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Original Article

Prevalence of Multidrug-Resistant Organisms and Risk Factors for Carriage among Patients Transferred from Long-Term Care Facilities

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Conflict of Interest
No conflicts of interest.

ABSTRACT

Background: Patient transport between acute care hospitals and long-term care facilities (LTCFs) plays a significant role in microbial migration. The study aimed to estimate the prevalence and risk factors associated with the colonization of multidrug-resistant organisms (MDROs) among patients transferred from LTCFs.
Materials and Methods: We retrospectively reviewed medical records to examine the colonization of MDROs. All patients who were transferred from LTCFs and admitted to an acute care hospital with 800 beds in Daejeon between March 2018 and February 2019 were included in the study. We surveyed rectal cultures and nasal swabs obtained for screening vancomycin-resistant *Enterococcus* (VRE), carbapenem-resistant *Enterobacteriaceae* (CRE), and methicillin-resistant *Staphylococcus aureus* (MRSA) at the time of hospitalization. We conducted a multivariable logistic regression to assess the association between clinical variables and the carriage of MDROs.
Results: Four hundred and fifteen patients from 86 LTCFs were enrolled. A total of 31.1% (130/415) of participants carried MDROs; VRE colonization was detected in 17.1% (71/415) of participants, and MRSA colonization was shown in 19.5% (81/415) of participants. No CRE was isolated. Previous use of antibiotics within three months [odds ratio (OR) 2.28; (95% confidence interval (CI) 1.30 - 4.00), $P = 0.004$], use of antibiotics for longer than two weeks [OR 2.16; (95% CI 1.03 - 4.53), $P = 0.040$], and previous colonization of MDROs within one year [OR 2.01; (95% CI 1.15 - 3.54), $P = 0.015$] were independently associated with increased risk for carriage of MDROs.
Conclusion: Our study showed that a third of patients transferred from LTCFs carried VRE or MRSA, and prior antibiotic therapy was highly associated with the carriage of MDROs, which suggested more efficient management approaches for high-risk patients.

Keywords: Antibiotic resistance; Long-term care facilities; Risk factors

INTRODUCTION

Long-term care facilities (LTCFs) are specialty-care hospitals designed for patients with serious medical problems that require intense, special treatment for an extended period of

Author Contributions

Conceptualization: HSJ, SHK. Data curation: HSJ. Formal analysis: HSJ. Methodology: HSJ, SHK, HJC. Project administration: HSJ. Supervision: SHK, HJC. Validation: SHK. Visualization: HSJ. Writing - original draft: HSJ. Writing - review & editing: SHK.

time. Due to the rapid aging of the population, the number of LTCFs in Korea has increased by almost two times over the last eight years from 867 in 2010 to 1,560 in 2018 [1]. The total number of beds in LTCFs concerning population (1,000 population aged over 65 years old) was around 36.7, approximately ten times higher than the average in the Organization for Economic Cooperation and Development countries in 2017 [2]. The population in LTCFs is usually at risk for critical events such as illness and accidents, leading to hospitalization. Therefore, the referral of patients to and from acute care hospitals (ACHs) frequently occurs, and LTCFs have become essential in the health care system.

There is evidence that a stay in an LTCF is a risk factor for the carriage of multidrug-resistant organisms (MDROs) [3-9]. Microorganisms can migrate by direct contact between patients, caregivers, and inanimate medical environments in LTCFs [4, 5, 10]. In addition, patient transport between ACHs and LTCFs plays a significant role in microbial migration [11-14]. Identifying the patients who carry MDROs and prevent the hospital from nosocomial spreading is challenging. The point prevalence of MDROs and risk factors of carriage among patients, environmental surfaces, and hands and clothing of healthcare workers in various LTCFs were evaluated [3, 5, 7, 8, 10, 15-17]. However, studies are limited in Korea, and the actual prevalence remains unclear [18-20].

In our hospital, we completed active surveillance to screen the carriage of MDROs among patients who were previously hospitalized at other facilities for longer than 48 hours before admission. The screening included vancomycin-resistant *Enterococcus* (VRE), carbapenem-resistant *Enterobacteriaceae* (CRE), and methicillin-resistant *Staphylococcus aureus* (MRSA). Medical records were collected, and the prevalence of the carriage of VRE, CRE, and MRSA among patients transferred from LTCFs was estimated. Also, clinical risk factors for carriage were characterized using logistic regression.

MATERIALS AND METHODS

1. Study participants and clinical information

We retrospectively reviewed the medical records of patients transferred from LTCFs to a referral teaching hospital with 800 beds in Daejeon. All patients who were transferred from LTCFs and admitted to the hospital between March 2018 and February 2019 were initially eligible for the study. We excluded patients who had stayed for less than 48 hours in LTCFs. LTCFs were limited to medical care hospitals and geriatric hospitals, and nursing homes were not included.

The demographic and clinical data of the participants were collected from electronic medical records. We used the initial assessment at the time of hospitalization when obtaining age, sex, and comorbidities such as hypertension, diabetes, dementia, cardiovascular disease, cerebrovascular disease, chronic lung disease, connective tissue disease, chronic liver disease, chronic kidney disease, solid tumor, hematologic disease, the presence of a pressure sore, history of surgical procedures within one year, and the presence of indwelling medical devices (urinary catheter, tracheal tube, central venous catheter, percutaneous gall bladder drainage catheter, percutaneous feeding tube, or electric medical devices such as a cardiac pacemaker). The Charlson Comorbidity Index (CCI) and the age-adjusted CCI were used to provide a composite score of comorbid conditions. Functional status was described using the Eastern Cooperative Oncology Group (ECOG) performance status. Additional data on the length of stay at LTCFs, prior admission at the intensive care unit (ICU), prior colonization

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of MDROs, and previous exposure to antibiotics were collected based on the information provided by the former hospital staff. Further clinical information on any infectious conditions in the urinary tract, respiratory, hepatobiliary tract, gastrointestinal tract, soft tissue, bone, and joints was determined with laboratory analysis, microorganisms isolated from body fluids, and image findings.

2. Specimen collection and microbiologic test

At the time of admission, we cultured three series of samples for active surveillance. They included two rectal swabs for determining the colonization of VRE and CRE and a nasal swab to screen the colonization of MRSA. For VRE screening, rectal swabs were inoculated in Enterococcosel™ enrichment broth (Becton Dickinson, Oxford, UK) and plated onto a ChromID™ VRE (bioMérieux, Marcy l'Etoile, France) agar plate. All morphologically distinct colonies were identified, and their antimicrobial susceptibility was tested by MicroScan WalkAway 96 plus system (Siemens Healthcare Diagnostics Inc, West Sacramento, CA, USA) following the manufacturer's recommendations. For screening CRE and MRSA, a ChomID™ Carba (bioMérieux, Marcy l'Etoile, France) agar plate and a ChromID™ MRSA (bioMérieux) agar plate were used, respectively. Colonies were tested in an automated system (MicroScan WalkAway 96 plus system, Siemens Healthcare Diagnostics Inc, West Sacramento, CA, USA).

3. Risk factor assessment

The clinical information of participants carrying VRE, CRE, or MRSA was compared to that of the other participants. Continuous variables are presented as means and standard deviation (SD) or medians and interquartile range (IQR), and categorical variables are presented as numbers and percentages. Variables were compared using the Chi-square test or Fisher's exact method for categorical data and independent Student's *t*-test or Mann-Whitney *U* test for continuous data, as required. In all studies, a two-tailed *P*-value of 0.05 was considered to indicate significance.

In a multivariable logistic analysis, the dependent variable was the presence of VRE, CRE, or MRSA from at least one surveillance culture. Risk analysis was also conducted in each subgroup categorized by screening organisms. Multivariable logistic regression in a backward stepwise manner was used, incorporating factors with a *P*-value < 0.1 on univariate analysis. All statistical analyses were conducted using R version 3.6.1 (Foundation for Statistical Computing, Vienna, Austria) [21, 22].

4. Ethical Statement

The Institutional Review Board of Konyang University Hospital approved the conduct of this study (Registration No.: KYUH 2019-07-025).

RESULTS

1. Study Population and Clinical Information

During the study period, 436 patients were transferred from 86 LTCFs. Among them, ten patients stayed in LTCFs for less than 48 hours and 11 patients had omitted active surveillance culture. Finally, a total of 415 participants were enrolled in the study, as shown in **Figure 1**.

Table 1 shows the demographic and clinical details of the participants. The median age was 80, with a range of 36 to 98 [interquartile range (IQR) 74 - 85], and 197 (47.5%) participants

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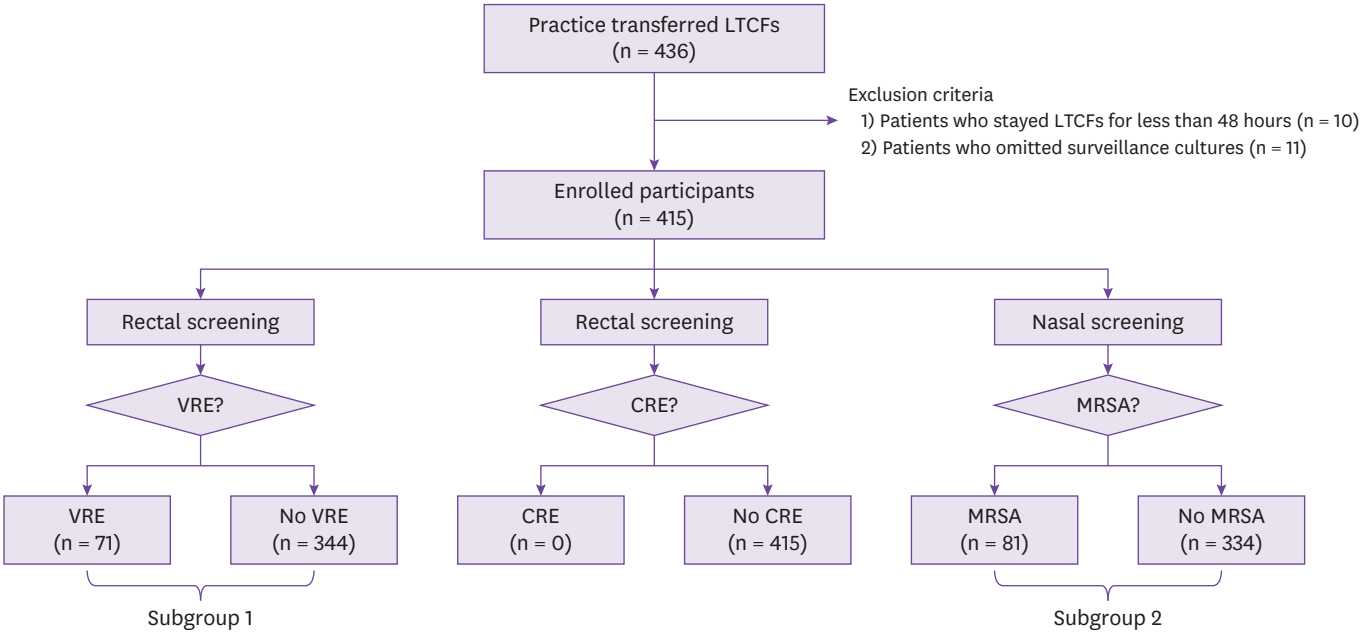

Figure 1. Approaches to determine the carriage of multidrug-resistant organisms among patients transferred from long-term care facilities.
LTCFs, long-term care facilities; VRE, vancomycin-resistant *Enterococcus*; CRE, carbapenem-resistant *Enterobacteriaceae*; MRSA, methicillin-resistant *Staphylococcus aureus*.

were male. The age-adjusted CCI was a median of 6 (IQR 5 - 8). Eighty-one (19.5%) participants had pressure sores, and 200 (48.2%) were nearly non-ambulatory. Ninety (23.2%) participants had stayed at an LTCF for less than one month and 155 (39.9%) for more than one year. Forty-three (10.4%) participants had surgeries within one year, and 88 (21.2%) were colonized with MDROs within one year. Two hundred and thirty-three (56.1%) participants were in any infectious condition upon admission, with pneumonia (41.2%) and urinary tract infections (37.8%) as the most common diseases. One hundred and forty-six (35.3%) participants received antibiotic treatment within three months before admission. One hundred and forty-seven (35.4%) participants had one or more medical devices.

The number of participants per LTCF ranged from 1 to 36, with a median of 2 (IQR 1 - 6). About 94% of all participants were transferred from LTCFs located at four major administrative regions (Daejeon Metropolitan City, Nonsan-Si, Gongju-Si, and Buyeo-Gun).

2. Prevalence of colonization of VRE, CRE, or MRSA

Among the 415 participants, it was revealed that a total of 130 (31.3%) participants carried MDROs. Seventy-one (17.1%) participants had VRE (subgroup 1) and 81 (19.5%) participants had MRSA (subgroup 2). No CRE was found. Twenty-two (5.3%) participants had both VRE and MRSA.

The colonization of MDROs ranged from 0.0% to 32.6% among different administrative regions. In the case of the four major regions, the prevalence was 32.6% (71/218) in participants transferred from LTCFs in Daejeon, 31.1% (32/103) in Nonsan-Si, 24.6% (14/57) in Gongju-Si, and 58.3% (7/12) in Buyeo-Gun. Their colonization difference was not statistically significant (P = 0.147). Also, the prevalence at five major LTCFs (where more than 15 patients were transferred during the study period) were 30.3% (10/33), 27.2% (6/22), 38.9% (7/18), 11.1% (2/18), and 26.7% (4/15), and colonization differences were not significant (P = 0.442).

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Table 1. Demographic and clinical information of participants enrolled (n = 415)

Characteristics	Value
Median age, years (IQR)	80 (74 - 85)
Gender, male, no (%)	197 (47.5)
Charlson's comorbidity index, median (IQR)	3 (2 - 4)
Age-adjusted Charlson's comorbidity index, median (IQR)	6 (5 - 8)
Comorbidities, no (%)	
Hypertension	295 (71.1)
Cardiovascular diseases	105 (25.3)
Cerebrovascular diseases	302 (72.8)
Chronic lung diseases	42 (10.1)
Connective tissue diseases	7 (1.7)
Liver diseases	23 (5.5)
Chronic kidney diseases	24 (5.8)
End-stage renal disease on hemodialysis	14 (3.4)
Diabetes	149 (35.9)
HbA1c, mean ± SD	6.5 ± 1.1
Solid tumors (any stages)	79 (19.0)
Hematologic diseases	16 (3.9)
Pressure sore, no (%)	81 (19.5)
ECOG performance status, no (%)	
2	25 (6.0)
3	190 (45.8)
4 (bed-ridden)	200 (48.2)
Length of stay at LTCFs at the time of admission[a], no (%)	
<1 month	90 (23.2)
≥1 month and <1 year	143 (36.9)
≥1 year	155 (39.9)
Surgery within one year, no (%)	43 (10.4)
Previous colonization of MDROs within one year, no (%)	88 (21.2)
History of exposure to antibiotics, no (%)	
<1 month	111 (26.7)
≥1 month and <3 months	35 (8.4)
Duration of antibiotic therapy, no (%)	
<2 weeks	84 (20.3)
≥2 weeks	62 (15.0)
Prior admission at ICU within one year, no (%)	69 (16.6)
Indwelling one or more medical devices, no (%)	147 (35.4)
Urinary catheters (including Foley, percutaneous nephrostomy, double-J catheters)	93 (63.3)
Feeding tubes (including nasogastric, percutaneous gastrostomy tubes)	57 (38.7)
Central venous catheters (including PICC and chemoport)	16 (10.9)
Endotracheal tubes	21 (14.3)
Biliary stents or catheter	7 (4.8)
Others[b]	3 (2.0)
Infectious condition, no (%)	233 (56.1)
Infection site, no (%)	
Lung	96 (41.2)
Urinary tract	88 (37.8)
Hepatobiliary tract	18 (7.7)
Gastro-intestine	23 (9.9)
Others[c]	8 (3.4)
Locations of LTCFs, no (%)	
Daejeon Metropolitan City	218 (52.5)
Nonsan-Si	103 (24.8)
Gongju-Si	57 (13.7)
Buyeo-Gun	12 (2.9)
Others[d]	25 (6.0)

[a]item was missing from 27 patients.
[b]intracardiac device (2), thoracic tube (1)
[c]gynecologic tract (1), bone, joint and soft tissue (5), catheter-related (2).
[d]Cheonan-Si (1), Cheongyang-Gun (1), Geumsan-Gun (3), Gunsan-Si (1), Gyeryong-Si (6), Hongseong-Gun (2), Muju-Gun (1), Okcheon-Gun (1), Seocheon-Gun (1), Seosan-Si (1), Taean-Gun (1), Wanju-Gun (1), Yeongi-Gun (2), Yeongdong-Gun (3).
IQR, interquartile range; SD, standard deviation; ECOG, Eastern Cooperative Oncology Group; LTCFs, long-term care facilities; MDROs, multidrug-resistant organisms; ICU, intensive care unit; PICC; peripherally inserted central catheter.

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Table 2. Univariable and multivariable logistic regression for assessment of risk factors associated with carriage of multidrug-resistant organisms

Independent variables	MDROs, n (%) n = 122	No MDORs, n (%) n = 265	Univariable analysis		Multivariable analysis	
			OR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
Gender, male	63 (51.6)	131 (49.4)	1.06 (0.79 - 1.44)	0.687		
Age, median (IQR)	80 (75 - 85)	79 (73 - 86)	1.02 (1.00 - 1.04)	0.098		
Age-adjusted CCI, median (IQR)			1.07 (0.97 - 1.18)	0.197		
Hypertension	80 (65.6)	194 (73.2)	0.70 (0.44 - 1.11)	0.126		
Cardiovascular diseases	38 (31.1)	60 (22.6)	1.55 (0.96 - 2.50)	0.075		
Cerebrovascular diseases	86 (70.5)	198 (74.7)	0.81 (0.50 - 1.30)	0.383		
Chronic lung diseases	16 (13.1)	24 (9.1)	1.52 (0.77 - 2.97)	0.226		
Liver diseases	5 (4.1)	17 (6.4)	0.62 (0.22 - 1.73)	0.364		
Chronic kidney diseases	6 (4.9)	16 (6.0)	0.81 (0.31 - 2.11)	0.659		
ESRD on dialysis	4 (3.3)	10 (3.8)	0.86 (0.27 - 2.81)	0.809		
Diabetes	42 (34.4)	100 (37.7)	0.87 (0.55 - 1.36)	0.530		
Solid tumor	20 (16.4)	56 (21.1)	0.73 (0.42 - 1.28)	0.277		
Hematologic diseases	5 (4.1)	11 (4.2)	0.99 (0.34 - 2.90)	0.981		
Pressure sore	33 (27.0)	46 (17.4)	1.77 (1.06 - 2.94)	0.029		
ECOG 4 (bed-ridden)	75 (61.5)	118 (44.5)	1.99 (1.28 - 3.08)	0.002		
Length of stay at LTCFs at admission						
<1 month	34 (27.9)	56 (21.1)	Reference	-		
<3 months	47 (38.5)	96 (36.2)	0.69 (0.47 - 1.03)	0.070		
>1 year	41 (33.6)	113 (42.6)	0.97 (0.67 - 1.39)	0.853		
Surgery within one year	19 (15.6)	22 (8.3)	2.04 (1.06 - 3.93)	0.033		
Previous colonization of MDROs within one year	47 (38.5)	40 (15.1)	3.52 (2.15 - 5.79)	<0.001	2.01 (1.15 - 3.54)	0.015
Exposure to antibiotics within three months	51 (41.8)	91 (34.3)	4.03 (2.56 - 6.34)	<0.001	2.28 (1.30 - 4.00)	0.004
Antibiotic therapy (≥2 weeks)	84 (68.9)	138 (52.1)	5.67 (3.16 - 10.17)	<0.001	2.16 (1.03 - 4.53)	0.040
Prior admission at ICU within one year	71 (58.2)	68 (25.7)	2.04 (1.19 - 3.47)	0.009		
Indwelling medical devices	40 (32.8)	21 (7.9)	1.37 (0.88 - 2.13)	0.158		
Infectious condition	31 (25.4)	38 (14.3)	1.23 (0.69 - 2.20)	0.002		

MDROs, multidrug-resistant organisms; OR; odds ratio; AOR, adjusted odds ratio; CI, confidence interval; CCI, Charlson's comorbidity index; ESRD, end-stage renal disease; ECOG, Eastern Cooperative Oncology Group; LTCFs, long-term care facilities; ICU, intensive care unit.

3. Risk Factors for Carriage of MDROs

Risk factors for the carriage of MDROs were analyzed with a multivariable logistic regression for a total of 387 participants (**Table 2**). Previous use of antibiotics within three months (odds ratio [OR] 2.28; (95% confidence interval [CI] 1.30 - 4.00), $P = 0.004$), use of antibiotics for longer than two weeks (OR 2.16; [95% CI 1.03 - 4.53], $P = 0.040$), and previous colonization of MDROs within one year (OR 2.01 [95% CI 1.15 - 3.54], $P = 0.015$) were independently associated with an increased risk for carriage of MDROs.

Risk assessment was also performed in each subgroup. In subgroup 1 (VRE group, **Supplementary Table 1**), exposure to antibiotics within three months (OR 4.41; [95% CI 2.08 - 9.34], $P < 0.001$), chronic lung disease (OR 3.54; [95% CI 1.52 - 8.28], $P = 0.003$), use of antibiotics for longer than two weeks (OR 2.72; [95% CI 1.28 - 5.80], $P = 0.001$), and ECOG 4 (OR 2.15; [95% CI 1.12 - 4.15], $P = 0.022$) were significantly associated with colonization of VRE in the rectum. On the contrary, participants who stayed at an LTCF longer than one year had a relatively lower risk of carrying VRE than participants who stayed for less than one month (OR 0.47; [95% CI 0.27 - 0.82], $P = 0.008$).

In subgroup 2 (MRSA group, **Supplementary Table 2**), previous colonization of MDROs within one year (OR 2.38; [95% CI 1.30 - 4.35], $P = 0.005$) was the single risk factor with statistical significance.

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DISCUSSION

Preventing the spread of MDROs migrating from LTCFs to hospitals is a challenge. There is evidence that LTCFs are possible reservoirs for MDROs, and frequent referrals of patients from or to LTCFs play a significant role in the migration of MDROs [11, 14, 23]. According to previous surveys on point prevalence conducted at various types of LTCFs, the overall prevalence of any MDROs varied greatly from 36.0% to 74.8% [3, 5, 7-9, 15-17], with a prevalence of up to 65.1% for MRSA, 55.0% for VRE, and 10.0% for CRE. Our observed prevalence among patients transferred from LTCFs was about 31.3%, which was generally in the range of previous data. The previous study conducted at an ACH in Korea showed 20.9% of VRE colonization among patients from LTCFs [18], which is similar to our rate. Notably, we observed no colonization of CRE. The previous survey also showed a low rate of CRE colonization among patients from LTCFs [18]; thus, we questioned the cost-effectiveness of screening culture for CRE among patients transferred from LTCFs. The early detection of asymptomatic carriers is essential for successful control of nosocomial spreading, and the colonization of MDROs will vary widely due to risk factors, resident populations, staff to patient ratios, and especially the local antibiotic resistance epidemiology [3, 14, 15, 24]. So, each hospital should have its policy based on regional prevalence, and we need to monitor the influx rate of MDROs continually.

In comparison with the ACH setting, LTCFs also face challenges with infection prevention strategies. The infrastructure, clinical practice, and patient profiles in LTCFs are substantially different from those of ACHs. In the current situation of LTCFs in Korea, there is insufficient recognition of the importance of infection control and also lacks budget and experts. Isolation of patients with MDROs is unrealistic, and even identifying carriers is often a difficult task [25]. The infection monitoring, epidemic investigation, monitoring of the proper use of antibiotics, and educational tasks were not actively conducted in the LTCFs [26]. While the general principles of infection control are applicable, interventions must be tailored to the specific context of the health care settings to be effective. In LTCFs, microorganisms can migrate by direct contact between patients, caregivers, and inanimate medical environments, and interactions or activities are frequent among residents. Many spaces such as facilities, bathrooms, and activity centers are shared. Therefore, appropriate contact precautions should be implicated for the most cost-effective measures, particularly for at-risk patients.

We observed that factors related to antibiotic use (use of antibiotics for longer than two weeks and previous use of antibiotics within three months) were the most significant risks for carrying MDROs. It is consistent with the conventional concept that antibiotic pressure selects resistant microorganisms. The previous studies conducted at various LTCFs also suggested that prior antibiotic therapy was highly associated with MDRO carriage [3, 6, 15, 27]. It also highlighted the importance of antimicrobial stewardship not only in ACHs but also in LTCFs. We further observed that the previous colonization of MDROs within one year predisposed patients to carrying MDROs, which is also consistent with the previous surveys showing that having resistant organisms in the past is a major risk factor [9, 27-29].

Studies carried out at ACHs also found that patients admitted from LTCFs had higher odds of colonization [14]. Exposure to antibiotics was found to be a risk factor for colonization of VRE in the rectum [18], and previous colonization of multidrug-resistant Gram-negative bacteria was the single risk factor [19] among patients transferred from LTCFs.

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Interestingly, a stay in an LTCF for longer than one year was revealed to be a protective factor for the carriage of VRE (subgroup 1, **Supplementary Table 1**), since residency in long-term care facilities may provide an opportunity for the person to person transmission of microorganisms. This finding supports published data showing that prolonged stays in LTCFs were associated with a decrease in the VRE colonization rate [24]. It might be because a large portion of patients who are admitted to LTCFs were previously discharged from ACHs. A recent study in nursing homes revealed that more than half of patients transferred from ACHs were colonized with VRE [30]. MDROs produced in ACHs can be transferred to the LTCFs and propagated back through the movement of patients. In this manner, shorter staying patients in LTCFs are more likely to have resistant bacteria. This is in line with a previous study that showed a length of stay longer than 14 days in an ACH was positively associated with colonization of VRE [27]. At present, it is not clear whether the new acquisition of MDROs occurs primarily in LTCFs or ACHs. However, it is clear that the frequent movement of patients plays a significant role in the spread of MDROs, and further studies are needed to understand the transmission dynamics between LTCFs and the ACHs in a health care network.

One of the strengths of this study is that all patients transferred from LTCFs were enrolled in the survey and surveillance culture for VRE, CRE, and MRSA was completed at a high rate (95.2%), which resulted in increased accuracy. Although point surveillance research should be further considered to assess the data more accurately, these results can be used to estimate the prevalence, risk factors, and improve the screening process.

The study has several limitations. First, as with all retrospective studies, the data were incomplete. Although we have obtained data using well-prepared medical templates, some data on prior care at LTCFs were unavailable. In particular, antibiotic use and length of LTCF stay were not apparent in some participants, which might have led to inaccuracies in accessing risk factors. Second, CRE was not found in this study; therefore, the risk factors for carrying CRE could not be included. Third, as the research was conducted in a single-center, data may not be representative of all LTCFs in the region and the result cannot be generalizable to other health care systems.

In conclusion, we surveyed the colonization of VRE, CRE, and MRSA among patients transferred from LTCFs in the Daejeon metropolitan area and showed that a third of them carried VRE or MRSA. The most significant risk for the carriage of MDROs was related with the prior antibiotic therapy. These results allow us for the improvement of the screening and management of high-risk patients.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

Univariable and multivariable logistic regressions for the assessment of risk factors associated with the carriage of vancomycin-resistant *Enterococcus* (subgroup 1)

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Supplementary Table 2

Univariable and multivariable logistic regressions for the assessment of risk factors associated with the carriage of methicillin-resistant *Staphylococcus aureus* (subgroup 2)

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