Overview of Nosocomial Infections, Including the Role of the Microbiology Laboratory." *Clinical Microbiology Reviews* 6(4): 428–42.

Gandhi, T.K., E. Graydon-Baker, C.N. Huber, A.D. Whittemore and M. Gustafson. 2005. "Closing the Loop: Follow Up and Feedback in a Patient Safety Program." *Joint Commission Journal on Quality and Patient Safety* 31(11): 614–21.

Kim, T., P.I. Oh and A.E. Simor. 2001. "The Economic Impact of Methicillin-Resistant Staphylococcus aureus in Canadian Hospitals." *Infection Control and Hospital Epidemiology* 22: 99–104.

Langley, G.L., K.M. Nolan, T.W. Nolan, C.L. Norman and L.P. Provost. 1996. *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance.* San Francisco: Jossey Bass. Available IHI.org. Retrieved August 10, 2006. <http://www.ihi.org/IHI/Topics/Improvement/ImprovementMethods/Literature/The+Improvement+Guide+A+Practical+Approach+to+Enhancing+Organizational+Performance.htm>

MacDonald, A., F. Dianh, D. MacKenzie and A. Wilson. 2004. "Performance Feedback of Hand Hygiene, Using Alcohol Gel as the Skin Decontaminant Reduces the Number of Inpatients, Newly Affected by MRSA and Antibiotic Costs." *Journal of Hospital Infection* 56: 56–63.

National Health Service. 1999. Informing Healthcare site. "Australian/New Zealand Standard: Risk Management." AS/NZS 4360. Retrieved August 10, 2006. <http://www.wales.nhs.uk/ihc/documents/A.4.1.4_Australia_and_New_Zealand_Methodology_AS_NZ%204360_1999.pdf>

Pittet, D. 2001. "Improving Adherence to Hand Hygiene Practice: A Multidisciplinary Approach." *Emerging Infectious Diseases* 7(2)(March/April): 234–40.

Public Health Agency of Canada. 2005. "Surveillance of Methicillin-Resistant *Staphylococcus aureus* in Canadian Hospitals" [report updated from the Canadian Nosocomial Infection Surveillance program]. *Canada Communicable Disease Report* (CCDR) 31(3)(February 1): 33–40. Retrieved August 10, 2006. <http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/05vol31/dr3103ea.html>

Salaripour M., S. Abramson, S. Canzian, P. McKernan, C. Murray, M. Oddi and R. Devlin. 2004. "Patient Safety and Staff Satisfaction: Developing a Hospital-wide Infection Prevention and Control Certification Program." Abstract # 0.02. *Fifth Congress of the International Federation of Infection Control*, Porec, Croatia.

Simor, A.E., M. Loeb and the CIDS/CAMM Guidelines Committee. 2004. "The Management of Infection and Colonization Due to Methicillin-Resistant *Staphylococcus aureus*: A CIDS/CAMM Position Paper." *Canadian Journal of Infectious Disease* 15(1): 39–48.

Simor, A.E., M.M. Ofner-Agostini, E. Bryce, K. Green, A. McGeer, M. Mulvey, S. Paton and the Canadian Nosocomial Infection Surveillance Program, Health Canada. 2001. "The Evolution of Methicillin-Resistant *Staphylococcus aureus* in Canadian Hospitals: 5 Years of National Surveillance." *Canadian Medical Association Journal* 165(1): 21–26.

Struelens, M.J. 1998. "The Epidemiology of Antimicrobial Resistance in Hospital Acquired Infections: Problems and Possible Solutions." *British Medical Journal* 317: 652–54.

Verhoef, J. 2001. "Stopping Short the Spread of Methicillin-Resistant *Staphylococcus aureus*: Commentary." *Canadian Medical Association Journal* 165(1): 31–32.

Zoutman, D.E., B.D. Ford, E. Bryce, M. Gourdeau, G. Hebert, E. Henderson and S. Paton. 2003. "The State of Infection Surveillance and Control in Canadian Acute Care Hospitals." *American Journal of Infection Control* 31(5): 266–73.