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Major article

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

Vincent C.C. Cheng MD [a,b], Josepha W.M. Tai PhD [b], Lisa M.W. Wong MSc (IC) [b], Radley H.C. Ching BSN [b], Modissa M.L. Ng MSN [b], Sara K.Y. Ho BN [b], Doris W.Y. Lee BSN [b], W.S. Li BSN [b], W.M. Lee MSN [b], Siddharth Sridhar MRCP [a], Sally C.Y. Wong FRCPath [a], P.L. Ho MD [a], K.Y. Yuen MD [a,*]

[a] Department of Microbiology, Queen Mary Hospital, Hong Kong Special Administrative Region, China
[b] Infection Control Team, Queen Mary Hospital, Hong Kong Special Administrative Region, China

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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.



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

* Address correspondence to K. Y. Yuen, MD, Department of Microbiology, Queen Mary Hospital, Hong Kong Special Administrative Region, China.
*E-mail address:* kyyuen@hkucc.hku.hk (K.Y. Yuen).

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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 $\chi^2$ 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).