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Impact of Antimicrobial Stewardship Program Implementation on Multidrug-Resistant Organism Incidence in Two Hospitals with Different Structural Designs of Intensive Care Units

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Background

Multidrug-resistant organisms (MDROs) in the intensive care unit (ICU) represent a major threat to patient safety, contributing to increased morbidity and mortality. Antimicrobial stewardship program (ASP) has been widely adopted as a key strategy to control antimicrobial resistance by optimizing antibiotic use and reducing selection pressure for MDROs. ICU structural design is another factor affecting infection control outcomes. Single-room ICUs, compared with open-bed ICUs, may reduce cross-transmission of pathogens through physical separation of patients, dedicated equipment, and enhanced hand hygiene compliance. However, whether ICU layout affects the effectiveness of ASP on MDRO incidence remains uncertain. Therefore, we compared changes in MDRO rates before and after ASP implementation at two hospitals with different ICU structural designs to evaluate whether ICU layout influences ICU-onset MDRO incidence.

Methods

A quasi-experimental study was conducted at two university-affiliated hospitals: Hospital A with single-room ICUs and Hospital B with open-bed ICUs. We compared pre-ASP (November 2023–October 2024; period 1) and post-ASP (December 2024–November 2025; period 2) periods. MDROs were defined as extended-spectrum β-lactamase-producing or carbapenem-resistant Enterobacterales, multidrug-resistant *Acinetobacter baumannii*, multidrug-resistant *Pseudomonas aeruginosa*, methicillin-resistant *Staphylococcus aureus*, and vancomycin-resistant *Enterococcus*. ICU-onset MDROs were defined as a newly isolated MDROs occurring more than 2 days after ICU admission or within 2 days after ICU discharge. Difference-in-differences (DiD) analyses were performed using Poisson regression to estimate incidence rate ratios (IRRs) and interaction effects between hospital and period. Models were adjusted for age, sex, Charlson Comorbidity Index (CCI), and antibiotic use during ICU stay.

Results

Hospital A had a higher CCI than Hospital B, with shorter hospital stays, ICU stays, and antibiotic exposure days. In-hospital mortality was similar between the two hospitals. Hospital A (single-room ICUs) showed a trend toward reduced MDRO incidence after ASP implementation, whereas Hospital B (open-bed ICUs) showed minimal change. However, neither the within-hospital changes nor the DiD interaction term between hospitals and periods reached statistical significance, likely reflecting the limited number of MDRO events. Following ASP implementation, total antibiotic use decreased in both hospitals, with a steeper declining trend observed in Hospital A (−15.3%) than in Hospital B (−4.1%), though this difference was not statistically significant.

Table 1. Multidrug-resistant organism incidence (per 1,000 patient-days)
(A) Incidence of multidrug-resistant organism

Group	MDRO events	Patient-days	MDRO incidence (per 1,000 patient-days)
Hospital A – period 1 (n = 985)	7	6,458	1.08
Hospital A – period 2 (n = 1269)	1	6,481	0.15
Hospital B – period 1 (n = 1444)	6	12,266	0.49
Hospital B – period 2 (n = 1571)	5	12,079	0.41

(B) Difference-in-differences (DiD) analysis of multidrug-resistant organism using Poisson regression

Contrast	IRR (95% CI)	p-value
Poisson model (robust SE)		
Hospital A: period 2 vs period 1	0.15 (0.02–1.25)	0.08
Hospital B: period 2 vs period 1	0.82 (0.25–2.66)	0.74
Difference-indifferences (Hospital B vs. A)	5.41 (0.49–59.13)	0.17

Table 2. Changes in total antibiotic use in intensive care units following antibiotics stewardship program implementation
(A) Descriptive comparison

	Period 1	Period 2	% Change
Hospital A	1,678 ± 263	1,422 ± 189	−15.3%
Hospital B	1,560 ± 212	1,497 ± 223	−4.1%

(B) Interrupted time series and difference-in-differences (DiD) analysis

Analysis	Hospital	Pre-slope	Post-slope	Slope change	p-value
Interrupted time series analysis	Hospital A	−2.12	−14.51	−12.39	0.632
	Hospital B	−31.61	−2.06	+29.55	0.211
Difference-in-differences	A vs B			+41.94	0.228

Conclusions

Although ASP implementation was associated with a trend toward reduced MDRO incidence and greater antibiotic use reduction in Hospital A (single-room ICUs) compared with Hospital B (open-bed ICUs), no statistically significant difference was observed between the two hospitals. Given the limited number of ICU-onset MDRO events, the study may have lacked sufficient power to detect a meaningful interaction between ICU structural design and ASP implementation. Furthermore, differences in baseline characteristics between the two hospitals may have introduced residual confounding despite adjustment for key covariates. Nevertheless, the observed trends suggest that single-room ICU design may potentiate the effectiveness of ASP in reducing MDRO incidence. Larger multicenter studies with longer observation periods are warranted to clarify whether ICU structural design influences the impact of ASP on MDRO incidence.