### Title

The SHIELD Orange County Project: Multidrug-resistant Organism Prevalence in 21 Nursing Homes and Long-term Acute Care Facilities in Southern California.




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**Title:** The SHIELD Orange County Project –Multi Drug-Resistant Organism (MDRO) Prevalence in 21 Nursing Homes and Long Term Acute Care Facilities in Southern California

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**Brief Summary:** MDRO colonization prevalence was 67% in NH and LTACs in a large scale, randomized point-prevalence study. These data raise questions about allocation of infection control and antimicrobial stewardship resources. The SHIELD OC collaborative will measure regional impacts of a coordinated infection prevention initiative on MDRO carriage and infection.

**Abstract:**

**Background:** Multidrug-resistant organisms (MDROs) spread between hospitals, nursing homes (NH), and long-term acute care facilities (LTACs) via patient transfers. SHIELD OC is a regional public health collaborative involving decolonization at 38 healthcare facilities selected based upon their high degree of patient sharing. We report baseline MDRO prevalence in 21 NH/LTACs

**Methods:** A random sample of 50 adults for 21 NH/LTACs (18 NHs, 3 LTACs) were screened for methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* spp. (VRE), extended-spectrum beta-lactamase producing organisms (ESBL), and carbapenem-resistant Enterobacteriaceae (CRE) using nares, skin (axilla/groin), and peri-rectal swabs. Facility and resident characteristics associated with MDRO carriage were assessed using multivariable models clustering by person and facility.

**Results:** Prevalence of MDROs was 65% in NHs and 80% in LTACs. The most common MDROs in NHs were MRSA (42%) and ESBL (34%); in LTACs they were VRE (55%) and ESBL (38%). CRE prevalence was higher in facilities that manage ventilated LTAC patients and NH residents (8% vs. <1%, p<0.001). MDRO status was known for 18% of NH residents and 49% of LTAC patients. MDRO colonized adults commonly harbored additional MDROs (54% MDRO+ NH residents and 62% MDRO+ LTACs patients). History of MRSA [OR=1.7 C.I. (1.2, 2.4),p=0.004], VRE [OR=2.1 C.I.(1.2, 3.8),p=0.01], ESBL [OR=1.6 C.I.(1.1, 2.3),p=0.03] and diabetes [OR=1.3 C.I.(1.0, 1.7),p=0.03] were associated with any MDRO carriage.

**Conclusions:** The majority of NH residents and LTACs patients harbor MDROs. MDRO status is frequently unknown to the facility. The high MDRO prevalence highlights the need for prevention efforts in NH/LTACs as part of regional efforts to control MDRO spread.

**Introduction:**

The threat of antibiotic resistance in the U.S. healthcare system has been recognized by the Centers for Disease Control and Prevention (CDC)[1], Infectious Disease Society of America[2], Society for Healthcare Epidemiology of America[3], and the U. S. government.[4] CDC estimates that 2 million Americans become infected with bacteria that are resistant to antibiotics each year and 23,000 people die from these infections.[1]

Nursing Home (NH) and Long Term Acute Care (LTAC) patients and residents are disproportionately affected with morbidity and mortality from MDRO infections.[5-9] While infection prevention and antimicrobial stewardship strategies can reduce the impact of MDRO infections,[10, 11] resources for these programs are focused in short-term acute care hospitals (ACH).[12] An investigation in Maryland showed a four-fold difference in infection control full time equivalents in ACHs compared to NHs.[13]

Limiting infection control and stewardship resources for NHs and LTACs has serious implications for the entire U.S. health system.[14] Patients and residents in these settings are

transferred frequently and serve as a source of MDRO transmission.[7-9, 15-22] For example, methicillin-resistant *Staphylococcus aureus (*MRSA) spread from ACHs to NHs within the Veterans Affairs medical system.[23] Other MDROs have spread from hospitals into NHs[24, 25] More recently, NH residents and LTAC patients were associated with transmission of carbapenem-resistant Enterobacteriaceae (CRE) across a region.[26] Investment of resources in regional infection prevention programs that focus on NHs and LTACs has potential to attenuate the spread of MDROs and prevent morbidity and mortality across the U.S. healthcare system.[15, 27]

The Shared Healthcare Intervention to Eliminate Life-threatening Dissemination of MDROs in Orange County (SHIELD OC) is a large Southern California regional public health collaborative funded and supported by CDC and endorsed by the Orange County Health Care Agency and the California Department of Public Health. SHIELD OC involves 38 out of 104 healthcare facilities in Orange County, California. SHIELD OC Participants include 18 NH, 3 LTACs, and 17 Short Term Acute Care Hospitals. Orange County has a population of 3.1 million persons and is the 6th most populous U.S. County. Healthcare facilities were invited to participate based upon their high degree of direct and indirect patient sharing with one another.[28] Participants in the SHIELD OC collaborative project initiated a quality improvement performance improvement (QAPI) project focused on chlorhexidine bathing and nasal decolonization. SHIELD OC will measure the regional impacts of a coordinated infection prevention initiative on MDRO carriage and infection.[28] Herein, we report baseline colonization prevalence of common and emerging MDROs among NH and LTAC facilities participating in SHIELD OC.

**Methods:**

NH and LTAC facilities were provided the opportunity to conduct a point prevalence assessment of MDRO carriage. Sampling of patients in contact precautions was conducted in the 17 ACHs and will be published separately. The SHIELD OC program provided supplies, logistics, and microbiologic laboratory testing. SHIELD OC was a voluntary regional public health collaborative and was determined to be non-research and exempt from institutional review board oversight by the CDC and UCI IRBs.

*Point Prevalence MDRO Sampling*

A one-day point prevalence sampling of 50 NH residents and LTAC patients at 18 NHs and 3 LTACss was conducted between September 2016 and March 2017. Point prevalence sampling was conducted for pre-intervention purposes and was done by the facility as a QAPI program. LTAC patients and NH residents were informed of sampling verbally and in writing and allowed to refuse, but no written consent was deemed necessary for the low-risk procedure of nares and body swab collection. The SHIELD OC team trained facility nurses on swabbing technique and each nurse was required to show return demonstration of the proper swab techniques at the start of the point prevalence day. A swabbing team consisting of the trained nurse who performed all swabbing, and two SHIELD OC project coordinators.

Selection of patients for swabbing was based upon a random sample of occupied beds (excluding hospice) until 50 persons were swabbed. Facility nurses performed bilateral nares swabs for MRSA, as well as bilateral axilla/groin and peri-rectal swabs, which were processed for MRSA, vancomycin-resistant Enterococcus spp. (VRE), extended spectrum beta-lactamase producing organisms (ESBLs), and CRE. All swabs (BBL CultureSwab, Becton Dickinson) were pre-moistened prior to swabbing and processed within 6 hours of sampling. No protected health information were included on swabs.

*Microbiologic Testing*

Swabs were cultured for ESBL and CR Enterobacteriaceae, VRE and MRSA. The media used and order of inoculation was: MacConkey agar with a cefpodoxime disk (2 μg); MacConkey agar with a meropenem disk (2μg); *Campylobacter* agar (BD BBL, Becton Dickson, Sparks, Maryland) with 10% sheep blood with vancomycin 10 μg, cephalothin 15 μg, trimethoprim 5 μg, polymyxin-B 2.5 units, amphotericin-B 2 μg; and Spectra MRSA (Thermo Fisher Scientific, Waltham, MA).[29] Isolates on Spectra agar that were the typical morphology and color were not further confirmed. Isolates with atypical morphology or color on Spectra were confirmed as S. aureus by a tube coagulase or matrix assisted laser desorption ionization-time of flight mass spectrometry (MALDI-TOF-MS). In addition, with atypical isolates, methicillin resistance was confirmed by a standardized disk diffusion test using a cefoxitin disk. The identification of enterococci isolated on *Campylobacter* agar was verified by conventional biochemical and/or MALDI-TOF-MS. Vancomycin resistance was not confirmed given the known ability of this agar to detect VRE.[30] Isolates identified by the initial ESBL screen were further identified by MALDI-TOF-MS or the VITEK2 GN-card (bioMérieux, Marcy-l'Etoile, France) and phenotypic testing for the presence of ESBL using disk diffusion with cefotaxime and ceftazidime with and without clavulanic acid or the VITEK2 AST-GN69 card. Isolates identified as a CRE by the initial screen were further identified by MALDI-TOF-MS or the VITEK2 AST-GN69 card and disk diffusion using meropenem and, if needed due to a questionable result, the disk diffusion was repeated using meropenem, ertapenem, and imipenem.

*Collection of Clinical Data*

NH resident and LTAC patient characteristics were collected from the medical record by study staff using a standardized form. Medical devices (e.g., central venous catheters, urinary catheters, drains, tubes, or ventilators) and wounds were recorded by direct observation of each resident during sampling. Prior knowledge of MDRO status was determined from review of the medical record, as well as infection prevention and surveillance records. Additional variables abstracted from chart review included age, gender, length of stay, total care requirement (bed bound), incontinence, and presence of selected comorbidities (e.g., diabetes). Patient data were de-identified at each facility prior to analysis by the SHIELD OC team.

*Collection of Facility-Level Data*

Facility-level NH characteristics were collected from admission assessments in the Centers for Medicare & Medicaid Services minimum data set (MDS) for the most recent year available, 2016 (http:// www.resdac.org/MDS/data_available.asp), including the number of licensed beds, average daily census, mean length-of-stay, mean resident Elixhauser comorbidity score[31], and percentage of patients and residents with comorbidities. LTAC characteristics were obtained from the California Office of Statewide Health Planning and Development for the most recent year available, 2016 (http://www.oshpd.ca.gov). NH data on annual admissions, admissions per bed per year, occupancy ratio, proportion of patients and residents with Medicare, proportion of patients and residents with Medicaid, average resource utilization group (RUG-III) scores, mean activities of daily living (ADL) index, and average acuity index, were obtained for 2017 from LTCFocus.org. The RUG-III score approximates the relative nursing staff time associated with resident care, with a higher score indicating higher required resources. The ADL

index measures resident independence for bed mobility, transfer, locomotion, dressing, eating, toilet use, and personal hygiene. Each ADL is scored from 0-4 and the overall ADL index ranges from 0 (completely independent) to 28 (completely dependent). The facility acuity index is a measure of the care needed by a nursing home's residents, based on ADLs and the number of residents receiving special treatment. The proportion of adults who required mechanical ventilation was obtained at the time of surveillance. CMS Five-Star Quality Rating was obtained for 2017 (https://www.medicare.gov/nursinghomecompare).

*Statistical Analysis*

For each NH and LTAC, the prevalence of overall and individual MDROs (MRSA, VRE, ESBL, and CRE) were calculated as the proportion of swabbed patients and residents who were colonized at any body site with any MDRO or an individual MDRO, respectively. The median and range of overall and individual MDRO prevalence were then calculated across all facilities. The percent of NH residents or LTAC patients found to harbor an MDRO previously unknown to the facility was assessed.

To evaluate person-level and NH/LTACs characteristics associated with MDRO carriage, multivariate analyses of swab data were performed using generalized linear mixed models. Models accounted for clustering at the patient/resident and NH/LTAC levels. Analyses were performed for five outcomes: MRSA, VRE, ESBL, CRE, and any MDRO. Variables were retained in the models regardless of p-value unless there was evidence of collinearity or the variable caused the models to not converge. All analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC).

**Results:**

Of the 21 participating NH/LTACs sites in SHIELD OC, there were 14 NHs without ventilator beds, four NHs with ventilator beds (vNHs), and three LTACs. NH and LTAC characteristics are presented in Table 1. The mean age across sites was similar between NH (77 years) and LTACs (72 years) ($p= 0.25$), although the mean proportion of male patients and residents in NH was lower (45%) than LTACs (53%), ($p= 0.03$). Compared to LTACs, NHs had a higher average daily census (122 versus 63 $p= 0.050$), a longer length-of-stay (201 days versus 31 days, $p<0.001$), and fewer admissions per year (361 versus 462, $p= 0.008$). NHs had a higher mean proportion of residents with diabetes than LTACs (33% versus 13%, $p=0.004$), while renal insufficiency was more common in LTACs but did not reach statistical significance (23% versus 13%, $p= 0.09$).

A total of 3,150 swabs were obtained from 1,050 patients and residents, including 1,050 nares swabs, 1,050 combined axilla/groin swabs, and 1,050 peri-rectal swabs. Of the NH residents and LTAC patients approached, 9% and 8% declined to participate respectively. Two LTACs and two non-ventilator NHs had less than 50 patients/residents on the swabbing day and required a second visit two weeks later to complete the 50 swabs. Characteristics of NH residents and LTAC patients who were swabbed are listed in Table 2. The majority of NH residents and LTAC patients (67%, n=701) had at least one MDRO; 41% (n=427) had MRSA; 35% (n=366) had ESBL, 22% (n=231) had VRE, and 3% (n=31) had CRE. NH residents and LTAC patients who were MDRO carriers were found to harbor an average of 1.5 MDROs. Twenty-seven percent (n=284) of NH residents and LTAC patients were found to carry multiple MDRO

pathogens. Of those who harbored multiple MDROs, the most common combinations were MRSA and ESBL (n=180, 63%), MRSA and VRE (n=108, 38%), and VRE and ESBL (n=88, 31%).

In total, 238 (23%) NH residents and LTAC patients had a documented history of any MDRO colonization. Overall, 12% (n=127) of NH residents and LTAC patients had a history of MRSA, 9% (n=98) had a history of ESBL, 4% (n=42) had a history of VRE, and 3% (n=29) had a history of CRE. Among these NH residents and LTAC patients, 63% (n=151) had body cultures consistent with their prior history, including MRSA (64%, n=81), ESBL (71%, n=70), VRE (36%, n=15), and CRE (41%, n=12). Of all NH residents and LTAC patients with at least one MDRO, 91% (n=635) had an MDRO that was unknown to the NH or LTAC. Of all MDRO pathogens detected, 83% (n=877) were unknown to the NH or LTAC.

Facility-specific MDRO point prevalence results are found in Table 3 grouped by nursing homes without ventilator residents, nursing homes with ventilator residents, and LTACs. Any MDRO carriage ranged from 44% to 88%, with >75% MDRO colonization prevalence seen in two NHs, two vNHs, and two LTACs. The prevalence of MDRO colonized persons with no history of any MDRO colonization was high in NHs (median 55%, range 42%-72%), vNHs (median 74%, range 66-78%), and LTACs (median 66%, range 64-76%). MRSA carriage was found in all facilities, ranging from 24% to 62% (median 36%). ESBL colonization ranged 0% to 60% (median 36%) and exceeded MRSA colonization in four NH, two vNHs, and two LTACS. CRE prevalence was rare in NHs (<1%) compared to vNHs (median 10%, range 0-12) and LTACs (median 8%, range 8%-10%).

Multivariable models identified several person-level characteristics associated with MDRO carriage (Table 4). Medical devices were associated with each MDRO. Specifically, central venous catheters (OR=2.4 (CI: 1.3, 4.3), p=0.005) were associated with VRE carriage, and GI devices were associated with MRSA (OR=1.4 (CI: 1.0, 2.0), p=0.04), ESBL (OR=1.7 (CI:1.1, 2.5), p=0.009) and CRE (OR=19.7 (CI: 3.5, 109.4), p<0.001). In addition, a history of a specific MDRO was highly associated with a current positive culture for the MDRO, with the exception of VRE.

**Discussion:**

In a systematic assessment of key MDROs across a large number of facilities in Southern California, MDRO colonization was found in the large majority of NH residents and LTAC patients. While MDROs have been known to be found in NH/LTACs [7-9, 15-22], the scope and pervasiveness of the problem has not been previously described. Our observed colonization prevalence of 67% far exceeds the observed MDRO colonization prevalence of 10-20% seen in similar studies from acute care hospitals.[32, 33] MDRO prevalence was consistently high across all sites in this multisite, large-scale regional surveillance study suggesting that the findings are generalizable to similar facilities in other areas. It further highlights that MDRO pathogens are far more prevalent in the NH/LTAC setting than in short term acute care settings where most infection control and stewardship efforts are currently focused.

Our results raise important questions about how best to address MDRO prevalence and risk of spread in NH and LTAC settings. Our observed prevalence of 67% MDRO colonization was nearly three times higher than the 23% of people with a prior history of MDRO colonization, suggesting these facilities grossly underestimate their MDRO burden. An MDRO registry may be helpful in identifying these patients as some may have had a prior positive culture at another facility. Multivariate models identified patient characteristics associated with

MDRO colonization, notably medical devices and history of MDRO colonization. Nevertheless, while multivariate models found some predictors of MDRO status, these models are hard to translate into targeted intervention approaches for MDRO. The high absolute MDRO prevalence may obviate the value of "targeted" enhanced infection control strategies in favor of universal approaches.

Implementation of enhanced infection prevention protocols is complex in NH/LTACs and, at least in the nursing home setting, must respect that for some individuals, the NH may represent a person's home.[34] Rigorous application of contact precautions and universal chlorhexidine bathing has been effective in controlling CRE in LTACs in the Chicago region.[35] However, contact precautions for the majority of NH residents is often not practical and raises concerns for unique harms in this setting.[34] The SHIELD OC initiative will evaluate a regional intervention involving universal application of chlorhexidine bathing and nasal decolonization in an effort to reduce both MDRO colonization and affect regional MDRO infections. However, additional research into other universally adoptable interventions such as antimicrobial stewardship, better environmental cleaning protocols, more rigorous application of routine infection prevention protocols or other novel infection prevention protocols are also warranted.

The surveillance data collected as part of SHIELD OC are valuable to better understand the burden of MDROs in Orange County. The epidemiology of individual MDRO pathogens may be explained by differences in medical devices or patient history of MDROs which are more associated with one or another MDRO. Alternatively, it may simply reflect referral or patient transfer patterns not captured in this analysis.[15] In general, MRSA was the predominant MDRO across all facilities. However, ESBL predominated in several. The implication of high ESBL colonization is that these patients may become infected and thereby exposed to more carbapenem therapy, which can further drive emergence of CRE. Unlike other MDROs, there may be an opportunity to contain CRE in this region due to the low rates and recent introduction of the pathogen into California. It is notable that CRE concentrated in LTACs and vNHs, compared to NHs without ventilator beds, suggesting there may still be some opportunity for targeted CRE prevention efforts.[22] In fact, colonization with CRE was more commonly known to the facility, which likely reflected an ongoing effort by LTACs to conduct screening for CRE on admission and communication CRE status on transfer to other healthcare facilities.[27, 36]

Our data represent the largest MDRO point prevalence study published to date in NH and LTAC settings. Our study is limited in that we conducted surveillance only within a subset of more highly connected facilities southern California. Nevertheless, our findings are supported by similar studies in California, Illinois, Maryland, Massachusetts, Michigan, and Washington.[7-9, 15, 16, 18, 19, 37-41] Our study is strengthened by the fact that our surveillance was systematic and included tests for peri-rectal colonization, which have not been universally done in other settings.[39] Our study is further strengthened by the low refusal rate of 8% for the point prevalence study and our ability to conduct all patient sampling for all but four facilities in a single day. The low refusal rate and true single day point prevalence estimates suggest that our data are likely representative of the nursing home and LTAC populations. The representativeness was largely due to facility support and the fact that specific consent was not required for the low risk procedure of patient sampling to support a QAPI initiative.

In summary, MDRO colonization prevalence is high within the NH and LTAC setting, far exceeding published reports in acute care hospitals. These data demonstrate the importance of NH/LTACs as a dominant MDRO reservoir in the healthcare system. There is an urgent need to

engage NH/LTAC facilities in the effort to improve regional burden of colonization and infection with MDROs. The SHIELD OC initiative will assess one strategy to address MDROs, namely widespread use of decolonization products in NH/LTACs and hospitals. Investment in universal strategies of infection prevention and antimicrobial stewardship that are applicable to nursing homes and long term acute care hospitals are greatly needed and arguably overdue.

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**Disclaimer:** Companies contributing product have no role in the design, conduct, analysis, or publication of this study or other studies conducted by these investigators.

**Conflict of Interest Statement:** Stryker (Sage Products), Clorox, Medline, and Xttrium contributed antiseptic product to the SHIELD OC collaborative. Investigators are also conducting other studies in which contributed antiseptic product is provided to participating hospitals and nursing homes from Stryker (Sage Products) (JM, SSH, LH, RDS, LGM, KK, RS, TDD, ME, SY, HC, GG, JC, ST, SP, TT, JH, JN, RAW, MKH, MHC), 3M (JM, SSH, LH, RDS, LGM, TDD, ME, SP, ST, TT), Xttrium (JM, SSH, LH, RDS, LGM, KK, RS, TDD, ME, SY, HC, GG, JC, SP, ST, TT, JH, JN), Medline Industries, Inc. (JM, SSH, LH, RDS, LGM, KK, RS, TDD, ME, SY, HC, GG, JC, ST, SP, TT, JH, JN, MKH, RAW, MHC), Mölnlycke (SSH, KK, LH, RAW, MKH, MHC), and Clorox (SSH, LH, RDS, LGM, KK, RS, TDD, ME, SY, HC, GG, JC, ST, SP, TT, JH, JN, RAW, MKH, MHC). JM has received grants and personal fees from Achaogen and Allergan, and grants from Cempra, Melinta, Science37, Theravance, Thermo Scientific for the conduct of other studies. LGM has received grants from Gilead Sciences, Achaogen, Merck, Abbott, Cepheid and has served as a consultant for Tetraphase for the conduct of other studies. MKH has received an investigator-initiated grant from Clorox and no-cost laboratory testing from OpGen, Inc. for a research project. VM chairs the Independent Quality Committee for HCR-Manorcare and chairs the scientific advisory committee for naviHealth, and is compensated for both these roles. All other authors have no disclosures.

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**Table 1:** Characteristics of the NH/LTAC Facilities

| Variable | All Nursing Homes Median (Range) | NH[e] without Ventilator Beds Median (Range) | NH with Ventilator Beds (vNH) Median (Range) | LTACs[f] Median (Range) |
|---|---|---|---|---|
| N | 18 | 14 | 4 | 3 |
| Mean Age | 77 (69, 85) | 79 (69, 85) | 71 (69, 74) | 72 (71, 73) |
| % Male | 45 (31, 51) | 39 (31, 48) | 48 (47, 51) | 53 (53, 53) |
| % Long-stay[a] | 75 (70, 80) | 75 (70, 79) | 74 (72, 80) | 5 (3, 7) |
| % Medicare | 16 (6, 57) | 16 (6, 57) | 14 (7, 20) | 69 (68, 75) |
| % Medicaid | 58 (17, 76) | 55 (17, 76) | 67 (60, 76) | 0 (0, 6) |
| % Diabetes | 33 (23, 57) | 32 (23, 43) | 53 (36, 57) | 13 (9, 16) |
| % Chronic Lung Disease | 17 (10, 38) | 15 (10, 29) | 23 (11, 38) | 21 (19, 23) |
| % Renal Insufficiency | 13 (2, 33) | 13 (2, 23) | 14 (5, 33) | 23 (21, 24) |
| % Ventilated | 0 (0, 58) | 0 (0, 0) | 32 (10, 58) | 40 (37, 52) |
| Licensed Beds (N) | 118 (59, 250) | 106 (59, 250) | 135 (99, 202) | 59 (48, 109) |
| Average Daily Census (N) | 122 (56, 231) | 101 (56, 231) | 138 (109, 214) | 63 (39, 89) |
| Occupancy Ratio | 0.83 (0.62, 0.98) | 0.82 (0.62, 0.98) | 0.92 (0.83, 0.97) | 0.93 (0.84, 0.93) |
| Mean Length-of-Stay | 201 (185, 227) | 199 (185, 227) | 215 (191, 223) | 31 (29, 32) |
| Total Annual Admissions | 361 (104, 602) | 368 (104, 602) | 249 (128, 394) | 462 (425, 945) |
| Admissions/bed/year (N) | 2 (1, 7) | 2 (2, 7) | 2 (1, 3) | 7 (5, 9) |
| Elixhauser Comorbidity Score[b] | 3 (2, 5) | 3 (2, 4) | 3 (2, 5) | 3 (3, 3) |
| Average RUG-III Index (N)[c] | 1 (1, 1) | 1 (1, 1) | 1 (1, 1) | - |
| CMS Five-Star Quality Rating | 3 (1, 5) | 3 (1, 5) | 4 (3, 5) | - |
| ADL index (N)[d] | 12 (10, 15) | 12 (10, 13) | 14 (12, 15) | - |
| Average Acuity Index (N) | 13 (11, 18) | 13 (11, 14) | 16 (13, 18) | - |

## Table 1 Legend

[a] % long stay refers to the proportion of patients and residents with a length-of-stay >100 days
[b] [31]
[c] RUG-III, Resource Utilization Groups version III
[d] ADL, activities of daily living, NH, Nursing Home
[e] NH, Nursing Home
[f] LTAC, Long Term Acute Care Facility

**Table 2:** Characteristics of the NH/LTAC Patients and Residents who were Swabbed*

| Variable | NH and LTAC N (%) |
|---|---|
| **N** | 1,050 |
| **Female** | 593 (56) |
| **Age (years)** | |
| >=80 | 519 (49) |
| 60-79 | 375 (36) |
| <60 | 156 (15) |
| **LOS (days)** | |
| >100 | 501 (48) |
| >30-100 | 202 (19) |
| 15-30 | 125 (12) |
| <15 | 222 (21) |
| **MDRO History by Chart Review** | |
| Any MDRO | 238 (23) |
| MRSA | 127 (12) |
| VRE | 42 (4) |
| ESBL | 98 (9) |
| CRE | 29 (3) |
| **Incontinence Status** | |
| Stool | 687 (65) |
| Urine | 564 (54) |
| **Diabetes** | 360 (34) |
| **Bed Bound** | 281 (27) |
| **Urinary Catheter** | 254 (24) |
| **GI Device** [a] | 157 (15) |
| **Central Venous Catheter** | 90 (9) |
| **Wounds** | 230 (22) |

**Table 2 Legend**
***NOTE.** Resident characteristics were obtained from chart review, staff interview, and direct observation of the resident for presence of wounds and devices.
[a] GI Device, naso-gastric tubes, oral-gastric tubes, oral-jejunal tubes, percutaneous gastric tubes

**Table 3:** Point Prevalence MDRO Carriage Among All Residents and Patients Swabbed at Nursing Homes and LTACs

| Facility Type | Chart History of Any MDRO N (%) | MDRO Carriage N (%) | MRSA Carriage N (%) | VRE Carriage N (%) | ESBL Carriage N (%) | CRE Carriage N (%) | MDRO without MDRO History N (%) | Additional MDRO with MDRO History N (%) |
|---|---|---|---|---|---|---|---|---|
| **Nursing Home without Ventilator Beds** | | | | | | | | |
| 1 | 5 (10) | 22 (44) | 12 (24) | 3 (6) | 10 (20) | 0 (0) | 21 (42) | 1 (2) |
| 2 | 3 (6) | 22 (44) | 15 (30) | 1 (2) | 12 (24) | 1 (2) | 21 (42) | 2 (4) |
| 3 | 3 (6) | 26 (52) | 18 (36) | 6 (12) | 7 (14) | 0 (0) | 24 (48) | 1 (2) |
| 4 | 6 (12) | 28 (56) | 23 (46) | 10 (20) | 0 (0) | 0 (0) | 25 (50) | 3 (6) |
| 5 | 13 (26) | 29 (58) | 17 (34) | 8 (16) | 12 (24) | 0 (0) | 23 (46) | 3 (6) |
| 6 | 7 (14) | 29 (58) | 19 (38) | 17 (34) | 9 (18) | 0 (0) | 29 (58) | 4 (8) |
| 7 | 11 (22) | 29 (58) | 17 (34) | 9 (18) | 20 (40) | 0 (0) | 27 (54) | 5 (10) |
| 8 | 12 (24) | 29 (58) | 17 (34) | 5 (10) | 16 (32) | 0 (0) | 28 (56) | 9 (18) |
| 9 | 12 (24) | 32 (64) | 21 (42) | 10 (20) | 12 (24) | 0 (0) | 26 (52) | 4 (8) |
| 10 | 9 (18) | 32 (64) | 18 (36) | 8 (16) | 18 (36) | 0 (0) | 28 (56) | 5 (10) |
| 11 | 8 (16) | 34 (68) | 18 (36) | 7 (14) | 19 (38) | 0 (0) | 31 (62) | 4 (8) |
| 12 | 7 (14) | 34 (68) | 31 (62) | 5 (10) | 14 (28) | 0 (0) | 33 (66) | 4 (8) |
| 13 | 11 (22) | 38 (76) | 26 (52) | 7 (14) | 27 (54) | 0 (0) | 34 (68) | 5 (10) |
| 14 | 13 (26) | 41 (82) | 18 (36) | 15 (30) | 27 (54) | 1 (2) | 36 (72) | 6 (12) |
| Median % (Range) | 17 (6, 26) | 58 (44, 82) | 36 (24, 62) | 15 (2, 34) | 26 (0, 54) | 0 (0, 2) | 55 (42, 72) | 8 (2, 18) |
| **Nursing Homes with Ventilator Beds (vNH)** | | | | | | | | |
| 15 | 9 (18) | 36 (72) | 28 (56) | 7 (14) | 24 (48) | 5 (10) | 33 (66) | 6 (12) |
| 16 | 11 (22) | 37 (74) | 26 (52) | 12 (24) | 20 (40) | 5 (10) | 35 (70) | 8 (16) |
| 17 | 4 (8) | 39 (78) | 24 (48) | 7 (14) | 28 (56) | 0 (0) | 39 (78) | 4 (8) |
| 18 | 20 (40) | 44 (88) | 30 (60) | 11 (22) | 33 (66) | 6 (12) | 39 (78) | 14 (28) |
| Median % (Range) | 20 (8, 40) | 76 (72, 88) | 54 (48, 60) | 18 (14, 24) | 52 (40, 66) | 10 (0, 12) | 74 (66, 78) | 14 (8, 28) |
| **LTACs** | | | | | | | | |
| 19 | 24 (48) | 36 (72) | 15 (30) | 25 (50) | 15 (30) | 5 (10) | 32 (64) | 13 (26) |
| 20 | 25 (50) | 41 (82) | 13 (26) | 28 (56) | 19 (38) | 4 (8) | 33 (66) | 14 (28) |
| 21 | 25 (50) | 43 (86) | 21 (42) | 30 (60) | 24 (48) | 4 (8) | 38 (76) | 19 (38) |
| Median % (Range) | 50 (48, 50) | 82 (72, 86) | 30 (26, 42) | 56 (50, 60) | 38 (30, 48) | 8 (8, 10) | 66 (64, 76) | 28 (26, 38) |

## Table 3 Legend

**Abbreviations:** LTAC, long-term acute care hospital; MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant *Enterococci*; ESBL, extended-spectrum β-lactamase–producing *Enterobacteriaceae*; CRE, carbapenem-resistant Enterobacteriaceae

**Table 4:** Multivariable Regression for Factors Associated with MDRO Colonization in NHs and LTACHs

| Variable | OR (95% CI) | *P* Value |
|---|---|---|
| **Any MDRO** | | |
| Diabetes | 1.3 (1.0, 1.7) | 0.03 |
| History of MRSA | 1.7 (1.2, 2.4) | 0.004 |
| History of VRE | 2.1 (1.2, 3.8) | 0.01 |
| History of ESBL | 1.6 (1.1, 2.3) | 0.03 |
| Swab Location | | |
| Axilla/Groin | 1.0 | <0.001 |
| Nares | 0.3 (0.3, 0.4) | |
| Peri-rectal | 1.4 (1.1, 1.7) | |
| **Any MRSA** | | |
| Diabetes | 1.3 (1.0, 1.8) | 0.05 |
| GI Device[b] | 1.4 (1.0, 2.0) | 0.04 |
| Incontinence of Stool | 1.5 (1.1, 2.0) | 0.01 |
| History of MRSA | 2.6 (1.7, 3.9) | <0.001 |
| Swab Location | | 0.03 |
| Axilla/Groin | 1.0 | |
| Nares | 1.0 (0.8, 1.2) | |
| Peri-rectal | 0.8 (0.6, 0.9) | |
| Season | | |
| Winter | 1.0 | 0.01 |
| Fall | 0.6 (0.4, 0.9) | |
| **Any VRE** | | |
| Female | 0.7 (0.5, 0.9) | 0.03 |
| Age per Decade | 0.8 (0.7, 0.9) | <0.001 |
| Length-of-stay | 0.98 (0.97, 0.98) | <0.001 |
| Central Venous Catheter | 2.4 (1.3, 4.3) | 0.005 |
| Swab location | | |
| Axilla/Groin | 1.0 | <0.001 |
| Peri-rectal | 2.0 (1.5, 2.6) | |
| **Any ESBL** | | |
| GI Device | 1.7 (1.1, 2.5) | 0.009 |
| History of ESBL | 4.1 (2.5, 6.7) | <0.001 |
| History of VRE | 2.6 (1.3, 5.3) | 0.008 |
| Swab Location | | |
| Axilla/Groin | 1.0 | <0.001 |
| Peri-rectal | 1.9 (1.5, 2.4) | |
| Occupancy Ratio | 2.0 (1.0, 3.9) | 0.04 |
| Admissions/Bed/Year | 0.01 (<0.001, 0.4) | 0.02 |
| **Any CRE** | | |
| GI Device | 19.7 (3.5, 109.4) | <0.001 |
| History of CRE | 29.8 (8.5, 103.6) | <0.001 |
| History of VRE | 4.8 (1.3, 17.9) | 0.02 |

**Table 4 Legend**

**Abbreviations:** MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant *Enterococci*; ESBL, extended-spectrum β-lactamase–producing Enterobacteriaceae ; CRE, carbapenem-resistant Enterobacteriaceae; GI, gastrointestinal

[a] Models adjust for clustering by person and by site. Variables were entered into the model unless there was evidence of collinearity. Only significantly associated variables shown.

[b] GI Device, naso-gastric tubes, oral-gastric tubes, oral-jejunal tubes, percutaneous gastric tubes