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Feature Article

The impact of the Hospital Elder Life Program on the treatment of asymptomatic bacteriuria: An unexpected benefit

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ABSTRACT

Delirium in older adults is often inappropriately attributed to presumed urinary tract infections (UTIs) leading to unnecessary prescribing of antibiotics for asymptomatic bacteriuria. We sought to examine whether implementation of the Hospital Elder Life Program (HELP), a delirium prevention program, reduced the inappropriate treatment of asymptomatic bacteriuria. We conducted a secondary data analysis of administrative data and electronic health records on a descriptive study in which HELP was implemented at an academic community hospital. Patients aged 70 and older admitted before HELP was implemented ($n = 687$) were compared to the intervention group after HELP implementation ($n = 637$). HELP intervention participants, compared to pre-intervention patients, were less likely to receive inappropriate treatment for asymptomatic bacteriuria (3.0% versus 6.7%, adjusted odds ratio=0.46, 95% confidence interval=0.26–0.79, $P = 0.005$). HELP was associated with a reduction in the treatment of asymptomatic bacteriuria. Therefore, HELP may decrease adverse events and costs related to unnecessary exposure to antibiotics.

Introduction

Asymptomatic bacteriuria is defined as bacteriuria without local urinary tract symptoms or evidence of systemic infection.[1] Asymptomatic bacteriuria is common in older adults, with rates up to 19% among community-dwelling older adults and up to half of older adults in long-term care facilities.[2] Despite evidence that asymptomatic bacteriuria is unlikely to cause a patient to develop delirium, many providers still presume that if asymptomatic bacteriuria is present in patient with delirium, a urinary tract infection (UTI) is the cause until proven otherwise.[2–4] The revised McGeer criteria, which help to identify individuals who likely require treatment with antibiotics for suspected UTI, do not include an acute change in mental status in non-catheterized patients.[5] Additionally, UTIs are unlikely to cause delirium unless the patient is also having systemic signs and symptoms of infection (i.e. sepsis).[1,2,5]

Delirium affects up to 60% of the older hospitalized population.[6] The etiology of delirium is often multifactorial, making it difficult to discern an exact cause.[7] Delirium is often viewed as a symptom of UTIs in the elderly, although there is little evidence to support this relationship.[2–4,8] In the investigation of delirium, older adults will often be found to have bacteriuria due to the high prevalence of asymptomatic bacteriuria in this population. Treatment of asymptomatic bacteriuria is unnecessary, except in the setting of urologic procedures and pregnancy, and may result in harm in some populations, especially older adults.[9–10] Unnecessary exposure to antibiotics is associated with the propagation of antibiotic resistance, *Clostridium difficile* infection, adverse drug events, and increased healthcare costs.[11–15]

The Hospital Elder Life Program (HELP) is an evidence-based program that aims to reduce the incidence of delirium in older adults in the hospital through a multicomponent intervention that strives to keep patients oriented to their surroundings, maximize their nutritional status, promote healthy sleep patterns, and encourage mobility.[16] Multicomponent non-pharmacological delirium interventions have demonstrated a 44% reduction in the odds of delirium.[17] In the setting of an academic community hospital, we sought to examine whether implementation of HELP reduced the inappropriate treatment of asymptomatic bacteriuria. At our hospital, the delirium incidence after implementation of the HELP program decreased from 24.0% in the pre-intervention group ($n = 96$) to 4.8% in the intervention group ($n = 377$, $P < 0.001$), which maintained statistical significance in the multivariate analysis (adjusted odds ratio (OR) = 0.22, 95% confidence interval (CI) 0.10–0.48, $P < 0.001$).[18] This reduction in delirium incidence is consistent with results demonstrated by other HELP programs.[19] We hypothesized that the reduction in the incidence of delirium would indirectly influence provider behavior

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through a reduction in the suspicion of UTI and therefore fewer urinalyses and cultures would be sent, and therefore fewer antibiotics prescribed for asymptomatic bacteriuria (Fig. 1).

Materials and methods

Study design

We conducted a secondary data analysis of administrative data and electronic health records to compare the ordering of urinalyses and urine cultures and inappropriate treatment of asymptomatic bacteriuria in older adults before and after implementation of HELP. The pre-intervention period was December 1, 2014 through December 31, 2015, and the intervention period was May 1, 2016 through August 31, 2017. The inclusion criteria were: (1) age over 70 and (2) admission to one of three units at the hospital on which HELP was implemented (medical-surgical, telemetry, and step-down) for at least 2 days. Patients with an admission diagnosis of acute encephalopathy were excluded from the pre-intervention group. Exclusion criteria for the intervention group after HELP implementation included: (1) inability to communicate (e.g. coma, severe aphasia, severe dementia); (2) refusal by patient or family member (if patient was incapacitated); (3) droplet, airborne, or neutropenic precautions (patients in contact isolation were enrolled). HELP was first implemented on a pilot unit then expanded to three additional units. The sample consisted of consecutive patients who fulfilled inclusion and exclusion criteria on units where HELP was deployed. The intervention included visits from trained volunteers over three shifts, seven days per week, with the goal of enhancing cognitive orientation, communication, and social support. Patients were also visited by the HELP nurse specialist, who identified delirium risk factors and provided education on delirium to the nursing staff on the unit. The study was granted exempt status by the Allegheny Health Network Institutional Review Board.

Measurement strategy

We utilized administrative data to obtain information for demographic data including age, gender, race/ethnicity, and marital status. Admission-related data collected included diagnoses of UTIs as defined by ICD-9/ICD-10 codes, type and duration of antibiotics given, and urinalyses and urine cultures ordered. A comprehensive review of electronic medical records was performed by a physician (A.J.O.) on all patients with a diagnosis of UTI. The revised McGeer criteria were used to determine if antibiotics were appropriate.[5] Patients who received antibiotics for asymptomatic bacteriuria because they were undergoing a urological procedure were not considered to have been treated inappropriately. Empiric antibiotics given before urine cultures were available (criteria 2 of the revised McGeer criteria) were considered inappropriate if they did not meet criteria 1 of the revised McGeer criteria. We excluded patients with concomitant infections for which antibiotic administration would have been appropriate. A geriatrician (L.W.) and infectious disease specialist (T.L.W.) reviewed the charts of patients to come to a consensus when there was uncertainty concerning whether diagnoses of UTI and antibiotic use were appropriate.

Sample size

Assuming a baseline rate of presumed UTIs (as defined by ICD-9/ICD-10 codes from administrative data) of 20%, a sample size of 484 patients per group was necessary in order to detect a 30% reduction in UTIs between groups with 80% power. There were 687 patients in the pre-intervention group and 637 patients in the HELP intervention group.

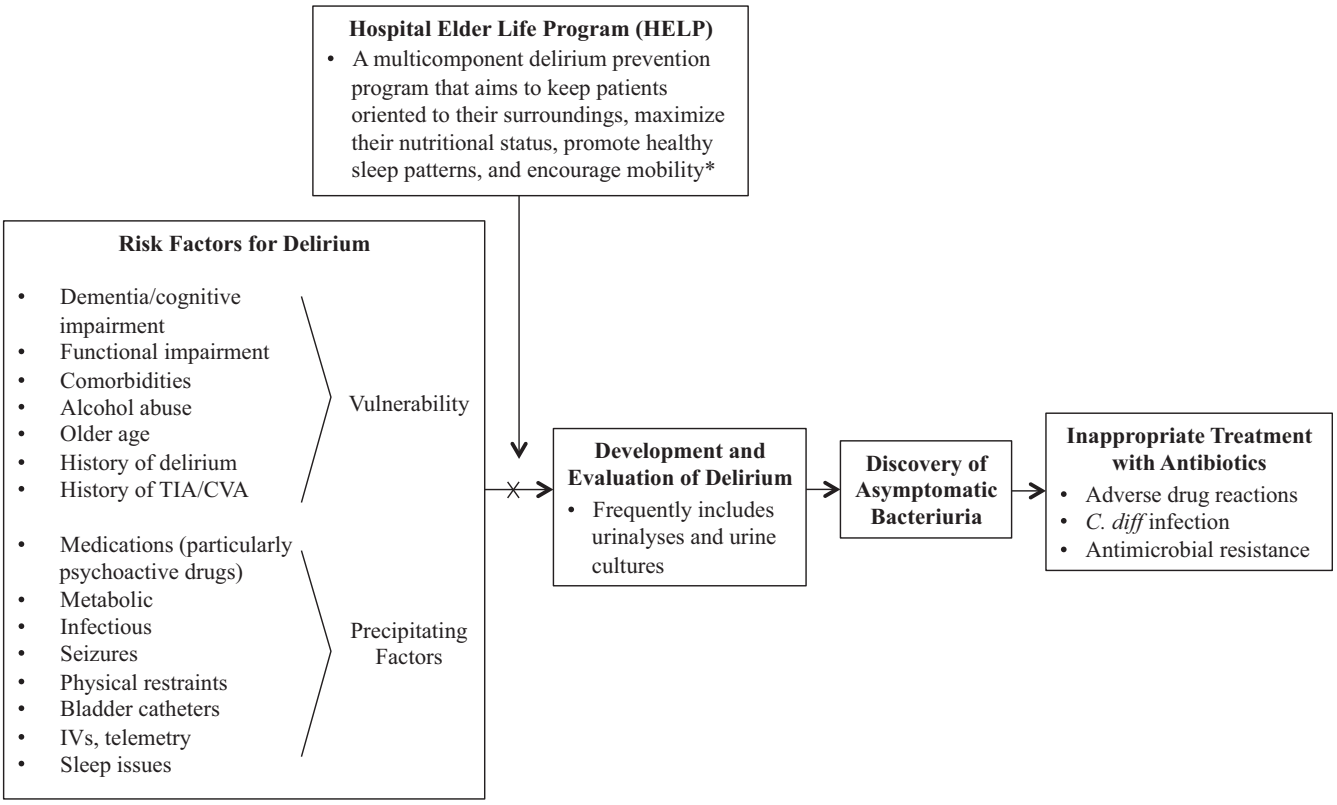

Fig. 1. Conceptual model for the hypothesis that participation in HELP may reduce the treatment of asymptomatic bacteriuria. * Inouye et al., 2000.

Table 1
Baseline patient characteristics by group (n = 1324 patients).

	Pre-intervention group (n = 687)	HELP intervention group (n = 637)	P-value
Sociodemographic characteristics			
Age, mean in years (s.d.)	79.3 (6.9)	78.4 (6.6)	0.014
Gender, women, n (%)	437 (63.6)	396 (62.2)	0.59
White, n (%)	458 (66.7)	491 (77.1)	<0.001
Married, n (%)	284 (41.3)	283 (44.4)	0.26

Abbreviations: s.d., standard deviation; HELP, Hospital Elder Life Program.

Analysis

Descriptive statistics were calculated for the patients in the pre-intervention and intervention groups. Comparisons between the pre-intervention and intervention groups were made using $\chi 2$ tests and Student's t tests for categorical and continuous variables, respectively. Logistic regression models were used to calculate ORs and Poisson regression models were used to calculate risk ratios (RRs) as appropriate to examine the relationship between the intervention and inappropriate treatment of asymptomatic bacteriuria. Multivariable models were adjusted for age, gender, race/ethnicity, and marital status. $P < 0.05$ were considered statistically significant. All analyses were conducted in SAS 9.4 (SAS Institute, Cary, NC).

Results

Baseline characteristics

The mean age of our sample was 78.4 years in the intervention group and 79.3 in the pre-intervention group (P = 0.014). In the pre-intervention group, 63.6% (n = 437) were women compared to 62.2% (n = 396) of the intervention group (P = 0.59). Persons in the intervention groups were more likely to be white/Caucasian than non-white/Caucasian compared to the pre-intervention group (77.1% versus 66.7%, $P < 0.001$). In the pre-intervention group, 41.3% (n = 284) of patients were married compared to 44.4% (n = 283) of the intervention group (P = 0.26) (Table 1).

The effect of HELP on treatment of asymptomatic bacteriuria

We examined the relationship between participation in the HELP intervention and diagnoses and inappropriate treatment of asymptomatic bacteriuria (Table 2). In total, 130 patients had a diagnosis of UTI by ICD-9/ICD-10 codes. These charts were reviewed to determine if the patients had a diagnosis of true UTI or asymptomatic bacteriuria and whether antibiotics were appropriate or not as determined by the revised McGeer criteria. Patients who participated in the HELP intervention were over 50% less likely to be inappropriately treated for asymptomatic bacteriuria (3.0% versus 6.7%, crude OR = 0.43, 95% CI = 0.25–0.74, P = 0.002). After adjusting for differences in age, gender, ethnicity, and marital status, HELP participants continued to be less likely to be inappropriately treated for asymptomatic bacteriuria (adjusted OR = 0.46, 95% CI = 0.26–0.79, P = 0.005). HELP participants also had fewer inappropriate inpatient antibiotic days (2.4 versus 6.6 antibiotic days/100 hospital days, adjusted RR = 0.39, 95% CI = 0.29–0.52, $P < 0.001$) and inappropriate combined inpatient and outpatient antibiotic days (4.1 versus 11.2 antibiotic days/100 hospital days, adjusted RR = 0.39, 95% CI = 0.29–0.53, $P < 0.001$). There was no effect of HELP participation on the ordering of urinalyses and urine cultures (41.3% versus 41.2%, adjusted OR = 1.07, 95% CI = 0.86–1.34, P = 0.53). The rate of UTI as determined by the revised McGeer criteria was 3.9% in the pre-intervention group versus 3.5% in the intervention group (P = 0.65).

Discussion

The principal finding of this study is that participation in the HELP intervention was associated with a reduction in the inappropriate treatment of asymptomatic bacteriuria. While no conclusions can be drawn from this study regarding causation between reduction in delirium and inappropriate treatment of asymptomatic bacteriuria as this was a descriptive study, there are several possible mechanisms through which HELP may both directly and indirectly influence provider behavior. HELP may have directly reduced the inappropriate treatment of asymptomatic bacteriuria through the education of providers and nursing staff about the prevention, diagnosis, and treatment of delirium. HELP may have indirectly influenced provider behavior as well. Given that the etiology of delirium is often multifactorial and difficult to discern, the onset of delirium typically prompts providers to investigate for UTI. This leads to treatment when infection does not truly exist.[2–4] Efforts to reduce delirium may therefore reduce the treatment of asymptomatic bacteriuria.

In the United States, 20 to 50% of all antibiotics prescribed in hospitals are unnecessary or inappropriate.[20] Unnecessary exposure to antibiotics places patients at risk for adverse drug events and *Clostridium difficile* infection without providing clinical benefit. Inappropriate antibiotic use is also associated with the propagation of antibiotic resistance and increased healthcare costs.[11-15,20] The Centers for Disease Control and Prevention recommends that

Table 2
Study outcomes for Hospital Elder Life Program (HELP) intervention group (reference: pre-intervention group) (n=1324 patients).

Outcome (reference: pre-intervention group)	Pre-intervention group n (%)	HELP Intervention group n (%)	Crude OR [95% CI]	Adjusted OR [95% CI]
Inappropriate treatment for asymptomatic bacteriuria	46 (6.7)	19 (3.0)	0.43 (0.25–0.74)*	0.46 (0.26–0.79)*
			P = 0.002	P = 0.005
Urinalyses and/or urine culture ordered	283 (41.2)	263 (41.3)	(0.81–1.25)	1.07 (0.86–1.34)
			P = 0.97	P = 0.53
			Crude RR [95% CI]	Adjusted RR [95% CI]
Inpatient antibiotic days, inappropriate use (antibiotic days/100 hospital days)	6.6	2.4	0.37 (0.27–0.49)*	0.39 (0.29–0.52)*
			$P < 0.001$	$P < 0.001$
Inpatient and outpatient antibiotic days, inappropriate use (antibiotic days/100 hospital days)	11.2	4.1	0.36 (0.27–0.49)*	0.39 (0.29–0.53)*
			$P < 0.001$	$P < 0.001$

Abbreviations: OR, odds ratio; CI, confidence interval; RR, risk ratio.
Logistic regression models were used to calculate ORs and Poisson regression models were used to calculate RRs. All multiple models adjusted for age, gender, race and marital status.
* $P < 0.05$; UTI, urinary tract infection.

interventions for reducing unnecessary antibiotic exposure for presumed UTIs should focus on avoiding treatment of patients with asymptomatic bacteriuria and avoiding unnecessary urine cultures.[20] This study demonstrates that programs like HELP may contribute to antibiotic stewardship for presumed UTIs.

This study also found that there was no significant change in the frequency with which urinalyses and urine cultures were ordered after HELP implementation, even though patients were less likely to inappropriately receive antibiotics for asymptomatic bacteriuria after HELP was implemented. Urinalyses and urine cultures are routinely ordered during evaluation of patients in the emergency department, where the HELP intervention is not implemented. We theorize that this may have been one reason why there was no change in the frequency of urinalyses and urine cultures ordered, although we were not able to explore this with our data. Additionally, urinalyses are sent for reasons other than concern for UTI, such as renal failure or diabetes mellitus, which was not captured by our study.

Misinterpretation of urinalyses in patients without symptoms consistent with a true invasive UTI may lead to inappropriate treatment of asymptomatic bacteriuria. The revised McGeer criteria take into account the low probability of UTI in patients if localizing symptoms are not present as well as the importance of positive urine culture results for confirmation of diagnosis.[5] In a study of older women diagnosed with presumed UTI in the emergency department, 43% did not have microbiologic evidence of a UTI, yet 95% patients with negative cultures received antibiotics to treat presumed UTIs.[21] The above study demonstrates the current approach to treatment of presumed UTI in many medical settings and importance of antimicrobial stewardship programs. Delirium is often viewed as a symptom of UTIs in the elderly, and therefore, urinalyses and urine cultures are often obtained as part of the work-up for delirium.[8] However, the high prevalence of asymptomatic bacteriuria in older adults, particularly among older adults residing in long-term care facilities, means that patients with delirium will often be found to have bacteriuria, although the presence of bacteriuria is not causally related to the true underlying cause of delirium.[2] Asymptomatic bacteriuria is unlikely to cause a patient to become delirious, as multiple randomized trials and cohort studies report no benefits of screening for or treating asymptomatic bacteriuria in older adults.[2] Eriksson and colleagues demonstrated that in patients who develop delirium, other causes, such as Alzheimer's disease, vascular dementia, depression, and heart failure, are at least as great of risk factors for delirium as UTI.[22] When delirium is mistakenly attributed to asymptomatic bacteriuria, harm may result to patients not only from inappropriate exposure to antibiotics but also from the delayed opportunity of identifying and treating the true cause of delirium.

The results of our current study should be considered in the context of several potential study limitations. First, the pre-intervention group could have included patients who had an inability to communicate, while these patients were excluded from the HELP intervention. We attempted to mitigate this by excluding patients with an admission diagnosis of acute encephalopathy. Second, this was a retrospective review of patient charts and administrative data and therefore may be subject to confounding factors and reviewer bias. However, despite chart reviewers not being blinded, we attempted to limit bias by using standardized criteria for UTI and asymptomatic bacteriuria (the revised McGeer criteria), a data collection form, and electronic data extraction for capture when possible. Additionally, the pre-intervention/post-intervention design has a number of limitations, including difficulty in measuring or controlling for important confounding variables and regression to the mean. However, one possible confounding factor, our hospital antibiotic stewardship program, was already in place prior to the pre-intervention period used in our analysis. We were also unable to control for several possible confounding factors, including comorbidities and cognitive and physical function, due to limitations in our data. Ideally, we would have been able to include Charlson Comorbidity Index data in our analyses. Additionally, administrative data is limited by provider documentation and clinical documentation specialists, leading to a known underreporting of delirium and likely underreporting of presumed UTIs as well. However, this would likely affect both our pre-intervention and intervention groups equally. Finally, antibiotics days were measured as any day that a person had received an antibiotic for asymptomatic bacteriuria. This measurement was used because it is an accepted measurement,[20] with the consideration that it does not take into account multiple doses of the same antibiotic on the same day.

Conclusions

Our results are important to consider given that this study is one of the first to examine the relationship between HELP and the inappropriate treatment of asymptomatic bacteriuria. Our results suggest that the HELP program may influence the frequency with which patients are diagnosed with presumed UTIs and inappropriately prescribed antibiotics for asymptomatic bacteriuria. Further work exploring the relationship between HELP and reduction in the inappropriate treatment of asymptomatic bacteriuria may be useful to identify interventions that may reduce unnecessary antibiotic exposure.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi: 10.1016/j.gerinurse.2019.03.011.

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