Prevalence of methicillin-resistant staphylococcus aureus in residential care homes for the elderly in Hong Kong

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Abstract

Background

The World Health Organization has recently listed Methicillin-Resistant Staphylococcus aureus (MRSA) as one of the priority pathogens posing threat to human health in 2017. Long term care facilities (LTCFs)/ Residential Care Homes for Elderly (RCHEs) are considered as important reservoirs for MRSA transmission. However, the characteristics of RCHE facilities and residents and infection control practice in Hong Kong associated with MRSA infection/colonization and persistent colonization were not well-addressed.

Methods

To identify determinants of MRSA carriage, we applied a multi-level mixed-effect logistic regression model to the data extracted from the previous commissioned project (Project reference number: 41_M2011000081) between The Chinese University of Hong Kong and Department of Health. A modified compartmental model was also constructed to study the transmission dynamics of MRSA among residents and health care workers (HCWs) in different RCHE settings in accordance with the size of the RCHEs.

Results

From the past data, on the resident-level, the chance of MRSA colonization was positively associated with being male (adjusted OR[aOR]:1.38; 95% CI: 1.09, 1.74), a resident's health status as measured by Charlson Index (aOR: 1.21-2.36; p-value<0.05), loss of mobility as indicated by decreasing Barthel score (aOR:0.99; 95% CI: 0.98, 0.99), use of medical device (aOR:1.79; 95% CI:1.33, 2.41), and presence of skin conditions (aOR:2.44; 95% CI:1.39,4.26). On the RCHE-level, heterogeneity of MRSA level among RCHEs was observed. In the absence of resident-level variables, MRSA level appeared to be associated with the proportion of residents using medical device (p<0.05) and (marginally) associated with the use of 1:4 household bleach to daily clean blood contaminated area (p=0.12).

Discussion

RCHE-level medical profiles of residents are informative while handy, and therefore is worth monitoring regularly. Meanwhile, our findings suggested that MRSA is endemic in different sizes of RCHE in Hong Kong which may result in different infections.

Introduction

Staphylococcus aureus (S. aureus) was first identified in 1880, causing high case-mortality risk among infected patients in the pre-antibiotic era [1]. There have been four waves of antibiotic resistance achieved by S. aureus since 1940. Methicillin-resistant Staphylococcus aureus (MRSA) often induces infections that are difficult to treat because of its ability to survive most antibiotics. The World Health Organization has recently listed MRSA as one of the priority pathogens posing threat to human health [2].

MRSA is endemic in Hong Kong [3, 4] with occasional outbreaks in hospitals, resulting in bacteremia, pneumonia and surgical site infections. Empirical studies have shown that non-hospital residential facilities are important reservoirs for MRSA transmission. Facilities with individuals residing for a substantial period, such as long term care facilities (LTCFs)/ Residential Care Homes for Elderly (RCHEs), are considered as at particularly high risk. Some studies reported a MRSA colonization prevalence rate of 50% in nursing homes (NHs) [5-7], significantly higher than that of 1.5 % in the general population [8, 9]. The MRSA acquisition rate was reported to be higher among residents in LTCFs than their stays in hospitals [10]. An endemic prevalence rate was found in a longitudinal MRSA study in home care setting and national health care services in United Kingdom [11] [12]. Also aging trend becomes a major concern in Hong Kong [13]. The increasing number of private RCHE without full-time health care workers (HCWs) and nurses is expected to be an escalating challenge to the public health workers in the area of infection control of MRSA in RCHE setting. Compared to acute care hospital setting, little was known about the MRSA epidemiology in RCHE. In light of this, we aimed to address the characteristics of RCHE facilities and residents and infection control practice in Hong Kong associated with MRSA infection/colonization and persistent colonization.

Methods

To identify determinants of MRSA carriage, we applied a multi-level random-effects model to the data extracted from the previous commissioned project (Project reference number: 41_M2011000081) between The Chinese University of Hong Kong and Department of Health. Using the status of nasal colonization of individual as the response variable, we consider variables of RCHE facility, RCHE residents' characteristics and infection control practice as possible covariates of the proposed statistical models. The proposed statistical models also account for the within-clustering correlations between residents within the same RCHE. A statistical significance of 0.05 was specified. Akaike information criterion (AIC) was used for model selection.

Results

Data of 2278 residents were analyzed. Table 1.1 describes the demographics of the enrolled residents. The average age of study residents was 82.5 years old, with the majority being female (62.4%). Their average length of stay in RCHEs was 3.6 years. A significant proportion of residents (83%) were with some degree of comorbidity (Charlson Index>1), and a high proportion of residents (68.4%) were mobility-compromised (Barthel score ≤80). Overall speaking, the rate of nasal colonization was 17.8% (405/2278).

The study residents were from 32 RCHEs. Table 1.2 shows the facility-level characteristics of the study RCHEs. Most RCHEs (84.4%) were at least of medium scale (facility size ≥64), and the staff-to-resident ratio (proxied by number of residents taken care by one full-time caring-related staff) ranged from 1:2.3 to 1:10.6. There was variation in the medical situation among study RCHEs in terms of proportion of residents with urinary catheter (mean: 4.6%; range: 0%-13.9%) and that with nasogastric tube (mean:5.6%; range: 0%-21.7%). In terms of hygienic practice, only 21 RCHEs (out of 32) provided alcohol-based hand rub for staff use and only 4 RCHEs (out of 32) had nursing staff carrying portable alcohol-based hand rub. The MRSA level also differed in study RCHEs (range: 4.0% - 31.1%).

Both the resident-level and RCHE-level characteristics were examined with a univariate multi-level logistic regression model (Table 1.3). On the resident level, being male (OR:1.37; 95% CI: 1.09, 1.71), having more co-morbidities (OR: 1.47-3.70; p-value: 0.00-0.06), use of medical device (OR: 2.74; 95% CI: 2.06, 3.62), presence of skin conditions (OR: 3.70; 95% CI: 2.15,6.30) and having less mobility ability (OR: 1.79-3.92; P-value: 0.00-0.01) were significantly associated with higher chance of MRSA colonization. On the RCHE-level, the medical situation inside the RCHE (as proxied by the proportion of residents using medical devices such as urinary catheter and nasogastric tube) were significantly associated with higher MRSA level in the RCHEs. Some environmental hygienic practice may possibly be associated with decreased MRSA level in the RCHEs, including the use of 1:4 household bleach in daily cleaning of blood contaminated area (OR:0.74; 95% CI: 0.5, 1.09; P-value: 0.12).

Significant variables identified in the univariate analysis were re-considered in the multivariable analysis (Table 1.4). Using the AIC as the selection criteria, the final model (with the smallest AIC) include: being male, number of years stayed in the RCHE, charlson index, barthel score, use of medical device and presence of skin conditions. Addition of RCHE-level factors did not significantly improve the model. Heterogeneity of MRSA level among RCHEs is highlighted in the caterpillar plot (Figure 1.1).

There were 80% (1832/2278) of residents who provided nasal specimens in study Round 2, which was 2.7-13.7 months apart from Round 1. Among these 1832 swabbed residents, 6% (110/1832) of them had positive MRSA colonization results in both study rounds. Denoting this status (positive results in both rounds) as persistent colonization, except for gender, other variables associated with MRSA colonization in Round I were also significantly associated with this persistent colonization status.

Discussion

From previous data, we found that the health status predominantly determined the MRSA colonization status. Interestingly, in our data, it was found that the length of stay in RCHE was negatively associated with MRSA colonization. It may be plausible that long length-of-stay in RCHEs were only achieved by the relatively healthier residents. As echo, on the RCHE-level, the prevalence of MRSA colonization in a RCHE was associated with the use of medical device. While the individual health status is expensive and time-consuming to assess, the RCHE-level figures and data are handy to retrieve. Therefore, it will be useful to have RCHEs to routinely report RCHE-level health-related figures in order to grasp a macro-picture of the MRSA endemicity in community RCHEs.

RCHE-level medical profiles of residents are informative while handy, and therefore is worth monitoring especially when resident-level data is not always available.

Tables and Figures

Table 1.1 Characteristics of enrolled RCHE residents

Resident-level characteristics	Number of residents(%) (n = 2278)	
Age (years), mean ± sd	82.5 ± 9.7	
Sex		
Female	1421	(62.4)
Male	857	(37.6)
Length of stay in RCHE (years), mean ± sd	3.6 ± 3.9	
Charlson Index		
Zero	388	(17.0)
One	705	(30.9)
Two	617	(27.1)
Three	362	(15.9)
Four or above	204	(9.0)
Barthel score		
0-20	887	(38.9)
21-40	210	(9.2)
41-60	193	(8.5)
61-80	268	(11.8)
81+	720	(31.6)

Use of medical device	282	(12.4)
Presence of stoma	12	(0.5)
Nasal colonization of MRSA	405	(17.8)

Table 1.2. Characteristics of participating 32 RCHEs

Facility-level characteristics	No. of RCHE (%) (n = 32)	
Facility size		
Small (≤63)	5	(15.6)
Medium (64-117)	15	(46.9)
Large (≥118)	12	(37.5)
Resident to staff ratio (number of residents taken care by one full-time caring staff [1])		
Low (< 1:4)	14	(43.8)
Medium (1:4 to <1:7)	13	(40.6)
High (≥1.7)	5	(15.6)
Proportion of residents with urinary catheter (%)		
<4	18	(56.3)
≥ 4	15	(46.9)
Proportion of residents with nasogastric (Ryles) tube (%)		
< 5	14	(43.8)
5 to <10	13	(40.6)
≥10	5	(15.6)
Presence of residents with percutaneous endoscopic gastrostomy (PEG) tube		
Yes	3	(9.4)

No	29	(90.6)
Presence of residents receiving peritoneal dialysis		
Yes	7	(21.9)
No	25	(78.1)
Implementation of the following hygiene measures		
Daily cleaning of high touch area with 1:99 household bleach	26	(81.3)
Daily cleaning of fecal contaminated area with 1:49 household bleach	20	(62.5)
Daily cleaning of blood contaminated area with 1:4 household bleach	9	(28.1)
Nursing staff carry portable alcohol based hand rub	4	(12.5)
Availability of the following hand hygiene measures		
Hand-washing facilities between resident rooms	18	(56.3)
Liquid soap for basins	31	(96.9)
Alcohol-based hand rub for staff use	21	(65.6)
Nasal colonization of MRSA (%) , median (range)	18.0 (4.0, 31.1)	

[1] Caring staff includes: registered nurses, enrolled nurses, health workers and personal care workers

Table 1.3 Univariate multi-level logistic regression analysis

	Crude OR	(95% CI)	P-value
Resident-level variables			
Age	1.00	(0.99 , 1.01)	0.71
Sex			
Female	-	-	-
Male	1.37	(1.09 , 1.71)	0.01
Length of stay in RCHE (years)	0.95	(0.91 , 0.98)	0.00
Charlson Index			
Zero	-	-	-
One	1.47	(1.00 , 2.21)	0.06
Two	2.02	(1.38 , 3.02)	0.00
Three	2.78	(1.85 , 4.25)	0.00
Four or above	3.70	(2.36 , 5.86)	0.00
Barthel score			
81+	-	-	-
61-80	1.79	(1.14 , 2.78)	0.01
41-60	1.89	(1.15 , 3.05)	0.01
21-40	3.54	(2.32 , 5.40)	0.00
0-20	3.92	(2.88 , 5.40)	0.00
Use of medical device	2.74	(2.06 , 3.62)	0.00
Presence of skin conditions	3.70	(2.15 , 6.30)	0.00
Presence of stoma	0.86	(0.13 , 3.33)	0.84

Table 1.3 (Continued)

	Crude OR	(95% CI)	P-value
RCHE-level variables			
Facility size			
Small (≤63)	1.06	(0.58 , 1.91)	0.85
Medium (64-117)	0.83	(0.56 , 1.23)	0.32
Large (≥118)	-	-	-
Resident to staff ratio			
Low (< 1:4)	1.05	(0.60 , 1.81)	0.85
Medium (1:4 to <1:7)	1.05	(0.59 , 1.86)	0.86
High (≥1.7)	-	-	
Proportion of residents with urinary catheter (%)			
<4	0.67	(0.47 , 0.94)	0.02
≥ 4	-	-	-
Proportion of residents with nasogastric (Ryles) tube (%)			
< 5	0.55	(0.35 , 0.87)	0.01
5 to <10	0.86	(0.55 , 1.37)	0.49
≥10	-	-	-
Presence of residents with percutaneous endoscopic gastrostomy (PEG) tube			
No	-	-	-
Yes	1.01	(0.54 , 1.86)	0.98
Presence of residents receiving peritoneal dialysis			
No	-	-	-
Yes	1.28	(0.84 , 1.99)	0.24
Implementation of the following hygiene measures			
Daily cleaning of high touch area with 1:99 household bleach	1.08	(0.65 , 1.82)	0.76
Daily cleaning of fecal contaminated area with 1:49 household bleach	0.90	(0.60 , 1.33)	0.59

Daily cleaning of blood contaminated area with 1:4 household bleach	0.74	(0.50 , 1.09)	0.12
Nursing staff carry portable alcohol based hand rub	0.99	(0.55 , 1.78)	0.98
Availability of the following hand hygiene measures			
Hand-washing facilities between resident rooms	1.15	(0.79 , 1.69)	0.45
Liquid soap for basins	2.53	(0.88 , 7.83)	0.08
Alcohol-based hand rub for staff use	0.89	(0.60 , 1.32)	0.54

Table 1.4. Multivariate multi-level analysis

| Resident-level variables	Adjusted OR	(95% CI)	P-value
Age	-	-	-
Sex			
Female	-	-	-
Male	1.38	(1.09 , 1.74)	0.01
Length of stay in RCHE (years)	0.94	(0.91 , 0.98)	0.00
Charlson Index			
Zero	-	-	-
One	1.21	(0.81 , 1.83)	0.35
Two	1.42	(0.95 , 2.15)	0.09
Three	1.84	(1.20 , 2.85)	0.01
Four or above	2.36	(1.48 , 3.79)	0.00
Barthel score	0.99	(0.98 , 0.99)	0.00
Use of medical device	1.79	(1.33 , 2.41)	0.00
Presence of skin conditions	2.44	(1.39 , 4.26)	0.00
Presence of stoma	NA	NA	NA
AIC		1975.25	
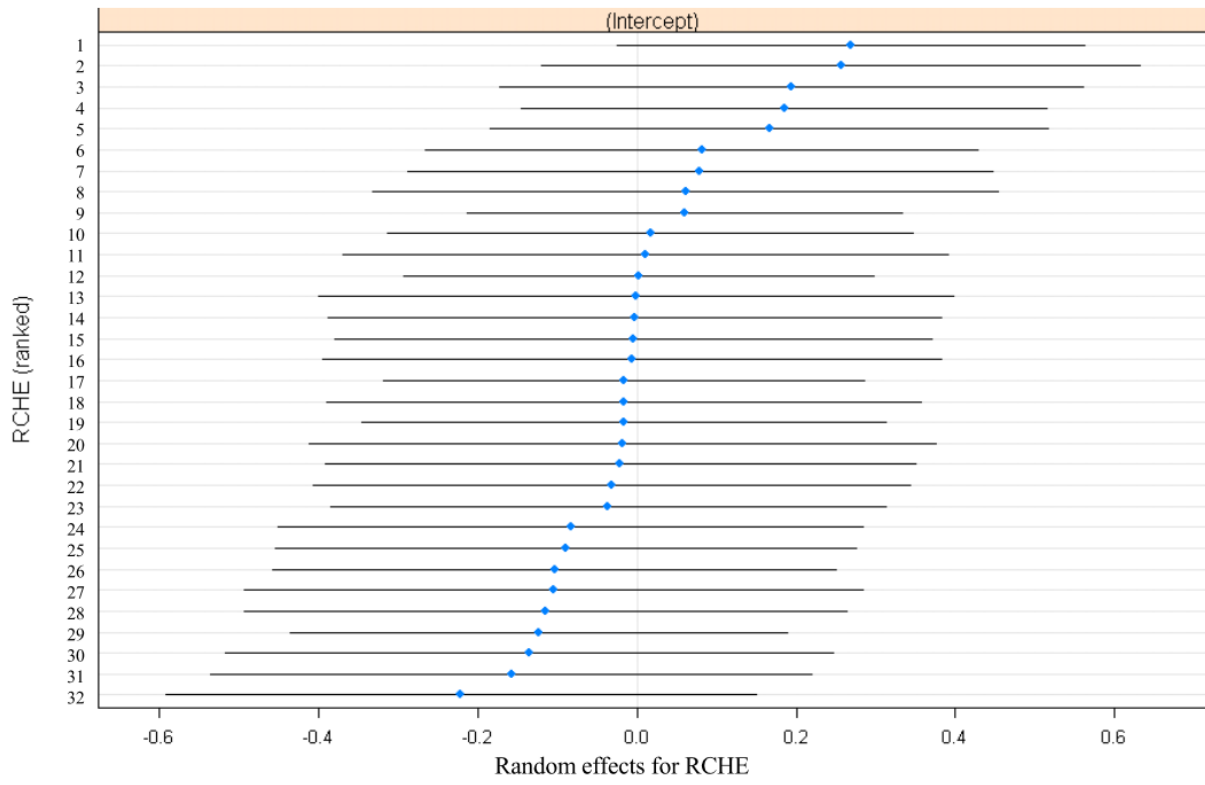
Figure 1.1. Caterpillar plot showing variance in MRSA level in RCHEs