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ENTANGLED PRACTICES, ENTANGLED EPIDEMICS: ANTIBIOTIC PRACTICES AND HEALTHCARE ASSOCIATED INFECTIONS IN NURSING HOMES AND HOSPITALS

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Abstract: Each year ~388,000 deaths occur due to infections in nursing homes. The U.S. Department of Health and Human Services 2013 National Action Plan to Prevent Healthcare-Associated Infections ranked long-term care as the next priority setting in which to reduce healthcare-associated infections. The changing nature of U.S. nursing homes to increasingly post-acute, skilled nursing facilities has created a "revolving door" between hospitals and nursing homes which increases the potential for spread of healthcare-associated infections. We provide a review of what is known about antibiotic use and infections in both hospital and nursing home settings. A review of the extent of healthcare-associated infections in hospitals and nursing homes underscores the importance of the problem. Taken together, the information provided in this article highlights an acute and growing need for practical, foundational knowledge about transitions among healthcare settings across institutions within networks sharing care for vulnerable older adults. The interconnectedness of nursing homes and hospitals must be considered when devising sustainable strategies to reduce healthcare-associated infections in both settings.

Key words: Nursing homes, infections, healthcare-associated infections, antibiotics, hospitals.

Introduction

The United States Department of Health and Human Services National Action Plan to Prevent Healthcare-Associated Infections (HAIs) was updated in 2013 to rank long-term care as the next priority setting in which to reduce HAIs. Over the course of a year, ~ 3.5 million people will spend time as residents of a nursing home or skilled nursing facility (SNF). Those who do will have a high likelihood of developing an infection. An estimated 1.6-3.8 million infections occur in nursing homes each year (1) with 388,000 deaths due to infections in this setting (1). The Medicare Payment Advisory Commission notes that three of the five conditions accounting for 78% of all 30-day SNF re-hospitalizations are infections (2). Applying this estimate to the total cost for readmissions from SNFs, ~$3.39 billion is spent annually on potentially avoidable SNF re-hospitalizations. In the United States, nursing homes are changing to increasingly post-acute, SNF settings, creating a "revolving door" between hospitals and nursing homes increasing the potential for spread of HAIs (3).

More commonly than any other source, nursing home admissions occur as transfers from acute care hospitals (36%) (4). As a result, nursing homes have been left to deal with (or perpetuate) poor hospital-antibiotic prescribing decisions and to care for newly admitted residents suffering from HAIs. Provisions of the Affordable Care Act and the Medicare Hospital Readmissions Reduction Program payment reform are creating incentives for hospitals to improve their role in patients' successful transition to outpatient or subacute care facilities (5-8). This paradigm shift which incentivizes accountability for care across the continuum of care underscores the need for evidence beyond institutional silos.

This article reviews information regarding HAIs in institutional settings caring for the growing aging population. We review the increasing importance of nursing homes in the healthcare industry and the changing landscape of the nursing home sector in the wake of the Affordable Care Act. We then provide a review of what is known about antibiotic use and infections in both hospital and nursing home settings. A review of the extent of HAIs in hospital and nursing home settings underscores the importance of the problem. Taken together, the information provided in this article highlights an acute and growing need for practical, foundational knowledge about transitions among healthcare settings across institutions within networks sharing care for vulnerable older adults. With a new emphasis on "care throughout the continuum", the impetus for hospitals to work collaboratively with post-acute care providers to assure the well-being of patients in post-acute care settings now exists (9).

The increasing role of nursing homes in the healthcare industry

The population is aging rapidly. While 14% of adults in the US are currently aged ≥65 years (10), it is projected that this demographic will increase to 25% in 2050 (11). Those aged ≥85 years will nearly triple, reaching 17.9 million (4.5% of the total population) (12). Currently, older adults account for >40% of all health care spending, with per capita health expenditures 3 times higher for those aged ≥65 years and 5.7 times higher

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for those aged ≥85 years compared to those <65 years (13). Infectious diseases are responsible for one third of all deaths among those aged 65 years or older (14).

In the United States, there are ~1.8 million certified nursing homes beds in which ~1.4 million residents live on any given day (14). Estimates from the National Clearinghouse for Long-Term Care Information indicate that 21 million people required long-term care services in 2008. As the population ages, increased use of nursing homes (15) and an accelerated rise in nursing home expenditures (16) is expected. The demand for long-term care services is projected to nearly double to 27 million by 2050 (17, 18). Nursing homes account for the largest share of healthcare costs for people ≥85 years (13) due to a high disability rate, lack of social supports, and need for assistance in activities of daily living (17, 19, 20). Currently, there are 15,637 Medicare/Medicaid certified nursing homes in operation in the United States. Most nursing homes (69%) are for-profit (20). Medicaid is the primary payer for ~2/3 of nursing home residents' care (11). For Medicare-Medicaid eligible nursing home residents ("dual-eligibles"), perverse incentives derived from the lack of coordination between Medicare and Medicaid often results in higher Medicaid and Medicare costs and poorer quality of care (21). The stakeholders involved (payers and providers) attempt to unload costs to one another and quality of care suffers because accountability for provider performance is unclear (22). One end result is frequent re-hospitalizations from SNFs (3) which increases the potential for spread of infections. In 2006, Mor et al estimated that 23.5% of Medicare beneficiaries discharged from the hospital to a SNF were readmitted within 30 days costing Medicare $4.34 billion (3). The Medicare Payment Advisory Commission notes that three of the five conditions accounting for 78% of all 30-day SNF re-hospitalizations are infections (2). Applying this estimate to the total cost for readmissions from SNFs, ~$3.39 billion was spent on potentially avoidable SNF re-hospitalizations (3).

Rise of post-acute care needs

Hospitalizations account for nearly one-third of the total $2 trillion spent on health care in the United States. (10, 23, 24). Hospital payment incentives, such as global payments and bundled payments (25), incentivize healthcare organizations to discharge patients as soon as possible which may necessitate hospital-level care in post-acute care settings (26). Among Medicare hospital discharges, 25% are sent to a post-acute setting including 3.2% acute rehab, and 15% discharged to home health (27). Post-acute care now represents approximately 20% of all Medicare spending, a proportion expected to increase. If a patient meets eligibility requirements, Medicare covers post-acute care in a SNF up to 100 days with the first 20 days fully covered and days 21-100 subject to co-pays up to $157.50 per day (28). In 2012, Medicare spent $5.5 billion on long-term care for about 124,000 beneficiaries and more than 140,000 stays (29). Elderly people residing in post-acute and long-term care settings frequently move between care settings (home, hospital, long-term care) due to changes in health and functional status (30, 31). In a study of almost 5 million elderly post-acute patients ≥65 years of age, more than 15 million transitions occurred and 22% of patients had evidence of potential transition problems including "emergency room visits, potentially avoidable hospital stays, and return to an institutional setting following discharge to the community" (31, 32). An estimated 20% of all Medicare hospitalizations are re-hospitalizations within 30 days of discharge (23, 33) and of all SNF discharges, 17.5% are potentially avoidable hospital readmissions during or within 30 days of the SNF stay (26). Some vulnerable older adults are at particular risk for transition problems following a hospitalization. At greatest risk are those with multiple medical conditions, cognitive limitations, mental health problems, lack of social support, low income, immigrant and/or refugee status, or those with limited English proficiency (31, 34). Adding to the transition problems are those created when patients are placed into a long-term care setting from a home- or community-based setting, as care coordination is often fragmented among these settings (35).

Antibiotic use in institutional settings

Improved antibiotic prescribing can decrease antibiotic-related adverse events including the development of antibiotic-resistant and Clostridium difficile infections. Antibiotics are commonly used in hospitals, with the majority of patients receiving one during a hospital stay (37). Broad-spectrum antibiotics including fluoroquinolones, vancomycin, third-generation cephalosporins and β-lactam/β-lactamase inhibitor combinations, such as piperacillin/tazobactam, comprise the majority used in hospitals, both for the treatment of community acquired infections and HAIs (37, 38). The most common infection types treated with antibiotics include lower respiratory and urinary tract, and skin and soft tissue infections. A large degree of antibiotic prescribing can be improved upon, including the areas of antibiotic choice and duration (39, 40). In one study, antibiotic prescribing could have been improved in 37% of clinical scenarios wherein antibiotics were prescribed for urinary tract infections or when vancomycin was prescribed (40). It has been estimated through modeling techniques that a 30% decrease in broad-spectrum antibiotic use can result in a 26% reduction in C. difficile infection (40). Variability in antibiotic use in hospitals has also been shown, indicating that there is a need for antibiotic prescribing improvement. Among hospitals reporting data to the National Healthcare Safety Network in 2012, there was a threefold difference in usage noted among medical/surgical wards (40). We have also previously found that there is variability in total antibiotic use among academic medical centers (37).

In nursing homes, ~40% of residents were taking or had taken a systemic antibiotic within the past month and some were taking more than one (41). In the course of a year, more

than ¾ of residents receive an incident antibiotic treatment course, with 45% exceeding a 7 day course of treatment (42). Commonly prescribed agents include nitrofurantion, levofloxacin, ciprofloxacin, and cephalexin (43). Variation in inappropriate antibiotic use across nursing homes exists (44). Provider preference, rather than patient characteristics, explains this variation. In one study 20% of prescribers were responsible for 79% of excessive duration of course of treatment. Overall, between 25% and 75% of antibiotic prescribing in nursing homes is inappropriate (45-47) and little evidence of adherence to Loeb minimum standards for initiation of antibiotics has been observed (48). High rates of institutional antibiotic use for prolonged periods may lead to the development of antimicrobial resistance. The level of fluoroquinolone prescribing (49) in nursing homes has been called "surprising" given the association between the use of these antibiotics and C. difficile infection (50). Only 15% of initial antibiotic prescribing in nursing homes (49) was based on culture results.

Although effective in hospitals, antibiograms have unknown utility in nursing homes and antimicrobial stewardship programs developed for hospital settings are unlikely to be easily transferable to the nursing home context. Compared to acute care hospitals, nursing homes present unique challenges. This is due to factors such as relatively lower educational level of nursing home staff, variations in care-giver knowledge, the family-nurse-physician triad, limited access to physicians, overall lack of resources, limited coordination of medical care, lack of on-site diagnostic laboratories, limited surveillance data, and a tendency to treat patients empirically relying on broad-spectrum antibiotics (51-53). In nursing homes, nursing staff are the driving force behind antibiotic prescribing (54) as physicians rarely visit nursing home residents to confirm diagnosis, rather accepting the nurse's assessment of the resident. Nurses often respond to family pressure often leading to increased inappropriate antibiotic prescribing. A systematic-review of trials to improve the appropriateness of antibiotic prescribing in nursing homes identified four randomized trials with mixed effects and lack of sustainability of effect, albeit the few studies identified suffered from methodological issues (55). Intervention efforts conducted more recently have shown promise (56, 57).

Infections in institutional settings

In the acute hospital setting, 4.0% of all hospitalized patients, or one out of every 25 inpatients, had at least one HAI according to the most recent data (58). Device-related infections, such as central-catheter associated bloodstream, catheter-associated urinary tract, and ventilator-associated pneumonia infections account for approximately one-quarter of all hospital acquired infections, with C. difficile infection and non-device associated pneumonias accounting for the majority of infections (58). Regarding the occurrence of C. difficile infection, 65.8% of cases are healthcare-associated while just 24% have onset in the hospital (59). For every 1% increase in the proportion of hospital patients aged 65 years and above, there is a corresponding 1% increase in C. difficile infection (60). In this study, unfortunately, the proportion of hospital patients admitted from nursing homes was not evaluated as a hospital level factor in the analysis.

Within nursing homes, the most frequently cited estimate of the number of infections is 1.6 to 3.8 million per year (61, 62). Yet, these estimates were from 2000 (63) and studies since then have indicated increases in infections (64). In nursing homes, the most common infections are urinary tract, soft tissue (e.g., pressure ulcers), gastrointestinal, and respiratory tract (41, 65-69). Nursing home residents are at increased risk for infection due to age-related vulnerabilities including immune dysfunction, malnutrition, functional impairment, chronic diseases, polypharmacy, and use of invasive devices like feeding tubes and urinary catheters (61, 70). Infections in elderly nursing home residents are difficult to diagnose due to cognitive deficits and communication difficulties, multiple pre-existing chronic conditions, and atypical or vague symptoms (46, 71). Nursing homes have often been cited for deficiencies in both infection control (15%) (72) and hand hygiene (9%) (73) and disease outbreaks within the nursing home account for 10-20% of all nursing home infections (71, 74). Nursing homes not only provide skilled nursing and rehabilitation services but also provide a setting for long-term residence in a confined setting with group activities (51) where residents socialize and live (71). The challenges of preventing infections in this setting are unique (75).

Due to greater health services utilization, elders are exposed to antibiotic resistant bacteria at higher rates (76) and many elderly admitted from hospitals to nursing homes are already colonized with antibiotic-resistant bacteria (52, 70). Nursing facilities may become reservoirs for antibiotic-resistant organisms (76). Nursing home residents are commonly colonized with methicillin-resistant Staphylococcus aureus and fluoroquinolone-resistant gram-negative bacilli (77-79) and antibiotic resistant infections are on the rise in nursing homes (64). Although 57% of residents acquire a multidrug resistant organism infection in the nursing home setting, 41% acquire a multidrug resistant organism infection at an acute care hospital (80). While significant variation across nursing homes has been noted (77), research to understand the variation is lacking.

Interconnectedness of hospitals and nursing homes

In the United States, it is often unclear who has responsibility for a patient's care during the transition from one care setting to another (31, 81). Under Medicare, hospitals currently do not incur penalties for re-admitting patients who had been discharged to SNFs. In part because of the lack of incentives, hospitals' accountability for their patients ends at time of discharge. Hospitals have not invested in

improved transition of care processes and have not worked collaboratively with nursing homes to address HAI prevention and control. SNFs are in a precarious position. They need the customers (patients) hospitals provide, but have no leverage which could be used to engage hospitals to improve care coordination and to prevent untoward events such as HAIs.

Provisions of the Affordable Care Act and the Medicare Hospital Readmissions Reduction Program payment reform are creating incentives for hospitals to improve their role in patients' successful transition to outpatient or subacute care facilities (6-8). The extent to which provisions in the Affordable Care Act address the unique needs of vulnerable subgroups who require long-term services and support has been questioned (82). Given Medicare financial penalties for high 30-day readmission rates, there is a growing realization that coordination with post-acute providers is key to reducing unnecessary re-hospitalizations (23). Recently, the Department of Health and Human Services has instituted goals for basing Medicare fee-for-service payments on quality or value by the end of 2018 (83). The expectation is that commercial payers will implement value-based payment programs as well. With a new emphasis on "care throughout the continuum", there will likely be an impetus for hospitals to work collaboratively with post-acute care providers to assure the well-being of patients in post-acute care settings (10). Successful programs (84, 85) to improve transitions require organizational capacity reflected by the structural characteristics of hospitals (84). Yet until recently, hospitals have largely not made significant efforts to coordinate, monitor or enhance the quality of care within SNFs (27). Post-acute SNF networks are being developed to extend quality and cost control measures across the patient care continuum (27). These networks address quality standards, share data, and provide services to reduce avoidable re-hospitalizations (25). Additional changes, such as shared savings through Accountable Care Organizations will likely influence incentives across the healthcare system to improve quality patient care (23).

Given this paradigm shift of "care across the continuum", understanding how HAIs and inappropriate antibiotic prescribing practices impact on the ability to provide quality of care within healthcare networks is needed. Understanding the inter-institutional variation in HAIs and antibiotic prescribing may help reduce HAIs in both settings (77). Though the occurrence of HAIs and amounts of antibiotic drug usage has been quantified in hospitals and in long-term care facilities, there is a paucity of data that examines the relationships between the two settings. Cross-sectional prevalence studies of HAIs and antibiotic use are usually conducted in either setting alone, but have not captured HAIs and antibiotic use across settings during transitions of care. Evidence suggests that these transitions are opportunities for resistant-organisms to be spread (86), and errors in antibiotic prescribing to be continued in different healthcare facilities.

Conclusions

The United States Department of Health and Human Services is committed to preventing and reducing HAIs. Launched in 2008, the National Action Plan to Prevent Healthcare-Associated Infections: Roadmap to Elimination initially targeted acute care settings, followed by ambulatory surgical centers and end stage renal disease centers, and finally in 2013 included CDC-led initiatives targeting long-term care settings. Further, national goals for reducing HAIs are included in the objectives for Healthy People 2020 and the National Partnership for Patients strives to reduce hospital readmissions by focusing on reducing complications during transitions from one care setting to another.

The information reviewed in this article underscores the importance of "simultaneous, cooperative interventions" among nursing homes and hospitals within the same geographic area (80). Surprisingly, studies that incorporate the interconnectedness of hospitals and nursing facilities into interventions aimed at reducing HAIs are scant. This paucity of information exists despite the fact that nursing home admissions occur as transfers from hospitals more commonly than any other source (4) and hospitalization is a risk factor for post-discharge infection occurrence (87, 88).

Transitions in care are opportunities for resistant-organisms to be spread (86), and errors in antibiotic prescribing to be continued. The success of improving antibiotic prescribing and reducing HAIs in hospitals and nursing homes has been limited. This may be in part because research to date has neglected the symbiotic relationship between nursing homes and hospitals. Although 2.4% of all hospital admissions for those ≥65 years are from NHs and SNFs, these hospital stays were longer, more likely to result in death, and more likely to be infection-related than among older adults admitted from community settings (9). Despite this, the interrelationship between NHs and hospitals has largely been ignored in attempts to reduce HAIs. A paradigm shift is required. The data and statistical methods exist to further understand how entangled hospitals and nursing homes are with respect to HAIs. The time has come to move away from silo-based research in favor of a new generation of information regarding antibiotic prescribing practices and HAIs which considers the continuum of institutions that care for the growing aging population in the dynamic context of care settings in which they traverse.

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Ethical standards: This review of the literature was not human subjects research and thus did not require IRB oversight.

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