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Major Article

Correlations between quality ratings of skilled nursing facilities and multidrug-resistant urinary tract infections

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Background: The purpose of this study was to determine risk factors for the acquisition of urinary tract infections (UTIs) and multidrug-resistant organisms (MDROs) in residents of skilled nursing facilities (SNFs).
Methods: Using the informational database provided by the Centers for Medicare and Medicaid Services (CMS), a retrospective logistic regression was performed on 1,523 urine cultures from 12 SNFs located in Long Island, New York.
Results: Of the 1,142 positive urine cultures, *Escherichia coli* was most prevalent. Additionally, 164 (14.4%) of the UTIs were attributed to an MDRO. In multivariate logistic regression, sex and overall quality rating predicted the occurrence of UTIs, whereas identification of MDROs was dependent on the level of nursing care received. The mean predicted probability of UTIs and receipt of contaminated samples was inversely dependent on the facility's rating, where the likelihood increased as overall quality ratings decreased.
Conclusions: The CMS's quality rating system may provide some insight into the status of infection control practices in SNFs. The results of this study suggest that potential consumers should focus on the overall star ratings and the competency of the nursing staff in these facilities rather than on individual quality measures.

Long-term care facilities provide essential services to older adults, including rehabilitation, assisted living, and skilled nursing care. This type of care has become an increasingly important public policy concern because the U.S. Census Bureau is approximating the elderly population will reach >80 million individuals by the year 2050.[1] This estimate takes into account the aging baby boomer generation and individuals comprising the oldest old category.[2] The exponential growth of this population will undoubtedly result in increased health care costs in addition to an increased need for long-term care, including skilled nursing facilities (SNFs).

Nursing Home Compare, launched by the Centers for Medicare and Medicaid Services (CMS) in 1998, is an informational database rating SNFs on a 5-star scale.[3] Ratings are determined from quality measures, which include staffing, quality of clinical care, and performance on health inspections. Indeed, 2 separate literature reviews have concluded that higher SNF staffing are associated with better quality of care.[4,5] SNFs with low staffing levels, especially low registered nurse (RN) levels, tend to have higher rates of poor resident outcomes, such as pressure ulcers, catheterization, the inability to independently perform daily living activities, and depression.[5] The data collected for Nursing Home Compare are mostly self-reported by these facilities. Therefore, they may not be an accurate indicator of quality and overall consumer satisfaction.[6]

Short lengths of stay are often anticipated by most residents in SNFs, as many either die or suffer complications that require hospitalization.[7] A major contributor to the overall quality rating and the morbidity and mortality rates in these facilities is the infection rate. Urinary tract infections (UTIs) account for >30% of infections and are associated with a higher likelihood of requiring increased services and specialized care.[8] Complicated UTIs among elderly populations are very common, often arising from the inability to completely void urine, resulting in the persistence of pathogens in the genitourinary tract.[9] One study reported the average

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time for new acquisition of infections in residents was common and would occur anywhere from 75 days to 186 days on average.[10] Moreover, health care–associated infections (HAIs) traditionally have resulted in prolonged hospitalization, poor outcomes, and increased costs. It has been estimated that the annual direct medical care costs for HAIs ranges anywhere from $28-$45 billion per year.[11] UTIs in residents contribute to these costs, resulting in a vast economic burden on the health care system that will only continue to grow as the population ages.

The most common cause of UTIs is *Escherichia coli*; however, they are also frequently caused by a range of pathogens, including *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecalis*, and *Staphylococcus saprophyticus*.[12] Residents of SNFs with indwelling urinary catheters are more prone to UTIs and subsequent episodes of bacteremia and septicemia.[13] Catheterization can also greatly increase the likelihood of a UTI. One study found that approximately 3%-7% of residents with an indwelling urinary catheter developed a UTI and that by day 30 after catheter insertion, the prevalence of bacteriuria was almost 100%.[14]

The misuse of antibiotics has resulted in increased resistance in bacteria, rendering antibiotics less effective in the treatment of patients. In the hospital setting, approximately one-third of all patients receive antibiotics as part of their therapy. At least one-half of the prescriptions prescribed to these patients are unnecessary, poorly chosen, or incorrectly administered.[15] The Centers for Disease Control and Prevention estimates that in the United States, >2 million people become infected with a multidrug-resistant organism (MDRO) each year; subsequently, at least 23,000 die from these infections and from complications resulting from these illnesses.[11] Additionally, it has been found that up to one-third of prescriptions for suspected UTIs in residents of SNFs are for asymptomatic bacteriuria. Recently, it was estimated that as many as one-third of the 1.5 million SNF residents in the United States are colonized with at least 1 MDRO.[16] The extensive use of broad-spectrum antibiotics has resulted in an increase in the occurrence of colonization rates of MDROs, such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), and Gram-negative bacteria, which produce extended-spectrum β-lactamases (ESBLs) in SNFs.[17]

The most common type of MDRO is MRSA, determined by its resistance to oxacillin, with colonization rates ranging from 10%-50% in residents of SNFs.[18,19] UTIs attributed to MRSA, if left untreated, can result in complications and sepsis because it is typically resistant to multiple antimicrobials.[20,21] Another serious threat associated with antibiotic resistance is the emergence of VRE. This organism causes a range of different illnesses, including infections of the bloodstream, surgical sites, and the urinary tract. In the United States, there are an estimated 20,000 annual cases of VRE infections with an estimated 1,300 annual deaths. Approximately 30% of *Enterococcus* HAIs are now caused by VRE, leaving few if any treatment options.[11] Gram-negative bacteria expressing ESBLs are also resistant to several types of antibiotics. ESBL producers arise from mutations in these enzymes or standard plasmid-mediated β-lactamases. They have the ability to hydrolyze third-generation penicillins, cephalosporins, and aztreonam.[22] A recent study found that >40% of SNF residents were colonized with ESBL-producing *E coli*, however, more than half had no recent hospital admissions, suggesting that SNFs may help facilitate colonization with MDROs and play an important role in transmission.[23]

Infections caused by MDROs add considerable costs to the already overburdened U.S. health care system. In most cases, these types of infections require prolonged and sometimes costlier treatments, extended hospital stays, increased doctor visits, and increased health care use. Although the total economic impact of antibiotic resistance on the U.S. economy is difficult to calculate, estimates have ranged as high as $20 billion, whereas the cost to society for lost productivity has been estimated to be as high as $35 billion per year (in 2008 U.S. dollars).[11] Moreover, UTIs caused by MDROs are associated with a significant clinical consequences and additional costs which are not compensated for by reimbursement.[24] Therefore, the aim of this study was to determine risk factors for the acquisition UTIs and MDROs in residents of SNFs, using data from the CMS.

METHODS

Data acquisition and sampling

A retrospective analysis was performed on urine cultures obtained from 12 SNFs located in Long Island, New York, over a 6-month period in 2013. Patient data was deidentified, as were the facilities to maintain confidentiality throughout this work. Institutional review board approval was obtained prior to the start of this study. There were 895 (58.8%) women and 628 (41.2%) men, with an age range of 23-107 years (mean, 80.3 years; median, 82.9 years). The urine samples were clean catch midstream urine, straight catheterized urine, suprapubic bladder aspiration, or urine from an indwelling catheter. Urine samples for culture were refrigerated immediately after collection and cultured within 24 hours. On collection, some urine specimens were placed in a Cul-Tect vial (Globe Scientific, Paramus, NJ), containing boric acid–sodium formate, which preserves bacterial viability in urine for 72 hours with or without refrigeration. Urine culture and sensitivities were performed on 1,523 specimens after 24 hours of growth. All urine samples obtained were plated on both 5% sheep blood agar and MacConkey plates (Remel, Lenexa, KS) using a calibrated 0.001 mL sterile loop. Less than 10,000 colony forming units/mL was interpreted as a negative UTI and reported as no significant bacterial growth isolated. Greater or equal to 10,000 colony forming units/mL of a single potential pathogen or for each of 2 potential pathogens was interpreted as a positive UTI. Samples were considered contaminated and improperly collected when >3 distinct organisms were identified on culture plates and were reported as ≥3 organisms isolated. Bacteria isolated from urine were identified, and antibiotic sensitivities were determined using the appropriate Gram-positive or Gram-negative biochemical test card and the VITEK 2 system (bioMérieux, Durham, NC).

Logistic regression analysis

Data were analyzed using STATA/SE 13.1 (StataCorp, College Station, TX). The analysis was performed on 3 distinct sets of regressions; in the first set of regressions, the dependent variable was a binary variable of collecting positive urine cultures in the specimens (0 = no, 1 = yes). The second set examined factors associated with MDROs (0 = no, 1 = yes). Finally, the third set looked at factors associated with receipt of contaminated specimens (0 = no, 1 = yes). Because the dependent variables in the analysis were all binary, multivariate logistical regressions were used.

As the independent variables, age and sex of the subjects from whom the specimens were collected were used in addition to a number of features of the SNF they resided in. This includes, for example, the number of residential beds, occupancy rate, standard health deficiencies, expected RN staffing hours per resident per day, and various 5-star ratings of each nursing facility. For a complete list of variables used in this study see Supplementary Table S1. These data were obtained from the Data.Medicare.gov Web site (https://data.medicare.gov/). Throughout the analysis, *P* values of factors ≤.05 were considered significant.