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Effect of proactive infection control measures on benchmarked rate of hospital outbreaks: An analysis of public hospitals in Hong Kong over 5 years



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Background: Hospital outbreaks of epidemiologically important pathogens are usually caused by lapses in infection control measures and result in increased morbidity, mortality, and cost. However, there is no benchmark to compare the occurrence of hospital outbreaks across hospitals.

Methods: We implemented proactive infection control measures with an emphasis on timely education of health care workers and hospitalized patients at Queen Mary Hospital, a teaching hospital. Our benchmarked performance (outbreak episodes per 1 million patient discharges and 1 million patient-days) was compared with those of other regional public hospitals without these additional proactive measures in place between 2010 and 2014.

Results: During the study period, Queen Mary Hospital had 1 hospital outbreak resulting in 1.48 and 0.45 outbreak episodes per 1 million patient discharges and patient-days, respectively, values significantly lower than the corresponding overall rates in the 7 acute regional hospitals (24.26 and 6.70 outbreak episodes per 1 million patient discharges and patient-days, respectively; $P < .001$) and that of all 42 public hospitals in Hong Kong (41.62 and 8.65 outbreak episodes per 1 million patient discharges and patient-days, respectively; $P < .001$).

Conclusions: The results of this large study on benchmarked rate of hospital outbreaks per patient discharges or patient-days suggests that proactive infection control interventions may minimize the risk of hospital outbreaks.

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Hospital outbreaks of epidemiologically important pathogens such as respiratory viruses (eg, influenza virus, respiratory syncytial virus), gastrointestinal viruses (eg, norovirus, rotavirus), and multiple-drug-resistant organisms (MDROs) (eg, methicillin-resistant *Staphylococcus aureus* [MRSA], vancomycin-resistant

enterococci [VRE], carbapenemase-producing Enterobacteriaceae, and multiple-drug-resistant *Acinetobacter baumannii*) are usually caused by lapses in infection control measures. Besides the morbidity and mortality of these hospital-acquired infections, increased length of stay and expenditure, and even damage to a hospital's reputation can pose notable consequences.^{1,2} In particular, the clinical attack rate of influenza and norovirus outbreaks may be up to 10%–45% and 15%–42%, respectively.^{3,4} The magnitude of such outbreaks poses a great challenge to infection control professionals. However, there is no benchmark or quality indicator to compare the occurrence of hospital outbreaks across hospitals.

We adopted a policy of zero tolerance for hospital outbreaks and began to promote proactive infection control measures to prevent

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outbreak occurrence after the massive outbreak of severe acute respiratory syndrome-associated coronavirus (SARS-CoV) in 2003.^{5,6} Here, we describe our experience in minimizing the number of hospital outbreaks in a university-affiliated regional hospital and benchmark our results against the other hospitals in Hong Kong using a surrogate of hospital outbreak episodes per 1 million patient discharges and per 1 million patient-days.

METHODS

This study was conducted in Queen Mary Hospital, a university-affiliated acute regional public hospital of 1,700 beds in a health care network in Hong Kong West, Hong Kong Special Administrative Region, China. Proactive infection control measures with an emphasis on timely education of health care workers and hospitalized patients about directly observed hand hygiene along with active surveillance, opportunistic “added test” screening, rapid laboratory diagnostics, appropriate patient isolation and decolonization, and extensive contact tracing for potential secondary cases were performed to minimize the risk of outbreaks in our hospital between January 1, 2010, and December 31, 2014. The infection control team, composed of 1 infection control officer and 7 infection control nurses, conducted syndromic surveillance and monitored the detection of hospital-acquired microorganisms, defined as a positive microbiology test on specimens collected after 48 hours of admission, via a computerized surveillance system that is connected to the microbiology laboratory database. A clustering report is generated by the computerized surveillance system when 3 or more microorganisms are isolated in the same ward within 7 days. The retrospective surveillance period could be extended further if the microorganism has a longer incubation period. A hospital outbreak was defined as 3 or more patients acquiring epidemiologically important agents after 48 hours of hospitalization in the same ward. Epidemiologically important agents were classified into 4 categories: respiratory viruses (influenza A virus, influenza B virus, respiratory syncytial virus, human metapneumovirus, parainfluenza virus, adenovirus, and rhinovirus), gastrointestinal pathogens (norovirus, rotavirus, and *Clostridium difficile*), MDROs (VRE, carbapenemase-producing Enterobacteriaceae, multiple-drug-resistant *Acinetobacter baumannii*, and MRSA in pediatric and neonatal units), and miscellaneous pathogens of known epidemiologic significance (eg, scabies). MRSA in adult units and extended-spectrum β -lactamase-producing Enterobacteriaceae were not included because these 2 groups of bacteria have been highly endemic locally for many years. However, we still included MRSA for surveillance in pediatric and neonatal units.

In Hong Kong, the computerized surveillance system for outbreak detection was established for public hospitals under the governance of the Hospital Authority, which is a statutory governance structure managing all public hospitals. These 42 public hospitals are geographically organized in 7 hospital networks, namely Hong Kong West and Network A, B, C, D, E, and F, serving more than 90% of Hong Kong's population of 7 million. Each hospital network is led by the biggest acute regional hospital, such as Queen Mary Hospital leading the Hong Kong West network, and hospitals A1 (another tertiary referral hospital), B1, C1, D1, E1, and F1 of comparable bed numbers leading networks A, B, C, D, E, and F, respectively. The characteristics and services provided by the 7 acute regional hospitals are listed in Table 1. When an outbreak occurs, the hospital infection control officer is required to notify the Hospital Authority and the Centre for Health Protection, Department of Health. Upon receiving an outbreak notification, a press statement is released and

simultaneously uploaded to the public domain of the Hospital Authority website. The infection control performance of Queen Mary Hospital and Hong Kong West hospital network was analyzed with respect to the overall performance of the 7 regional hospitals and hospital networks. All acute regional hospitals and hospital networks had similar staff ratios in infection control: 1 infection control nurse per 250 beds. They do not implement similar proactive infection control measures but follow the Hospital Authority guidelines with regard to standard and transmission-based precautions for the prevention of nosocomial transmission of infectious diseases. Using the hospital outbreak episodes per 1 million patient discharges and per 1 million patient-days as benchmarks, the performance of all public hospitals in regard to outbreak prevention can be measured.

Statistical analysis

Appropriate tests, including χ^2 test and Student *t* test, were used. Comparison of the incidence of outbreak episodes per 1 million patient discharges and patient-days between Queen Mary Hospital and the overall results of public hospitals in Hong Kong was performed using R software (version 3.1.2; R Foundation for Statistical Computing, Vienna, Austria). Rate ratios with confidence intervals and *P* values were calculated using the Exact Poisson test. The differences between groups were considered to be significant if the *P* value was $\leq .05$.

RESULTS

Hospital outbreak in Queen Mary Hospital

The basic characteristics of the 7 leading acute regional hospitals are compared in Table 1. There was no significant difference in terms of the number of discharges, whereas the number of pediatric beds, the number of isolation beds serving patients with infectious disease, and the number of patients attending specialist outpatient clinics were significantly more unfavorable to Queen Mary Hospital, which has the most diverse case-mix, including many types of organ transplant services. In other words, Queen Mary Hospital has more medical staff per 1,000 beds compared with the regional average, but the differences in nursing staff allotted per 1,000 beds was not significantly different between Queen Mary Hospital and the regional average. Proactive infection control measures are performed by the infection control team of Queen Mary Hospital (Table 2).^{4,7-16} After implementation of hand hygiene practice using alcohol-based handrub, the overall hand hygiene compliance was 66.4% in 2010, 76.3% in 2011, 78.6% in 2012, 75% in 2013, and 76.2% in 2014. Except for the infection control program for MRSA and *C difficile* described previously,^{12,13,17} 322 episodes of nosocomial cases without clustering or with clustering of <3 cases were investigated in Queen Mary Hospital. Two hundred fifty-five of 322 episodes (79.2%) were due to viruses, whereas 67 episodes (20.8%) were due to MDROs. Respiratory syncytial virus (61 episodes, 18.9%), parainfluenza virus (59 episodes, 18.3%), norovirus (47 episodes, 14.6%), influenza A virus (31 episodes, 9.6%), and VRE (28 episodes, 8.7%) constituted 70% of sporadic nosocomial cases. An unprecedented investigation of a sporadic case of nosocomial legionellosis was made and described previously.¹⁸ Of the 322 investigation episodes, 92 (28.6%) were performed in the medical unit, whereas 58 (18.0%) and 35 (10.9%) were conducted in the pediatric surgery and general pediatric units, respectively. In response to the first nosocomial case, rapid infection control response was initiated to prevent further nosocomial spread (Table 3).

Table 1

Characteristics of 7 acute regional hospitals (Queen Mary Hospital, Hospital A1, B1, C1, D1, E1, and F1) within the public hospital service network in Hong Kong over 5 years*

	Queen Mary Hospital	Average of 7 hospitals	P value
No. of hospital beds	1,698 (100%)	1,640 (100%)	NA
No. of pediatric beds	137 (8.1%)	99 (6.1%)	<.05
No. of isolation beds	90 (5.3%)	148 (9.1%)	<.05
No. of medical staff per 1,000 hospital beds			<.05 [†]
2009–2010 (baseline)	309 (100%)	295 (100%)	
2010–2011 (% change with baseline)	315 (+1.9%)	293 (−0.7%)	
2011–2012 (% change with baseline)	326 (+5.5%)	299 (+1.4%)	
2012–2013 (% change with baseline)	331 (+7.1%)	302 (+2.4%)	
2013–2014 (% change with baseline)	327 (+5.8%)	306 (+3.7%)	
No. of nursing staff per 1,000 hospital beds			NS
2009–2010 (baseline)	993 (100%)	914 (100%)	
2010–2011 (% change with baseline)	1,025 (+3.2%)	911 (−0.3%)	
2011–2012 (% change with baseline)	1,060 (+6.7%)	957 (+4.7%)	
2012–2013 (% change with baseline)	1,115 (+12.3%)	1,006 (10.1%)	
2013–2014 (% change with baseline)	1,092 (+10.0%)	1,053 (+15.2%)	
No. of hospital discharges			NS
2009–2010 (baseline)	119,781 (100%)	124,862 (100%)	
2010–2011 (% change with baseline)	124,017 (+3.5%)	131,211 (+5.1%)	
2011–2012 (% change with baseline)	132,103 (+10.3%)	138,407 (+10.8%)	
2012–2013 (% change with baseline)	134,907 (+12.6%)	142,303 (+14.0%)	
2013–2014 (% change with baseline)	139,396 (+16.4%)	144,317 (+15.6%)	
No. of patients attending specialist outpatient clinics			<.05
2009–2010 (baseline)	597,872 (100%)	548,269 (100%)	
2010–2011 (% change with baseline)	640,333 (+7.1%)	570,066 (−4.0%)	
2011–2012 (% change with baseline)	666,788 (+11.5%)	580,192 (−5.8%)	
2012–2013 (% change with baseline)	690,407 (+15.5%)	596,348 (−8.8%)	
2013–2014 (% change with baseline)	718,348 (+20.2%)	605,667 (−10.5%)	
Special service provision [‡]	Liver, heart, lung, and adult and pediatric blood and marrow transplantation	NA [§]	NA
Infection control practice	Proactive infection control measures in additional to standard and transmission based precautions	Following standard infection control practice according to standard and transmission based precautions	NA

NA, not applicable; NS, not statistically significant.

*The data are presented as financial year using April 1 as the cut-off date according to the Hospital Authority Annual Report (http://www.ha.org.hk/gallery/ha_publications.asp?Library_ID=12&lang=en).[†]Queen Mary Hospital has significantly more medical staff due to the provision of special clinical services.[‡]Special service provision in addition to acute medical, surgical, pediatric, and orthopedic services.[§]Another tertiary referral center in Hong Kong also provides pediatric blood and marrow transplantation service.^{||}Refer to Table 3 for details of proactive infection control measures in Queen Mary Hospital.**Table 2**

Regular and proactive infection control measures to prevent hospital outbreaks

1.	Promotion of hand hygiene practice using alcohol-based handrub by regular open staff forums, and audits with immediate feedback to staff demonstrating suboptimal practice. ^{4,7}
2.	Practice of “entry and exit” control by implementing directly observed hand hygiene for conscious patients before oral hygiene, ingestion of meals and medications, and after using the toilet. ^{8,9}
3.	Daily visit (patrol) by infection control nurse during office hours to the wards with 3 or more episodes of sporadic cases of nosocomial transmission per year as syndromic surveillance for influenza-like illnesses and diarrheal illnesses.
4.	Active surveillance of high-risk patients for early identification of patients with asymptomatic colonization by MDROs, and use of “added test” as opportunistic screening for both epidemiologically important virus ⁴ and MDROs. ^{8,10}
5.	Provision of rapid laboratory diagnostics: Use of chromogenic agar plate with or without MALDI-TOF MS for MDROs, ⁸ and molecular testing for viruses. ^{4,7,11}
6.	Daily monitoring of computer data (a computer program to transform microbiology laboratory data into an infection control format) by infection control team for early detection of patients with nosocomial acquisition of epidemiologically important pathogens.
7.	Priority use of single-room isolation for patients requiring contact precautions. ¹²
8.	Decolonization of patients with MDROs if necessary. ^{13,14}
9.	Environmental disinfection of frequently and mutually touched surfaces or items by health care workers, patients, and visitors by sodium hypochlorite 1,000 ppm in general wards, and 2:1 disinfection system (Tristel wipe Tristel, Cambridgeshire, UK) in single rooms and isolation wards caring for patients with MDROs. ¹⁵
10.	Antimicrobial stewardship programs to reduce antibiotic selective pressure and emergence of MDROs. ¹⁶
11.	Provision of pamphlets for hospitalized patients and visitors to enhance compliance with infection control measures for personal protection against nosocomial acquisition of pathogens.
12.	Timely education and reminder to frontline staff when there is hospital outbreak reported from another public hospital in Hong Kong.

MALDI-TOF MS, matrix-assisted laser desorption ionization-time of flight mass spectrometry; MDROs, multiple-drug-resistant organisms, which include vancomycin-resistant enterococci, multiple-drug-resistant *Acinetobacter baumannii*, methicillin-resistant *Staphylococcus aureus*, and carbapenem-resistant Enterobacteriaceae.

Among 322 episodes of nosocomial-acquired cases, 259 episodes (80.4%) involved 1 patient only, whereas 62 episodes (19.3%) involved 2 patients. The remaining episode was a cluster of 5

patients with respiratory syncytial virus in pediatric surgery. This was the only hospital outbreak in Queen Mary Hospital, constituting 1.48 hospital outbreaks per 1 million patient discharges and

Table 3
Rapid infection control response to the first patient with hospital-acquired viruses or multiple-drug-resistant bacteria

	Nosocomial acquisition with epidemiologically important respiratory and gastrointestinal viruses in the clinical area	Nosocomial acquisition with epidemiologically multiple-drug-resistant bacteria that are not yet endemic in our locality
Timely and appropriate patient isolation	Single-room isolation and contact precautions are required for patients with respiratory syncytial virus, parainfluenza virus, norovirus, and rotavirus. For influenza A virus, single-room isolation, if available, is preferred. Otherwise, corner bed in open cubicle with droplet precautions is required. If the cluster of respiratory virus infections involved > 1 case where a single room is not available, cohort nursing according to World Health Organization guideline on acute respiratory diseases (WHO/CDS/EPR/2007.6)	Single-room isolation and contact precautions are mandatory for patients colonized or infected with VRE and CPE
Environmental disinfection	A specialized cleansing team performs cleaning and disinfection of patient care area, toilet facilities, and the entire ward using sodium hypochlorite 1,000 ppm. Thereafter, ward-based cleaning team performs cleaning and disinfection of the single room or corner bed holding the index case at least twice daily with sodium hypochlorite 1,000 ppm	
Directly observed hand hygiene	Alcohol-based handrub is administered to all health care workers, patients, and visitors once every 2-3 hours by a health care assistant	
Specialized measures	Dashboard monitoring of clinical symptoms of exposed patients: Hospitalized patients are divided into 3 groups. Group 1 is the index case. Group 2 comprises of patients who have been exposed to the index case. Group 3 comprises patients admitted after the isolation of the index case. Infection control nurses observe patient's symptomatology daily for 2 incubation periods in the affected clinical area. Appropriate clinical specimens such as nasopharyngeal specimens or stool samples are collected from patients in groups 2 and 3 if they develop clinical symptoms suggestive of respiratory or gastrointestinal infections	Extensive contact tracing for potential secondary cases ^{8,24,25} : All hospitalized patients staying with the index case are screened for VRE or CPE by fecal samples (rectal swab with visible fecal staining or stool). Patients discharged home are tagged in the hospital computer system and screening is performed upon readmission. Patients discharged to residential care homes for elderly will be screened by community geriatric assessment team. Infection control team monitors the compliance of screening
Reporting hospital outbreak	When 3 or more nosocomial-acquired cases with epidemiologic link are found in the same clinical area, the infection control officer should report the outbreak to the Centre for Health Protection, Department of Health and the Hospital Authority head office. A press release is issued to inform the public. The hospital infection control team collaborates with epidemiologists from the Centre for Health Protection to control the hospital outbreak	

VRE, vancomycin-resistant enterococci; CPE, carbapenemase-producing Enterobacteriaceae.

0.45 hospital outbreaks per 1 million patient-days during the study period, which was 16 and 15 times lower than the corresponding overall benchmarked performance of hospital outbreaks among 7 acute regional hospitals in Hong Kong (Table 4). The difference was statistically significant ($P < .001$).

Hospital outbreaks in Hong Kong

A total of 317 hospital outbreaks involving 2,483 persons (patients or health care workers) in the 7 hospital networks were reported in Hong Kong. The median number of persons involved in each outbreak was 7 (range, 3-39 persons). The medium number of hospital outbreaks per 1 million patient discharges and per 1 million patient-days was 41.62 (range, 6.66-107.59) and 8.65 (range, 1.70-17.87), respectively, of which the Hong Kong West hospital network had the lowest corresponding number among the 7 hospital networks.

Among 317 hospital outbreaks, 114 (36.0%) were observed in extended-care units, whereas 85 (26.8%) and 53 (16.7%) were reported in medical and psychiatric units, respectively. One hundred thirty-one (41.3%) of 317 hospital outbreaks were due to MDROs, of which VRE constituted 109 (83.2%) of 131 episodes, whereas 119 (37.5%) and 51 (16.1%) of 317 outbreaks were due to respiratory viruses and gastrointestinal pathogens, respectively (Fig 1). Of 114 outbreaks in the extended-care units, 32 episodes (28.1%) were due to influenza A, followed by VRE (23 episodes, 20.2%), *C difficile* (13 episodes, 11.4%), and norovirus (12 episodes, 10.5%). The number of hospital outbreaks in Hong Kong increased from 30 episodes in 2010 to a peak of 106 in 2013, and dropped to 72 in 2014.

DISCUSSION

Through this study, we established the local benchmark hospital outbreak rates of all Hong Kong public hospitals as 42 episodes per 1 million patient discharges and 9 episodes per 1 million patient-days. Although there are no corresponding international benchmarked data for comparison at this moment, setting up such surveillance data for hospital outbreaks, similar to the surgical site- and device-related infections found in the National Healthcare Safety Network report and International Nosocomial Infection Control Consortium, respectively, is worthy of consideration.^{19,20}

The risk of occurrence of hospital outbreaks depends on the nature of the clinical setting. In our analysis of hospital outbreaks in 7 local hospital networks over 5 years, one-third of outbreaks occurred in extended-care units because patients in these units had a longer length of stay and tended to be more dependent on nursing care. Transmission of epidemiologically important pathogens may occur when there is a lapse in hand hygiene and other infection control practices. Influenza A virus was the most common agent causing outbreaks in extended-care units, which corroborates previous findings.²¹

Our hospital network, Hong Kong West network, had the lowest number of hospital outbreaks in terms of per million patient discharges and patient-days. Because the patient case mix of the 7 hospital networks in Hong Kong may be different, we attempted to assess infection control performance using number of hospital outbreaks per 1 million patient discharges and patient-days among the biggest acute regional hospitals, which are comparable in annual discharges within each hospital network. As for the

Table 4

Number of hospital outbreaks in 7 acute regional hospitals within the public hospital service network in Hong Kong between 2010 and 2014

	Queen Mary Hospital	Hospital A1, B1, C1, D1, E1, and F1	Overall results
Causative agent			
Multiple-drug-resistant organisms ^a	0	72	72
Respiratory viruses ^b	1	22	23
Gastrointestinal pathogens ^c	0	22	22
Others ^d	0	2	2
Total number of outbreaks	1	118	119
Number of outbreaks per 1 million patient discharges	1.48	5.66-58.85	24.26
Number of outbreaks per 1 million patient-days	0.45 [¶]	1.72-16.07	6.70

^aIncludes vancomycin-resistant enterococci (57 outbreaks), multiple-drug-resistant *Acinetobacter baumannii* (9 outbreaks), methicillin-resistant *Staphylococcus aureus* in pediatric and neonatal wards (5 outbreaks), and carbapenem-resistant Enterobacteriaceae (1 outbreak).

^bIncludes influenza A virus (13 outbreaks), respiratory syncytial virus (6 outbreaks), parainfluenza virus (2 outbreaks), influenza B virus (1 outbreak), and metapneumovirus (1 outbreak).

^cIncludes norovirus (13 outbreaks), rotavirus (6 outbreaks), and *Clostridium difficile* (3 outbreaks).

^dIncludes scabies (1 outbreak) and *Trichosporon asahii* (1 outbreak).

^{||}The number of outbreaks per 1 million patient discharges in Queen Mary Hospital is 16 times lower than the overall results (rate ratio, 0.061; 95% confidence interval, 0.001-0.341; $P < .001$).

[¶]The number of outbreak per 1 million patient-days in Queen Mary Hospital is 15 times lower than the overall results (rate ratio, 0.068; 95% confidence interval, 0.002-0.376; $P < .001$).

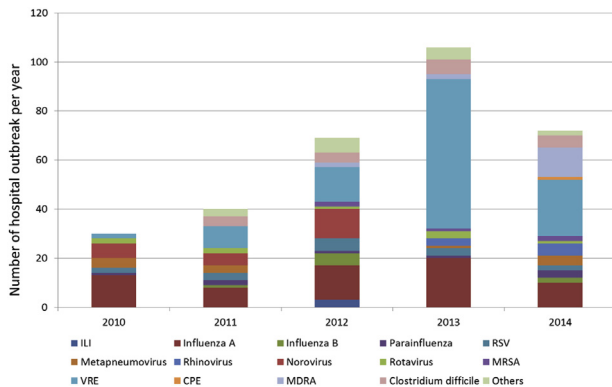


Fig 1. Causative agents of hospital outbreaks in 7 hospital networks in Hong Kong between 2010 and 2014. CPE, carbapenemase-producing Enterobacteriaceae; ILI, influenza-like illness; MDRA, multiple-drug-resistant *Acinetobacter* spp; MRSA, methicillin-resistant *Staphylococcus aureus*; RSV, respiratory syncytial virus; VRE, vancomycin-resistant enterococci.

outbreak-prone divisions in the hospital such as pediatrics and infectious disease services, all acute regional hospitals provide pediatric service, and Queen Mary Hospital has the highest number of pediatric beds. Infectious disease services are provided by all 7 acute regional hospitals, whereas 1 acute regional hospital, Hospital B1, is designated for admission of the first few cases of any emerging infectious diseases with high mortality such as avian influenza and SARS-CoV. However, after the outbreak of SARS-CoV in 2003, airborne infection isolation rooms were built in all acute regional hospitals for preparedness for emerging infectious diseases, but these isolation beds are used for patients requiring contact precautions even when there is no emerging infectious disease outbreaks. Queen Mary Hospital has a significantly lower number of isolation beds for general infection control purposes. Despite these factors, Queen Mary Hospital achieved almost zero

hospital outbreaks during a 5-year time period with the implementation of proactive infection control measures, and our outbreak episodes per 1 million patient discharges and patient-days was 16 and 15 times lower than the benchmark, respectively, among 7 acute regional hospitals in Hong Kong.

It is very difficult to minimize the number of hospital outbreaks over a sustained period, and 322 episodes of nosocomial-acquired cases were detected during the 5-year period through our syndromic and computerized surveillance system that allows early detection of the first hospital-acquired case. Nonetheless, only 1 cluster of 5 patients with respiratory syncytial virus was observed during our study period. Therefore, the low number of hospital outbreaks most likely reflects the effectiveness of our timely implementation of enhanced infection control measures in response to the first patient, as illustrated in Table 3, instead of a failure to detect outbreaks. This surveillance system also worked well at the time of an unprecedented outbreak of SARS-CoV in 2003. Out of 386 infected health care workers in Hong Kong, only 2 (0.52%) were from Queen Mary Hospital.²² We speculate that our practice of daily monitoring of microbiology laboratory data to identify the first hospital-acquired case, proactive approach to perform timely education of health care workers by the infection control team at the bedside, environmental disinfection, priority use of single-room isolation, and implementation of “exit entry control” directly observed hand hygiene of hospitalized patients by health care workers, appears to be effective in terminating nosocomial transmission of epidemiologically important pathogens.^{4,7-9,13,23} Among these measures, provision of timely education by our infection control team, in particular, empowers frontline staff to comply with hand hygiene and infection control practices. We promoted our proactive infection control measures to other public hospitals in the third quarter of 2013, which may explain the overall reduction in hospital outbreaks in 2014.

Finally, under the sophisticated system of syndromic and computerized surveillance, the low number of hospital outbreaks reflects the effectiveness of our timely implementation of enhanced infection control measures in outbreak prevention instead of a failure to detect outbreaks.

There are several limitations in this study. First, whereas all hospitals in Hong Kong follow the guidance provided by the Hospital Authority on infection control measures, details of infection control practice inevitably vary across different hospitals and will change over time as practices are tailored toward local infectious diseases occurrence. Such variations could not be incorporated into our analysis. Second, we had more than 300 episodes of sporadic hospital-acquired cases across a 5-year time period. Although the risk of having a hospital outbreak was only 0.3% (1 outbreak out of 322 episodes of sporadic hospital-acquired cases) in our acute regional hospital, we must remain vigilant in enforcing infection control measures to achieve the target of zero nosocomial infections.

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