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Concise Communication

The incidences and outcomes of acquiring multidrug-resistant Enterobacterales and enterococci colonization among hospitalized hematologic malignancy patients

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Abstract

This study demonstrated the incidences of hospital-acquired colonization by extended-spectrum beta-lactamase-producing Enterobacterales (ESBL-E), carbapenem-resistant Enterobacterales (CRE), and vancomycin-resistant enterococci (VRE) of 22%, 8%, and 8% among hematologic malignancy patients. Difference in time to colonization detection between VRE (14 d) and ESBL-E and CRE (7 d) may inform appropriate surveillance measures.

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Introduction

The significant burden associated with infections due to multidrug-resistant organisms (MDROs), including extended-spectrum beta-lactamase-producing Enterobacterales (ESBL-E), carbapenem-resistant Enterobacterales (CRE), and vancomycin-resistant enterococci (VRE), can be attributed to lack of effective antibiotic therapy, severity of the infections, and patient-related factors.[1] Hematologic malignancy patients are vulnerable to these infections due to their immunodepressed status, resulted from both the underlying diseases and intensive chemotherapy.

Gastrointestinal colonization by ESBL-E, CRE, and VRE was associated with the increased risk of subsequent infections due to these MDROs.[2] Prior studies reported the rates of acquiring multidrug-resistant Enterobacterales and VRE colonization among hospitalized hematologic malignancy patients to be 20% and 28%, respectively.[3,4] However, no studies have reported these colonization rates, time to colonization detection, and related outcomes in the same setting. In addition, factors associated with hospital-acquired colonization of these MDROs were reported only in patients without hematologic malignancies.[2,5,6]

Methods

This prospective study was conducted from 1st April 2024 to 15th April 2025 at Thammasat University Hospital, a Thai tertiary-care center, and approved by the Human Research Ethics Committee of Thammasat University (Medicine).

All hospitalized hematologic malignancy patients 18 years or older, anticipated by the attending hematologists to require hospitalization for at least 14 days, and provided informed consent were included. Exclusion criteria included a history of colonization or infection caused by ESBL-E, CRE, and VRE at any sites within one year prior to enrollment, and patients with contraindications to rectal swab collection. All participants would undergo a rectal swab sampling (1 swab) each on days 0, 7, and 14 of hospitalization (each participant would undergo 3 samplings in total unless they died or were discharged or transferred before day 14). These rectal swab specimens were collected by one investigator and cultured on the sheep blood and MacConkey agar. Colonies suspected of being Enterobacterales or enterococci will be identified and tested for antibiotic susceptibililty using Sensititre™ and confirmed using MALDI-TOF MS, Bruker. All tests were performed and interpreted according to the Clinical and Laboratory Standards Institute guidelines, the 34th edition.

Participants were considered evaluable for assessment of hospital-acquired colonization only if they stayed for at least 7 days and underwent at least 2 rectal swab samplings. Those defined as acquiring colonization by these MDROs must have day-0 rectal swab culture negative for such MDROs. The incidences of hospital-acquired colonization were calculated by dividing the number of study participants who were found to have new colonization of each MDRO on day 7 and/or day 14 by the total number of participants who did not have colonization of such MDRO on day 0.

Based on the previously reported incidence of hospital-acquired colonization of the MDROs of 19.7%,[7] with the margin of error of 10%, and anticipated number of non-evaluable participants, the required sample size was 75. Independent factors associated with acquiring colonization of ESBL-E, CRE, and VRE were determined

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Table 1. Demographic, clinical, and admission characteristics of the study participants

Characteristics	All (*N* = 65)	Evaluable group (*N* = 54)	Only one baseline swab (*N* = 11)	P[a]
Demographic data				
Age (years, median, IQR)	49 (34–67)	46 (32–65)	64 (55–73)	0.006
Male Sex	45 (69)	39 (72)	6 (55)	0.25
Medical coverage				0.42
Universal Health	29 (45)	25 (46)	4 (36)	
Social security	17 (26)	15 (28)	2 (18)	
Government officer	19 (29)	14 (26)	5 (46)	
Alcohol use	2 (4)	2 (4)	0 (0)	1.00
Tobacco use	4 (6)	4 (7)	0 (0)	1.00
Illicit drug use	1 (1)	1 (2)	0 (0)	1.00
Functional status				0.81
Independent	63 (96)	52 (96)	11 (100)	
Partial dependent	1 (2)	1 (2)	0 (0)	
Totally dependent	1 (2)	1 (2)	0 (0)	
Underlying hematologic malignancies				0.13
Leukemia	32 (49)	29 (53)	3 (27)	
Myeloid	19 (29)	18 (33)	1 (9)	
Lymphoid	13 (20)	11 (20)	2 (18)	
Lymphoma	30 (46)	22 (41)	8 (73)	
B-cell	28 (43)	20 (37)	8 (73)	
T cell	2 (3)	2 (4)	0 (0)	
Myeloma	2 (3)	2 (4)	0 (0)	
Other hematologic malignancies[b]	1 (2)	1 (2)	0 (0)	
History prior admission within 6 months	48 (74)	44 (81)	4 (36)	0.005
Admitted in a university hospital	33/48 (69)	31/44 (70)	2/4 (50)	0.004
Admitted in a provincial hospital	14/48 (29)	13/44 (30)	1/4 (25)	
Admitted in a rural hospital	1/48 (2)	0/44 (0)	1/4 (25)	
Prior chemotherapy within 6 months	36 (55)	33 (61)	3 (27)	0.05
Complication of prior chemotherapy	31/36 (86)	4/33 (12)	1/3 (33)	0.37
Phase of hematologic malignancy				0.26
Induction treatment	54 (83)	43 (80)	11 (100)	
Consolidation treatment	4 (6)	4 (7)	0 (0)	
Relapse/refractory	7 (11)	7 (13)	0 (0)	
Comorbid disease				
Diabetes mellitus	11 (17)	7 (13)	4 (36)	0.24
Hypertension	4 (6)	4 (7)	0 (0)	1.00
Dyslipidemia	5 (8)	5 (9)	0 (0)	0.58
Chronic kidney disease	1 (1)	1 (2)	0 (0)	1.00
Chronic liver disease	1 (1)	1 (2)	0 (0)	1.00
Rheumatic disease	2 (3)	1 (2)	1 (9)	0.31
Others[c]	14 (22)	9 (17)	5 (46)	0.03
None	27 (42)	26 (48)	1 (9)	0.02
History of ICU admission within 6 months	2 (3)	1 (2)	1 (9)	0.31
History of mechanical ventilation within 6 months	1 (1)	0 (0)	1 (9)	0.17
History of central venous catheter insertion within 6 months	0 (0)	0 (0)	0 (0)	–

(*Continued*)

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Table 1. (*Continued*)

Characteristics	All ($N = 65$)	Evaluable group ($N = 54$)	Only one baseline swab ($N = 11$)	P[a]
History of Foley's within 6 months catheter insertion				1.00
Current admission data	2 (3)	2 (6)	0 (0)	0.006
Admitting ward				
Chemotherapy	30 (46)	27 (50)	3 (27)	
General Female	11 (17)	11 (20)	0 (0)	
Private Female	5 (7)	1 (2)	4 (36)	
General Male	6 (9)	5 (9)	1 (10)	
Private Male	2 (3)	2 (4)	0 (0)	
CCU/ICU	0 (0)	0 (0)	0 (0)	
Other Private wards	11 (18)	8 (15)	3 (27)	
Current admission data				
Primary diagnosis for this admission				0.06
Hematologic malignancy	55 (85)	48 (90)	7 (64)	
Infection	6 (9)	3 (5)	3 (27)	
Others[d]	4 (6)	3 (5)	1 (9)	
Treatment				0.08
Chemotherapy	53 (82)	46 (85)	7 (64)	
Antimicrobial drug	6 (9)	3 (6)	3 (27)	
Symptomatic/supportive treatment	6 (9)	5 (9)	1 (9)	
ICU admission	3 (5)	3 (6)	0 (0)	1.00
Mechanical ventilation	4 (6)	3 (6)	1 (9)	0.53
Central venous catheter insertion	3 (5)	3 (6)	0 (0)	1.00
Foley's catheter insertion	5 (8)	4 (7)	1 (9)	1.00

Note. Data are in numbers (%) unless indicated otherwise.
[a]Comparison between the evaluable and non-evaluable groups
[b]Including myelodysplastic syndrome and myelofibrosis
[c]Including thalassemia, chronic obstructive pulmonary disease, asthma, and cerebrovascular disease
[d]Including electrolytes abnormality, fatigue, and gastrointestinal hemorrhage
CCU, cardiac care unit; ICU, intensive care unit; IQR, interquartile range.

using multivariable logistic regression analysis. All statistical analyses were performed using IBM SPSS Statistics version 29.0.

Results

A total of 79 participants initially met the inclusion criteria; 14 individuals (18%) were excluded due to a history of colonization with ESBL-E, CRE, or VRE. Of the remaining 65 participants, 11 (17%) underwent a rectal swab only once as they had been discharged prior to reaching day 7 of hospitalization due to improvement in conditions they were initially admitted for, 18 (28%) underwent a rectal swab twice, and 36 (55%) underwent a rectal swab three times. Characteristics of the participants categorized by evaluability for acquired colonization are shown in Table 1.

Of the 54 evaluable participants, the incidence of acquired ESBL-E colonization was 22% (8/36). The majority of the acquired colonization detected on day 7 of admission (63%). Having prior chemotherapy-related complications was the only independent factor associated with ESBL-E colonization acquisition (adjusted odds ratio 42.50, 95% confidence interval 3.16–571.82; $P = .002$). Other characteristics were not significantly different between the acquired ESBL-E and non-acquired MDRO groups (Supplementary Table 1). The incidence of hospital-acquired CRE colonization was 8% (4/52). The majority of the acquired colonization detected on day 7 (75%). Other characteristics were not significantly different between the acquired CRE and non-acquired MDRO groups (Supplementary Table 2). The incidence of hospital-acquired VRE colonization was 8% (4/53). All cases of acquired VRE colonization were detected on day 14. Other characteristics were not significantly different between the acquired VRE and non-acquired MDRO groups (Supplementary Table 3). Distribution of bacteria causing rectal colonization among the participants on days 0, 7 and 14 is shown in Supplementary Tables 4–6. A statistically significant increase in the proportion of VRE colonization was observed on day 14 of admission compared to the earlier time points (Supplementary Table 6).

As shown in Table 2, there were no significant differences in hospital survival rates between patients with acquired colonization of ESBL-E, CRE, or VRE and those without MDRO acquired colonization. However, acquired CRE colonization was significantly associated with longer length of stay (LOS). Subsequent infections caused by the colonizing MDROs and other complications were not significantly different between the groups.

Discussion

Hospital-acquired colonization in this study was mainly due to ESBL-E, consistent with high rates of infections and colonization due to these organisms in Thailand.[8] The incidence of acquired

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Table 2. Comparison of in-hospital outcomes between participants with hospital-acquired colonization of extended-spectrum beta-lactamase-producing Enterobacterales (ESBL-E), carbapenem-resistant Enterobaterales (CRE), or vancomycin-resistant enterococci (VRE) and those without multidrug-resistant organism (MDRO) colonization acquisition

Outcomes	Acquired ESBL-E colonization			Acquired CRE colonization			Acquired VRE colonization		
	Yes (N = 8)	No MDRO (N = 28)	P	Yes (N = 4)	No MDRO (N = 28)	P	Yes (N = 4)	No MDRO (N = 28)	P
Survival through discharge	8 (100)	28 (100)	–	4 (100)	28 (100)	–	3 (75)	28 (100)	0.13
Length of stay (days, median, IQR)	16 (12–34)	15 (8–23)	0.38	24 (20–46)	15 (9–23)	0.04	19 (17–20)	15 (8–23)	0.19
Subsequent MDRO infection	1 (13)	0 (0)	–	0 (0)	0 (0)	–	0 (0)	0 (0)	–
ESBL-E	1/1 (100)								
CRE	0/1 (0)								
VRE	0/1 (0)								
Infection complication	4 (50)	11 (39)	0.89	2 (50)	10 (35)	0.10	2 (50)	11 (39)	0.89
Type of infection			0.68			0.49			0.33
Febrile neutropenia	2/4 (50)	4/11 (36)		0/2 (0)	4/10 (41)		1/2 (50)	3/11 (32)	
HAP/VAP	1/4 (25)	1/11 (9)		0/2 (0)	1/10 (10)		0/2 (0)	2/11 (16)	
Bloodstream infection	0/4 (0)	2/11 (18)		0/2 (0)	1/10 (10)		1/2 (50)	1/11 (11)	
Unknown primary source	1/4 (25)	4/11 (36)		2/2 (100)	4/10 (40)		0/2 (0)	5/11 (41)	

Note. Data are in numbers (%) unless indicated otherwise.
HAP, hospital-acquired pneumonia; IQR, interquartile range; VAP, ventilator-associated pneumonia

ESBL-E colonization (22%) was comparable to an Indian study (20%)[3] but lower than the French study (82%).[2] The incidence of CRE colonization of 8% was lower than that reported from France (15%),[7] while the incidence of VRE colonization was lower than a US study (28%)[4] but higher than the French ICU study (0%).[7] These findings reflect differences in study populations, the baseline overall incidences of infections and colonization of the MDROs, and infection control practices. A locally conducted study is thus needed in each setting. Prior chemotherapy-related complication was the only factor found to be associated with ESBL-E acquisition in this study. This might be related to the risk of colonization following mucositis and secondary infections caused by chemotherapy.

In this study, most of the acquired ESBL-E and CRE colonization occurred during the first 7 days of admission, consistent with previous studies,[5,9] while all acquired VRE colonization occurred during day 7–14. These findings may suggest the appropriate time point for MDRO surveillance among hematologic malignancy patients, which varied among each MDRO. This study is the first to report in-hospital outcomes associated with nosocomial colonization acquisition by the MDROs among hematologic malignancy patients. Although we did not observe impacts on survival, subsequent infections and complications, hospital-acquired CRE colonization was significantly associated with prolonged LOS. This finding was consistent with those reported from previous studies,[9,10] suggesting close monitoring of CRE-colonized patients for any adverse events that can cause extended LOS.

The small sample size and single-study design may limit accurate assessment of factors associated with MDRO colonization, impacts on in-hospital outcomes, and generalization of results. In addition, the study was not designed to collect data on other patients, family members, hospital environment, healthcare workers, and prior specific antibiotic use. Despite the limitations, our study demonstrates the low to moderate incidences of hospital-acquired colonization by ESBL-E, CRE, and VRE among hematologic malignancy patients which align with the local prevalence of infections/colonization by these MDROs. Performing rectal swabs to detect the colonization may be guided by the study results.

Supplementary material. The supplementary material is available online at https://doi.org/10.1017/ash.2025.10171

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Competing interests. None declared.

Ethical approval. This study was approved by the Human Research Ethics Committee of Thammasat University (Medicine).

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