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Abstract

Misdiagnosis of asymptomatic bacteriuria as a urinary tract infection continues to occur, leading to the overuse of antibiotics. Due to the growing elderly population in long-term care facilities (LTCFs), LTCFs can play a critical role in antimicrobial stewardship. Urinary tract infections are a starting point for moving toward antimicrobial stewardship, since urinary tract infections are common in LTCFs. A retrospective chart review of 156 cases with suspected urinary tract infections (UTIs) was completed in a LTCF. The purpose of the scholarly project was to assess diagnostic and treatment practices for UTIs and compare them to a diagnostic and treatment algorithm. The overarching finding of the scholarly project was that this particular LTCF's management of UTIs did not correspond with the selected algorithm's recommendations. Because the elderly frequently have complex and confounding health factors related to UTIs, the selected algorithm did not adequately capture the nuances for UTI diagnosis in the elderly population. As currently published, the algorithm is not generalizable to elderly women in LTCFs. The symptoms component of the diagnostic portion of the algorithm may benefit from further revision for use in the elderly population. Small-scale change at LTCFs could include encouragement of watchful waiting and improved use of guidelines for antibiotic treatment.

Keywords: urinary tract infections, elderly, diagnosis and management, guidelines, algorithm

Background

By 2030, one-fifth of the United States population is projected to be 65 years or older (High et al., 2009). Adults over the age of 65 are at greater risk for infections due to factors such as decreased immune function, comorbidities, alteration in mucosal linings, and institutionalization (Lim, Kong, & Stuart, 2014; Mody, 2017). Infections most commonly experienced by the elderly are urinary tract infections (UTIs), respiratory infections, and soft-tissue infections (Montoya & Mody, 2011). More specifically, UTIs account for 20-30% of all infections within long-term care facilities (LTCFs) (Centers for Disease Control and Prevention [CDC], 2012b). The management of UTIs in the elderly is a persistent issue in the healthcare community due to the population′s complexity of various health factors. The complexity has foiled the establishment of a gold standard for diagnosis and treatment (Nace, Drinka, & Crnich, 2014; Rowe & Juthani-Mehta, 2014).

Asymptomatic bacteriuria (ASB) is common in the elderly and is defined as colonization of bacteria in the urinary tract, creating a positive urine culture without signs and symptoms of an infection (CDC, 2015; Nicolle, 2014). Screening for and treating ASB in institutionalized elderly increases the risk for antimicrobial resistance, adverse effects, and healthcare expenditure, and is not recommended by the Infectious Diseases Society of America (IDSA) (High et al., 2009). Despite the IDSA recommendation, misdiagnosis and treatment of ASB as a UTI still occurs at a high rate and has led to overuse of antibiotics (Doernberg, Dudas, & Trivedi, 2015; Drekonja et al., 2013; Lee et al., 2015).

Long-term care facilities with patterns of high antibiotic use have higher rates of adverse effects from antibiotics, such as *Clostridium difficile* infections (CDIs) and antimicrobial resistant organisms (Daneman et al., 2015). Moreover, antibiotic exposure, type of antibiotic such as fluoroquinolones and cephalosporins, increased length of stay in healthcare settings, immunosuppression, and increased age are all correlated with an increased risk of CDI (CDC, 2012a; Cohen et al., 2010). Additionally, the elderly were found to be five times more likely to contract a CDI than adults aged 45-64 (Lessa et al., 2015). Patients who contract a CDI may have a twofold increase in mortality (Shorr, Zilberberg, Wang, Baser, & Yu, 2016). Such complications reinforce the need to appropriately diagnosis UTIs in the elderly and to steward antibiotics.

Problem Statement

The elderly population in the United States is steadily growing. Meanwhile, misdiagnosis of ASB as a UTI in the elderly continues to occur, leading to the overuse of antibiotics. Because unnecessary use of antibiotics can have devastating adverse effects in the elderly population, a study was needed to compare current practices for UTI management in one LTCF with a diagnostic and treatment algorithm.

Purpose

The purpose of the scholarly project was to compare diagnostic and treatment practices for urinary tract infections (UTIs) in elderly women at one LTCF in Nashville, Tennessee with a specific diagnostic and treatment algorithm. The research questions were:

- How do current practices within the LTCF compare to Rowe and Juthani-Mehta's (2014) algorithm for diagnosis and treatment of UTIs?
- How often do clinicians meet both the diagnostic and treatment portion of the algorithm?

Review of Evidence

Definitions

Urinary tract infections are often defined as signs and symptoms related to the genitourinary tract in conjunction with a positive urine culture (Stone et al., 2012). However, because variations of this definition occur related to increased age and the presence or absence of complications, currently, no universally accepted definition for UTIs within the elderly exists (Gupta et al., 2011; Hooton & Gupta, 2016; Rowe & Juthani-Mehta, 2014). Cystitis refers to an infection within the lower urinary tract, which is the focus of this scholarly project (Hooton & Gupta, 2016). Diagnosis of a lower UTI can be further categorized into complicated or uncomplicated based on a patient′s history and current conditions, which can alter the antibiotic selection and course (Hooton & Gupta, 2016).

Risk Factors

Residents in LTCFs are at greater risk for UTIs due to factors such as aging, comorbidities, indwelling catheters, and cognitive and functional impairment (Genao & Buhr, 2012; Rowe & Juthani-Mehta, 2014). Women are at greater risk for contracting a UTI due to the short anatomical structure of the urethra (National Institutes of Health [NIH], 2016). Further, many elderly women in LTCFs meet multiple risk factors and have a higher incidence of UTIs than elderly men (Rowe & Juthani-Mehta, 2013). Moreover, a history of UTIs increases future risk of recurrence (Hooton & Gupta, 2016).

Asymptomatic Bacteriuria

Asymptomatic bacteriuria (ASB) in women is defined as two consecutive voids with bacteriuria present in the absence of genitourinary symptoms (Nicolle, 2016; Rowe & Juthani-Mehta, 2014). One study reported 55% of clinicians working in LTCFs would prescribe antibiotics for ASB (Juthani- Mehta et al., 2005). Additionally, surveys of resident physicians showed between one-third and half were unable to differentiate cases of ASB from UTI, leading to a substantial overuse of antibiotics (Drekonja et al., 2013; Lee et al., 2015). Lee et al. (2015) reported 46% of those surveyed acknowledged consciously prescribing unnecessary antibiotics for ASB. The inconsistent application of current evidence to clinical practice highlights not only the challenges of balancing guideline directed care for complex patients, but also the potential erroneous calculation of antibiotic exposure risk.

Guidelines

The guidelines for infection control surveillance regarding UTIs have evolved over time. McGeer's diagnostic guideline for UTIs was published in 1991 to distinguish between a symptomatic UTI from asymptomatic bacteriuria (McGeer et al., 1991). Juthani-Mehta et al. (2007) found the 1991 McGeer's guideline to have a sensitivity of 30% for identifying a UTI, providing evidence that not utilizing the guideline may be a result of clinicians′ fear of missing infections and the consequent risk to patients of untreated infections. The low probability of UTI detection using McGeer's 1991 guideline incentivized the Society for Healthcare Epidemiology of America (SHEA) to update McGeer's guideline in 2012 (Stone et al., 2012). Subsequently, Rowe and Juthani-Mehta (2014) proposed a diagnostic and treatment algorithm with additional evidence-based adaptations to SHEA′s guidelines to increase the diagnostic specificity and value in the LTCF clinical context. Rowe and Juthani-Mehta's algorithm is more prescriptive in that it requires dysuria to be present along with either a change in urine character, mental status, or hematuria, whereas SHEA specifies a positive symptomology as dysuria alone (Rowe & Juthani-Mehta, 2014; Stone et al., 2012).

The algorithm proposed by Rowe and Juthani-Mehta (2014) was implemented in this scholarly project because (1) it aimed to increase the specificity of diagnosing UTIs, (2) it combined guidelines for both diagnostic and treatment recommendations of UTIs, and (3) it had not yet been used to compare current diagnostic and treatment practices of UTIs in the LTCF setting. Since it was adapted from evidence-based guidelines, the algorithm could be considered the most up to date compilation of evidence-based practice guidelines for UTIs in LTCFs. An extensive review of the literature failed to identify any previous studies that have utilized the algorithm. Rowe and Juthani- Mehta's (2014) compilation of evidence-based guidelines will be referred to as the algorithm within this project report and is displayed in Figure 1.

Diagnosis

Elderly patients may not present signs of an infection in the same manner as the general population. For example, the elderly are less likely to exhibit a fever with an infection than the general population due to decreased immune function (Chester & Rudolph, 2011; High et al., 2009). Elders frequently have atypical clinical presentations of illness including lack of fever and non-specific symptoms such as mental status changes (Balogun & Philbrick, 2014; Limpawattana, Phungoen, Mitsungnern, Laosuangkoon, & Tansangworn, 2016). Determining the origin of a possible infection is especially challenging with atypical presentations, increasing the risk of diagnostic errors (Balogun & Philbrick, 2014).

Diagnostic errors result from clinicians' mental models, which are related to clinical cues in the elderly, such as concern of missing an infection or concern for overall health status, that are not articulated within diagnostic guidelines (Abbo, Smith, Pereyra, Wyckoff, & Hooton, 2012; Trautner et al., 2013). Additionally, the diagnostic process can be complicated by cognitively impaired elderly who are unable to describe their symptoms, yet still generate a positive urine culture (Walker, McGeer, Simor, Armstrong-Evans, & Loeb, 2000). Due to the complexity of the elderly, clinicians may be non-adherent to guidelines for fear of overlooking a serious condition, leading to unnecessary treatment (Filice et al., 2015; Rowe & Juthani- Mehta, 2014).

Treatment

Treatment decisions for UTIs include selection and initiation of an appropriate antibiotic with the recommended dosage and duration. Treatment for UTIs may differ between men and women, with men often being diagnosed with complicated UTIs (Beveridge, Davey, Phillips, & McMurdo, 2011). Although current guidelines for treatment of uncomplicated UTIs in women recommend sulfamethoxazole/trimethoprim, nitrofurantoin, fosfomycin trometamol, and pivmecillinam, fluoroquinolones are often found to be prescribed for uncomplicated UTIs for women in primary care and LTCF settings (Grigoryan, Zoorob, Wang, & Trautner, 2015; Gupta et al., 2011; Rotjanapan, Dosa, & Thomas, 2011). A recommended course of watchful waiting decreases the use of antibiotics and thereby fosters antimicrobial stewardship by delaying antimicrobial use until confirmation of a UTI through diagnostic workup (Beveridge, et al., 2011; Nace, et al., 2014; Rowe & Juthani-Mehta, 2014)

Recommendations regarding antibiotic duration vary. Although SHEA recommends women with symptomatic lower UTIs should be treated for 3-7 days with antibiotics, a more recent guideline by the IDSA suggests 3-5 days of antibiotics are sufficient (Gupta et al., 2011; Nicolle, Bentley, Garibaldi, Neuhaus, & Smith, 2000). No consensus on a universally accepted duration for treatment of UTIs in LTCFs exists currently (Hooton, 2017; Rowe & Juthani-Mehta, 2014).

Methodology

Scholarly Project Purpose

The purpose of the scholarly project was to compare diagnostic and treatment practices for urinary tract infections (UTIs) in elderly women at one LTCF in Nashville, Tennessee with a specific diagnostic and treatment algorithm. The research questions were:

- How do current practices within the LTCF compare to Rowe and Juthani-Mehta's (2014) algorithm for diagnosis and treatment of UTIs?
- How often do clinicians at the selected LTCF meet both the diagnostic and treatment portion of the algorithm?

Question one determined if decisions were aligned with evidence-based recommendations and question two assessed how often the entire algorithm was met. The scholarly project findings could be the basis for a future quality improvement effort related to antimicrobial stewardship practices at one LTCF.

Theoretical Model

Avedis Donabedian's (1988) structure-process-outcomes (S-P-O) model evaluates quality improvement within healthcare. The S-P-O framework has been used to evaluate care coordination interventions, implementation of electronic medical records, and improvement of patient safety culture (Holup, Dobbs, Temple, & Hyer, 2014; McDonald et al., 2007; Thomas et al., 2012). Using the S-P-O theoretical model, this scholarly project examined the associations between the concepts of structure, process, and outcomes. The S-P-O model was applied to this scholarly project; see Figure 2.

Assumptions

The three important assumptions related to the S-P-O model are 1) the structures, processes, and outcomes are all related; 2) medical professionals are interested in improving outcomes and care; and 3) relationships between structure, process, and outcomes are unidirectional (Donabedian, 1988).

Structure

Structure is composed of material structures, human resources, and organizational configurations (Donabedian, 1988; Hickey & Brosnan, 2017). Structure also includes characteristics regarding systems, patients, and providers (Hickey & Brosnan, 2017). Material structures in the scholarly project included the building and finances that enabled the LTCF to function. Human resources refer to facility staffing, their qualifications, and their training. These aspects are vital to structure; however, infrastructure was the feature most imperative to this scholarly project due to the retrieval of data from the electronic medical record (EMR).

Process

Process entails interactions between residents and providers with the assumption that the exchange of providing and receiving care will affect outcomes (Donabedian, 1988; Hickey & Brosnan, 2017). Donabedian (1988) noted examples of processes related to diagnosis and treatment decisions. Current practices for the diagnosis of UTIs in the LTCF were assessed as a primary process. The diagnostic process is teamwork-oriented and occurred when clinicians gathered information from facility staff, residents, and residents' families (Bunting & Groszkuger, 2016). Data collection facilitated greater understanding of current process and practices at the LTCF.

Outcomes

The concept, outcomes, is evidence of all attributes of care, even attributes related to the patient (Donabedian, 1988). Attributes of care can include resident characteristics, facility characteristics, and facility or clinician processes. Specifically, the most important attribute of care within the scholarly project was the clinicians' process of diagnosing residents with suspected UTIs; therefore, the administration or omission of antibiotics was an outcome of the diagnostic process and the scholarly project. Although outcomes can be the health of patients and populations, this was beyond the scope of the project (Donabedian, 1988).

Project Design

The scholarly project utilized a retrospective cohort chart review design to compare a UTI algorithm to current diagnostic and treatment practices at one urban LTCF. The retrospective chart review included cases of residents with a documented urinalysis (UA) or UA with culture and sensitivity in one LTCF in Nashville, Tennessee. The study design was selected to minimize bias related to provider awareness of data collection of diagnostic and treatment practices for UTIs. The retrospective chart review captured UAs from July 1, 2016 to June 30, 2017. A total of 156 cases related to residents' urine specimens were included in the analysis. The scholarly project protocol and data collection and design was approved by the Belmont University Institutional Review Board and supported through collaboration with LTCF corporation who granted access to the retrospective data.

Clinical Setting

The LTCF is a part of a large corporation which operates several LTCFs in multiple states. The LTCF is a 131-bed facility, with 24 beds allocated for assisted-living and 107 beds available for skilled nursing residents.

Project Population

The project population consisted of cases in which a requisition for a urinalysis was sent for a suspected UTI. This project included inclusion and exclusion criteria to ensure a consistent and relevant sample. Any urinalyses associated with a resident meeting the following criteria were excluded:

- males;
- residents under 65;
- residents with urinary catheters within the previous 48 hours before the urine specimen was collected;
- residents already on a course of antibiotics;
- residents who did not utilize the facility's providers as primary care providers;
- hospice care residents;
- residents with suspected or diagnosed pyelonephritis.

Males were excluded since their UTIs are often considered complicated cystitis, which leads to differing treatment regimens (Hooton, 2017; Rowe & Juthani- Mehta, 2014). Only people over 65 years old were included because the algorithm focused on addressing the elderly in LTCFs (Rowe & Juthani-Mehta, 2014). Treatment for a catheter associated UTI is different from treatment for those without an indwelling catheter; therefore, residents with catheters were excluded (Rowe & Juthani-Mehta, 2014). Residents already on a course of antibiotics were also excluded, due to the potential of altered culture results. Residents who received treatment from a clinician outside of the facility were excluded because their treatment would not translate to current practices within the facility. Additionally, hospice patients were excluded because of external factors that may drive clinicians to respond differently to hospice patients' symptoms.

Residents with pyelonephritis were excluded because illness severity and treatment differ from that of cystitis and were not covered in the algorithm. Overall, 156 cases met the criteria to be included in the sample with 169 cases excluded. See Figure 3 for details regarding inclusion and exclusion.

Data Collection Instruments

Based on the literature review and Rowe and Juthani-Mehta's (2014) algorithm, the Appropriateness of Antibiotics for Urinary Tract Infections instrument was developed for the scholarly project and can be reviewed in Exhibit 1. A list of urinalyses results was obtained from the laboratories and covered the time period from July 2016 to June 2017. This list was used to evaluate the case chart information for determining if the case met the inclusion criteria. The scholarly project defined a positive urine culture with the algorithm's definition for urine specimens collected via clean catch and straight in and out catheterization methods (Rowe & Juthani-Mehta, 2014). The project leader categorized cases without an order for the invasive procedure of in and out catheterization as a clean catch. Definitions of fever, leukocytosis, mental status change, change of character in urine, and a positive UA are listed in Figure 1. Two reviewers placed cases into groups based on diagnostic components and treatment. If a culture or UA was missing, other contextual factors were used to determine the category of the case. For example, if the patient chart associated with the case met the symptoms component, had a positive UA, but was negative for pyuria and had a missing culture, then the case was categorized as a negative culture since the pyuria component had to be positive to produce a positive culture.

Treatment aligned with the algorithm if watchful waiting was utilized until the urine culture and sensitivity returned or if antibiotic treatment was initiated with one of the two antibiotics listed in the algorithm. To discern rationale for antibiotic treatment, factors including drug allergies and renal function were considered. If the resident was allergic to both recommended antibiotic treatment options then treatment with any other antibiotic was considered appropriate. Additionally, if recommendations for creatinine clearance (CrCl) levels for medication administration were not met, other antibiotic prescriptions were considered appropriate. Creatinine clearance (CrCl) measured renal function and was calculated using creatinine level, weight, height, and age with the Cockcroft-Gault equation (MDCalc, 2018). If height was unavailable then only weight and creatinine level were used to create the estimated CrCl. *The Sanford Guide to Antimicrobial Therapy* (2016) and Rowe and Juthani-Mehta (2014) were used for renal dosing recommendations for this scholarly project.

Data Collection Process

The LTCF requested a laboratory requisition list for all collected UAs or UAs with culture and sensitivity from the two labs which analyzed urine specimens during the targeted dates. After receiving appropriate approval, the project leader reviewed LTCF residents' EMRs from a facility laptop in a private office. Review of residents' charts associated with UAs and UAs with culture and sensitivity included resident characteristics, providers' notes, nurses' notes, vital signs, documented signs and symptoms related to the urinalysis, laboratory orders and results, and medication orders and administrations. Residents' data were de-identified and then recorded on the data collection sheets.

Assessment of Appropriateness of Antibiotics for Urinary Tract Infections Items

Data related to the collection of cases are covered in the Assessment of Appropriateness of Antibiotics for Urinary Tract Infections instrument with 30 questions (Exhibit 1). Questions 1 and 3 provided background information on the UA event. Exclusion criteria were addressed in questions 2, 4, and 5. Diagnostic criteria were assessed in questions 6-10. Question 6 assessed for signs and symptoms of a UTI and question 7 addressed the results of the urinalysis. Culture results were addressed in questions 8-10. Question 11 concentrated on antibiotic allergies for comparison to antibiotic choices. Questions 12-16 addressed antibiotics, susceptibility of organisms, and antibiotic changes. Treatment guidelines were assessed in questions 17-22, indicating whether treatment aligned with the algorithm for antibiotic selection, dosage, duration, and frequency. Questions 23-29 identified residents' history and comorbidities. The final question, #30, assessed if all facets of the treatment regimen were met.

Data Analysis

Information from the Appropriateness of Antibiotics for Urinary Tract Infections instrument was transferred into Excel and processed in IBM® Statistical Packages for Social Sciences (SPSS) 24.0 software between December 2017 and March 2018. The first research question "How do current practices within the LTCF compare to Rowe and Juthani-Mehta's (2014) algorithm for diagnosis and treatment of UTIs?" was answered using descriptive statistics related to diagnostic factors including symptomology, UA results, and culture results as well as facets of treatment, including: antibiotic selection, dosage, duration, and frequency. Research question two assessed how often both diagnostic and treatment criteria were met, which was calculated with a frequency. Demographic data and comorbidities were captured with descriptive statistics. Results related to the urine specimen will be referred to as cases in subsequent sections of this work.

Results

Sample Characteristics

The sample consisted of 156 cases which met the inclusion criteria. These cases were assessed for current practice and compliance to a diagnostic and treatment algorithm for UTIs. The 156 cases were collected from 111 LTCF residents. Eighty-seven residents (78.4%) had only one case, 16 (14.4%) had two, 2 residents (1.8%) had three, and 6 residents (5.4%) had 4 or more cases during the study period.

Characteristics including age, gender, history, and comorbidities are provided in Table 1. Age ranged from 65 to 101 years old with an average age of 82.5 (SD=7.96). A majority of cases were noted in skilled care (80.8%, n=126) and 20.2% (n=30) were in non-skilled care. According to chart documentation, 21.2% (n= 33) had a history of chronic kidney disease and 18.6% were immunocompromised (n=29). A majority of residents with a reviewed case had cognitive impairment (53.2%, n=83) and 29.5% were incontinent (n=46). Half of residents with a reviewed case had received a previous antibiotic in the last three months (n=79, 50.6%), of which 78.5% (62/79) of the previous antibiotic prescriptions were for a UTI. Sample characteristics were obtained from individual cases, over-representing residents who had multiple UTIs.

Diagnostic Criteria

All cases were evaluated as to whether the diagnostic criteria were met or not. Stepwise evaluation of guideline-driven diagnosis was derived from three diagnostic components as designated by the algorithm:

- Did the resident have documented symptoms? If so which ones, how many, and did they meet the algorithm criteria for diagnosis?
- Was the urinalysis negative or positive for leukocyte esterase, nitrites or both?

- Did the urine culture results confirm pyuria and an organism colony count sufficient for confirmation of acute infection?

Results are presented in Table 2 and sample breakdown categories are illustrated in Figures 4 and 5.

Symptoms.

The symptomatology component of the diagnostic criteria was composed of two different processes to help identify potential UTIs. Table 3 summarizes those that met symptomology. Out of twelve identified symptoms of a UTI, the cases had a range of 0- 7 symptoms documented. The mean number of symptoms associated with each case was 1.97 (SD 1.41). Thirty-four percent of cases (n=53) met the symptoms component of the algorithm and warranted additional laboratory diagnostics, such as a urinalysis and culture, for diagnosis of a UTI consistent with the algorithm, and 66% (n=103) did not. Figure 4 details results of cases that met the symptomology component of the diagnostic criteria, while Figure 5 shows results for cases that did not meet symptomology.

The project leader assessed the differences between cases that had a positive UA and culture, but either did or did not meet symptoms. Of 29 cases that did not meet the symptoms component, but had a positive UA and culture, 19 (65.5%) were associated with residents who were cognitively impaired. However, of the 23 cases that met the symptoms component and had a positive UA and culture, only 9 (39.1%) were associated with residents who had cognitive impairment.

Urinalysis.

Of the 156 cases, 69.2% (n=108) were positive and 30.8% (n=48) were negative with 39 meeting symptoms criteria and 69 not meeting the symptoms criteria (see Figure 4 and 5). Table 3 summarizes those that met UA criteria.

Culture.

Of 156 cases, cultures were positive in 35.3% (n=55), negative in 57.1% (n=89), and missing in 7.6% (n=12). Table 3 summarizes those that met culture criteria.

Treatment Criteria

All cases were evaluated as to whether the treatment criteria were met or not. Stepwise evaluation of guideline-driven treatment was derived from treatment components as designated by the algorithm (see Figure 1). Table 2 provides results regarding cases that met the treatment criteria.

The details of the treatment guidelines reveal a majority of cases received the action of watchful waiting while culture results were pending (56.4%, n=88) and 43.6% (n=68) received an antibiotic before culture results were available. Of the 68 cases that received antibiotic treatment before culture results were available, 27 (39.7%) had treatment selections that aligned with algorithm guidelines but had discrepancies in duration (93%, n=25); dose (3%, n=1); or a combination of dose, duration, and frequency (3%, n=1). Over half of cases met treatment criteria: 56.4% (n=88).

Overall, none of the cases met both diagnostic and treatment criteria.

Discussion

Process: Diagnosis

Since only 1/3 of cases collected met the symptoms component of the diagnostic portion of the algorithm, clinicians may be perceiving and evaluating a different set of signs and symptoms than what the algorithm recommended, which aligns with Trautner et al.'s (2013) finding that clinical cues for diagnosis often come from mental models that are incongruent with guidelines. Specific clinical cues related to the elderly that influenced decisions for prescribing antibiotics were (1) concerns about missing an infection and (2) concerns for critically ill or immunocompromised patients (Abbo, et al., 2012). These clinical cues may be congruent with clinicians' rationale at the LTCF. Further research on clinicians' mental models and perception of guidelines could be useful.

Confirming the higher percentage of cognitive impairment in the group that did not meet symptoms yet had a positive UA and culture compared to cases that did meet symptoms concurs with findings in the literature stating that patients with cognitive impairment are more difficult to diagnose due to deficits in communication (Rowe & Juthani- Mehta, 2013). Moreover, these findings are supported by D'Agata, Loeb, and Mitchell (2013), who found within a sample of patients with advanced dementia that only 16% met the diagnostic criteria necessary for antibiotic treatment. This emphasizes the finding that the diagnostic portion of the algorithm is not useful for patients with cognitive deficits, although future research is warranted to identify additional diagnostic criteria that may protect this vulnerable population from over exposure to antibiotics in the absence of symptoms. Further, this finding echoes Ryan, Gillespie, and Stuart's (2018) report of discrepancy between guideline application and the clinical presentation of cognitive and communication impaired LTCF residents with UTIs.

Another result of the study was a higher frequency of positive UAs than that of positive cultures. This illuminates that many patients may have positive screening with a UA, but prove to not have a UTI upon culture. Two previous studies found the positive predictive value of a UA to range from 41-45% (Leman, 2002; Tomas, Getman, Donskey, & Hecker, 2015). This low positive predictive value highlights why watchful waiting is a beneficial strategy for antimicrobial stewardship and patient safety from adverse effects. Rowe and Juthani-Mehta (2014) recommend watchful waiting for patients with non-specific symptoms during the diagnostic workup. A recent study of healthy women who postponed antibiotic treatment of a UTI for one week reported that 71% stated improvement or cure in symptoms, with none reporting the adverse event of pyelonephritis (Knottnerus, Geerlings, Moll van Charante, & ter Riet, 2013). Within this scholarly project, 40.5% of cases associated with patients who received antibiotics had a negative culture. These findings reinforce the encouragement of watchful waiting for residents with nonspecific symptoms who are not acutely ill while awaiting UA and culture results.

Of cases that met symptoms and had a negative UA, none had a positive culture or received antibiotics. However, of the cases that did not meet symptoms and had a negative UA, three had a positive culture and received antibiotics. Overall, of the 48 cases with negative UAs, only three (6.25%) had a positive culture. This finding highlighted that a negative UA, while suggestive of a negative culture, is not conclusive within this sample. Because previous studies suggested a negative UA is strongly predictive of a negative culture in the elderly population in LTCFs, cultures should not be routinely performed on urine specimens that produce a negative UA for pyuria, leukocyte esterase, and nitrites (High et al., 2009; Juthani-Mehta, Tinetti, Perrelli, Towle, & Quagliarello, 2007; Sundvall & Gunnarsson, 2009). See Figure 4 and 5 for detailed breakdown.

Outcomes: Treatment

Less than half (39.7%) of cases associated with patients who received an antibiotic received a selection choice in accordance with the algorithm (Rowe & Juthani-Mehta, 2014). Although the IDSA guidelines recommend Bactrim and Macrobid as therapies for uncomplicated cystitis, certain experts have not categorized postmenopausal women with UTIs as uncomplicated UTIs (Gupta et al., 2011). Further, Hooton and Gupta (2016) state the definition of uncomplicated cystitis varies and does not mention postmenopausal women. Cases with the comorbidities chronic kidney disease and immunosuppression were included in the study and considered to be uncomplicated cystitis. However, Hooton and Gupta (2016) categorized chronic kidney disease and immunosuppression as complicated cystitis. This inconsistency in the literature highlights the tension between uncomplicated and complicated cystitis, as well as the conundrum clinicians experience when managing postmenopausal women with comorbidities.

The finding that no cases evaluated in the project met all facets of the antibiotic regimen in the algorithm is similar to the low adherence rates to all facets of IDSA's treatment guidelines for community-dwelling women with uncomplicated cystitis in the United States, as well as several European countries (Kim, Lloyd, Condren, & Miller, 2015; Philips et al., 2014). Perhaps concern about poor compliance with treatment guidelines may prompt research into both the usability and clinician adoption of the algorithm.

Implications for Practice

Key findings from the literature suggest that most providers treat empirically in the absence of McGeer's criteria because symptoms are hard to detect and confirm in this population. These findings were mirrored in this study. However, when symptoms are insufficient to meet diagnostic criteria, there is strong evidence to encourage watchful waiting until culture results are received. This approach mitigates the risk of unnecessary treatment with broad-spectrum antibiotics, representing an important step toward improved antimicrobial stewardship. Changes in structure will influence the processes and outcomes for the management of UTIs in LTCFs and could include modification to the EMR infrastructure. One potential strategy to improve diagnosis and treatment might be a charting system to nudge clinicians to include particular items - specific symptoms, collection methods, and results - prior to ordering an antibiotic. This might include automated pop-ups in the EMR when ordering a UA or antibiotic, requiring the clinicians to clarify if diagnostic criteria were met, which might encourage clinicians to be more mindful of their course of action. This recommendation could be a formative amendment that could be a future quality improvement project.

Data analysis revealed valuable findings related to use of the algorithm in this clinical setting. One of particular importance is that a majority of cases associated with patients who received antibiotics did not meet the symptoms component of the algorithm. Similarly, Rotajapan, Dosa, and Thomas (2011) found that 41% of patients received antibiotics despite not meeting diagnostic guidelines. The project leader postulates that these concurrent findings, could be influenced by:

- Cognitive impairment and other co-morbidities complicating clinicians' ability to accurately diagnose and treat possible infections;
- Clinicians risk-assessment for the elderly;
- A complex patient population - Elderly patients in LTCFs - whose signs and symptoms cannot be captured by a guideline;

- Clinical experience dictating a different story than those suggested by the guidelines;
- Guidelines' inability to accurately articulate the nuances of the patient encounter and extraneous variables influencing diagnosis and treatment; and
- Incomplete documentation of the full patient encounter.

Another valuable finding was a majority of cases associated with no antibiotic did not meet the symptoms component of the diagnostic criteria. While the documentation did not support the urine specimen collection, the outcome of treatment agreed with guidelines through omission from the algorithm (Rowe & Juthani-Mehta, 2014). The majority of both treatment groups did not meet the symptoms component, emphasizing that the symptoms component of the diagnostic algorithm may be a potential area for further revision or education for clinicians. Additional recommendations for clinical practice, stemming from the scholarly project, include guideline revisions and amendments to treatment practices. The symptoms component of the diagnostic guidelines may need to be adapted for more accurate use with the elderly population in LTCFs. Use of SHEA's diagnostic criteria for UTI's may capture more patients with a UTI than Rowe and Juthani- Mehta's (2014) algorithm, since dysuria can be a stand-alone symptom for meeting diagnostic criteria for a UA. Studies comparing the sensitivity and specificity of guidelines could provide useful insight into vulnerable populations, such as women in LTCFs.

Besides increasing accuracy in the diagnosis of UTIs, antimicrobial stewardship can also be accomplished through interventions aimed at treatment. The Agency for Healthcare Research and Quality (2016) supports watchful waiting while urine specimen results are processed, instead of antibiotic therapy. Watchful waiting is advantageous not only for antimicrobial stewardship, but also may spare the patient from adverse side effects of antibiotics. The relative risk of watchful waiting is well established in the literature but the reflection of this evidence in clinician’s mental models and clinical practice is less evident (Lieberthal et al., 2013). Improving clinician's confidence to opt for watchful waiting will require better dissemination of quality evidence to the practice setting that exposes the harm of empiric treatment in the absence of symptoms. This practice change will also require provider education on how to discuss clinical reasoning with families who may be pressuring providers to start antimicrobial therapy. The literature on watchful waiting for pediatric otitis media provides strong support for discussing watchful waiting with worried parents (Lieberthal et al., 2013). This evidence could be applied to the clinical context of adult children feeling concern about their institutionalized elderly parents and the need to provide education on watchful waiting as another method of advocating for their elderly parent. However, if antibiotics are prescribed, clinicians should use the shortest treatment duration recommended by guidelines. Another way to encourage antimicrobial stewardship in clinical practice is direct feedback regarding prescribing practices in LTCFs, which was effective in reducing the number of inappropriate urine cultures, decreasing antimicrobial days, and reducing treatment of asymptomatic bacteriuria (Abbo & Hooton, 2014). Additionally, qualitative studies on clinicians’ mental models and risk-assessment of the elderly may be warranted to further explore rationale for urine specimen collection from patients who do not meet the symptoms component of the diagnostic criteria.

Limitations and Strengths

With a retrospective chart review design, the project leader acknowledges documentation may not accurately reflect the clinical process and individuality within each case. If the clinician or nurse did not document signs or symptoms related to the UA, then the case was considered to be asymptomatic, which may not have been true. Lack of documentation on collection method specifics of a UA made it difficult for the project leader to determine culture results and led the project leader to make assumptions for interpretation of clinical results. Additionally, several cases occurred shortly after admission to the LTCF and often lacked a detailed history about previous antibiotic use and UTIs. Lack of this information may have skewed the results. Residents noted as immunosuppressed were kept within the sample, even though this information may have prompted clinicians to respond differently in clinical practice, altering results of the study. Additionally, some residents were overrepresented in the sample due to multiple cases with suspected UTIs, which may have skewed sample characteristics.

Another limitation is that the project leader was unable to determine the clinicians' rationale for treatment choices. Treatment choices may have been derived from previous encounters, UTIs, and treatment; cost of antibiotics; availability of specific antibiotics to the facility; chronic conditions; and patient or family request.

To the author's knowledge, this was the first study to implement Rowe and Juthani-Mehta's algorithm (2014) in comparison to clinical practice. However, this algorithm was not used as a facility policy and clinicians were unaware of this algorithm during the timeframe of the laboratory requisitions.

While the scholarly project's sample size was small and confined to one facility, it offered an assessment of the complex issue of diagnosis and treatment of UTIs in one LTCF. Addressing quality improvement in one LTCF, by analyzing the diagnostic and treatment practices for UTIs, may translate to changes within multiple facilities within the same healthcare corporation.

Conclusion

Overall, the predominant finding within the scholarly project was Rowe and Juthani-Mehta's algorithm did not align with clinical practice and was not suitable for most elderly patients in the particular LTCFs. Non-adherence to guidelines could be attributed to clinicians accounting for multiple extraneous variables not captured within the guidelines. In addition, the symptoms component of the diagnostic criteria of the algorithm is rigorous. Seemingly, clinicians are patient advocates in practice by addressing the patient directly in front of them, to ensure a suspected UTI is addressed in a timely manner, even though all the symptoms necessary for diagnosis, per guidelines, are not present. Further studies could assess the necessity of guideline adjustment to enhance UTI diagnosis in this patient population as well as the creation of an institution-specific antibiogram to give prescribers additional data to guide decision-making.

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Tables

Table 1: Descriptive Statistics

	M(SD)
Age	82.5 (7.96)
Number of Symptoms	1.97 (1.41)
Estimated CrCl	53.2 (27.23)
Empiric Therapy Duration (n=68) in Days	6.76 (2.17)
Post-Culture Therapy Duration (n=34) in Days	7.71(1.98)
Gender	N (%)
Female	156 (100)
Service	
Skilled	126 (80.8)
Non-skilled	30 (19.2)
Treatment Before Culture Results	
Antibiotic	68(43.6)
No Antibiotic	88 (56.4)
Conditions	
Cognitive Impairment	83 (53.2%)
Incontinence	46 (29.5%)
Chronic Kidney Disease	33 (21.2%)
Immunosuppression	29 (18.6%)
Previous Antibiotic Use	79 (51%)
Antibiotics for a UTI in the Last 3 Months	62 (39.7%)

Table 2: Diagnostic and Treatment Evaluation Results

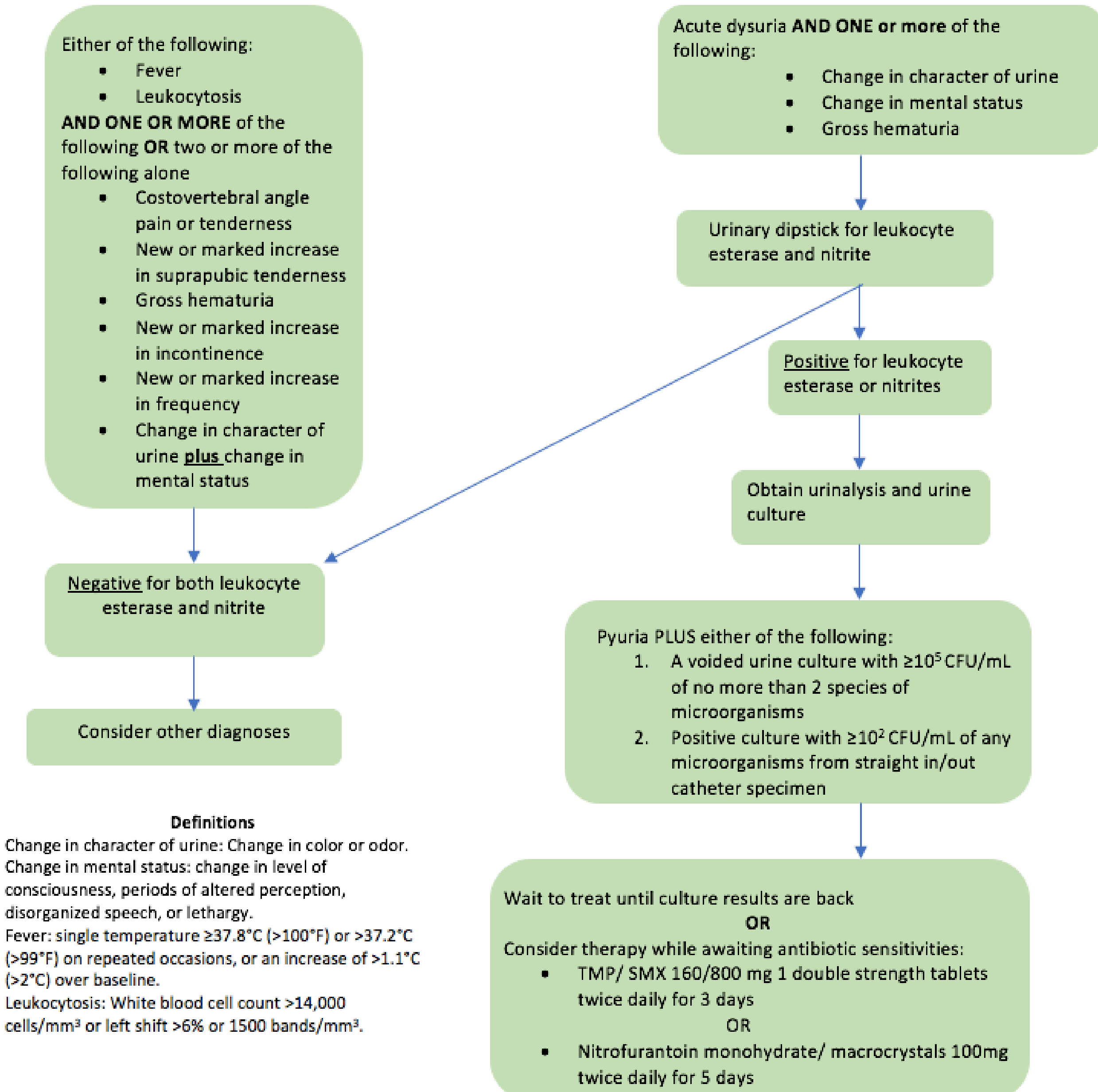
Criteria	
Met All Components of the Diagnostic Criteria	20 (12.8%)
Met All Components of the Treatment Criteria	88 (56.4%)
Met All Diagnostic & Treatment Criteria	0 (0.0%)

Table 3: Components of the Diagnostic Criteria

	N (%)
Symptomology	
Symptomology Met	53 (34.6)
Urinalysis	
Urinalysis Met	108 (69.2)
Culture	
Culture Met	55 (35.3)

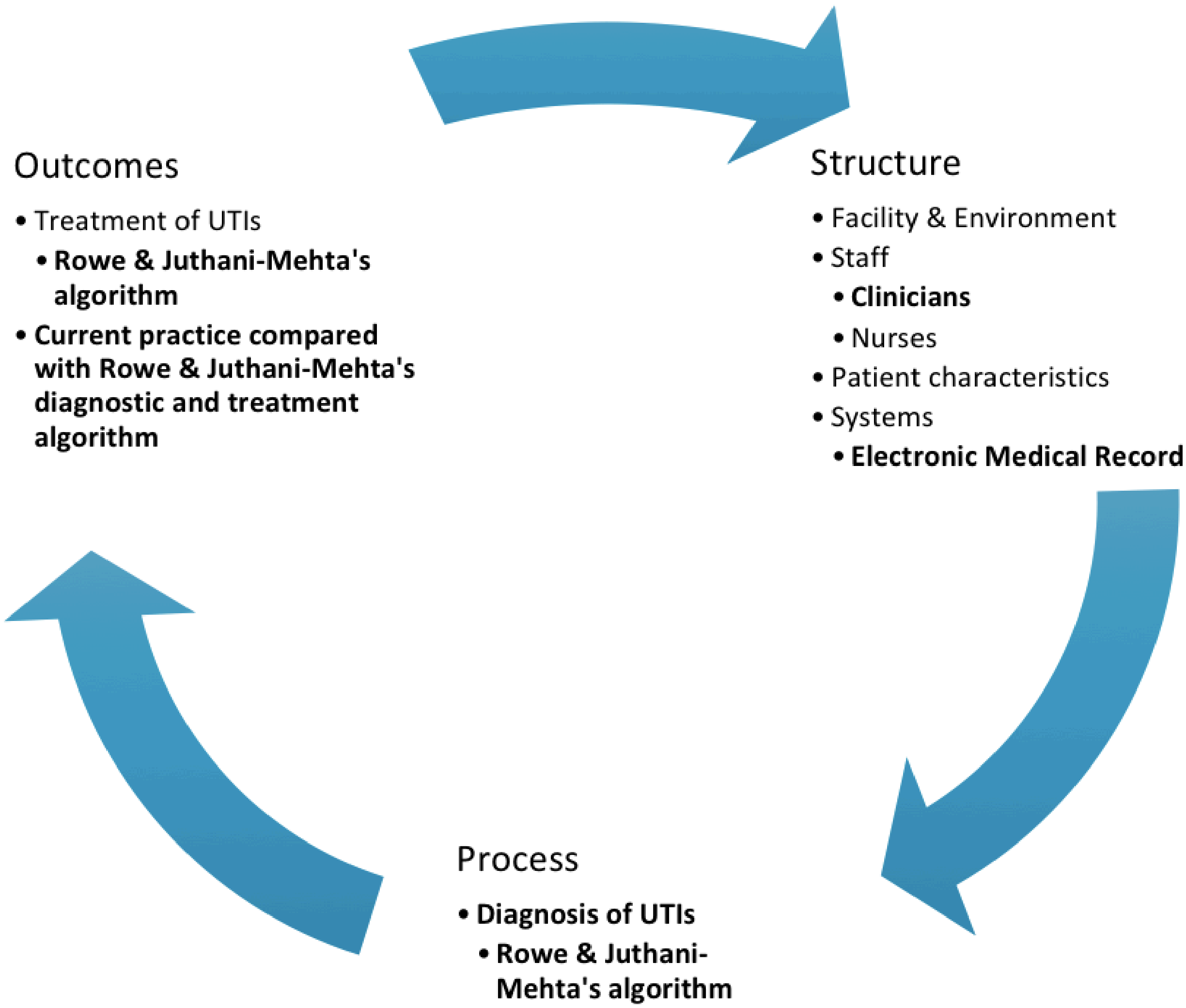
Figures

Figure 1: Diagnostic and Treatment Algorithm for UTIs



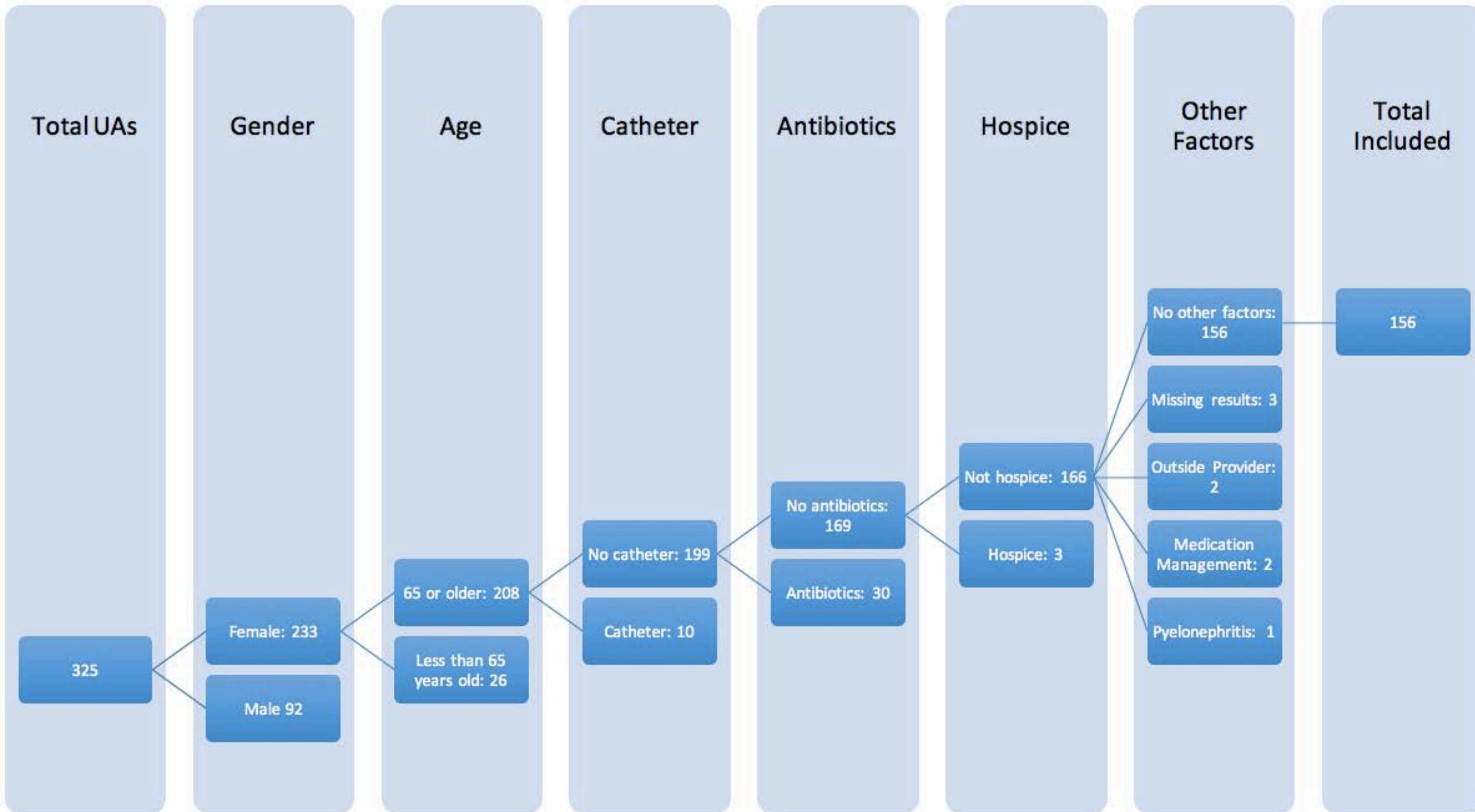
This algorithm is derived from T.A. Rowe and M. Juthani-Mehta (2014, pp. 8, 17). This figure represents the management of UTIs without an indwelling catheter in LTCFs.

Figure 2: The S-P-O Model



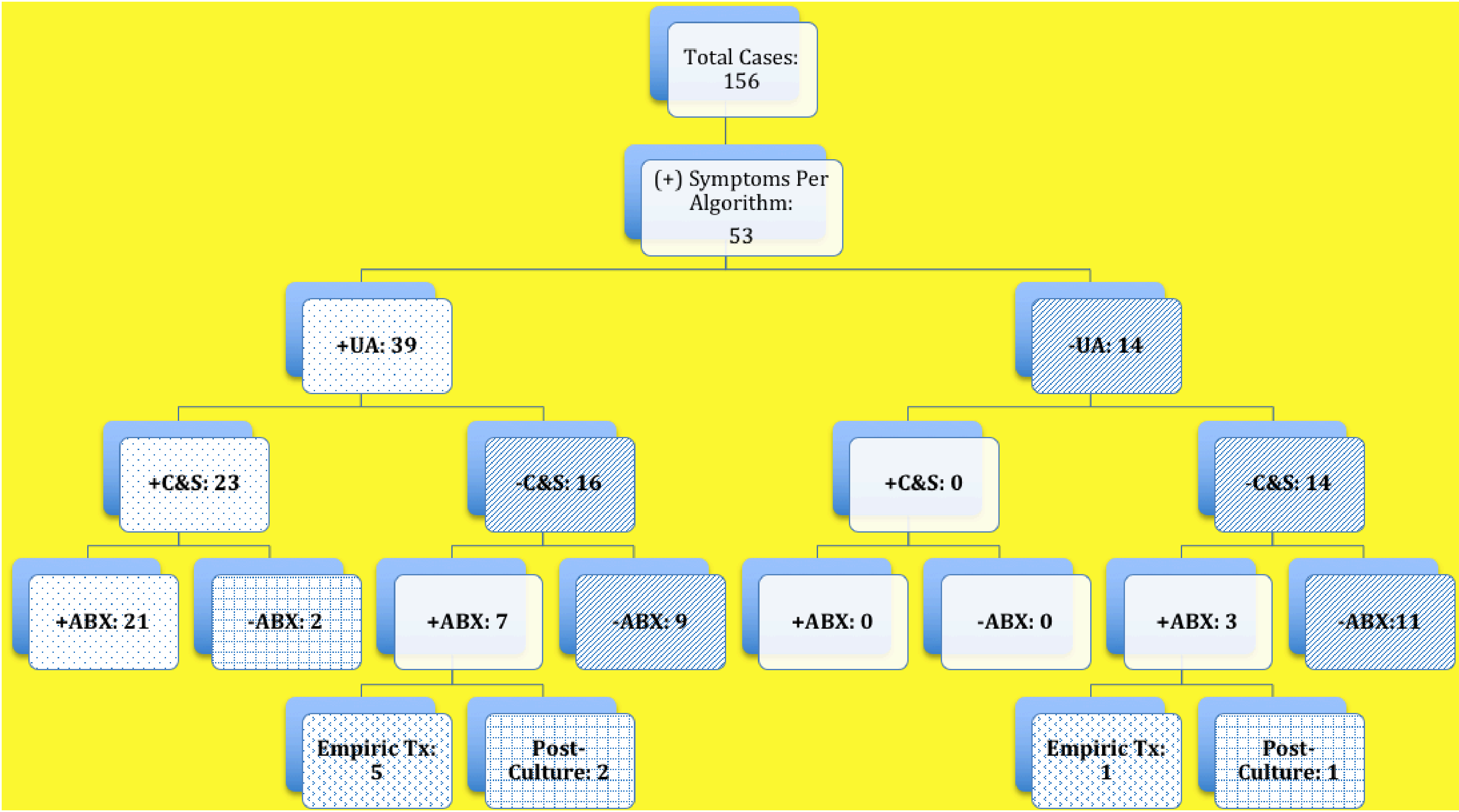
A. Donabedian (1988, p. 1745).

Figure 3: Inclusion and Exclusion Criteria Flowchart



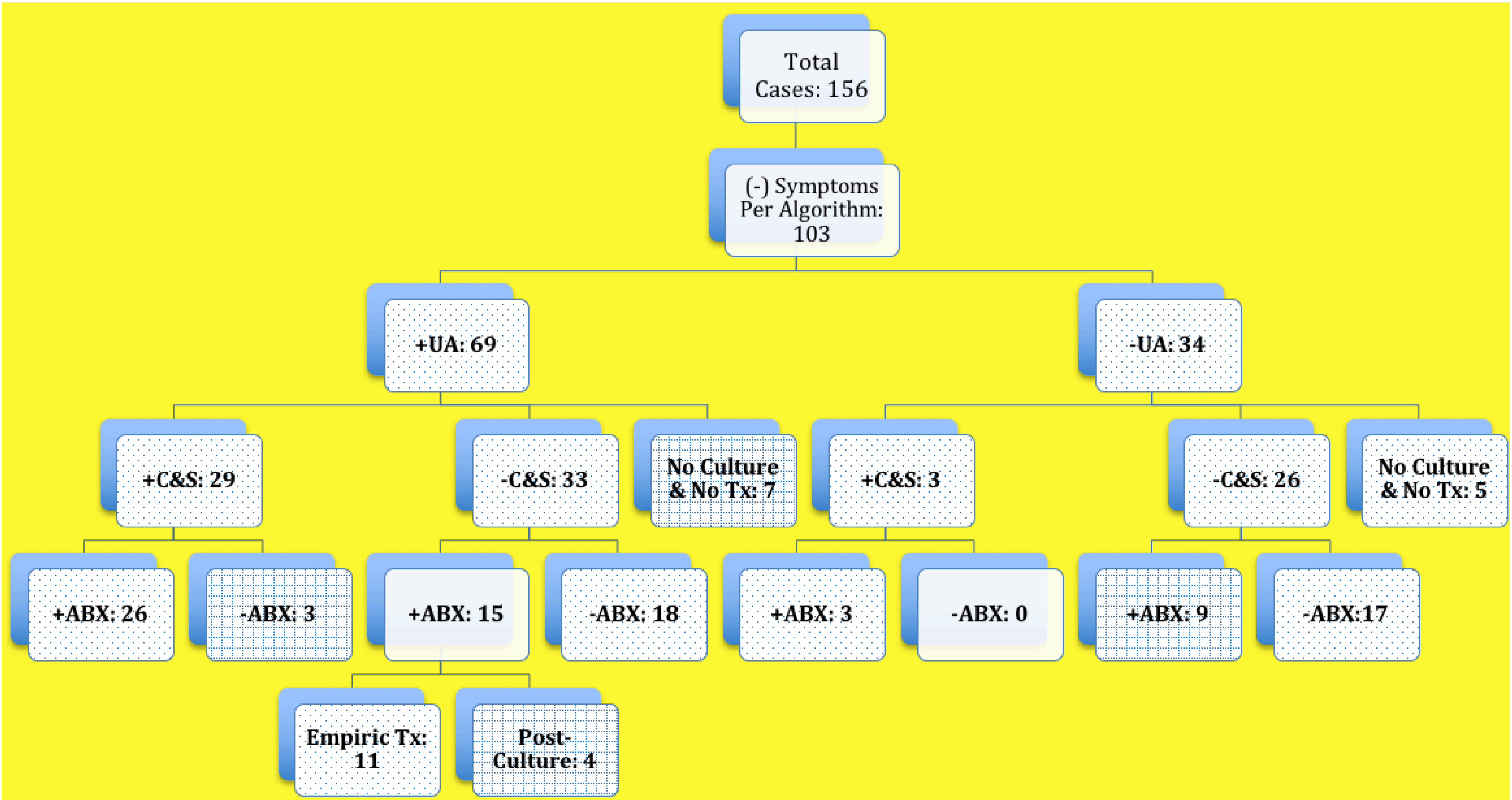
Notes: Out of 325 patient events 156 patient encounters were able to be included. Excluded: 92 males, 26 residents less than 65 years old, 30 residents on antibiotics, ten residents with catheters, three hospice care, three missing results, two outside providers, two medication management, and one pyelonephritis.

Figure 4: Results of the Patient Encounters That DID Meet Symptom Criteria



Cases with a POLKA DOT pattern were appropriately managed according to guidelines and represents patients who met all components for a diagnosis of a UTI.
Cases with a STRIPE pattern were appropriately managed according to guidelines and were not diagnosed as UTIs.
Cases with an ARROW pattern were appropriately managed according to guidelines and received empiric treatment.
Cases with a GRID pattern were inappropriately managed according to guidelines and did not meet diagnostic requirements.

Figure 5: Results of the Patient Encounters That DID NOT Meet Symptom Criteria



Cases with a POLKA DOT pattern were treated appropriately for laboratory results, despite not meeting the diagnostic portion of the algorithm.
Cases with a GRID pattern were inappropriately managed according to guidelines.

Exhibits

Exhibit 1: Data Collection Instrument

Assessment of Appropriateness of Antibiotics for Urinary Tract Infections (UTIs)

1. Date of symptoms: ________________
2. Age: ____
3. Service:
   a. __0=Skilled
   b. __1=Non-skilled
4. Did the patient have a urinary catheter in place at the time of diagnosis or in the 48h preceding diagnosis?
   a. __ Yes __ No
5. Was the patient receiving antibiotics prior to collection of the urine culture? Y__ N__
6. Signs/Symptoms:
   a. Either of the following:
      i. Fever
         1. __0=Yes __1=No
      ii. Leukocytosis
         1. __0=Yes __1=No

   AND ONE OR MORE of the following **OR** two or more of the following alone
      i. Costovertebral angle pain or tenderness
         a. __0=Yes __1=No
      ii. New or marked increase in suprapubic tenderness
         a. __0=Yes __1=No
      iii. Gross hematuria
         a. __0=Yes __1=No
      iv. New or marked increase in incontinence
         a. __0=Yes __1=No
      v. New or marked increase in frequency
         a. __0=Yes __1=No
      vi. Change in character of urine **plus** change in mental status
         a. __0=Yes __1=No

   OR

   b. Acute dysuria
      i. __0=Yes __1=No
   c. **AND ONE or more** of the following:
      i. Change in character of urine
         1. __0=Yes __1=No
      ii. Change in mental status
         1. __0=Yes __1=No
      iii. Gross hematuria
         1. __0=Yes __1=No
7. Did UTI event meet algorithm criteria for diagnosis? __0= Yes __1= No
8. What date was the UA sent? ____
   a. If **Yes**, was there evidence of pyuria ($\geq$ 5-10 WBCs/high power field)? __0=Yes __ 1=No
   b. If **Yes**, were epithelial cells noted? (please specify number/high power field) ________________________________
   c. If dipstick results available, were either of the following detected? (Check all that apply)
      i. ___0=none noted
      ii. ___1= leukocyte esterase
      iii. ___2= nitrites
9. If a urinalysis and/or urine culture were collected, please designate how urine was collected:
   a. __ 0= Clean catch

b. __ 1= Straight catheterization
c. __ 2= Collection method not specified

10. Was a culture sent? __0=Yes __1=No Date? ____
    a. If yes, was the culture positive? __0= Yes __1=No
    b. If the culture was positive, document the date received and organism(s):
        i. ____
    c. Which of the following categories does the culture meet?
        i. __ 0= no growth
        ii. __ 1= less than 10^2 in/out catheter
        iii. __ 2= less than 10^5 clean catch
        iv. __ 3= less than 10^5 method not specified
        v. **__ 4= greater than 10^2 in/out catheter**
        vi. **__ 5= greater than 10^5 clean catch**
        vii. **__ 6= greater than 10^5 any method**
11. Antibiotic Allergy? __0= NKDA __1= Bactrim __2= Macrobid __3= Both __4= Other
    Type(s): ____________
12. Were empiric antibiotics ordered and started prior to culture results? __0=Yes __1=No
    a. Was the selected antibiotic consistent with Rowe & Juthani- Mehta's algorithm for empiric therapy?
        i. __ 0= Yes __1=No
        ii. Empiric Therapy: ____
13. Were empiric antibiotics stopped if no organism was isolated by culture? __0=Yes __1=No __2=NA
    a. If **No**, was an indication documented for continued antibiotics documented?
        i. __0= Yes __1= No __2= NA__
        ii. Indication for continuation: ________________________
14. If an organism was isolated by culture, was it susceptible to the empirically prescribed antibiotic?
    a. __ 0=Y__ __1=No __2= NA
       (PRINT ANTIBIOTIC SUSCEPTIBILITY REPORT and attach after patient information removed]
15. Were antibiotics changed after culture results were available?
    a. __0=Yes __1=No __2= Not initiated until culture received __3=NA
    b. If **YES**, please document antibiotic change:
       ____
16. Is the new or continued antibiotic prescribed listed on the susceptibility report?
    a. __ 0=Yes __1=No __ 2= NA
    b. If no, is the antibiotic in the same class? __0=Yes __1= No __2= NA
17. Total duration ordered for empiric therapy: ___ days
18. Total duration ordered on culture proven antibiotic therapy for UTI: __ days
19. Correct duration for empiric therapy as stated by Rowe & Juthani- Mehta's algorithm?
    a. __0=Yes __1= No
    b. If no,
        1. ___ 0= Too short __1= Too long __2= NA
20. Renal Function: CrCl: ___________
    a. Creatinine: ____ Weight: _____
21. Was the empiric medication dosage in accordance to Sanford's guide? __0=Yes __1= No
    a. If no,
        1. __ 0= Too low __1= Too high __2= NA
22. Was the empiric medication frequency in accordance to Sanford's guide? __0=Yes __1= No
        i. If no,
            1. __ 0= Too little __1= Too often __2= NA
23. Previous antibiotic exposure within the last 3 months?
        i. __ 0= Yes __1= No
        ii. If yes, for what indication? __ 0= UTI __1= Other __ 2=NA
24. Diabetes __0= Yes __1= No

25. Impaired cognitive status at baseline? __0= Yes __1= No
26. History of Incontinence? __0= Yes __1= No
27. ICD code for chronic kidney disease (CKD) stage 1-4 or dialysis? __0= Yes __1= No
28. Immunocompromised? __0= Yes __1= No
29. Did the patient contract a CDI within the 8 weeks after antibiotic exposure?
    a. __0= Yes __1= No __2= Unknown
    b. Hospitalized? __0= Yes __1= No __2= Unknown
    c. Result in death? __0= Yes __1= No __2= Unknown
        i. If unknown, please state reason why: ______________________________
30. Did empiric treatment meet ALL treatment guidelines considering allergies and renal function (selection, dose, duration, frequency)?
    a. __0=Yes __1=No

Data collection sheet adapted from the Centers for Disease Control and Prevention (2017).