Systematic Review of Interventions to Reduce Urinary Tract Infection in Nursing Home Residents

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BACKGROUND: Urinary tract infections (UTIs) in nursing homes are common, costly, and morbid.

PURPOSE: Systematic literature review of strategies to reduce UTIs in nursing home residents.

DATA SOURCES: Ovid MEDLINE, Cochrane Library, CINAHL, Web of Science and Embase through June 22, 2015.

STUDY SELECTION: Interventional studies with a comparison group reporting at least 1 outcome for: catheter-associated UTI (CAUTI), UTIs not identified as catheter-associated, bacteriuria, or urinary catheter use.

DATA EXTRACTION: Two authors abstracted study design, participant and intervention details, outcomes, and quality measures.

DATA SYNTHESIS: Of 5794 records retrieved, 20 records describing 19 interventions were included: 8 randomized controlled trials, 10 pre-post nonrandomized interventions, and 1 nonrandomized intervention with concurrent controls. Quality (range, 8-25; median, 15) and outcome definitions varied greatly. Thirteen studies employed strategies to reduce catheter use or improve catheter care; 9 studies employed general infection prevention strategies (eg, improving hand hygiene, surveillance, contact precautions, reducing antibiotics). The 19 studies reported 12 UTI outcomes, 9 CAUTI outcomes, 4 bacteriuria outcomes, and 5 catheter use outcomes. Five studies showed CAUTI reduction (1 significantly); 9 studies showed UTI reduction (none significantly); 2 studies showed bacteriuria reduction (none significantly). Four studies showed reduced catheter use (1 significantly).

LIMITATIONS: Studies were often underpowered to assess statistical significance; none were pooled given variety of interventions and outcomes.

CONCLUSIONS: Several practices, often implemented in bundles, such as improving hand hygiene, reducing and improving catheter use, managing incontinence without catheters, and enhanced barrier precautions, appear to reduce UTI or CAUTI in nursing home residents. *Journal of Hospital Medicine* 2017;12:356-368. © 2017 Society of Hospital Medicine

Given the limited number of geriatricians in the U.S., hospitalists commonly manage nursing home residents admitted for post-acute care.[1-4] Urinary tract infection (UTI) is one of the most common infections in nursing homes, often leading to sepsis and readmission to acute care.[5] Inappropriate use of antibiotics to treat asymptomatic bacteriuria is both common and hazardous to nursing home residents.[6] Up to 10% of nursing home residents will have an indwelling urinary catheter at some point during their stay.[7-9] Residents with indwelling urinary catheters are at increased risk for catheter-associated urinary tract infection (CAUTI) and bacteriuria, with an estimated 50% of catheterized residents developing symptomatic CAUTI.[5] While urinary catheter prevalence is lower in nursing homes than in the acute care setting, duration of use is often prolonged.[7,10] In a setting where utilization is low, but use is prolonged, interventions designed to reduce UTI in acutely ill patients[11] may not be as helpful for preventing infection in nursing home residents.

Our objective was to review the available evidence to prevent UTIs in nursing home residents to inform both bedside care and research efforts. Two types of literature review and summary were performed. First, we conducted a systematic review of individual studies reporting outcomes of UTI, CAUTI, bacteriuria, or urinary catheter use after interventions for reducing catheter use, improving insertion and maintenance of catheters, and/or general infection prevention strategies (eg, improving hand hygiene, infection surveillance, contact precautions, standardizing UTI diagnosis, and antibiotic use). Second, we performed a narrative review to generate an overview of evidence and published recommendations in both acute care and nursing home settings to prevent UTI in catheterized and non-catheterized older adults, which is provided as a comprehensive reference table for clinicians and researchers choosing and refining interventions to reduce UTIs.

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METHODS

The systematic review was performed according to the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis recommendations. The protocol was registered at the PROSPERO International Prospective Register of Systematic Reviews, (CRD42013005787). The narrative review was performed using the articles obtained from the systematic search and a targeted literature review by topic for a comprehensive list of interventions, including other interventions summarized in published reviews and guidelines.

Eligibility Criteria Review

Study Design. To address the breadth and depth of literature available to inform interventions to prevent UTI in nursing homes, broad eligibility criteria were applied with the expectation of varied designs and outcomes. All included studies for the systematic review were published manuscripts reporting a comparison group. We included randomized controlled trials as well as nonrandomized trials (pretest/posttest, with or without concurrent or nonconcurrent controls), with any duration of postintervention follow-up. Observational and retrospective studies were excluded.

Participants. We were interested in interventions and outcomes reported for nursing homes, defined as facilities providing short-stay skilled nursing care and/or rehabilitation, as well as long-term care. We also included evidence derived from rehabilitation facilities and spinal cord injury programs focused on reducing CAUTI risk for chronically catheterized residents. We excluded long-term acute care hospitals, hospice, psychiatric/mental health facilities, pediatric, and community dwelling/outpatient settings.

Interventions. We included interventions involving urinary catheter use such as improving appropriate use, aseptic placement, maintenance care, and prompting removal of unnecessary catheters. We included infection prevention strategies with a particular interest in hand hygiene, barrier precautions, infection control strategies, infection surveillance, use of standardized infection definitions, and interventions to improve antibiotic use. We included single and multiple interventions.

Outcomes

1. Healthcare-associated urinary tract infection: UTI occurring after admission to a healthcare facility, not identified specifically as catheter-associated. We categorized UTI outcomes with as much detail as provided, such as whether the reported outcome included only noncatheter-associated UTIs, the time required after admission (eg, more than 2 days), and whether the UTIs were defined by only laboratory criteria, clinically diagnosed infections, symptomatic, or long-term care specific surveillance definitions.

2. Catheter-associated urinary tract infection: UTI occurring in patients during or immediately after use of a urinary catheter. We noted whether CAUTI was defined by laboratory criteria, clinical symptoms, provider diagnosis, or antimicrobial treatment for case identification. We were primarily interested in CAUTI developing after placing an indwelling urinary catheter, commonly known as a Foley, but also in CAUTI occurring with other catheter types such as intermittent straight catheters, external or "condom" catheters, and suprapubic catheters.

3. Bacteriuria: We included the laboratory-based definition of bacteriuria as an outcome to include studies that reduced asymptomatic bacteriuria.

4. Urinary catheter use measures: This includes measures such as urinary catheter utilization ratios (catheter-days/patient-days), prevalence of urinary catheter use, or percentage of catheters with an appropriate indication.

Study Characteristics for Inclusion. Our systematic search included published papers in the English language. We did not exclude studies based on the number of facilities included or eligible, residents/patients included (based on age, gender, catheter use or type, or antibiotic use), intervention details, study withdrawal, loss to follow-up, death, or duration of pre-intervention and postintervention phases.

Data Sources and Searches

The following data sources were searched: Ovid MEDLINE (1950 to June 22, 2015), Cochrane Library via Wiley (1960 to June 22, 2015), CINAHL (1981 to June 22, 2015), Web of Science (1926 to June 22, 2015), and Embase.com (1946 to June 22, 2015). Two major systematic search strategies were performed for this review (Figure). Systematic search 1 was designed broadly using all data sources described above to identify interventions aimed at reducing all UTI events (defined under "*Outcomes*" above) or urinary catheter use (all types), focusing on interventions evaluated in nursing homes. Systematic search 2 was conducted in Ovid MEDLINE to identify studies to reduce UTI events or urinary catheter use measures for patients with a history of long-term or chronic catheter use, including nursing homes and other post-acute care settings such as rehabilitation units or hospitals and spinal cord injury programs, which have large populations of patients with chronic catheter needs. To inform the completeness of the broader systematic searches, supplemental systematic search strategies were performed for specific topics including hydration (supplemental search 1), published work by nursing home researchers known to the authors (supplemental search 2), and contact precautions (supplemental search 3). Search 1 is available at http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42013005787. Full search strategies for search 2 and supplemental searches are available upon request.

Study Selection

One author performed an initial screen of all records retrieved by the systematic searches by title and abstract and applied the initial exclusions (eg, non-human, no outcomes of interest), identified duplicate records, and assigned potentially relevant studies into groups such as review articles, epidemiology, interventions, and articles requiring further text review before categorization (Figure). After initial screening, Dr. Meddings reviewed the records by title/abstract. Reference

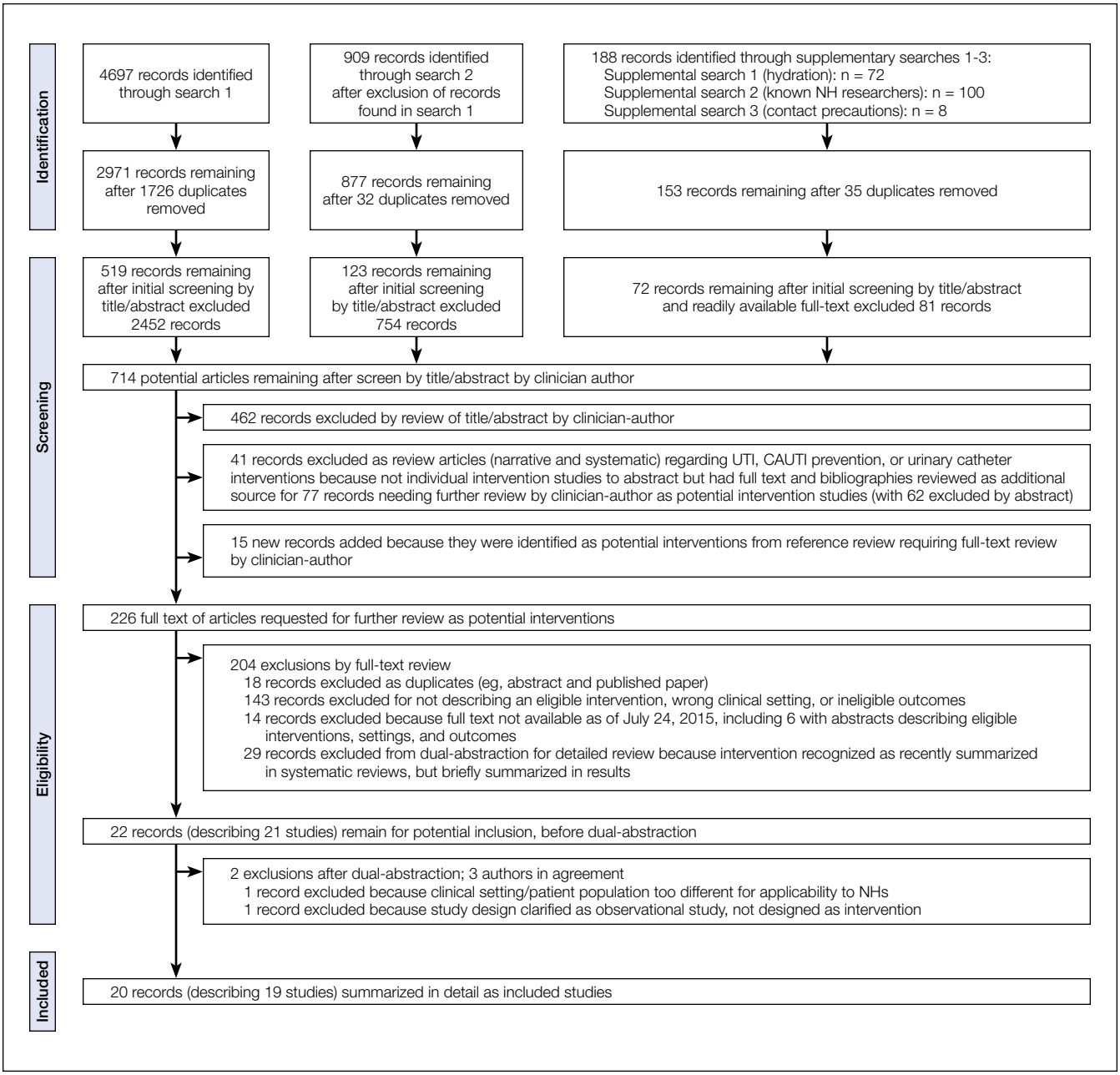

FIG. Study Flow Diagram.

NOTE: Abbreviations: CAUTI, catheter-associated urinary tract infection; NH, nursing home; UTI, urinary tract infection.

lists were reviewed for potential articles for inclusion. Full-text article review informed the selection of those for dual abstraction and quality scoring performed by 2 authors, with discrepancies resolved by a third author. We requested additional information from authors from whom our search had generated only an abstract or brief report, or when additional information such as pre-intervention data was needed.[12-18]

Data Extraction and Quality Assessment

Relevant data regarding study design, participants, inclusion/exclusion criteria, outcomes, and quality criteria were abstracted independently by 2 authors. Methodological quality scores were assigned using a modification of the Quality index checklist developed by Downs and Black appropriate for assessing both randomized and nonrandomized studies of healthcare interventions.[19] We also reviewed study funding sources and other potential quality concerns.

Data Analysis

Due to large trial heterogeneity among these studies about interventions and outcomes reported, outcome data could not be combined into summary measures for meta-analysis to give overall estimates of treatment effects.

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TABLE 1. Characteristics of Included Studies

First Author, Year, Country	Study Design	Participants/Setting Total N if provided	Interventions to Reduce UTI, CAUTI or Urinary Catheter Use[a]			Reported Outcomes Types[b]
			Strategies to reduce or improve catheter use	Infection prevention strategies	Other strategies	
Studies including participants who could be with or without urinary catheterization (ie, not limited to catheterized patients only)						
Ahlbrecht, 1999, U.S.[20]	Pre-post NRT	Residents of a 220-bed community nursing home	Maintenance	Antibiotic review, hand hygiene, infection control, standardize UTI diagnosis, surveillance	Improve resident/patient hygiene	UTI
Brownhill, 2013, United Kingdom[15]	Pre-post NRT	Residents of 47 care homes	Maintenance, catheter securement, standard supplies, incontinence care, other: more leg/night bag sizes, improve urine sampling	Antibiotic use review, standard UTI diagnosis definitions	Programs to reduce falls and pressure ulcers	UTI, CAUTI
Cools, 1988, The Netherlands[21]	Pre-post NRT	320-bed skilled nursing facility	Appropriate indications, prompt removal, incontinence care	Antibiotic guide, hand hygiene, infection control, standardize UTI definitions, surveillance.	Weekly data and new patient review by physicians; improve ventilation by chairs, exercise, physiotherapy	UTI, catheter use
Fendler, 2002, U.S.[22]	NRT with concurrent internal and external controls	Residents of a 275-bed extended care facility providing rehabilitation and subacute care	None specified	Hand hygiene	None specified	CAUTI
Klay, 2005, U.S.[23]	Pre-post NRT of same patients	42 female residents with urinary incontinence in 1 extended care facility	Incontinence care	None specified	Family education on incontinence	UTI
Lin, 2013, Taiwan[24]	Pre-post NRT with external controls	Incontinent residents of 6 nursing homes	None specified	None specified	Increase hydration	Bacteriuria
McConnell, 1984, U.S.[25]	Pre-post NRT	102 residents of nursing home	Appropriate indications, prompt removal Incontinence care	None specified	Increase hydration, ambulation program	UTI
Mentes, 2003, U.S.[26]	RCT-cluster (randomized at facility level)	42 elderly residents from 4 nursing homes (2 VA nursing homes, 2 community nursing homes)	None specified	None specified	Increase hydration	UTI
Miller, 2014, U.S.[27]	Pre-post NRT panel survey of stratified proportionate random sample of nursing directors and administrators compared to resident outcomes	824 nursing homes in large study on implementation of culture change between 2005-2010	Comprehensive "culture change program" anticipated to improve measures including percentage on bladder training programs and reduction of UTI events	None specified	Introduction of "culture change practices," as quantified by a culture change practice score reflecting 3 domains: nursing home environment, resident-centered care involving bladder training programs, staff empowerment	UTI
Stuart, 2015, Australia[28]	Pre-post NRT	Residents in 2 urban aged care facilities; 130 beds	None specified	Nurse-led antibiotic stewardship program, infection control, and surveillance programs	Nurse-physician communications about antibiotics and data	UTI
Van Gaal, 2011, The Netherlands[29,30]	RCT-cluster (randomized at ward level)	392 residents from 10 wards in 6 nursing homes	Hand hygiene/gloves for catheter/bag contact, appropriate indications, standard catheter supplies, maintenance, catheter securement, prompt removal, incontinence care	Surveillance	Fall, pressure ulcer, UTI prevention programs with nurse education/feedback	UTI Catheter use
Yeung, 2011, China[31]	RCT-cluster (randomized at facility level), unblended	1268 elderly residents in 6 nursing homes	None specified	Hand hygiene	None specified	UTI
Studies including only catheterized participants or in settings where very high urinary catheterization rates expected						
Darouiche, 2006, U.S.[32]	RCT single-blind	127 adults with spinal cord injury with long-term indwelling catheters, 4 hospitals	Catheter securement by StatLock device (C.R. Bard, Inc., Covington, Georgia)	None specified	None specified	CAUTI
Evans, 2013, U.S.[33]	Pre-post NRT	22 VA acute care spinal cord injury units	None specified	MRSA bundle of surveillance, contact precautions, hand hygiene	Institutional culture change	UTI

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TABLE 1. Characteristics of Included Studies (continued)

First Author, Year, Country	Study Design	Participants/Setting Total N if provided	Interventions to Reduce UTI, CAUTI or Urinary Catheter Use[a]			Reported Outcomes Types[b]
			Strategies to reduce or improve catheter use	Infection prevention strategies	Other strategies	
Mody, 2015, U.S.[34]	RCT-cluster (randomized at facility level)	418 residents with devices (catheters or feeding tubes) in 12 community nursing homes	Hand hygiene promotion including gown/gloves when working with indwelling devices	Standardize UTI diagnosis, hand hygiene/gown/gloves with morning/evening patient care, splashing activity, MDRO-active surveillance, pre-emptive barrier precautions if device	Staff program education	CAUTI
Priefer, 1982, U.S.[35]	RCT	17 male residents with indwelling catheters in 1 VA nursing home	Scheduled catheter change (monthly + for block/infection) compared to change only for block/infection	None specified	None specified	CAUTI
Saint, 2006, U.S.[36]	RCT unblinded	75 men >40 years requiring a urinary collection device in 1 VA hospital's units (medicine, neuro, rehab, nursing home)	Condom catheterization vs. indwelling Foley catheterization	None specified	None specified	Bacteriuria, and composite of bacteriuria or CAUTI or death
Suardi, 2001, Italy[37]	Pre-post NRT, for same patients	20 spinal cord injury rehab patients with neurogenic bladder with intermittent catheterization	Time-volume dependent catheterization using bladder scanner	None specified	None specified	Catheter use
Tang, 2006, China[38]	RCT	81 females with urinary retention in geriatric rehab ward	Comparing intermittent vs. indwelling catheters, bladder scan protocol	None specified	None specified	CAUTI, bacteriuria

[a]Supplemental Table 2 provides details of the interventions, duration of study, and measure collection details.

[b]UTI: urinary tract infection not identified specifically as catheter-associated; bacteriuria: bacteriuria, not otherwise identified as UTI or CAUTI; outcome results provided in Table 2.

NOTE: Abbreviations: CAUTI: catheter-associated urinary tract infection; MDRO, multidrug resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus;* NRT, nonrandomized trial; RCT, randomized controlled trial; VA, Veterans Affairs.

RESULTS

Systematic Search Results and Study Selection

As detailed in the study flow diagram (Figure), 5794 total records were retrieved by systematic search 1 (4697 studies), search 2 (909 studies), and supplemental searches (188 studies). Hand searching of reference lists of 41 reviews (including narrative and systematic reviews) yielded 77 additional studies for consideration. Twenty-nine records on interventions that were the focus of systematic reviews, including topics of cranberry use, catheter coatings, antimicrobial prophylaxis, washout/irrigation strategies, and sterile versus clean intermittent straight catheterization, were excluded from dual abstraction. Two records were excluded after team discussion of the dual-abstraction results, because 1 study did not meet criteria as an intervention study and 1 study's setting was not applicable in nursing homes. A total of 20 records[15,20-38] (in which 19 studies were described) were selected for final inclusion for detailed assessment and reporting for the systematic review.

Characteristics of Included Studies

Table 1 describes the 19 intervention studies in terms of design, participants, setting, and whether the study included specific categories of interventions expected to decrease UTI or catheter use. These studies included 8 randomized controlled trials (4 with cluster-randomization at the facility or unit level), 10 pre-post nonrandomized interventions, and 1 nonrandomized intervention with concurrent controls. Twelve studies included participants with or without catheters (ie, not limited to catheterized patients only) in nursing homes.[15,20-31] Seven[32-38] studies included catheterized patients only or settings with high expected catheterization rates; settings for these studies included spinal cord units (n=3), nursing homes (n=2), rehabilitation ward (n=1) and VA hospital (n=1), including acute care, nursing home, and rehabilitation units. Total quality scores for the studies ranged from 8 to 25 (median, 15), detailed in Supplemental Table 1.

As detailed in Table 1 and Supplemental Table 2, 7 studies[22,24,26,31,32,35,36] involved single interventions and 12 studies[15,20,21,23,25,27-30,33,34,37,38] included multiple interventions. Interventions to impact catheter use and care were evaluated in 13 studies, including appropriateness of use,[21,25,29,30] improving catheter maintenance care,[15,20,29,30] securement,[15,29,30,32] prompting removal of unnecessary catheters,[21,25,29,30] improving incontinence care,[15,21,23,25] bladder scanners,[37,38] catheter changes,[35]and comparing alternatives (condom catheter or intermittent straight catheter) to use of an indwelling catheter.[36,38] None focused on improving aseptic insertion. General infection control practices studied included improving hand hygiene,[20-22,29-31,33,34] improving antibiotic use,[15,20,21,28,34] initiation of infection control programs,[20,21,28] interventions to improve identification of UTIs/CAUTIs using infection symptom/sign criteria,[15,20,21,34] infection surveillance as an intervention,[28-30,33,34] and barrier precautions,[33,34] including

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TABLE 2. Summary of Outcomes from Included Studies

First Author, Year	UTI, CAUTI, Bacteriuria measures	Comparison Group	Intervention	Urinary Catheter Use Measures	Comparison Group	Intervention
Studies including participants who could be with or without urinary catheterization (ie, not limited to catheterized patients only)						
Ahlbrecht, 1999[20]	Overall UTI rate/1000 resident days	1.18 (CI: 0.36, 2.01)	1.14 (CI: 0.94, 1.34), P = 0.65	None reported		
	UTIs in nonambulatory females without indwelling catheters/1000 resident days	2.40 (CI: 1.96, 2.84)	3.06 (CI: 2.19, 3.93), P = 0.05	Not applicable		
Brownhill[a], 2013[15]	Mean UTI/month	55 UTIs	18.8 UTIs	Not reported		
	Mean CAUTI/month	18.3 CAUTIs	4.3 CAUTIs	Not reported		
Cools, 1988[21]	UTIs treated with antimicrobials (includes with and without catheters)	0.49 (256 UTIs in 515 residents) in year 1	0.125 (66 UTIs in 527 residents in year 6	Prevalence (%) of indwelling catheters	Year 1=21% (109/515)	Year 6=10% (52/527)
Fendler, 2002[22]	CAUTIs per 1000 patient-days, by symptomatic infection, 1991 McGeer criteria[42]	0.77 (133 CAUTIs per 172,897 patient-days)	0.63 (51 CAUTIs per 81,036 patient-days)	Not reported		
Klay, 2005[23]	Number of UTIs (not defined further by symptom or catheter-association)	31 UTIs	6 UTIs	Not reported		
Lin, 2013[24]	Asymptomatic bacteriuria in patients without indwelling catheters	Control group Baseline: 16.7% (n=5 of 30) Follow-up: 10% (n=3 of 30)	Intervention group Baseline: 38.6% (n=17 of 44) Post-intervention: 22.7% (n=10 of 44)	Not reported		
		No significant bacteriuria for either group				
McConnell, 1984[25]	Number of UTIs (unclear if restricted to symptomatic; population seems to include both those with and without catheters)	Monthly rates of 3-9 UTIs in months June-November 1982 (before full implementation in December 1982)	Monthly rates of 1-3 UTI in December-June 1982 (after December 1982 full implementation)	Not reported		
Mentes, 2003[26]	Hydration-linked event of UTI diagnosed by a provider (unclear if symptoms, catheter use, or other criteria), proceeded by urine specific gravity of ≥ 1.010 and decreased fluid intake	1 UTI (4.1% of 24 control patients)	0 UTI (0% of 25 treatment patients)	Not reported		
Miller, 2014[27]	Percentage of residents with UTI in last 30 days reported in Minimum Data Set:	531 NHs in bottom 3 quartiles of culture change composite score Baseline period: 8.4%±5.6 (SD) Follow-up period: 8.9%±5.4 (SD)	207 NHs in top quartile of culture change composite score Baseline period: 8.8%±4.9 (SD) Follow-up period: 8.6%±5.1 (SD)	Not reported		
		Coefficient +0.72 (SE, 0.28), meaning higher UTI rates, P = 0.01	Coefficient -0.06 (SE, 0.54), P = 0.92			
Stuart, 2015[28]	UTI rates form surveillance data using McGeer's criteria	Data not provided, but text indicates surveillance infection rates surveillance data remained stable over the 2 data collection periods		Not reported		
Van Gaal, 2011[29,30]	Symptomatic UTI confirmed by physician, reported as incidence rate per patient per week	Baseline period: n=28 UTIs for 127 patients, occurring at rate of 0.03 per patient per week Follow-up period: n=57 UTIs for 196 patients, occurring at rate of 0.02 per patient per week	Baseline period: n=23 UTIs for 114 patients, occurring at rate of 0.03 per patient per week Follow-up period: n=58 UTIs for 196 patients, occurring at rate of 0.02 per patient per week	Patients with indwelling catheters with a correct indication (%)	Usual care Baseline: 6% Follow-up: 34%	Intervention Baseline: 34% Follow-up: 32%
		Overall UTI outcome for this study, reported as ratio of UTIs in intervention versus usual care group: 0.85 with 96% CI: 0.43-1.67				

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TABLE 2. Summary of Outcomes from Included Studies (continued)

First Author, Year	UTI, CAUTI, Bacteriuria measures	Comparison Group	Intervention	Urinary Catheter Use Measures	Comparison Group	Intervention
Yeung, 2011[31]	UTIs requiring hospitalization, unclear if with or without catheters	Baseline period: 3 UTIs per 32,726 resident-days, calculated as 0.09 per 1000 resident-days Follow-up period: 22 UTIs per 81,177 resident-days, calculated as 0.27 per 1000 resident-days, $P = 0.06$	Baseline period: 6 UTIs per 21,862 resident-days, calculated as 0.27 per 1000 resident-days Follow-up period: 8 UTIs per 50,441 resident-days, calculated as 0.16 per 1000 resident-days), $P = 0.30$	Not reported		
Studies including only catheterized participants or in settings where very high urinary catheterization rates expected						
Darouiche, 2006[32]	Number of symptomatic CAUTIs in patients with Foley or suprapubic catheters	14 CAUTIs (24.1% of 58 patients followed)	8 CAUTIs (13.3% of 60 patients followed). RR=0.55, 95% CI: 0.25-1.22; $P = 0.16$	Not reported		
	Symptomatic CAUTI rate as CAUTIs per 1000 device days	4.9 CAUTI per 1000 device days	2.7 CAUTI per 1000 device days, $P = 0.16$ but study not powered to detect significant change	Not reported		
Evans, 2013[33]	MRSA hospital-associated UTIs	Actual Ns and rates were not provided in report	Quarterly UTI rates declined by 33% ($P = 0.07$)	Not reported		
Mody, 2015[34]	Clinically-defined (symptomatic) first new CAUTIs per 1000 device-days	10.0 CAUTIs per 1000 device-days	5.2 CAUTIs per 1000 device-days (HR, 0.54; (95% CI: 0.30, 0.97), $P = 0.04$[b]	Not reported		
	Clinically-defined (symptomatic) all new CAUTIs (includes recurrent) per 1000 device-days	9.2 CAUTIs per 1000 device-days	5.9 CAUTIs per 1000 device-days (HR, 0.69 (95% CI: 0.49, 0.99), $P = 0.045$[b]	Not reported		
Priefer, 1982[35]	Number (%) of patients with symptomatic CAUTI in patients with indwelling catheters	Control group: 6 of 7 (83%) men	Experimental 3 of 10 (30%) men	Not reported		
	Number of symptomatic CAUTIs per patient in 6 months in indwelling catheter patients	Control group: 1.0 ±0.6	Experimental: 0.4 ±0.7 $P > 0.05$	Not reported		
Saint, 2006[36]	Number with bacteriuria (≥10^3 CFUs per mL of single/predominant species)	Indwelling catheters: n=17 (SE, 41.5)	Condom catheter group: n=13 (SE, 38.2)	Not reported		
	Bacteriuria per 1000 patient-days (95% CI)	Indwelling catheters: 111/1000 patient-days, 95% CI (69-178)	Condom catheter group: 61/1000 patient-days with 95% CI (35-104), $P = 0.11$	Not reported		
	Composite outcome: number with bacteriuria *or* CAUTI (defined by bacteriuria and ≥ 1 UTI sign/symptom) *or* death	Indwelling catheters: n=20 (48.8%)	Condom catheter group: n=15 (44.1%)	Not reported		
		HR, 2.11 (95% CI, 1.03-4.31), $P = 0.04$ comparing this event in those with indwelling vs. condom catheters				
	Composite outcome: combined event (bacteriuria or CAUTI *or* death) per 1000 patient-days	Indwelling catheters: 131 per 1000 patient-days with 95% CI (85-203)	Condom catheter group: 70 per 1,000 patient-days with 95% CI (42-116), $P = 0.07$	Not reported		
Suardi, 2001[37]	Not reported			Number of intermittent catheterizations and indwelling catheters used	No Ns reported	No Ns reported. By text, reduced indwelling catheters, $P < 0.001$[b]
Tang, 2006[38]	Symptomatic CAUTI by day 14	Indwelling catheter group: 0	Intermittent catheter group: 1. $P = 0.400$	Days to become catheter-free	Indwelling catheters: 9.2±4.0 days	Intermittent catheters: 8.6±3.3 days $P = 0.609$
	Bacteriuria by day 14	Indwelling catheter group: 21 of 34 (61.8%) P=0.888	Intermittent catheter group: 14 of 22 (63.6%)	Number patients catheter-free by day 14 with postvoid residual <150 mL	Indwelling catheters: 27 of 39 (69.2%),	Intermittent catheters: 16 of 27 (59.3%) $P = 0.403$

[a]Study author provided outcome data not in published article.

[b]Result statistically significant, $P < .05$.

NOTE: Abbreviations: CAUTI: catheter-associated urinary tract infection; CFU, colony-forming units; CI, 95% confidence intervals; UTI, urinary tract infection not specified as catheter-associated; HR, hazard ratio; MRSA, methicillin-resistant Staphylococcus aureus; NH, nursing home; SD, standard deviation. SE, standard error.

TABLE 3. Comprehensive List of Interventions Considered for Prevention of UTI and CAUTI

This table includes a comprehensive list of potential interventions that have been considered for prevention of UTI or CAUTI (including those in acute and long-term settings), as summarized from this evidence report, and prior comprehensive narrative[43-57] or systematic reviews.[11,58-68] Blue-shaded cells describe interventions that are not recommended based on available evidence or rationale. Nonshaded cells describe interventions that have some evidence of benefit (not always from controlled-intervention studies) for certain populations and settings.

Interventions	General Summary of Available Evidence and Recommendations Provided
Interventions for Patients Regardless of Urinary Catheter Status	
Hand hygiene	Interventions to improve hand hygiene have been studied as single interventions[22,31] and part of bundles[12,21,33,34] for prevention of UTI and CAUTI in LTC settings with decreased (without statistical significance) CAUTI rates[22] with no clear benefit in UTIs require hospitalization[31] marked decrease in MRSA UTIs[33] and CAUTIs[34] in a multi-intervention studies[33,34] including contact precaution interventions
Encourage fluid intake/hydration to reduce infection	Studied as single interventions[24,26] and part of bundles[25] for the LTC setting with no significant benefits demonstrated regarding infection prevention
Improve general patient hygiene to reduce infection	Studied only as part of CAUTI bundles in the LTC setting including 1 with marked decreases in unspecified CAUTIs without statistical significance noted[12] and 1[20] without improvement in symptomatic UTIs
Cranberry product as prophylaxis	The use of cranberry-containing products (eg, juice, capsules/tablets, extracts) has been assessed in recent systematic reviews and meta-analyses,[58,59,69] evaluating a total of 14 heterogeneous studies in multiple settings (outpatient, hospital, LTC, spinal cord injury). Both recent meta-analyses[58,59] demonstrated similar nonsignificant pooled risk ratios for symptomatic UTIs, although 1 meta-analysis found a significant protection for subgroups such as women with recurrent UTIs[59] that was seen in the other meta-analysis.[58] Of note, individual studies in the LTC setting have reported mixed results on bacteriuria outcomes[70-72] and UTIs.[73-75] Cranberry studies in spinal cord injury patients[76,77] did not reduce either bacteriuria or UTI outcomes. A very recent abstract[78] regarding a double-blind placebo-controlled RCT published regarding effectiveness of twice daily cranberry capsules in LTC suggested reduced rates of clinically defined UTIs with treatment effect of 0.79 (95% CI, 0.60-1.03) among patients at high risk for UTI (long-term catheterization, diabetes, ≥1 UTI in prior year) and 0.83 (95% CI, 0.60-1.16) among patients at low risk for UTI, but not likely to be cost effective.[79] In contrast, another very recently published double-blinded placebo-controlled RCT regarding the effectiveness of 2 oral cranberry capsules once daily resulted in no significant difference in the presence of bacteriuria plus pyruria over 1 year among older women residing in nursing homes.[80]
Vitamin/mineral supplement as UTI prophylaxis	Ineffective in RCT[81] for prevention of symptomatic UTIs per 1000 resident-days in LTC setting
Treatment of atrophic vaginitis as UTI prophylaxis	Treatment of atrophic vaginitis with topical vaginal estrogens in postmenopausal women with recurrent UTIs (in outpatient setting) has been supported by RCTs (single blind[82] and double-blind[52] and by a respective chart review of a case series[83] of female LTC nursing home residents with recurrent UTI.
Interventions to improve management of urinary incontinence	Studied as educational strategies[21,23,25,29,30,38,39] and protocols regarding incontinence care for staff and residents/family, in addition to interventions of incontinence specialists,[23,39] providing individualized treatment plans to LTC residents, which can include a variety of interventions such as pelvic floor exercises, medical treatment for specific types of incontinence including avoidance of exacerbating medication and treatment of atrophic vaginitis
Implementation of effective infection control program	Infection control program implementation often includes several interventions including hand-hygiene programs, and surveillance of nosocomial infections including UTI with the potential as feedback[20] to motivate reductions in unnecessary catheter use and improved catheter care. Such interventions have been studied in the LTC setting in studies[20,21] including other specific interventions targeting CAUTIs (including infection control "walk rounds" for CAUTI detection, fed back daily to nurses).[20]
Interventions to Reduce Unnecessary Indwelling Urinary Catheter Placement: Disrupting Lifecycle Stages 1 and 4 of Urinary Catheters	
Education regarding the hazards of urinary catheters	Educational interventions aiming to improve staff knowledge of CAUTI and urinary catheter risks are common components in multi-intervention studies implemented in both acute and LTC settings. Of note, in the LTC setting, educational strategies studied have included modules specific for all healthcare workers (unlicensed and licensed) who care for catheters with separate modules for nurses who insert catheters, with multiple formats including online,[84,85] small-group teaching sessions and case reviews, and education of patients/residents[13,25,29] and families.[13,29]
Education and/or policies regarding appropriate indications for indwelling catheters	Education and policies regarding appropriate (and inappropriate) indications for indwelling catheters have been common in the acute care setting,[11] often as part of a bundle of CAUTI preventive strategies, implementing the HICPAC list[86] of appropriate indications. These lists have also been implemented in the LTC setting[13,39] with either modifications of lists from acute care or LTC.[87]
Requiring physician order with appropriate indication before placing indwelling catheters	Requiring physician orders for catheter placement has been studied in both acute care[11] and LTC settings[13,84]
Requiring documentation of staff who insert the catheters with reason for catheter placement	Requiring nurses to document insertion with indication has been an intervention employed specifically in the emergency setting[84] where catheters were placed without electronic orders and in settings where nurses are empowered to remove catheters by criteria
Education and supplies for alternatives to indwelling catheters such as external catheters, ISCs, and noncatheter strategies for managing incontinence	Facilitating use of alternatives to indwelling catheters is recommended[86] and supported by either lower UTI or other complication rates in patients treated with external catheters,[36] intermittent catheters, and noncatheter[88] strategies compared to indwelling Foley catheters
Urinary retention protocols for ISC and/or bladder scanner use before indwelling catheters requested	Bladder scanners have been used in acute care (postprocedure and floor settings) and in the rehabilitation setting[37,38] to confirm sufficient urinary retention prior to catheterization, to reduce the number of catheterizations.
Interventions to Improve Catheter Insertion Technique: Disrupting Lifecycle Stage 1 of Urinary Catheters	
Education for aseptic insertion of indwelling catheters	Although not confirmed as effective by limited evidence,[89] aseptic (as opposed to clean non-sterile) insertion of indwelling catheters is the accepted and recommended[86,90] practice in all settings. Nurse education regarding urinary catheter avoidance, maintenance, insertion, and removal that included one-on-one teaching is preferred, and resulted in higher adherence to CAUTI prevention bundle elements over online education alone.[91]
Hands-on training/competency assessments regarding aseptic indwelling catheter insertion	Catheter placement by "only properly trained persons" using aseptic technique is recommended.[86] The use of competency assessments in LTC has been studied[12,13,85] in CAUTI bundles, although the individual impact of competency training interventions cannot be assessed from available studies. The CDC evidence-based guideline[86] recommends that healthcare personnel and others who care for catheters be given periodic in-service training regarding techniques and procedures for catheter insertion, maintenance, and removal.
Options regarding intermittent catheterization	Clean vs. sterile, and single-use vs. multi-use intermittent catheterization has also been studied including several studies in the LTC and rehabilitation settings,[92-95] with a systematic review[60] indicating no evidence that UTI rates are impacted by these options, in agreement with evidence-based guidelines[86,90] indicating that clean (non-sterile) ISC is acceptable for patients requiring chronic ISC, with guidelines still recommending aseptic insertion for indwelling catheters, although the limited evidence[89] regarding this is not convincing.

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TABLE 3. Comprehensive List of Interventions Considered for Prevention of UTI and CAUTI (continued)

Interventions	General Summary of Available Evidence and Recommendations Provided
Standardizing catheter-placement supplies/kit	Catheter kit standardization (aiming to standardize catheter placement by making the necessary supplies readily available) is occurring in some acute care settings similar to prior "kit" interventions for prevention of blood-stream infections. Some LTC setting studies[13] mention interventions regarding selection of catheter products but have not been specific regarding use of a catheter kit as opposed to individual catheter products.
Interventions to Improve Catheter Insertion Technique: Disrupting Lifecycle Stage 1 of Urinary Catheters	
Type of catheterization	Comparing different types of catheterization (indwelling catheters vs. ISCs vs. external catheters) has also been the subject of systematic reviews. One[62] systematic review had zero studies meeting the inclusion criteria. Another[66] systematic review focused on suprapubic catheters, with the available evidence of 14 studies (no RCTs, 1 prospective nonrandomized study with a comparator, 8 retrospective reviews with comparators, a case series, and qualitative/descriptive assessments of quality of life) reports no evidence of differences between symptomatic UTI outcomes between suprapubic and urethral catheters, although the evidence is limited by varied UTI definitions applied for outcomes. However, a Cochrane systematic review[96] comparing short-term (<14 days) of indwelling urethral urinary catheters to suprapubic urinary catheters found that groups with indwelling urinary catheters had more cases of bacteriuria (RR 2.6, 95% CI, 2.12, 3.18) and significantly more patient discomfort (RR 2.98; 95% CI, 2.31, 3.85). Evidence-based guidelines[86] recommend ISC use is preferable to indwelling suprapubic or urethral catheters for bladder-emptying dysfunction, based on decreased rates of symptomatic UTIs and unspecified UTIs in select patient populations. Despite some evidence of lower CAUTI rates for external catheters and ISC compared to indwelling catheters, no catheter is preferable because of increased rates[97,98] of symptomatic UTI even with nonindwelling catheters by observational studies.
Catheter coating/materials	Different options in catheter coatings (such as hydrophilic-coated, antiseptic or antibiotic-impregnated) and materials (latex, PVC, silicone) have been studied. Systematic reviews suggest either insufficient evidence for recommendation[99] or no evidence that UTI rates are impacted by these options; the CDC[86] targeted systematic review suggesting antimicrobial/aseptic catheters may be useful if CAUTI rates are not decreasing with other strategies. A more recent RCT in the acute care setting demonstrated no benefit of antimicrobial catheters.[100] Although prior evidence-based guidelines were mixed[86,90] regarding routine use of hydrophilic catheters for ISC, a 2013 systematic review and meta-analysis[61] of hydrophilic catheters in the spinal cord injury population indicate these may be preferable (compared to standard nonhydrophilic catheters) for intermittent straight catheterization, with a significantly lower incidence of symptomatic or treated UTIs (OR, 0.36; 95% CI, 24%-54%; $P < 0.001$).
Catheter tip options	Different options in catheter tip configurations for catheters used for intermittent catheterization (such as straight, coude, olive tip, or introducer-tip) are discussed in narrative reviews citing potential benefits for certain patient populations (such as using coude catheters for men with enlarged prostates). These types of recommendations may be valid clinically and are choices sometimes recommended by urologists in cases of difficult placement.[56] There is insufficient evidence to recommend specific catheter tips as a general CAUTI bundle component for the average patient.
Catheter size	The smallest bore catheter possible with consistent good drainage is recommended to avoid black neck and urethral mucosa trauma.[54,86]
Catheter length	Narrative reviews suggest than the optimal catheter length varies by gender[54] (45 cm, males; 25 cm, females) to avoid kinking. Specific recommendations regarding catheter length have not been provided by recent evidence-based reviews, although keeping the catheter free from kinking to maintain unobstructed urine flow is recommended.[86,90]
"Closed" drainage systems	Evidence-based guidelines[86,90] recommend the use of closed catheter drainage systems to reduce CAUTI in patients with indwelling catheters. Closed drainage systems for intermittent straight catheters also exist but with limited evidence[56] regarding benefit.
Catheter securing devices	Properly securing indwelling catheters after insertion is recommended to decrease movement and urethral trauma and has been studied as part of a bundle[85] in the rehabilitation setting. The use of a specific device (StatLock) was studied in the spinal cord injury acute care setting with a marked reduction (without meeting statistical significance) in symptomatic CAUTI rates;[32] the implications of this study have been mixed with some interpreting it as evidence for supporting use of this type of catheter-securing device, and other[86] reviews interpreting as not evidence for using these devices given no significant difference in CAUTI or meatal erosion.
Maintenance/Care of Patients with Catheters: Disrupting Lifecycle Stage 2 of Urinary Catheters	
Handwashing, gloving before and after catheter/bag care	Hand hygiene is recommended[86] immediately before and after insertion or any manipulation of the urinary catheter or site. Gloves should be worn during any manipulation of catheterized patients or when providing intimate care. Gown use should be considered during catheter insertions, manipulation, and when providing assistance during activities of daily living. These strategies are useful regardless of a resident's colonization status with multidrug resistant organisms.
Keeping drainage bag below bladder	Keeping the collecting bag below the level of the bladder at all times without placement of the bag on the floor is recommended by evidence-based guidelines.[86]
Routine perineal cleaning strategies with antiseptics	Evidence-based guidelines[86,90,101] recommend against cleaning the periurethral area with antiseptics to prevent CAUTI while the catheter is in place. Routine hygiene (cleansing of the meatal surface during daily bathing) is appropriate.[90]
Irrigations, washouts, and instillations	The practice of irrigating or washing out long-term indwelling urinary catheters has also been assessed by systematic reviews[65,102] including reviews of various solutions (eg, saline, acidic solutions, antiseptic, and antibiotic solutions) have summarized 5 studies in multiple settings that were noted to be of poor quality and also did not appear to support these interventions as effective at either reductions of symptomatic CAUTIs or time to requiring first catheter change. Our own systematic search strategy identified several studies involving these interventions that either had been evaluated for the previously published systematic reviews (as included[103,104] or excluded[105] studies). Washout and irrigation strategies have also been assessed at length by a recent CDC-targeted systematic review,[86] with agreement that bladder irrigation and catheter drainage bag instillations are not recommended, given no differences in symptomatic UTI and mixed results in bacteriuria outcomes.
Catheter replacement issues	Catheter replacement at routine, fixed intervals is not recommended by evidence-based guidelines[86] and did not decrease UTIs in the study reviewed in detail in this systematic review.[35] A recent integrative review on catheter change intervals concluded there was insufficient evidence to support or refute the common practice of routine catheter changes but is a pre-emptive strategy employed in those who encrust and develop recurrent blockage.[106]
Avoid equipment sharing between catheterized patients	This has been recommended in narrative reviews[45,107] and is reasonable and recommended by the CDC guideline[86] with regard to not sharing catheter-care supplies (such as devices used to empty catheter bags).
Spatial separation of catheterized patients	Spatial separation has been recommended by a case-control study,[108] but further research is needed to assess the benefit of spatial separation of catheterized patients.[86]

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TABLE 3. Comprehensive List of Interventions Considered for Prevention of UTI and CAUTI (continued)

Interventions	General Summary of Available Evidence and Recommendations Provided
Maintenance/Care of Patients with Catheters: Disrupting Lifecycle Stage 2 of Urinary Catheters	
Prophylaxis with systematic antimicrobials	The use of antimicrobial prophylaxis for chronically catheterized patients studied in several studies[109-112] yielded by our search strategy has also been reviewed in a recent systematic review[68] (of 8 studies, including indwelling catheters and ISCs) and systematic review and meta-analysis[67] (of 15 studies involving ISCs) systematic reviews[67,68] and meta-analyses[67] with no benefit seen in patients with either chronic catheters or ISCs (with increased resistance[67] suggested in ISC patients), in agreement with a recent CDC[86] targeted systematic review. Our search did reveal a very recent study[64] supporting the use of antimicrobial prophylaxis when short-term catheters are removed in the acute care setting; however, other studies indicate that prophylactic antimicrobials are not routinely indicated for changes of chronic catheters due to little morbidity[45,113,114] reported with chronic catheter changes.
Other systemic chemoprophylaxis	The evidence for methenamine IN preventing CAUTI is limited for use in both short-term catheterizations (studied only for postoperative gynecologic surgery) and long-term catheterizations, and not recommended for routine use for patients with long-term intermittent or long-term indwelling urethral or suprapubic catheterization according to evidence-based guidelines.[86,90]
Bacterial interference interventions	Novel interventions are being studied[115] regarding the feasibility and potential benefit of "bacterial interference" interventions involving urinary colonization with benign bacteria, with the goal to reduce symptomatic infections by pathologic bacteria.
Prompting Removal of Unnecessary Catheters: Disrupting Lifecycle Stage 3 of Urinary Catheters	
Trial removal of indwelling catheters present at admission to LTC setting	This practice has been studied as a bundle component[21,25,39] in LTC settings, and functions as a type of stop-order by prompting a trial removal of all indwelling catheters upon admission to LTC setting. This type of intervention may function similarly to stop-orders studied in the acute care setting. Studies reporting this type of intervention are advised to assess and report potential adverse events to patients, similar to acute care interventions using reminders and stop-orders.[11]
Urinary catheter reminders, reminding staff that patient/resident has a catheter to consider removing Urinary catheter stop-orders, requiring removal of catheter unless specific clinical criteria are met	The use of reminders and/or stop-orders has been demonstrated by a recent systematic review and meta-analysis[11] focused on the acute care setting to reduce CAUTIs per 1000 catheter-days by more than 50%; these studies often included reminders/stop-orders as part of a CAUTI prevention bundle. Reminder types included use of daily checklists, electronic reminders, and the use of catheter patrols. Similar interventions have also been implemented in a few LTC studies including the use of catheter audit tools,[39] daily assessment for continued catheter need,[13] electronic removal reminder systems[14] with some studies reporting decreased infections or catheter use, although most studies were underpowered to detect statistical significance of these interventions in the LTC setting.

NOTE: Abbreviations: CAUTI, catheter-associated urinary tract infection; CDC, Centers for Disease Control and Prevention; CI, confidence interval; HICPAC, Healthcare Infection Control Practices Advisory Committee; ISC, intermittent straight catheterization; LTC, long-term care; OR, odds ratio; PVC, polyvinyl chloride; RCT, randomized controlled trial; RR, relative risk; UTI, urinary tract infection.

preemptive precautions for catheterized patients.[34] Hydration was assessed in 3 studies.[24-26]

Outcomes of Included Studies

Table 2 describes the studies' outcomes reported for UTI, CAUTI, or bacteriuria.[15,20-38] The outcome definitions of UTI and CAUTI varied widely. Only 2 studies[22,39] reported UTI outcomes using definitions specific for nursing home settings such as McGeer's criteria[40] a detailed review and comparison of published CAUTI definitions used clinically and for surveillance in nursing homes is provided in Supplemental Table 3. Two studies reported symptomatic CAUTIs per 1000 catheter-days.[32,34] Another study[22] reported symptomatic CAUTIs per 1000 resident-days. Three reported symptomatic CAUTIs as counts.[35,38] Saint et al[36] reported CAUTIs as part of a combined outcome (ie, bacteriuria, CAUTI, or death).

The 19 studies (Table 2) reported 12 UTI outcomes,[15,20,21,23,25-31,33] 9 CAUTI outcomes,[15,22,32,34,35,38] 4 bacteriuria outcomes,[24,36,38] and 5 catheter use outcomes.[21,29,30,37,38] Five studies showed CAUTI reduction[15,22,32,34,35] (1 significantly[34]); 9 studies showed UTI reduction[13,18,19,21,23-25,27,28,31] (none significantly); 2 studies showed bacteriuria reduction (none significantly). One study[36] reported 2 composite outcomes including bacteriuria or CAUTI or death, with statistically significant improvement reported for 1 composite measure. Four studies reported catheter use, with all showing reduced catheter use in the intervention group; however, only 1 achieved statistically significant reduction.[37]

Synthesis of Systematic Review Results

Overall, many studies reported decreases in UTI, CAUTI, and urinary catheter use measures but without statistical significance, with many studies likely underpowered for our outcomes of interest. Often, the outcomes of interest in this systematic review were not the main outcome for which the study was designed and originally powered. The interventions studied included several currently implemented as part of CAUTI bundles in the acute care setting, such as improving catheter use, and care and infection control strategies. Other included interventions target common challenges specific to the nursing home setting such as removing indwelling catheters upon admission to the nursing home from an acute-care facility[21,25] and applying interventions to address incontinence by either general strategies[21,23,25,30,38] or the use of an incontinence specialist[23] to provide individual treatment plans. The only intervention that demonstrated a statistically significant reduction in CAUTI in chronically catheterized patients employed a comprehensive program to improve antimicrobial use, hand hygiene (including hand hygiene and gloves for catheter care), and preemptive precautions for patients with devices, along with promotion of standardized CAUTI definitions and active multidrug resistant organism surveillance.[34]

Narrative Review Results

Table 3 includes a comprehensive list of potential interventions that have been considered for prevention of UTI or CAUTI (including those in acute care and nursing home

settings), as summarized from this systematic review and prior narrative or systematic reviews.[43-115]

DISCUSSION

We performed a broad systematic review of strategies to decrease UTI, CAUTI, and urinary catheter use that may be helpful in nursing homes. While many studies reported decreased UTI, CAUTI, or urinary catheter use measures, few demonstrated statistically significant reductions perhaps because many were underpowered to assess statistical significance. Pooled analyses were not feasible to provide the expected impact of these interventions in the nursing home setting.

This review confirms that bundles of interventions for prevention of CAUTI have been implemented with some evidence of success in nursing home settings, with several components in common with those implemented in the acute care setting, such as hand hygiene and strategies to reduce and improve catheter use.[41] Some studies focused on issues more common in nursing homes such as chronic catheterization and incontinence. A nursing home CAUTI bundle should be designed with the resources and challenges present in the nursing home environment in mind, and with recognition that, although the number of patients with catheters is less than in acute care, there will be more patients with chronic catheterization needs and incontinence.

Although catheter utilization in nursing homes is low, further reductions in catheter days and CAUTIs can be achieved. Catheter removal reminders and stop orders have demonstrated a greater than 50% reduction in CAUTIs in acute care settings;[11] an example of a stop-order intervention in nursing homes is trial removal of indwelling catheters present at facility admission without clear urologic need present at the time of admission.[25] Nursing home interventions to avoid catheter placement should include incontinence programs, discussion of alternatives to indwelling urinary catheters with patients, families, and frontline personnel, and urinary retention protocols. Programs to reduce CAUTI should include education to improve aseptic insertion, and to maintain awareness and proper care of catheters in place by regular assessment of catheter necessity, securement, hand hygiene, and preemptive barrier precautions for catheterized patients. Interventions that focus on improving appropriate use of urine tests and antibiotics to treat UTIs can also significantly affect the rates of reported symptomatic CAUTIs, with the potential to decrease unnecessary antibiotic use.[20,21]

The main limitation of this review is that many studies provided little information about their intervention and definition of outcomes. The strength of this review is the detailed and broad search strategy applied with generous inclusion of interventions and outcomes to highlight the available evidence and details of interventions that have been studied and implemented.

CONCLUSION

This review synthesizes the current state of evidence and proposes strategies to reduce UTIs in nursing homes. Interventions that motivate catheter avoidance and catheter removal to prevent CAUTI in acute care[11] and nursing home settings are supported by the strongest available evidence, although the strength of that evidence is less in the nursing home setting. Limitations notwithstanding, interventions such as incontinence care planning and hydration programs can reduce UTI in this population and is important for overall wellbeing.

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