The Reduction of the acquisition rate of carbapenem resistant *Acinetobacter baumannii* (CRAB) after room privatization in the intensive care unit

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Introduction

- *Acinetobacter baumannii* is one of the major pathogens of hospital-acquired infection recently and hospital outbreaks have been reported worldwide.

- In 2017, CRAB was estimated to cause 8,500 infections in hospitalized patients and 700 deaths in the United States, and in Korea, *Acinetobacter baumannii* was the major pathogen of pneumonia in intensive care unit(ICU), and isolated strain had an imipenem resistance reached to 89.6%.

- On September 2017, New intensive care unit(ICU) with only single rooms, remodeling from old ICU with multibed bay rooms, was opened in an acute-care tertiary hospital in Seoul, Korea.

- We investigated the effect of room privatization in the ICU on the acquisition of carbapenem-resistant *Acinetobacter baumannii* (CRAB).

Methods

Hospital setting
- ICU remodeling was progressed from March to September 2017 in 1800 beds acute-care tertiary hospital in Seoul.

- The old ICU had 20 beds in the open bay and 2 single isolated rooms without anteroom. The new ICU has 12 single rooms and 2 isolated rooms with anteroom.

Study population
- Patients admitted to the medical ICU before remodeling of the ICU, from January 2015 to February 2017, were designated as the control group and patients admitted to the medical ICU after remodeling of the ICU, from July 2017 to January 2019, were designated as the intervention group.

- Patients colonized with CRAB or patients with CRAB identified in screening test were excluded from the study population.

Statistical analysis
- Risk factors for CRAB acquisition were analyzed using multivariable Cox regression model.

- Multivariable Cox regression model was performed using variables with p-values of less than 0.1 in the univariate analysis. The statistical analyses were performed using IBM SPSS version 25.0.

Table 1. Comparison of baseline characteristics between the before and after remodeling group.

	Before remodeling (n = 687)	After remodeling (n = 418)	p-value
Age, years (± SD)	63.75 (± 16.27)	64.40 (± 15.07)	0.509
Sex (M)	409 (59.5%)	258 (60.4%)	0.486
Body weight (kg) (± SD)	52.88 (± 15.96)	52.68 (± 23.93)	0.878
Charlson's comorbidity index (± SD)	3.42 (± 2.54)	3.86 (± 2.94)	0.012*
SOFA score (± SD)	9.05 (± 4.21)	9.26 (± 4.69)	0.524
Prior exposure to antibiotics			
Beta-lactam and Beta-lactamase inhibitor	436 (63.5%)	292 (69.9%)	0.031*
1st generation cephalosporine	2 (0.3%)	4 (1.0%)	0.207
2nd generation cephalosporine	2 (0.3%)	2 (0.5%)	0.636
3rd generation cephalosporine	180 (26.2%)	51 (12.2%)	0.000*
4th generation cephalosporine	49 (7.1%)	41 (9.8%)	0.140
Aminoglycoside	21 (3.1%)	8 (1.9%)	0.332
Fluoroquinolone	347 (50.5%)	248 (59.3%)	0.005*
Carbapenem	29 (4.2%)	245 (58.6%)	0.000*
Vancomycin	291 (42.4%)	200 (47.8%)	0.081
Therapeutic variables			
Mechanical ventilation	274 (79.7%)	292 (80.4%)	0.851
Tracheostomy	147 (22.0%)	70 (18.2%)	0.155
Central venous catheter	426 (63.3%)	194 (50.7%)	0.000*
Feeding tube	500 (72.8%)	279 (66.7%)	0.035*
Continuous renal replacement therapy	207 (32.1%)	123 (33.2%)	0.728
Duration of hospital stay			
The length of total hospital stay (days) (± SD)	55.66 (± 88.49)	61.46 (± 121.75)	0.120
The length of ICU stay (days) (± SD)	10.29 (± 11.25)	10.07 (± 18.10)	0.804
CRAB acquisition	110 (16.0%)	16 (3.8%)	0.000*
In-hospital mortality	191 (27.8%)	136 (32.5%)	0.103

*p < 0.05; SD, standard deviation; M, male; CRAB, Carbapenem-resistant Acinetobacter baumannii

Table 2. Univariate analysis of risk factors for CRAB acquisition

	CRAB acqusition (n = 126)	No CRAB (n = 979)	p-value
Age, years (± SD)	62.51(± 17.82)	64.18(± 15.55)	0.263
Sex (M)	80 (63.5%)	587 (60.0%)	0.498
Body weight (kg) (± SD)	54.21 (± 17.32)	52.62 (± 19.60)	0.386
Charlson's comorbidity index (± SD)	3.28 (± 2.58)	3.63 (± 2.72)	0.174
SOFA score (± SD)	8.99 (± 4.19)	9.18 (± 4.50)	0.724
Prior exposure to antibiotics			
Beta-lactam and Beta-lactamase inhibitor	87 (69.0%)	641 (65.5%)	0.485
1st generation cephalosporine	0 (0.0%)	6 (0.6%)	1.000
2nd generation cephalosporine	0 (0.0%)	4 (0.4%)	1.000
3rd generation cephalosporine	23 (18.3%)	208 (21.2%)	0.486
4th generation cephalosporine	16 (12.7%)	74 (7.6%)	0.056
Aminoglycoside	1 (0.8%)	28 (2.9%)	0.240
Fluoroquinolone	79 (62.7%)	516 (52.7%)	0.037*
Carbapenem	18 (14.3%)	256 (26.1%)	0.004*
Vancomycin	72 (57.1%)	419 (42.8%)	0.002*
Therapeutic variables			
Mechanical ventilation	69 (92.0%)	497 (78.6%)	0.009*
Tracheostomy	43 (34.1%)	174 (18.8%)	0.000*
Central venous catheter	91 (73.4%)	529 (56.8%)	0.000*
Feeding tube	115 (91.3%)	664 (67.8%)	0.000*
Continuous renal replacement therapy	44 (35.5%)	286 (32.1%)	0.474
Duration of hospital stay			
The length of total hospital stay (days) (± SD)	68.15 (± 95.54)	56.53 (± 103.145)	0.230
The length of ICU stay (days) (± SD)	19.90 (± 34.04)	8.96 (± 8.16)	0.000*
In-hospital mortality	43 (34.1%)	284 (29.0%)	0.254

*p < 0.05; SD, standard deviation; M, male; CRAB, Carbapenem-resistant Acinetobacter baumannii

Table 3. Multivariate analysis of risk factors for CRAB acquisition

	Beta-coefficient	Hazard ratio (95% CI)	p-value
Room privatization	-1.540	0.214 (0.121-0.382)	0.000*
Length of stay in ICU	-0.016	0.984 (0.965-1.004)	0.114
Feeding tube	1.555	4.737 (1.907-11.762)	0.001*

*p < 0.05; CRAB, Carbapenem-resistant Acinetobacter baumannii

Results

- A total of 1,105 cases admitted to the ICU during the study period were analyzed. CRAB was isolated from 110 cases in the control group(n=687), and 16 cases in the intervention group(n=418).

- In comparison between the before and after remodeling group, Charlson's comorbidity index and prior exposure to carbapenem, fluoroquinolone, Beta-lactam/Beta-lactamase inhibitor were higher in the intervention group, but the presence of the central venous catheter and feeding tube (Levin tube or percutaneous gastrostomy) and prior exposure to 3rd generation cephalosporine, were higher in the control group, significantly (p<0.05) (Table 1).

- In univariate analysis, room privatization, prior exposure to antibiotics (carbapenem, vancomycin, fluoroquinolone), mechanical ventilation, central venous catheter, tracheostomy, the presence of feeding tube and the length of ICU stay were significant risk factors for the acquisition of CRAB (p<0.05) (Table 2).

- In the multivariable Cox regression model, the presence of feeding tube(Hazard ratio(HR) 4.815, 95% Confidence interval(CI) 1.94-11.96, p=0.001) and room privatization(HR 0.024, 95% CI 0.127-0.396, p=0.000) were independent risk factors (Table 3).

Conclusion

- In the present study, room privatization of the ICU was correlated with he reduction of CRAB acquisition independently.

- Remodeling of the ICU to the single room would be an efficient strategy for preventing the spreading of multidrug-resistant organisms and hospital-acquired infection.