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Pandemic-driven transmission-based prevention as an observational scenario for multidrug-resistant organisms

Chiara Peconi[a], Gilda Pelusi[a], Donatella Sarti[a], Beatrice Gasperini[b], Annamaria Frascati[a], Katiuscia Di Biagio[a], Emilia Prospero[a,*]

[a] Department of Biomedical Sciences and Public Health, Università Politecnica delle Marche, Ancona, Italy
[b] Azienda Ospedaliero-Universitaria delle Marche, Ancona, Italy

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ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic was associated with changes in infection prevention and control (IPC) measures and antimicrobial resistance epidemiology across healthcare settings.

Methods: We conducted a retrospective observational study assessing multidrug-resistant organisms (MDROs) in an Italian community hospital. The facility provides intermediate care, defined as a range of services aimed at facilitating the transition from hospital to home or long-term care. We compared the proportion of patients with infection-positive clinical cultures and MDRO-positive clinical cultures across three periods: pre-COVID-19 (January 2019 to January 2020), COVID-19 (February 2020 to March 2021) and post-COVID-19 (April 2021 to December 2023), defined according to the evolution of the disease in the Marche Region. Comparisons were performed using chi-square/Fisher exact tests and multivariable logistic regression.

Results: 903 patients were included in the study; 51% had infection-positive clinical cultures, and 30% had an MDRO-positive culture. All cultures were obtained from clinical specimens collected for diagnostic purposes; no surveillance screening cultures were performed. The proportion of patients with MDRO-positive cultures differed significantly across periods and was lowest during the COVID-19 period ($P = 0.013$), as confirmed in the multivariable analysis ($P = 0.004$). Urinary catheter and pressure sores were associated with increased odds of MDRO-positive clinical cultures.

Conclusions: In this cohort, the proportion of patients with MDRO-positive clinical cultures was lower during the COVID-19 period than in the post-COVID-19 period. Urinary catheter and pressure sores were independently associated with MDRO-positive clinical culture detection. This finding may reflect multiple concurrent factors, including changes in IPC practices and bed occupancy and highlight the need for continuous IPC improvements.

1. Introduction

Antimicrobial resistance (AMR) is the ability of microorganisms (viruses, bacteria, fungi and parasites) to survive or grow despite antimicrobial treatment [1]. AMR is a growing public health problem that increases morbidity and mortality. It is among the top 10 global health threats worldwide[2,3]. A European survey estimates 133 000 deaths AMR-related in the whole WHO European region in 2019 [4].

Inappropriate antibiotic use is considered one of the main drivers of the increasing burden of multidrug-resistant organism (MDRO) infections. During the coronavirus disease 2019 (COVID-19) pandemic, a high rate of inappropriate antibiotic prescriptions was described [5,6].

Several studies describe a significant increase in healthcare-associated infections and MDROs during the COVID-19 pandemic, largely due to healthcare system overload, increasing patient complexity and resource constraints [7–11]. Conversely, other evidence suggests that extensive infection prevention and control (IPC) measures implemented during the COVID-19 pandemic may have contributed to limiting the spread of MDROs [12].

While the impact of COVID-19 on MDROs has been extensively studied in acute-care settings, data from intermediate-care com-

* Corresponding author. Mailing address: Department of Biomedical Sciences and Public Health, Università Politecnica delle Marche, Via Tronto 10, 60126 Ancona, Italy.

E-mail address: e.prospero@staff.univpm.it (E. Prospero).

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Table 1
Demographic and clinical characteristics of patients admitted to the intermediate care unit according to the three study periods: Pre-COVID-19 (January 2019 to January 2020), COVID-19 (February 2020 to March 2021) and post-COVID-19 (April 2021 to December 2023).

	Total sample $N = 903$ n (%)	Pre-COVID-19 $N = 225$ n (%)	COVID-19 $N = 187$ n (%)	Post-COVID-19 $N = 491$ n (%)	P-value
Age, y, mean ± SD[a]	82.2 ± 9.9	82.6 ± 9.4	82.4 ± 9.7	81.8 ± 10.3	0.702
Males, *n* (%)	366 (41)	95 (42)	65 (35)	206 (42)	0.195
Place before hospitalization					
Hospital	576 (64)	142 (63)	100 (53)	334 (68)	<0.001
Home	224 (25)	65 (29)	47 (25)	112 (22.8)	0.001
Other structure	87 (10)	6 (3)	37 (20)	44 (9)	<0.001
Missing	16 (1)	12 (5)	3 (2)	1 (0.2)	
Length of stay, d, median (IQR[a])	26 (10–52)	29 (14–55)	20 (4–44)	27 (10–52)	0.005
Mortality, *n* (%)	250 (28)	50 (22)	60 (32)	140 (29)	0.073

[a] SD, standard deviation; IQR, interquartile range; missing was not included in the test.

munity hospital remain limited [13–15]. Intermediate care includes a range of services aimed at facilitating the transition from hospital to home or long-term care [16]. This setting hosts fragile patients with prolonged length of stay and frequent device use, representing a population at high risk of MDRO acquisition, but often underrepresented in surveillance studies. The aim of this study was to assess MDRO detection based on clinical cultures in an Italian community hospital in the Marche Region before, during and after the COVID-19 pandemic.

2. Methods

2.1. Study design

This was a retrospective observational study that included all patients admitted to the Intermediate Care Unit of the Community Hospital in Loreto (Ancona, Marche Region, Italy) between January 2019 and December 2023. This Community Hospital was an inpatient healthcare facility that served as an intermediate-care facility between acute hospital care and discharge home or to long-term care facilities. The Intermediate Care Unit provided continuous care to patients requiring close clinical monitoring and/or frequent nursing interventions. Nursing care was provided 24 h a day, 7 d a week. This ward had 25 nurses, 3 physicians and 7 general practitioners.

The Loreto facility received patients from private and public facilities throughout the surrounding area, as well as patients from their own homes. The intermediate care unit had 29 beds in 2019–2020, decreasing to 24 in the following 3 y due to COVID-19 restrictions. During the COVID-19 pandemic, the facility was declared COVID-free and remained so for almost a year. Patients with positive SARS-CoV-2 swabs or COVID-19 symptoms were not admitted. A SARS-CoV-2 swab was administered to each new admission. After approximately 1 y, the first SARS-CoV-2-positive patient was admitted. SARS-CoV-2-positive patients were placed in single rooms and rapidly transferred to dedicated isolation facilities whenever possible.

No exclusion criteria were applied. The study was approved by the Ethics Committee of the Polytechnic University of Marche on 02/08/2024 (protocol no. 0198638) and received an 'exempt' status for patients' consent due to the type of study. Patient anonymity was guaranteed throughout data collection, analysis and reporting process in accordance with the European General Data Protection Regulation 2016/679 [17].

2.2. Data collection

Clinical and nursing records of all patients were reviewed to extract demographic, clinical, device-related, microbiological and outcome variables relevant to MDRO-positive clinical culture detection. Three study periods were identified: pre-COVID-19 (January 2019 to January 2020), COVID-19 (February 2020 to March 2021) and post-COVID-19 (April 2021 to December 2023). These study periods were identified based on the evolution of the disease in the Marche Region starting from the first case recorded (February 2020) until the easing of containment measures (March 2021).

Data were retrospectively collected from the patients' clinical records and included: socio-demographic information (age, gender), clinical variables (date of admission and discharge, diagnosis at admission, comorbidities, pressure sores, length of stay), the use of medical devices, including central venous catheter, urinary catheter (UC), peripherally inserted central venous catheter and total parenteral nutrition, information on patient's place before hospitalization (home, hospital, nursing home) and discharge destinations (home, acute care hospital, nursing home, in-hospital death). All microbiological cultures performed during admission to the intermediate care unit were included in the analysis; no surveillance screening cultures were performed during admission or before admission to the unit. MDRO-positive patients were cohorted with patients carrying the same bacterial species; immunocompromised patients were placed in single rooms.

For Tables 1–3, percentages were calculated using patients as denominator; for Table 4, percentages were calculated using the total number of isolates of the same species in each period as denominator. For patient-level analyses (Tables 2 and 3), each patient was counted once according to the detection of at least one infection-positive or MDRO-positive clinical culture. For species-level analyses (Table 4), each bacterial species was counted once per patient; repeated isolation of the same species in the same patient was not counted more than once.

Infection-positive cultures were classified as present on admission if detected within 48 h before or after admission, and as detected >48 h after admission if identified later during the hospital stay [18]. For each identified microorganism, antimicrobial susceptibility testing results were reviewed to assess resistant patterns. AMR was defined according to breakpoints recommended by the European Committee for Antimicrobial Susceptibility Testing (EUCAST) [19]. MDROs were defined as non-susceptibility to at least one agent in three or more antimicrobial classes, in accordance with international consensus criteria [20]. Species-specific MDRO proportions were computed as the number of isolates with AMR positivity divided by the total number of isolates of the same species in each period. The organisms included in the MDRO analysis were *Acinetobacter baumannii, Enterococcus faecalis, Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa* and *Staphylococcus aureus* were the selected organisms included in the MDRO analysis.

Table 2
Comparison across three study periods of microbiological findings, multidrug-resistant organism (MDRO) detection, use of medical devices and pressure sores in patients admitted to the intermediate care unit.

	Total sample $N = 903$ n (%)	Pre-COVID-19 $N = 225$ n (%)	COVID-19 $N = 187$ n (%)	Post-COVID-19 $N = 491$ n (%)	P-value
Microbiological findings					
Patients with infection-positive culture	465 (51)	129 (57)	80 (43)	256 (52)	**0.012**
Patients with MDRO-positive culture	269 (30)	67 (30)	40 (21)	162 (33)	**0.013**
Infection-positive culture on admission	125 (14)	42 (19)	17 (9)	66 (13)	0.078
MDRO-positive culture on admission	53 (6)	15 (7)	8 (4)	30 (6)	0.558
Infection-positive culture detected >48 h after admission	340 (38)	87 (39)	63 (34)	190 (39)	0.454
Type of culture					
Patient with MDRO-positive urine culture	205 (23)	44 (20)	34 (18)	127 (26)	**0.044**
Patient with MDRO-positive blood culture	31 (3)	4 (2)	5 (3)	22 (4)	0.149
Patient with MDRO-positive other culture	53 (6)	17 (8)	4 (2)	32 (7)	**0.044**
Devices					
Patients with devices	661 (73)	149 (66)	124 (66)	388 (79)	**<0.001**
Patients with devices and infection-positive culture	371 (41)[a]	100 (44)	51 (27)	220 (45)	**<0.001**
Patients with devices and MDRO-positive culture	223 (25)	55 (24)	26 (14)	142 (29)	**<0.001**
UC	581 (64)	129 (57)	108 (58)	344 (70)	**<0.001**
CVC	55 (6)	17 (8)	7 (4)	31 (6)	0.261
PICC	169 (19)	43 (19)	34 (18)	92 (19)	0.971
MIDLINE venous catheter	154 (17)	24 (11)	33 (18)	97 (20)	**0.011**
TPN	38 (4)	12 (5)	3 (2)	23 (5)	0.127
Pressure sores	377 (42)	95 (42)	85 (45)	197 (40)	0.447

CVC, central venous catheter; PICC, peripherally inserted central venous catheter; TPN, total parenteral nutrition; UC, urinary catheter.
Boldface indicates statistical significance (P<0.05).
[a] The percentage was made over the total number of patients (903).

Table 3
Multivariable analysis of variables associated with the detection of MDROs among patients admitted to the intermediate care unit.

Variable	OR	95% CI	P-value
Age	1.01	0.99–1.03	0.088
Female (reference male)	0.93	0.68–1.29	0.694
Period (reference: post-COVID-19)			
Pre-COVID-19	0.81	0.53–1.22	0.306
COVID-19	0.51	0.32–0.81	**0.004**
Place before hospitalization (reference: home)			
Other structure	0.88	0.59–1.33	0.556
Hospital	1.04	0.56–1.93	0.904
Device (ref. absence of device)			
UC	2.11	1.43–3.13	**<0.001**
CVC	1.09	0.55–2.16	0.796
PICC	1.18	0.76–1.82	0.451
TPN	1.57	0.75–3.25	0.227
MIDLINE venous catheter	1.47	0.96–2.25	0.077
Pressure sores (reference no sores)	1.85	1.19–2.87	**0.007**
Length of stay	1.018	1.01–1.02	**<0.001**

CVC, central venous catheter; PICC, peripherally inserted central venous catheter; TPN, total parenteral nutrition; UC, urinary catheter.
Boldface indicates statistical significance (P<0.05).

During the COVID-19 pandemic, staff wore all the PPE required by the emergency and provided masks and handwashing supplies to patients and any visitors. To provide context regarding IPC practice during the study period, a schematic comparison between MDRO-related and COVID-19-related preventive measures is provided in the Supplementary Box [21]. The main difference in IPC during the COVID-19 pandemic was the use of medical mask or respirators and gowns; the application of airborne precautions; and enhanced room sanitization, in particular the use of ozone that was introduced during the COVID-19 pandemic.

In the post-COVID-19 period, the facility observed a shift in patient case-mix with fewer orthopaedic patients compared to previous years. It remains unclear whether these changes were related to the 2022 legislative reforms concerning community hospitals, other organizational factors or broader changes in referral patterns.

2.3. Statistical analysis

For descriptive analysis, absolute and relative frequencies were used for categorical variables, and chi-square or Fisher's exact test for group comparisons. For Tables 1–3, percentages were calculated using patients as the denominator. For Table 4, species-specific MDRO proportions were calculated as the number of MDRO-

Table 4
Species-specific proportion of MDRO-positive cultures across study periods.

MDRO Isolates	Pre-COVID-19 [a]n (%)	COVID-19 [a]n (%)	Post-COVID-19 [a]n (%)	P-value
Acinetobacter baumannii	4 (100)	4 (100)	16 (100)	NA
Enterococcus faecalis	3 (14)	6 (40)	17 (43)	0.274
Escherichia coli	17 (44)	10 (45)	22 (36)	0.241
Klebsiella pneumoniae	9 (39)	7 (47)	36 (69)	0.085
Proteus mirabilis	14 (61)	12 (71)	36 (80)	0.830
Pseudomonas aeruginosa	2 (8)	3 (21)	9 (24)	0.634
Staphylococcus aureus	6 (55)	3 (60)	5 (45)	0.253

[a] n = number of MDRO isolates; % = MDRO isolates/total isolates of the same species in that period.

positive isolates divided by the total number of isolates of the same species in each study period.

The study also evaluated the proportion of bacterial species isolated from clinical cultures and the proportion of MDRO-positive clinical cultures. Continuous variables were summarized as means and standard deviations or medians and interquartile range, as appropriate. ANOVA or Kruskal–Wallis test was done to compare age and length of stay across the three study periods. A multiple logistic regression model was developed to identify variables associated with MDRO-positive clinical culture detection. Age and length of stay were entered as continuous variables in the multivariable logistic regression model. Variables considered clinically relevant, together with variables associated with MDRO-positive clinical culture detection in univariable analysis, were included in the multivariable model. The area under the ROC curve was calculated to assess the discrimination of the multivariable logistic regression model. Patients' isolation was not included in the multivariate analysis because cohorting/isolation was applied as a facility policy across the study periods and reliable individual-level isolation exposure data were not available. Analyses were performed using STATA (StataCorp LLC, College Station, TX 322, USA), version 18. A two-sided P-value <0.05 was considered statistically significant.

3. Results

The Intermediate Care Unit in the Community Hospital included 29 beds in the 2019–2020 period, which were subsequently reduced to 24 in the following 3 y, due to COVID-19-related restrictions. A total of 903 patients were admitted to the facility during the study period. Table 1 shows the main characteristics of the study population across the three periods. The mean age of patients was 82.2 y (standard deviation ± 9.9) with no significant differences among periods. Overall, 41% of patients were male. Patients' admission source differed significantly across periods, with the highest proportion of admissions from acute care hospitals observed in the post-COVID-19 period ($P < 0.001$). Admission from home showed significant variation over time ($P = 0.001$) (Table 1). The median length of stay was 26 d (interquartile range 10–52) with a shorter median length of stay during the COVID-19 period than the pre- and post-COVID-19 periods. In-hospital mortality increased during the COVID-19 pandemic, although this difference did not reach statistical significance ($P = 0.073$).

3.1. Infection-positive and MDRO-positive clinical cultures

Overall, 465 patients (51%) had at least one infection-positive clinical culture during admission. MDRO-positive clinical cultures were identified in 269 patients, corresponding to 30% of the total study population and 58% of patients with at least one infection-positive clinical culture.

The proportion of patients with infection-positive clinical cultures and MDRO-positive clinical cultures varied significantly across the three study periods ($P = 0.012$ and $P = 0.013$), with a reduction observed during the COVID-19 period, followed by an increase in the post-COVID-19 period (Table 2). No statistically significant differences were observed in the proportion of infection-positive clinical cultures on admission or those observed >48 h after admission across the three study periods ($P = 0.078$ and $P = 0.454$, respectively).

During the observation periods, several microbiological analyses were performed. The number of patients with MDRO-positive urine cultures was 205 (23%), and those with MDRO-positive blood cultures were 31 (3%). The proportion of patients with MDRO-positive urine cultures differed significantly across the three periods, with the highest value observed in the post-COVID-19 period ($P = 0.044$), whereas no significant differences were observed for blood cultures ($P = 0.149$) (Table 2).

3.2. Medical devices and microbiological positivity

The proportion of patients with devices increased significantly across the study periods, as did the proportion of patients with devices who had infection-positive microbiological cultures or MDRO-positive clinical cultures ($P < 0.001$ for all comparisons).

Among the different devices analysed, the use of UCs and midline catheters increased significantly over time ($P < 0.001$ and $P = 0.011$, respectively). Pressure sores slightly decreased across periods; however, these differences did not reach statistical significance (42% to 40%, $P = 0.447$) (Table 2).

3.3. Variable associated with MDRO positivity

Multivariate logistic regression analysis was performed to evaluate factors associated with MDRO-positive clinical culture detection (Table 3). The COVID-19 period was independently associated with lower odds of MDRO detection than the post-COVID-19 period ($P = 0.004$). In contrast, the presence of a UC, pressure sores and longer length of stay were associated with significantly higher odds of MDRO-positive clinical culture detection ($P < 0.001$, $P = 0.007$ and $P < 0.001$). Isolation was not included in the multivariate analysis because cohorting/isolation was applied as a facility policy across the study periods and reliable individual-level exposure data were not available. The area under the ROC curve of the multivariable model was 0.70, indicating acceptable discrimination.

3.4. Microbiological findings

A total of 34 different bacterial species were identified in infection-positive cultures. The most frequently isolated species were *E. coli* (115 isolates, 19%), *K. pneumoniae* (84 isolates, 14%), *P. mirabilis* (90 isolates, 15% of the total), *P. aeruginosa* (70 isolates, 11%) and *E. faecalis* (63 isolates, 10%). For each identified microorganism, antimicrobial susceptibility testing was reviewed to assess multidrug resistance. The frequency of multidrug resistance varied widely according to the bacterial species, ranging from 100% for *A. baumannii* to 8% for *P. aeruginosa*; these estimate should be interpreted cautiously because of the limited number of isolates for some species.

The analysis of multidrug resistance across the three study periods revealed a general upward trend in resistance proportions for several species, although none of these changes reached statistical significance (all $p > 0.05$) (Table 4).

4. Discussion

This study compared MDRO-positive clinical culture detection across pre-pandemic, pandemic and post-pandemic periods in an Intermediate Care Unit of a Community Hospital (CH). The Marche regional legislation on Community Hospitals is based on framework laws such as the Regional Law 21/2016 and the Regional Law 19/2022, establishing that Community Hospitals are healthcare facilities for Intermediate Care, aimed at ensuring continuity of care between acute and community care [13].

Intermediate care promotes the transition from the hospital to community care and is characterized by prolonged length of stay, high nursing care needs and frequent use of invasive devices. It also supports protected discharge, as indicated by the National Recovery and Resilience Plan (PNRR) and Ministerial Decree 77/2022 [22,23]. Intermediate care differs from acute-care hospitals because it generally manages clinically stable but frail patients requiring prolonged nursing care, rehabilitation, monitoring and frequent device use. In contrast, acute-care settings manage sudden, severe or unstable conditions requiring higher-intensity diagnostics and treatment. These differences may affect MDRO epidemiology through different case-mix, length of stay, device exposure, antibiotic pressure and microbiological sampling practices. Therefore, findings from acute-care studies on pandemic-related AMR trends may not be directly generalizable to community hospital intermediate-care settings [24].

The results of our study show that more than half of the infection-positive cultures were detected during the stay in the Intermediate Care Unit. This finding may be related to the prolonged hospitalization and extended use of medical devices typical of this setting. Overall, 51% of patients had at least one infection-positive clinical culture, and 58% of these patients had at least one MDRO-positive clinical culture. Mortality of patients with MDRO-positive culture did not significantly differ in three periods (42%, 23% and 30%, respectively, $P = 0.204$), in line with data reported in another Italian study, conducted in comparable geriatric and post-acute setting [15].

The COVID-19 period was independently associated with lower odds of MDRO-positive culture detection than the post-COVID-19 period, as confirmed by the multivariate analysis ($P = 0.004$). Enhanced IPC measures during the COVID-19 pandemic may have contributed to lower MDRO-positive clinical culture detection, observed during this period; however, many pandemic-related measures overlapped with those routinely used for MDRO control. The structural changes applied during the COVID-19 pandemic, even in a community hospital setting (such as reduction of bed number and improvement of environmental cleaning), may also partly explain the reduction in MDRO detection during the COVID-19 period. In the post-COVID-19 period, moreover, a shift in the patient case-mix was also observed, with fewer orthopaedic patients than in previous years; this may have also contributed to the increased rates of MDRO-positive culture in comparison to the COVID-19 period.

In the multicentre acute-care study by Meschiari et al. [25], pandemic-related changes in IPC and antibiotic use were associated with heterogeneous AMR trends across countries, whereas our single-centre intermediate-care study showed lower MDRO-positive clinical culture detection during the COVID-19 period. Another study reported changes in MDRO detection and AMR during the COVID-19 pandemic, including increases in some European countries, Israel and United States [26]. They showed that MDRO rates varied greatly by countries and the factors associated with AMR onset included illness severity, comorbidities and prior exposure to antibiotics [26]. The discrepancy with our findings may be due to the different care setting (multicentre/acute care vs. single centre/intermediate care).

A recent review highlights that despite regional variations in MDRO prevalence – such as a significant increase in Asia (18%) and a decrease in North America (10.3%) – the overall odds ratio (OR = 0.91; 95% CI: 0.70–1.17) indicates no significant global change between the pre-COVID-19 and COVID-19 periods [27]. Our single-centre data also show no significant difference in the proportion of patients with MDRO-positive clinical cultures between pre-COVID-19 period and COVID-19 period.

In other studies, *E. coli* was the most commonly isolated bacterium, followed by *K. pneumoniae, P. mirabilis, A. baumannii* and *S. aureus* in the post-COVID-19 period [28–32]. In our study, species-specific MDRO for *E. faecalis, K. pneumoniae, P. mirabilis* and *P. aeruginosa* had an increasing trend, but it was not significant across the three study periods.

The significant difference observed in patient-level MDRO-positive clinical culture detection across periods should not be interpreted as a significant change in species-specific resistance proportions. Table 2 uses patients as the denominator and evaluates whether each patient had at least one MDRO-positive clinical culture. In contrast, Table 4 uses species-specific isolate denominators and evaluates, for each bacterial species, the proportion of isolates classified as MDRO in each period. Therefore, the post-COVID-19 increase in the proportion of patients with MDRO-positive clinical cultures may reflect changes in patient case-mix, device use, sampling patterns and the number of clinically positive cultures, even in the absence of statistically significant changes in species-specific MDRO proportions.

The observed increase in the proportion of patients with at least one MDRO-positive culture aligns with findings from several systematic reviews and observational studies, which report a rising trend in MDRO detection both during and after the COVID-19 pandemic [10,25–32]. Similarly, a 2022 CDC report described marked post-COVID-19 pandemic MDRO increases in US hospitals, particularly for *A. baumannii, P. aeruginosa* and *S. aureus* [32].

The microbiological analysis of urine cultures mainly identified *E. coli, E. faecalis, K. pneumoniae* and *P. mirabilis*, in agreement with findings from other Italian and international studies [31,32]. This distribution highlights the burden of MDROs in patients requiring prolonged care and invasive devices in intermediate care units.

This study has some limitations. First, its retrospective design and single-centre nature limit the generalizability of the findings; in particular, some parameters could not be evaluated, such as comorbidity burden, severity of illness and extent of device exposure. Second, detailed data on adherence to specific infection prevention measures, such as PPE use and environmental sanitization protocols, were not available. Another limitation is the use of clinical samples, which were not collected systematically from all patients and therefore may not reliably estimate MDRO prevalence, especially for opportunistic pathogens such as the majority of MDRO. The microbiological findings of clinical samples, moreover, were of different clinical importance (e.g. urine cultures vs. blood cultures, etc.). Despite these limitations, this study provides useful data from an underrepresented intermediate care setting. However, this study also had relevant results. MDRO data in intermediate care remain scarce despite the rapid expansion of this setting in Italy, due to population ageing, increasing patients' frailty and the reorganization of territorial health care services. In addition, the comparison across three distinct periods allowed us to identify temporal trends that may be important for infection prevention strategies.

5. Conclusions

In this single-centre intermediate-care cohort, the proportion of patients with MDRO-positive clinical cultures was lower during the COVID-19 period and increased again in the post-COVID-19 period. UC use, pressure sores and longer length of stay were independently associated with MDRO-positive clinical culture detection. Because only clinical cultures were analysed, no systematic screening was performed, and relevant case-mix changes occurred across periods, these findings should be interpreted as associations rather than evidence of a causal effect of IPC measures.

Declaration of competing interests: The authors report no conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jgar.2026.06.025.

References

[1] Tang KWK, Millar BC, Moore JE. Antimicrobial resistance (AMR). Br J Biomed Sci 2023;80:11387.

[2] Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet 2022;399:629–55.
[3] World Health Organization (WHO) Antimicrobial resistance, Geneva: World Health Organization; 2023. Available at: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance.
[4] World Health Organization (WHO). Antimicrobial resistance, 2024. Available at: https://www.who.int/europe/news-room/fact-sheets/item/antimicrobial-resistance#:~:text=In%20the%20WHO%20European%20Region,expenditure%20and%20workforce%20productivity%20losses.
[5] Calderón-Parra J, Muiño-Miguez A, Bendala-Estrada AD, Ramos-Martínez A, Muñez-Rubio E, Fernández Carracedo E, et al. Inappropriate antibiotic use in the COVID-19 era: factors associated with inappropriate prescribing and secondary complications. Analysis of the registry SEMI-COVID. PLoS One 2021;16:e0251340. doi:10.1371/journal.pone.0251340.
[6] Romaní L, León-Figueroa DA, Rafael-Navarro D, Barboza JJ, Rodriguez-Morales AJ. Association between the use of antibiotics and the development of acute renal injury in patients hospitalized for COVID-19 in a hospital in the Peruvian Amazon. J Clin Med 2022;11:4493. doi:10.3390/jcm11154493.
[7] Petrakis V, Panopoulou M, Rafailidis P, Lemonakis N, Lazaridis G, Terzi I, et al. The impact of the COVID-19 Pandemic on antimicrobial resistance and management of bloodstream infections. Pathogens 2023;12:780. doi:10.3390/pathogens12060780.
[8] Peconi C, Martini E, Sarti D, Prospero E. Impact of the COVID-19 pandemic on healthcare-associated infections and multidrug-resistant microorganisms in Italy: a systematic review. J Infect Public Health 2025;18:102729.
[9] Abubakar U, Al-Anazi M, Alanazi Z, Rodríguez-Baño J. Impact of COVID-19 pandemic on multidrug resistant gram positive and gram negative pathogens: a systematic review. J Infect Public Health 2023;16:320–31.
[10] Langford BJ, Soucy JR, Leung V, So M, Kwan ATH, Portnoff JS, et al. Antibiotic resistance associated with the COVID-19 pandemic: a systematic review and meta-analysis. Clin Microbiol Infect 2023;29:302–9.
[11] Kariyawasam RM, Julien DA, Jelinski DC, Larose SL, Rennert-May E, Conly JM, et al. Antimicrobial resistance (AMR) in COVID-19 patients: a systematic review and meta-analysis (November 2019-June 2021). Antimicrob Resist Infect Control 2022;11:45.
[12] Bentivegna E, Luciani M, Arcari L, Santino I, Simmaco M, Martelletti P. Reduction of multidrug-resistant (MDR) bacterial infections during the COVID-19 pandemic: a retrospective study. Int J Environ Res Public Health 2021;18:1003.
[13] López-Jardón P, Martínez-Fernández MC, García-Fernández R, Martín-Vázquez C, Verdeal-Dacal R. Utility of intermediate care units: a systematic review study. Healthcare (Basel) 2024;12:296.
[14] Bezabih YM, Bezabih A, Dion M, Batard E, Teka S, Obole A, et al. Comparison of the global prevalence and trend of human intestinal carriage of ESBL-producing *Escherichia coli* between healthcare and community settings: a systematic review and meta-analysis. JAC Antimicrob Resist 2022;4:dlac048. doi:10.1093/jacamr/dlac048.
[15] Gasperini B, Cherubini A, Lucarelli M, Espinosa E, Prospero E. Multidrug-resistant bacterial infections in geriatric hospitalized patients before and after the COVID-19 outbreak: results from a retrospective observational study in two geriatric wards. Antibiotics (Basel) 2021;10:95.
[16] Melis RJ, Olde Rikkert MG, Parker SG, van Eijken MI. What is intermediate care? BMJ 2004;329:360–1. doi:10.1136/bmj.329.7462.360.
[17] EU Regulation 2016/679, General Data Protection Regulation, of the European Parliament and of the Council of 27 April 2016. Available at: https://eur-lex.europa.eu/legal-content/it/TXT/?uri=CELEX:32016R0679.
[18] Centers for Disease Control and Prevention (CDC) Management of Multidrug-Resistant Organisms in Healthcare Settings, Atlanta: Centers for Disease Control and Prevention; 2006. Available at: https://www.cdc.gov/infection-control/hcp/mdro-management/index.html#toc.
[19] EUCAST, The European Committee on Antimicrobial Susceptibility Testing. Breakpoint tables for interpretation of MICs and zone diameters, version 16.0. 2026. Available at: https://eucast.org/clinical_breakpoints/.
[20] Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect 2012;18:268–81.
[21] Istituto superiore della Sanità, ISS, Rapporto ISS COVID-19 – n. 1/2020 “Indicazioni ad interim per l’effettuazione dell’isolamento e della assistenza sanitaria domiciliare nell’attuale contesto COVID-19”. Available at: https://www.epicentro.iss.it/coronavirus/sars-cov-2-rapporti-tecnici-iss.
[22] Gasperini B, Pelusi G, Frascati A, Sarti D, Dolcini F, Espinosa E, et al. Predictors of adverse outcomes using a multidimensional nursing assessment in an Italian community hospital. PLoS One 2021;16:e0249630. doi:10.1371/journal.pone.0249630.
[23] Vinceti SR. Reorganizing Italy’s Territorial Healthcare: the Ministerial Decree No. 77/2022 and its comparative significance. Ann Ig 2023;35:367–71. doi:10.7416/ai.2023.2556.
[24] Hirshon JM, Risko N, Calvello EJ, Stewart de Ramirez S, Narayan M, Theodosis C, et al. Health systems and services: the role of acute care. Bull World Health Organ 2013;91:386–8. doi:10.2471/BLT.12.112664.
[25] Meschiari M, López Lozano JM, Medioli F, Bacca E, Sarti M, Cancian L, et al. A time series analysis approach to quantify change in antibiotic resistance and antibiotic consumption during the COVID-19 pandemic epidemics: a multicentre cross-national ecological study on behalf of QUantifying change in Antibiotic resistance, ANTibiotic use, and INfection control during the COVID-19 pandemic Epidemics study project. Clin Microbiol Infect 2025;31:1500–9. doi:10.1016/j.cmi.2025.06.009.
[26] Yek C, Mancera AG, Diao G, Walker M, Neupane M, Chishti EA, et al. Impact of the COVID-19 pandemic on antibiotic resistant infection burden in U.S. hospitals: retrospective cohort study of trends and risk factors. Ann Intern Med 2025;178:796–807. doi:10.7326/ANNALS-24-03078.
[27] Stefanini I, De Renzi G, Foddai E, Cordani E, Mognetti B. Profile of bacterial infections in COVID-19 patients: antimicrobial resistance in the time of SARS-CoV-2. Biology (Basel) 2021;10:822. doi:10.3390/biology10090822.
[28] Ahmed H, Abideen ZU, Azmat A, Irfan M, Anjum S, Dirie A. Impact of COVID-19 on the prevalence of multi-drug-resistant bacteria: a literature review and meta-analysis. Antonie Van Leeuwenhoek 2025;118:165. doi:10.1007/s10482-025-02181-x.
[29] Khoshbakht R, Kabiri M, Neshani A, Khaksari MN, Sadrzadeh SM, Mousavi SM, et al. Assessment of antibiotic resistance changes during the Covid-19 pandemic in northeast of Iran during 2020-2022: an epidemiological study. Antimicrob Resist Infect Control 2022;11:121.
[30] Gavi F, Fiori B, Gandi C, Campetella M, Bientinesi R, Marino F, et al. Prevalence and antimicrobial resistance patterns of hospital acquired infections through the COVID-19 pandemic: real-world data from a tertiary urological centre. J Clin Med 2023;12:7278.
[31] Zand F, Vakili H, Asmarian N, Masjedi M, Sabetian G, Nikandish R, et al. Unintended impact of COVID-19 pandemic on the rate of catheter related nosocomial infections and incidence of multiple drug resistance pathogens in three intensive care units not allocated to COVID-19 patients in a large teaching hospital. BMC Infect Dis 2023;23:11.
[32] Centers for Disease Control and Prevention (CDC) COVID-19: US impact on antimicrobial resistance, special report 2022, Atlanta, GA: US Department of Health and Human Services, CDC; 2022. Available at: https://www.cdc.gov/drugresistance/covid19.html.