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Major Article

Clusters of emerging multidrug-resistant organisms in US health care facilities during the initial months of the SARS-CoV-2 pandemic

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Background: Outbreaks of emerging multidrug-resistant organisms (eMDROs), including carbapenem-resistant Enterobacterales, carbapenem-resistant *Acinetobacter baumannii*, and *Candida auris*, have been reported among severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) patients. We describe eMDRO clusters in SARS-CoV-2 units and associated infection control (IC) practices early in the SARS-CoV-2 pandemic.
Methods: We conducted a retrospective survey of a convenience sample of health departments in 11 states to describe clusters of eMDROs that began before November 1, 2020 and involved SARS-CoV-2 units. Cluster characteristics and IC practices during the cluster period were assessed using a standardized outbreak report form, and descriptive analyses were performed.
Results: Overall, 18 eMDRO clusters (10 carbapenem-resistant Enterobacterales, 6 *C auris*, 1 carbapenem-resistant *Pseudomonas aeruginosa*, and 1 carbapenem-resistant *A baumannii*) in 18 health care facilities involving 397 patients were reported from 10 states. During the cluster period, 60% of facilities reported a shortage of isolation gowns, 69% extended use of gowns, and 67% reported difficulty obtaining preferred disinfectants. Reduced frequency of hand hygiene audits was reported in 85% of acute care hospitals during the cluster period compared with before the pandemic.
Conclusions: Changes in IC practices and supply shortages were identified in facilities with eMDRO outbreaks during the SARS-CoV-2 pandemic and might have contributed to eMDRO transmission.

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BACKGROUND

Emerging multidrug-resistant organisms (eMDROs) typically associated with health care, such as carbapenem-resistant *Acinetobacter baumannii* (CRAB), carbapenem-resistant Enterobacterales (CRE), carbapenem-resistant *Pseudomonas aeruginosa* (CRPA), and *Candida auris* represent a substantial threat to public health due to their ability to spread rapidly.[1,2] These organisms affect vulnerable patient populations and exploit gaps in infection control (IC) to spread silently from patient-to-patient within health care facilities.[3,4] During the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic, several eMDRO threats increased nationally, including clinical cases of hospital-onset CRE, hospital-onset *Acinetobacter spp*, hospital-onset multidrug-resistant *P aeruginosa,* and *C auris*.[2]

Outbreaks of eMDROs among SARS-CoV-2 patients in acute care hospitals (ACHs) have been reported, including clusters of *C auris*, CRAB, and CRE.[5–9] Factors thought to have contributed to the size and severity of these outbreaks included the presence of critically ill SARS-CoV-2 patients, staff and personal protective equipment (PPE) shortages, implementation of PPE supply conservation strategies (eg, extended use of isolation gowns), and general disruptions of facilities' standard IC practices including reduced adherence to hand hygiene and PPE use, lack of cleaning of mobile medical equipment, and reductions in indwelling device maintenance rounds.[5–9] These reports have primarily described single-center outbreaks in ACHs and do not include reports from post–acute care facilities (PACFs) such as nursing homes. In addition, to date, no studies have systematically described the extent of eMDRO clusters and associated IC practices on SARS-CoV-2 treatment and observation units across different health care settings in the United States.

In response to multiple eMDRO clusters on SARS-CoV-2 units across different health care settings reported to the US Centers for Disease Control and Prevention (CDC) and health departments during the initial months of the SARS-CoV-2 pandemic, we aimed to systematically describe these clusters and IC practices in SARS-CoV-2 treatment and observation units among a convenience sample of US health departments.

METHODS

Cluster definition

We defined eMDROs as CRE, CRAB, CRPA, or *C auris*, isolated from any specimen source, or identification of a carbapenemase gene (bla_{KPC}, $bla_{OXA\text{-}48\text{-}like}$, bla_{NDM}, bla_{VIM}, bla_{IMP}, $bla_{OXA\text{-}23\text{-}like}$, $bla_{OXA\text{-}24/40}$, or $bla_{OXA\text{-}235}$) without the associated organism from a surveillance specimen. Clusters were defined as suspected or confirmed eMDRO transmission on a unit caring for patients or residents with SARS-CoV-2 infection or under observation for possible SARS-CoV-2 infection (SARS-CoV-2 unit) with index case specimen collection date before November 1, 2020. Clusters that began prior to the onset of the pandemic, March 1, 2020, were included if transmission continued during the pandemic and affected SARS-CoV-2 units.

Project design and settings

We conducted a systematic retrospective survey of health departments in the United States to describe eMDRO clusters that occurred on COVID-19 units in health care facilities within their jurisdictions. In early October 2020, the CDC asked 56 Healthcare-Associated Infection and Antibiotic Resistance Programs (HAI/AR programs[10]) at state and local health departments about their interest in completing a retrospective standardized outbreak report form (Appendix) for all clusters of eMDROs identified in SARS-CoV-2 treatment and observation units in health care facilities in their jurisdiction. Health care facilities were classified as ACHs or PACFs, which included long-term ACHs, ventilator-capable skilled nursing facilities, and other skilled nursing facilities. Programs that agreed to participate provided feedback on the development of the standardized outbreak report form and completed one form for each cluster. Forms were submitted electronically to the CDC using Research Electronic Data Capture (Vanderbilt University). The form collected facility and cluster characteristics, the number of patients associated with each cluster, patient outcomes, IC practices, changes in IC practices and frontline health care personnel (HCP) staffing due to the SARS-CoV-2 pandemic, the local epidemiology of eMDROs and SARS-CoV-2, and free-text fields to elicit perceived barriers to implementing changes recommended by HAI/AR programs in outbreak facilities to prevent eMDRO transmission. These data were reported for each cluster period, defined as 2 weeks prior to detection of the individual cluster until the transmission was controlled or through the time of survey completion if the transmission was ongoing.

Data collection and analytic methods

Data were collected and managed using Research Electronic Data Capture[11,12] electronic data capture tools hosted at CDC and were analyzed using R version 4.1.0 and version 4.3.1 software (R Foundation for Statistical Computing). A descriptive analysis was conducted for survey responses, including facility and cluster characteristics and IC practices that were reported during cluster periods. Results are reported overall for all clusters and stratified by health care facility type (ie, ACH or PACF). Pooled proportions across clusters and associated standard errors (SEs) were calculated for the proportion of patients that were identified by screening tests, the proportion of patients with any clinical culture with an eMDRO isolated, the proportion of patients coinfected with SARS-CoV-2, and the proportion of patients who expired within 30 days of specimen collection. Statistical comparisons between these proportions by health care facility type were conducted using a 2-proportion z test with Yates continuity correction implemented if fewer than 5 cases were detected in either facility type.

Project approval

This activity was reviewed by CDC and conducted consistent with the applicable federal law and CDC policy. It was determined to meet the requirements of public health surveillance as defined in 45 Code of Federal Regulations (CFR) 46.102(l)(2) (see, eg, 45C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq). This work did not receive any funding support.

RESULTS

Twelve HAI/AR programs (in 1 local and 11 state health departments) from 11 states, agreed to complete outbreak report forms that were submitted by March 12, 2021. Eleven of 12 HAI/AR programs reported ≥1 cluster of eMDROs involving SARS-CoV-2 treatment or observation units. One state health department HAI/AR program reported no clusters, and 1 state health department HAI/AR program only reported data for 2/4 (50%) clusters that occurred in their jurisdiction during the period of investigation. Overall, 18 clusters of CRE (n = 10), *C auris* (n = 6), CRPA (n = 1), and CRAB (n = 1) (Table 1) were reported: 4 clusters began prior to March 1, 2020, and continued during the SARS-CoV-2 pandemic and 14 began on or after March 1, 2020. Among the 17 clusters with information available, 5 (29%) were first recognized in a non-SARS-CoV-2 unit and later spread to a SARS-

Table 1
Characteristics of clusters of eMDROs involving SARS-CoV-2 treatment and observation units in ACHs and PACFs, 10 states, United States

N (%)	Total	Clusters in ACHs	Clusters in PACFs*
	N = 18	N = 11	N = 7
Facility characteristics			
Facility type			
Short-stay acute care hospital	11 (61%)	11 (100%)	-
Long-term acute care hospital	1 (6%)	-	1 (14%)
Ventilator-capable skilled nursing facility	4 (22%)	-	4 (57%)
Other skilled nursing facility	2 (11%)	-	2 (29%)
Number of licensed beds			
≤50	1 (6%)	0 (0%)	1 (14%)
51 to 200	5 (28%)	3 (27%)	2 (29%)
201 to 500	9 (50%)	5 (45%)	4 (57%)
Over 500	3 (17%)	3 (27%)	0 (0%)
Organisms			
Candida auris	6 (33%)	3 (27%)	3 (43%)
Carbapenem-resistant *Acinetobacter baumannii*†	1 (6%)	1 (9%)	0 (0%)
Carbapenem-resistant *Pseudomonas aeruginosa*‡	1 (6%)	1 (9%)	0 (0%)
Carbapenem-resistant Enterobacterales§	10 (56%)	6 (55%)	4 (57%)
Characteristics of unit(s) with transmission			
Type of unit in which eMDRO transmission was *initially* identified *(17 clusters)*			
Dedicated SARS-CoV-2 treatment or observation unit	7 (41%)	5 (50%)	2 (29%)
Unit with a mixture of patients or residents with confirmed or suspected SARS-CoV-2 infection, under observation for SARS-CoV-2 infection, or not known to have SARS-CoV-2 infection	5 (29%)	3 (30%)	2 (29%)
Unit exclusively for patients or residents not known to have SARS-CoV-2 infection nor under observation for infection**	5 (29%)	2 (20%)	3 (43%)
More than 1 unit affected	9 (50%)	8 (73%)	1 (14%)
Contextual factors			
Cluster is part of a larger outbreak involving multiple facilities	6 (33%)	4 (36%)	2 (29%)
Outbreak was ongoing at the time of survey *(16 clusters)*	4 (25%)	3 (27%)	1 (20%)
SARS-CoV-2 transmission†† in the surrounding community during the cluster period‡‡ (17 clusters)			
No to minimal	4 (24%)	2 (18%)	2 (33%)
Minimal to moderate	4 (24%)	1 (9%)	3 (50%)
Moderate to substantial	7 (41%)	6 (55%)	1 (17%)
Community transmission changed substantially over the cluster period	2 (12%)	2 (18%)	0 (0%)

NOTE. Denominators may vary by small n due to nonresponse.
Clusters were reported by 1 local and 10 state health departments in 10 US states.
ACH, acute care hospital; *eMDRO*, emerging multidrug-resistant organism; *PACF*, post–acute care facility; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.
*Post–acute care facilities include long-term acute care hospitals, ventilator-capable skilled nursing facilities, and other skilled nursing facilities.
†Carbapenemase genes detected in the *A baumannii* cluster were OXA-23-like and OXA-24/40-like.
‡Carbapenemase gene detected in the *Pseudomonas aeruginosa* cluster was VIM.
§Among 9 carbapenem-resistant Enterobacterales clusters, the following genes were detected: KPC (3 clusters), NDM (6 clusters), and OXA-48 (1 cluster); isolates in 1 carbapenem-resistant Enterobacterales cluster did not undergo carbapenem resistance mechanism testing.
**These clusters were first identified in a unit dedicated for patients or residents not known to have SARS-CoV-2 infection nor under observation for infection but subsequently affected patients or residents in SARS-CoV-2 treatment or observation unit(s).
††SARS-CoV-2 transmission levels were determined by submitting health departments based on their perception of transmission at the time and were categorized as no to minimal (evidence of isolated cases or limited community transmission, case investigations underway, and no evidence of exposure in large communal settings); minimal-to-moderate transmission (sustained transmission with high likelihood or confirmed exposure within communal settings and potential for rapid increase in cases); moderate-to-substantial transmission (large-scale community transmission, including communal settings [eg, schools, workplaces]). Two clusters occurred when community transmission level substantially changed: in both, SARS-CoV-2 community transmission was extremely high early in the cluster period for 3 months and began to decline in the following months.
‡‡Cluster period: the 2-week period prior to detection of the cluster until transmission was controlled or through the time of survey completion if transmission was ongoing.

CoV-2 treatment or observation unit. Seven (41%) clusters occurred in facilities located in communities with moderate-to-substantial SARS-CoV-2 transmission (Appendix) during the cluster period, and 10 (59%) occurred in jurisdictions where the eMDRO was considered endemic or regional, or interregional spread had been identified.

The clusters affected 345 patients in 11 ACHs (median [interquartile range]: 29 [7, 36] patients per cluster) and 52 patients or residents in 6 PACFs (median [interquartile range]: 9 [4.5, 12] patients per cluster), all of which were skilled nursing facilities. One additional cluster in a long-term ACH did not have information available on the number of affected patients. Among the 17 clusters with information available, the pooled proportion of patients that were identified by screening tests was 65% (SE% = 2%), and the pooled proportion of patients with any clinical culture with an eMDRO isolated was 67% (SE% = 2%). The pooled proportion of patients coinfected with SARS-CoV-2 was 54% (SE% = 3%) among the 16 clusters with information available, and the pooled proportion of patients who expired within 30 days of specimen collection was 37% (SE% = 3%) among the 11 clusters with information available. ACHs had a lower proportion of patients in all outbreaks identified by screening tests (pooled proportion [SE]: 63% [3%], n = 11 clusters) compared with PACFs (pooled proportion [SE]: 77% [6%], n = 6 clusters; pooled z-test *P* value: .024); a higher proportion of patients coinfected with SARS-CoV-2 (pooled proportion [SE]: 62% [3%], n = 10 clusters) compared with PACFs (pooled proportion [SE]: 6% [3%], n = 6 clusters; pooled z-test *P* value: < .001); and a higher proportion of patients who expired within 30 days of specimen collection (pooled proportion [SE]: 43% [3%], n = 6 clusters) compared with PACFs (pooled proportion [SE]: 2% [2%], n = 5 clusters; pooled z-test *P* value: < .001). In one cluster, 83% of patients expired within 30 days of specimen collection. This was a large CRAB outbreak that occurred in 2 SARS-CoV-2 intensive care units at an ACH and involved 96 patients, all of whom were coinfected with SARS-CoV-2. Excluding this cluster, the pooled proportion of patients who expired within 30 days of specimen collection was 19% (SE% = 3%).

Reported changes in frontline HCP staffing were common during the cluster period. Ten (71%) facilities, among the 14 with information available, increased use of contracted or agency HCP relative to prepandemic practices, and 8 (53%) reassigned HCP to units with a different patient acuity from those where they typically worked (Table 2). In 7 (58%), cleaning duties were reassigned to HCP providing direct patient care. Shortages of alcohol-based hand sanitizers and difficulty obtaining a facility's preferred disinfectant product(s) were reported in 5 (31%) and 8 (67%) facilities, respectively.

Among 15 facilities with information available regarding PPE availability during the cluster period, 9 (60%) reported experiencing a shortage of isolation gowns, and 1 (7%) reported experiencing a shortage of gloves (Table 2). Extended use of gowns, where HCP wore the same gown when interacting with more than 1 patient, was widely practiced, irrespective of actual shortage (8 [80%] ACHs and 3 [50%] PACFs); 4 (25%) facilities extended gown use between patients without considering whether patients had a history of multidrug-resistant organism (MDRO) colonization or infection. Gowns were also reused in 6 (67%) ACHs and 2 (33%) PACFs, such that the same gown was donned, doffed, stored, and then redonned for more patient encounters; in 2 (25%) ACHs, HCP extended the use of gowns and reused the same gown for multiple patients. In some facilities, HCP extended the use of gloves without changing them between patients or tasks (n = 3, 19%) or wore multiple layers of gloves (n = 4, 29%). All 3 facilities that reported extended use of gloves also reported performing hand hygiene over the gloves while still on at intervals when they would normally be changed.

ACHs reported substantial decreases in the frequency of auditing IC practices (Fig 1). Compared with practices in similar units prior to the pandemic, hand hygiene audit frequency decreased in 85% of affected units during the cluster period, and approximately half reported decreases in audits of PPE, environmental services, and indwelling device care. In contrast, most units in PACFs reported increases in hand hygiene and PPE audit frequencies during the cluster period (67% and 83%, respectively) (Fig 2).

HAI/AR programs described limited health care facility staff time, staffing shortages, and intermittent shortages of disinfectants, hand hygiene dispensers, and PPE as perceived barriers to implementing changes in outbreak facilities to prevent future eMDRO transmission. Facilities reported that even in the absence of an active SARS-CoV-2 surge, practices to conserve PPE supplies had become habitual since the onset of the pandemic and were employed in anticipation of

Table 2
Infection control practices during eMDRO clusters involving SARS-CoV-2 units, 10 states, United States

Practices during the cluster period[*] N (%)	Total N = 18[‡]	Clusters in ACHs N = 11[‡]	Clusters in PACFs[†] N = 7[‡]
Health care personnel			
Identified additional HCP beyond those used pre pandemic to work in the facility (eg, auxiliary or supplemental staffing)	10/14 (71%)	7/8 (88%)	3/6 (50%)
Reassigned HCP to units they had not typically worked in pre pandemic	8/15 (53%)	7/9 (78%)	1/6 (17%)
Hand hygiene			
Shortages of ABHS or soap	5/16 (31%)	3/9 (33%)	2/7 (29%)
Encouraged HCP to use soap and water for hand hygiene to conserve ABHS	2/14 (14%)	0/8 (0%)	2/6 (33%)
Environmental cleaning and disinfection			
Shortage of or difficulty obtaining the preferred disinfectant product	8/12 (67%)	6/9 (67%)	2/3 (67%)
Shifted cleaning responsibilities from environmental service staff to patient care staff due to SARS-CoV-2	7/12 (58%)	5/8 (63%)	2/4 (50%)
PPE			
PPE shortage			
Isolation gowns	9/15 (60%)	5/8 (63%)	4/7 (57%)
Gloves	1/15 (7%)	0/8 (0%)	1/7 (14%)
Shifted from disposable to reusable cloth gowns[§]	6/14 (43%)	2/8 (25%)	4/6 (67%)
Shifted from reusable cloth gowns to disposable gowns[§]	1/13 (8%)	0/8 (0%)	1/5 (20%)
Used coverall instead of isolation gowns[**]	3/15 (20%)	2/9 (22%)	1/6 (17%)
Prioritized gown for certain activities[**]	5/15 (33%)	4/9 (44%)	1/6 (17%)
Practiced extended use of gowns[††,‡‡]	11/16 (69%)	8/10 (80%)	3/6 (50%)
Extended the use of gowns regardless of patients' infection status of pathogens other than SARS-CoV-2	4/11 (36%)	3/8 (38%)	1/3 (33%)
Reused gowns[§§,‡‡]	8/15 (53%)	6/9 (67%)	2/6 (33%)
Dedicated reused gown to one patient (unknown for 1 ACH)	5/7 (71%)	3/5 (60%)	2/2 (100%)
Reused the same gown on multiple patients (unknown for 1 ACH)	2/7 (29%)	2/5 (40%)	0/2 (0%)
Wore multiple layers of gowns	8/14 (57%)	4/8 (50%)	4/6 (67%)
Extended use of gloves[‡‡]	3/16 (19%)	3/10 (30%)	0/6 (0%)
Wore multiple layers of gloves	4/14 (29%)	3/8 (38%)	1/6 (17%)

NOTE. Clusters were reported by health departments in 10 US states.
ABHS, alcohol-based hand sanitizers; *ACH*, acute care hospital; *eMDRO*, emerging multidrug-resistant organism; *HCP*, health care personnel; *PACF*, post–acute care facility; *PPE*, personal protective equipment; *SARS-CoV-2*, severe acute respiratory syndrome coronavirus 2.
[*]Cluster period: the 2-week period prior to detection of the cluster until transmission was controlled or through the time of survey completion if transmission was ongoing.
[†]Post-acute care includes long-term acute care hospitals, ventilator/tracheostomy-capable skilled nursing facilities, and other skilled nursing facilities
[‡]Denominators may vary by small n due to nonresponse.
[§]Conventional capacity strategy.[13]
[**]Contingency capacity strategy.[13]
[††]Extended use of gowns involves the use of isolation gowns (disposable or reusable) such that the same gown is worn by the same HCP when interacting with more than 1 patient without removing it between patients.
[‡‡]Crisis capacity strategy.[13]
[§§]Reused gowns such that the same gown was donned, doffed, stored, and then redonned for more patient encounters.

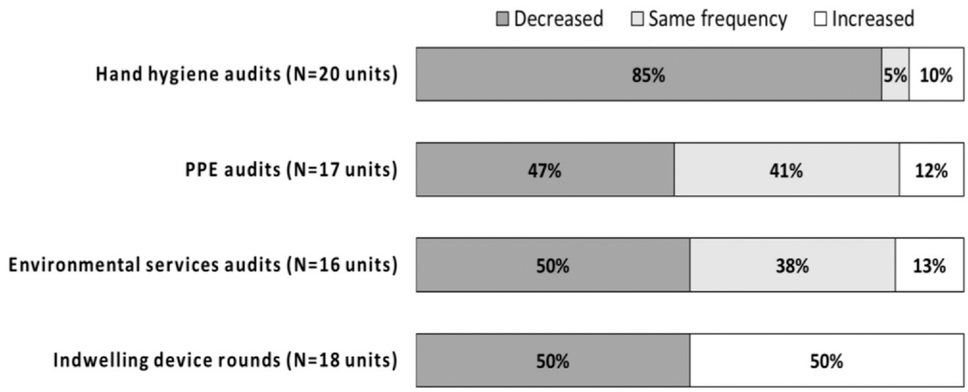

Fig. 1. Changes in IC practices during the eMRDO cluster period* compared to before the SARS-CoV-2 pandemic: units in acute care facilities. *Cluster period: the 2-week period prior to detection of the cluster until transmission was controlled or through the time of survey completion if transmission was ongoing. Data were collected for a maximum of 4 affected units per cluster, the numbers of affected units shown are an underestimation of all affected units in these clusters. Facilities that did not conduct audits of IC practices in the affected unit prior to SARS-CoV-2 and were excluded in this analysis. eMRDO, emerging multidrug-resistant organism; IC, infection control; PPE, personal protective equipment; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

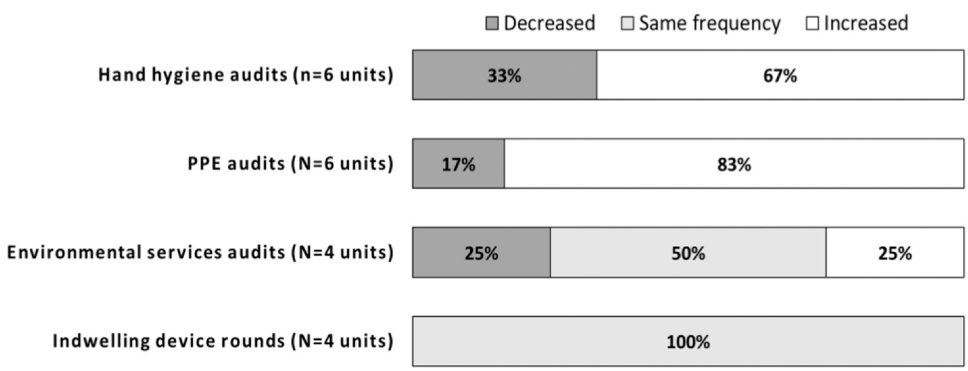

Fig. 2. Changes in IC practices during the eMRDO cluster period* compared to before the SARS-CoV-2 pandemic: units in post–acute care facilities. *Cluster period: the 2-week period prior to detection of the cluster until transmission was controlled or through the time of survey completion if transmission was ongoing. Data were collected for a maximum of 4 affected units per cluster, the numbers of affected units shown are an underestimation of all affected units in these clusters. Facilities that did not conduct audits of IC practices in the affected unit prior to SARS-CoV-2 and were excluded in this analysis. eMRDO, emerging multidrug-resistant organism; IC, infection control; PPE, personal protective equipment; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

future shortages. Competing priorities from other activities (eg, SARS-CoV-2 testing) impeded implementation of measures to mitigate eMDRO transmission, such as serial point prevalence surveys, contact tracing, and audits of IC practices, even though the frequency of hand hygiene and PPE practice audits increased in PACFs. Continued awareness of eMDRO transmissibility and close collaboration between health care facilities and health departments were cited as factors that mitigated transmission in some eMDRO clusters.

DISCUSSION

During the first 10 months of the SARS-CoV-2 pandemic and among a convenience sample of 11 states, we identified a total of 18 clusters of eMDROs in SARS-CoV-2 treatment and observation units. Most eMDRO clusters occurred in jurisdictions where the eMDRO associated with the cluster had been regularly identified in the region prior to identification of the cluster; only 1 cluster occurred in a jurisdiction that had not previously identified cases of the eMDRO and the only state that reported no eMDRO clusters has a very low underlying prevalence of these organisms. Although nearly half of reported clusters occurred in health care facilities in communities experiencing lower levels of community SARS-CoV-2 transmission, a far-greater proportion indicated implementing contingency and crisis capacity strategies[13] to manage actual or anticipated shortages of PPE. Together, these results suggest that changes in PPE practices in outbreak units, including extended use and reuse of isolation gowns, were common and were not limited to facilities facing SARS-CoV-2 surges. Changes in frontline HCP staffing such as reassigning HCP to units they did not typically work and use of auxiliary or supplemental staffing, decreases in IC audits in ACHs, and shortages of alcohol-based hand sanitizer, disinfectant products, and isolation gowns were also common and might have contributed to eMDRO transmission.

In ACHs, multiple outbreaks of emerging eMDROs among SARS-CoV-2 patients have been reported.[5–9] Similar to previous reports, we found that shortages of resources combined with the widespread use of PPE supply conservation strategies and reduced frequencies of IC audits were common. While staffing and PPE shortages were widespread at health care facilities during the SARS-CoV-2 pandemic,[14] multiple facilities that reported eMDRO clusters on SARS-CoV-2 treatment or observation units implemented PPE supply crisis strategies, such as extended use of gowns, when they were not experiencing a PPE shortage. These PPE supply crisis strategies are intended to be used temporarily during periods of known PPE shortages.[13] In addition, 3 ACHs, only 1 of which was experiencing an actual shortage of isolation gowns at the time, implemented extended gown use, regardless of patients' infection status of pathogens other than SARS-CoV-2. Unless no other options exist, extended use of gowns should only be considered if there are no additional co-infectious diagnoses transmitted by contact (such as *Clostridioides difficile*, *C auris*).[15]

Although multiple eMDRO outbreaks on SARS-CoV-2 treatment or observation units in ACHs have been reported in the literature,[5–9] we were unable to find similar reports in PACFs. However, our investigation demonstrates that these did occur and accounted for 39% of the reported clusters. Interestingly, many practices reported during PACF clusters would have been expected to decrease eMDRO transmission, such as increases in auditing frequencies for hand hygiene and PPE use. However, any benefits from these practices were likely offset by practices that facilitated cross-transmission, such as PPE supply conservation strategies, use of auxiliary or supplemental staff, and use of double layers of gowns and gloves, which has the added effect of exacerbating PPE supply shortages. PPE supply conservation strategies were commonly used nationwide early in the pandemic, with 94% of nursing homes implementing these measures.[16] This may have contributed to unrecognized broad transmission of MDROs in these settings and is similar to findings from our investigation where at least 86% of PACFs implemented 1 or more PPE supply conservation strategies.

While our investigation was limited to a relatively small number of health departments reporting eMDRO clusters, nationwide, several urgent and serious antimicrobial resistance threats increased substantially during the SARS-CoV-2 pandemic.[2] These included clinical cases of hospital-onset carbapenem-resistant *Acinetobacter spp* (78% increase in 2020 vs 2019), hospital-onset CRE (35% increase in 2020 vs 2019), hospital-onset multidrug-resistant *P aeruginosa* (32% increase in 2020 vs 2019), and combined hospital- and community-onset *C auris* (60% increase in 2020 vs 2019 and 95% increase in 2021 vs 2020).[2,17] In ACHs, elevated rates of health care-associated MDRO infections have been associated with increases in hospitalized SARS-CoV-2 patients[18] linked to their prolonged critical illness, overcrowding, higher antibiotic use, and shortages of HCP and PPE supplies.[9] Changes in IC practices resulting from the strain placed on the US health care system also may have contributed. These nationwide increases in MDROs that were realized during the pandemic have the potential for long-term negative impact on the prevention and control of antimicrobial-resistant organisms in the United States.

There are several limitations to this investigation. First, data sources varied substantially between participating HAI/AR programs and responses are subject to recall bias. Only 10 (59%) facilities (6 ACHs and 4 PACFs) received on-site visits by health departments or regulatory agencies during the cluster period, for the remainder, HAI/AR programs relied on a mixture of facility self-report, telephone assessment, and video walkthroughs to evaluate practices and experiences during the cluster period. This likely led to underestimation of the prevalence of IC gaps. Second, we were not able to assess and describe additional factors that could impact eMDRO transmission, such as communication of patient MDRO status at transfer, screening, cohorting practices, and antibiotic use. Third, we collected data only on facilities with eMDRO clusters associated with SARS-CoV-2 treatment and observation units. We were not able to compare practices in these facilities to other facilities that did not experience eMDRO clusters, or those with eMDRO clusters not associated with SARS-CoV-2 units, so we were unable to assess whether these practices were also common in other units that did not experience eMDRO clusters. Fourth, for patients who expired in the 30 days after specimen collection, we were not able to assess the cause of death and the role eMDRO or SARS-CoV-2 infection may have played in their death, nor to differentiate between eMDRO-colonized and -infected individuals. Finally, we collected data from a limited number of HAI/AR programs for a short time in 2020. Although we intended this to include all eMDRO clusters that occurred on SARS-CoV-2 treatment and observation units during the period of investigation, 1 HAI/AR program was only able to submit data for 2/4 (50%) clusters due to competing interests during the SARS-CoV-2 pandemic. As such, the results are not nationally representative and do not assess whether practices changed later in the pandemic after PPE supply chain shortages were resolved.

CONCLUSIONS

In both acute care and PACFs with eMDRO clusters, basic IC practices had often been modified because of the SARS-CoV-2 pandemic. In the United States, although acute shortages in PPE have been alleviated, staffing challenges may continue to affect health care facilities[19] and the long-term impact of the pandemic on IC practices and eMDRO transmission remains to be seen. While PPE supply conservation strategies were essential for keeping HCP safe during the SARS-CoV-2 pandemic, an unintended consequence of widespread implementation, combined with changes in staffing and other IC practices, might have been an increase in MDRO transmission. Now more than ever, due to the increasing prevalence of eMDROs, health care facilities require strong, well-supported IC programs to reverse the MDRO trends seen in recent years.

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APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at doi:10.1016/j.ajic.2024.07.013.

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