

Exploring the implementation of interventions to reduce catheter- associated urinary tract infections (ENACT)

Appendix F

Appendix F: Key characteristics of the 37 research interventions

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
Bell M and others (2016) (13)	USA; ICU unit in a hospital; nurses and physicians	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter insertion and maintenance. 3. Appropriate catheter removal. 	<ol style="list-style-type: none"> 1. Introduction of a CAUTI bundle listing indications for catheters, stressing sterile insertion and appropriate catheter care; introduction of StatLock devices to secure catheters. 2. Obtaining wicking pads as an alternative to a urinary catheter. 3. A multidisciplinary continuing medical education conference addressing CAUTI prevention for staff; A sentinel event patient case presented along with information regarding CAUTI, indications for urinary catheters, and strategies to reduce catheter use. 4. Medical records modified to create a mandatory drop-down selection box listing the appropriate indications for urinary catheter placement, requiring the provider to select one of the indications from the drop-down menu before they could continue with the urinary catheter order. 5. Daily tracking of patients with catheters added to the nursing staff daily management system. Numbers posted on a tracking board in each ward and updated daily. 6. Implementation of a service tracking patients having urinary catheters and the indications for use. 7. Creation of urine retention protocol based on best-practice guidelines approved by the CAUTI systemwide oversight team; protocol added to the hospital electronic health records as a nursing protocol. 8. Prompt added to the electronic health records reminding physicians each day about patients having catheters and asking whether the catheter could be removed. If the physician clicked no, the system asking for the indication for a continued use. 9. The resident quality champion sitting on the systemwide Quality Resource Management Committee, coordinating multidisciplinary continuing medical education 	Incidence of CAUTI	Decrease from pre-intervention period to post intervention period by 25% to 30% (year 2); no improvement in year 1.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				conferences, and coordinating patient safety case presentations at monthly resident-faculty meetings.		
Carr and others (2017) CAUTI (14)	USA; a 27-bed Progressive Care Unit at the Mayo Clinic; All staff	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter maintenance. 3. Appropriate documentation. 	<ol style="list-style-type: none"> 1. Implementation of a CAUTI bundle ensuring standardised approach in catheter use and maintenance involving: <ol style="list-style-type: none"> a. medical record reviews conducted every shift to ensure an IUC order was written, and indication within CDC (2009) guidelines b. daily assessment to determine medical necessity of IUCs c. collaboration with providers to discontinue IUC if no longer appropriate d. catheter care every 8 hours and as needed e. performing hand hygiene, monitoring for kinks in catheter and tubing, securing IUC appropriately with a leg strap, maintaining integrity of seal between catheter and drainage bag tubing, and ensuring catheter bag is always at least 6 inches above the floor and below the patient's bladder f. emptying catheter bag every 8 hours or when bag is two-thirds full g. accurate documentation in the electronic health record 2. Inservice sessions concerning use of a unit-wide CAUTI bundle and adherence audit forms developed by the workgroup. 3. An RN or PCT initiating the CAUTI Prevention Form for every patient with a newly inserted IUC, or admitted to PCU with existing IUC; The form kept in the patient's room, visible and accessible to staff. 4. Use of Cather Audit Form on a weekly basis to review staff documentation of related patient care in order to determine areas of improvement and further education. 5. Positive results disseminated widely to increase staff motivation and engagement. 6. Team huddles, flyers, and open communication reinforcing the teamwork. 	Incidence of CAUTI	Decrease from pre-intervention incidence of CAUTI of 3 to post-intervention of 0 (sustained for 22 months).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
Cartwright A (2018) (15)	UK; Hospital; All staff	Pre-post test	1. Correct use of standard catheters and catheterisation practices.	1. Standardisation of catheters across hospital. 2. Onsite training by catheter manufacturer to enable correct use of the tray in an aseptic manner. 3. Continence team visiting all areas of hospital to ensure staff aware of product change and to talk through the contents of catheter pack and answer staff questions.	Incidence of CAUTI	Decrease from pre-intervention in CAUTI incidence of 102 to post-intervention of 54 (year 1), 21 (year 2) and 13 (year 3).
Cho H and others (2017) (16)	USA; 5 medicine units in a 1,171-bed tertiary care hospital; hospitalists, other attending physicians, nurse practitioners, and medicine house staff	Pre-post test	1. Appropriate catheter use. 2. Timely removal of catheter	1. Development of an electronic health record (EHR) tool to identify catheter use based on nursing documentation. 2. The tool used by hospitalist medical director on the medicine units to query providers at daily interdisciplinary rounds whether patient needs a catheter; rounds attended by hospitalists, other attending physicians, nurse practitioners, and medicine house staff. 3. Education on catheter and CAUTIs added to the monthly orientation for clinicians rotating on the units. 4. Development of a mnemonic, NO TUBE, to help providers remember the acceptable indications for catheter use.	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention phase in CAUTI rate from 2.85 per 1,000 catheter-days to post-intervention of 0.32 per 1,000 UC days (p 0.001).
Davies and others (2018) (17)	USA; trauma centre; All staff	Pre-post test	1. Appropriate use, insertion and maintenance of catheters. 2. Timely discontinuation of catheters. 3. Appropriate urine culture practices	1. Nurse rounds 4 times a week in order to reinforce nurse indications for proper use, maintenance techniques and early discontinuation of catheters; each patient assessed for appropriateness and potential for removal of catheter. 2. Creation of a diagnosis algorithm to provide education and supplement bedside rounds. 3. Prospective surveillance of all new culture analysis by clinical pharmacists and a clinical nurse specialist in order to identify any discordance with guidelines; if that was the case the provider was contacted and provided with education to determine if the urine culture could be cancelled.	CAUTI rate	Effective in ICU trauma patients only: Decrease from pre-intervention CAUTI rate of 4.09 to post-intervention period of 1.08 (incidence rate ratio, 0.26; 95% CI, 0.01 to 1.68).
Dawson and others (2017) (18)	UK; district general hospital and major trauma centre;	Pre-post test	1. Appropriate catheter insertion. 2. Appropriate catheter management. 3. Decrease of catheter use.	1. Implementation of catheter care pathway aimed to consolidate documentation surrounding catheter care, including details of insertion and reviews, and enabling assessment of adherence to the guidelines.	Incidence of CAUTI; CAUTI rate	Decrease from early intervention phase in CAUTI incidence of 3.5% to late intervention phase of 2.4%.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
	all staff		4. Appropriate use of bladder scanners	<ol style="list-style-type: none"> 2. Adherence to pathway monitored in monthly audits by the continence nurse specialist, as part of ongoing quality improvement. 3. The acronym HOUDINI developed to enable staff to recognise indications for continued urinary catheter use. 4. HOUDINI checklists added to the front of pathway documentation, to aid staff in their decision-making process at the point of insertion and/or reviews; supported by a series of power training sessions, delivering education and training around the HOUDINI concept directly to staff within the healthcare setting. 5. HOUDINI further supported by its inclusion in annual infection prevention link staff study days allowing staff to explore the concept in detail, ask questions and return to their specific units to disseminate the practice. 6. All staff invited to enter a competition to design a 'catheter magnet' in order to raise awareness of catheter care; the winning design translated into a magnet and used on patient discharge boards to remind staff to review patient catheters with a view to TWOC (trial without catheter). 7. Introduction of bladder: Scanners to help identify urinary retention and identify cases where catheter use may not be required; scanners introduced to staff through the use of scheduled demonstrations and training sessions, facilitated by the manufacturers to ensure that the catheter care group and Trust staff aware of the optimal process for using bladder scanners. 		Average CAUTI rate below the national average (0.38% versus 0.73%).
Dy S and others (2016) (19)	USA; 3 hospitals; nurses	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter removal. 	<ol style="list-style-type: none"> 1. Creation of evidence-based practice report. 2. Development of a clinical decision support tool prompting staff to remove catheter. 3. Education of the staff using online modules, unit-based educational services, Clinical Nurse Specialist day and night rounds. 4. Appointment of a unit-based clinical nurse 'champion' resource. 5. Standardisation of protocol and policies across hospitals. 	CAUTI rate per 1,000 catheter-days; CAUTI rate per 1,000 patient days	<p>Only effective in hospital 1: Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 2.25 to post intervention rate of 1.63 (p=0.05).</p> <p>Decrease from pre-intervention CAUTI rate per 1,000 patient days of 0.42 to post</p>

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				6. Nurse-driven removal protocol (NDPR) set as default; providers having to unselect NDPR		intervention rate of 0.28 (p=0.02).
Kachare and others (2014) (22)	USA; 30-bed surgical oncology unit in a tertiary care centre; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Decreasing utilisation of catheters. 2. Early removal and decreased re-insertion of catheters. 3. Improved compliance with care processes such as hand hygiene and Foley bundle (h.c.p. assessing need for a catheter on a daily basis; placing a continue catheter use order on the electronic chart; using leg strap or locking device; using closed drainage system). 	<ol style="list-style-type: none"> 1. Hospital-wide guidelines published describing the indications for Foley catheters; medical staff encouraged to adhere to them. 2. Implementation of daily electronic “hard-stop” queries to the primary services through the electronic medical record. 3. Direct contact to the primary team as to medical necessity for continued Foley use. 4. Provision of education and coaching to physicians on recommended best practice and early removal of Foley catheters. 5. Implementation of Foley removal diagram (guiding management of patients after Foley removal) and guidelines for Foley reinsertions. 6. Tracking and monitoring of all processes. 7. Provision of closed drainage system. 	Median CAUTI rate	Reduction from pre-intervention median CAUTI rate of 4.6 to post-intervention of 0 (p=0.03).
Halperin and others (2016) (20)	USA; Neuro ICU; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use (including indications and alternatives) and removal. 2. Appropriate insertion and maintenance technique. 3. Removal of catheter before sending patients to neuro ICU. 4. Appropriate perineum care. 	<ol style="list-style-type: none"> 1. Re-educating neuro ICU personnel in criteria for appropriateness of catheter placement and removal. 2. Daily rounds questioning the continued need for catheter. 3. Introducing a new kit simplifying and standardising sterile insertion; and ensuring that other departments directly related to the ICU followed the same procedure as the ICU. Personnel trained at those departments. 4. All ICU staff retrained in Foley catheter insertion by watching a video and performing an observed simulation. 5. All RN and patient care technicians retrained in soap and water perineum care, which was then done every 12 hour shift. 	Incidence rate of CAUTI per month; CAUTI rate per 1,000 catheter-days	<p>Overall decrease from pre-intervention number of CAUTI per month of 2 to post-intervention rate of 0.8.</p> <p>Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 10.9 to post-intervention rate of 6.2 (p=0.04).</p>

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 6. Real time feedback including notification and dissemination of positive changes and maintaining a calendar indicating a number of days since the last CAUTI. 7. Placing a mobile CT scan in the neuro ICU to reduce transports for brain imaging. 		
Johnson P and others (2016) (21)	USA; ICUs; nurses and physicians	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate removal of unnecessary catheters. 2. Appropriate catheter maintenance. 	<ol style="list-style-type: none"> 1. Implementation of a nurse-driven catheter removal protocol not requiring additional physician's ordering the majority of cases. If patient not fitting the protocol, reason for it documented. 2. Daily assessment for the need of a catheter during multidisciplinary ICU rounds. 3. Education of all nurses in the ICUs, chief residents, and surgery and medicine physician teams on current CAUTI rates, information about new protocol and evidence guiding its development and review of routine catheter care and maintenance. 4. A laminated copy of the order set posted in each unit. 5. Changes in policies and procedures including utilization of smaller bore urinary catheters, and addition of silver-based cleansing products for urinary catheter care. 	Incidence of CAUTI; CAUTI rate	Overall reduction by 36%. Decrease from pre-intervention CAUTI rate of 0.60% to post-intervention rate of 0.43%.
Maxwell M (2018) (23)	USA; ICU and IMCU in a community hospital; nurses, physicians and nursing assistants	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter care, catheter use and use of alternatives. 2. Appropriate catheter maintenance. 3. Timely catheter removal. 	<ol style="list-style-type: none"> 1. Urine specimen collection only obtained from newly inserted catheters to remove the potential confounding factor of catheter biofilm. 2. Implementation of a 4 hour perineal care and cleaning of catheters every 12 hours. 3. Purchase of female urinals and male urinary devices. 4. Two nurses required to be present during insertion and then document it. 5. Approved criteria for catheter insertion added to the insertion order in the electronic records. 6. Development of evidence-based practice protocols for bladder scanning and catheter removal. 7. Use of straight catheterisation encouraged. 8. Purchase of additional bladder scanners. 9. Education to the ICU teams. 10. Catheter assessed daily during interdisciplinary rounds; goals set for anticipated date of catheter removal. 	Incidence of CAUTI	Decrease from pre-intervention CAUTI incidence of 8 to post-intervention rate of 1. Zero CAUTI rate sustained for 394 days.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 11. Encouragement provided for the use of other non-invasive catheter alternatives. 12. Education provided to all staff about insertion techniques via hands on demonstration; when necessary one-to-one education to physician and nurses in real time. 13. Project team working with Emergency Department to encourage them to delay catheter placement until person was assessed in the ICU or IMCU. 14. Daily monitoring including assessment and creation of a plan for catheter removal during multidisciplinary rounds. 15. Log maintained by the CNS or Charge RN each patient identifying the indication for the catheter, date inserted and the plan for removal to communicate the information between care givers. 16. Monitoring the insertion, removal and care components by the unit manager and Clinical Nurse Specialist (CNS). CAUTI and device utilization monitored by Infection Prevention. 17. The Critical Care physicians supporting the ICU and IMCU nurses when requesting primary care physician removal of the indwelling urinary catheter if no valid indication for the Foley found. 18. Recognition of individual and unit wide positive changes by daily verbal reinforcement and recognition for adoption of new behaviours (informal); and award for clinical staff demonstrating early adoption of the culture change, setting expectations for peers and another award for the one unit within the hospital with the greatest decrease in Foley utilization and actual CAUTI events. 19. Monthly review of catheter days, CAUTIs, compared against baselines. 20. Adherence audited and reinforced with staff who were late adopters. 21. The ICU or IMCU celebrating the accomplishment with 'Zero' by candy bars and a banner hung in the 		

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				department recognizing the effectiveness of their hard work.		
McCalla and others (2018) (24)	USA; a 292-bed community hospital; nurses, respiratory therapists, care managers, physicians, dietary aides, transporters, registrars, physical therapists, housekeeping staff, and technicians	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate hand hygiene routine. 2. Appropriate catheter insertion and maintenance. 	<ol style="list-style-type: none"> 1. Implementation of automated hand hygiene compliance system (HHCS): a wearable device reminding staff to carry out hand hygiene routine; a yellow and then red light on the device indicating until hand hygiene is performed, at which point the light shines green, assuring patients and anyone at the bedside that HHC was performed. 2. Implementation of new catheter insertion kit. 3. Implementing catheter insertion time-out process. 4. Introducing procedure for irrigating catheters. 5. Education of staff on proper catheter insertion and maintenance. 6. Hospital leadership fostering strong culture of HHC, empowering staff to intervene if non-compliance observed. 7. Use of user-level compliance data to reinforce efforts. 8. Use of real time feedback from management. 	CAUTI rate per 1,000 catheter-days;	Decrease from pre-intervention CAUTI rate per 1,000 catheter of 2.2 to post-intervention of 1.21 (RRR, 44.8%; 95% CI, 12.7% to 65.2%.
Miller and others (2016) (25)	USA; 2 ICUs; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Early removal of catheter. 2. Use of leg straps. 3. Appropriate catheter order. 	<ol style="list-style-type: none"> 1. Teams holding monthly discussions regarding CAUTI incidents. 2. Teams investigating each infection with help from the infection prevention team and developed interventions to help with barriers. 3. Nurses provided with education on cleaning patient prior to catheter insertion and every 8 hours. 4. Team reinforcement of the use of leg straps and early removal. 5. Team assessment of a written catheter order. 	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 3 to 1.6 per (year 3); p less than 0.05); and to 1 (year 4) p less than 0.001.
Mody and others (2015) (27)	USA; 12 community-based nursing homes; nurses' aides, nurses, physicians and infection preventionist	RCT	<ol style="list-style-type: none"> 1. Appropriate hand hygiene and gown and gloves wearing. 2. Use of relevant products. 3. Use of barrier precautions? 	<ol style="list-style-type: none"> 1. Implementation of pre-emptive barrier precautions including signs placed on the patient room doors, their medical records and nurses' station. Barriers precautions also promoted using posters, videos and dance routines. 2. H.c.p. encouraged to perform hand hygiene before and after providing any care; wearing gowns and gloves when performing care. 	Incidence of CAUTI; Incidence of CAUTI per catheter days	Intervention group: 56 new episodes of CAUTI over 9413 catheter-days, incidence rate of 5.9 per 1,000 catheter-days. Control group: 75 new episodes of CAUTI over 8,118 catheter-days, incidence rate of

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 3. Relevant products placed strategically at intervention sites. 4. Active surveillance for multidrug resistant organisms and infections which were reported monthly to staff with the use of graphs, tables and charts. 5. Nursing home staff education on key prevention practices and hand hygiene promotion using information pocket card focusing on infection recognition. 6. Infection preventionist invited for a half-day conference on surveillance methods for infections. 7. Educational programme consisting of 10 modules executed 2 to 3 months over 3 years including pre-test and post-test questions (targeted at nurses and nurses' aides); education on overview of infection prevention practices, hand hygiene, appropriate indications for device use and device care; sessions presented using DVD, and interactive component including games. 8. HCW also educated on the indications, technique and duration of effective hand hygiene and appropriate glove and gown use. 		9.2 per 1,000 catheter days (95% CI, 0.49 to 0.99; p=0.45).
Mody and others (2017) (26)	USA; 404 community-based nursing homes; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter care and maintenance. 2. Appropriate catheter removal. 3. Appropriate aseptic insertion. 4. Appropriate incontinence care planning and hydration practices. 	<ol style="list-style-type: none"> 1. Implementation of technical bundle highlighting key interventions: catheter removal, aseptic insertion, using regular assessments and feedback, training for catheter care, and incontinence care planning and hydration practices. 2. Bundle including infection prevention strategies (for example, hand hygiene, barrier precautions, and education for infection preventionists, frontline staff, residents, and families), as well as catheter-associated UTI prevention-specific strategies (for example, prompt removal of unnecessary catheters on admission, adopting evidence-based practices for catheter maintenance and insertion, reducing inappropriate catheter use, and considering alternatives to indwelling urinary catheters). 3. Technical bundle used as a framework for educational materials, toolkits and interactive strategies. 	CAUTI rate per 1,000 catheter days; reduction in CAUTI	Decrease from pre-intervention CAUTI rate per 1,000 catheter-days of 6.78 to mid-intervention rate of 4.17 and post-intervention rate of 2.63. 276 of 368 (75.0%) of the nursing homes reporting at least 40% reduction in CAUTI rates.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 4. Importance of the antimicrobial stewardship and appropriate use of diagnostic tests, such as urinalysis and urine culture emphasized. 5. Education on the technical and socio-adaptive bundles was provided through in-person or virtual learning sessions. 6. Monthly coaching calls led by the local organizational lead and national project team faculty providing teams with an opportunity to review data, discuss project implementation, and learn from each other by sharing successes and barriers. 7. Onboarding and training webinars at the start of the project preparing facility teams to implement technical and socio-adaptive interventions followed by monthly content webinars presented by faculty experts on the technical and socioadaptive principles of catheter-associated UTI prevention. 8. Organizational leads and coaches across the cohorts participating in a separate monthly call to review data trends, learn by sharing, identify barriers, and provide feedback to the national project team on needed resources to facilitate implementation. 9. Development of an implementation guide, as well as multiple tools, train-the-trainer educational materials to support facility teams at the start and throughout the project. 		
Mori C (2014) (28)	USA; 150-bed community hospital; nurses and physicians	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate use of indwelling catheters. 2. Removal of inappropriate catheters. 	<ol style="list-style-type: none"> 1. Implementation of a nurse driven protocol allowing nurses to remove catheter without a physician order; creation of a decision tree as a quick reference for all staff. 2. Review of indication or catheter use and alternatives with all nursing staff. 3. Education provided through on-line learning systems, poster boards and one-to-one sessions. 4. Education on importance of securing the drainage tubing to the bed sheet; positioning the tubing without 	CAUTI rate	Decrease from pre-intervention CAUTI rate of 0.77% to post-intervention rate of 0.35%.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<p>dependent loops and maintaining an intact tamper-evident seal.</p> <ol style="list-style-type: none"> Knowledge tests? CNS attending nurses and physician staff meetings to address questions related to new protocol. Adding insertion criteria to nursing computerised charting and physician order entry systems. Computerised charting required ongoing assessment by nurses for catheter need and review of indications. CNS team conducting spontaneous reviews to determine if patient received catheters according to defined criteria – this formed the basis for feedback. 		
Mullin, K. and others (2017) (29)	USA; ICU units in a 1,268-bed tertiary care academic centre	Pre-post test	<ol style="list-style-type: none"> Appropriate catheter insertion and maintenance. Maintaining a closed system 	<ol style="list-style-type: none"> Assessment of competency with catheter insertion and maintenance. Implementing a closed system for catheters. Implementation of a nursing driven protocol for catheter removal. Improved fidelity of electronic documentation of catheters. Implementation of preservative tubes for specimen collection. Periodic maintenance audits of catheters. 	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter-days of 3 to post-intervention rate of 1.9.
Nealon S and others (2018) (30)	USA; a surgical specialty unit in an 802-bed teaching hospital; surgical specialists and nurses	Pre-post test	<ol style="list-style-type: none"> Appropriate use of catheter. Timely removal of catheter. 	<ol style="list-style-type: none"> Implementation of the PURCE protocol involving: surgeon deciding in the OR whether catheter is needed and if it is required that it is placed in the OR with a defied time period (less than 48 hours or more than 48 hours); in the case of longer duration a yellow band is placed around the drainage tubing to indicate to nurses what to do and a written order is completed; after patient transferred to SSU nurses responsible for identification for the need of catheters and a yellow band; nurses required to remove all catheters without yellow order between 4am and 7am. Surgical safety checklist modified to include the news steps and posted in each, OR SSU daily audits conducted including possible protocol deviations and patient census; these communicated by 	CAUTI rate	Decrease from pre-intervention rate of 4.29 to post-intervention rate of 1.31.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				the nursing staff to the Infection Prevention Team daily at midnight.		
Pashnik B and others (2017) (31)	USA; inpatient, emergency, procedural and surgical areas of a teaching facility; nurses and nursing assistants	Pre-post test	<ol style="list-style-type: none"> 1. Avoidance of catheters. 2. Appropriate insertion and maintenance of catheters. 3. Appropriate removal of catheters. 	<ol style="list-style-type: none"> 1. Educational intervention emphasising CAUTI prevention as a team effort. 2. Educational intervention including a) online computer-based learning modules completed independently and b) 2 hour CAUTI prevention competency validation session focusing on utilisation of competency of assessment checklists, facility equipment and hands-on demonstration. 3. Employment of staff nurses to provide peer education and competency validation to highlight the value of nurses evaluating and influencing clinical practice. 4. Implementing practice of 2 nurses inserting catheter. 5. Learners objectives including: <ol style="list-style-type: none"> a. describing CAUTI prevention components b. demonstrating catheter insertion and removal techniques c. demonstrating proper urine specimen collection techniques d. demonstrating correct bladder scanner procedure 6. Learners going through 6 competency stations: insertion, care and maintenance of catheter; specimen collection, daily weights, use of bladder scanners and electronic documentation; and patient education. 7. CAUTI nurse champions validating peers' knowledge and competency focusing on avoidance of catheters, strict asepsis, catheter care, patient education and interdisciplinary education. 8. CAUTI champions completing 2 hour educational training verifying their competency in CAUTI prevention; these champions then trained their peers, manned the competency stations and validated peers knowledge of the CAUTI bundle. 	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter-days of 1.3 to post-intervention rate of 0.91 (30% reduction).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
Purvis S and others (2014) (32)	USA; academic medical centre; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter removal. 	<ol style="list-style-type: none"> 1. Modification of existing protocols regarding catheter removal, and indications for straight catheterisation to make them easy to use. 2. Protocols discussed with lead surgeon and hospitalist to secure their approvals for changes. 3. Lead surgeon and hospitalist physician discussing protocols with other medical providers to ensure agreement and to educate on writing orders. 4. Standardisation of protocols to ensure consistent approach among nurses. 5. Protocols linked to the clinician order on the electronic health records. 6. Catheter order formatted to automatically default to the new protocol; de-selection requiring a medical justification. 7. All patients with catheters and on bladder management protocol highlighted by a different icon in the electronic health records. 8. Each unit having CAUTI champion; the initiative endorsed by the Nursing Executive Council. 9. Education of all CAUTI champions (3 hour workshop). 10. Creation of a CAUTI toolbox on the hospital intranet including educational material. 11. Daily rounds by the CAUTI champions helping nursing staff to evaluate the necessity for catheter use. 12. Infection control practitioners providing regular updates on catheter use and CAUTI; rates added to each unit's scorecard. 	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 4.2 to post-intervention rate of 3.5 (year 1) and 2.4 (year 2).
Purvis S and others (2016) (33)	USA; a 592-bed academic tertiary medical centre; nursing and medical staff	Pre-post test	<ol style="list-style-type: none"> 1. Prevention of CAUTI. 	<ol style="list-style-type: none"> 1. Implementation of a hospital leadership walking rounds to discuss CAUTI prevention with front-line staff, analyse next steps, identify successes and areas for improvement and determine whether previous interventions were implemented. 2. Content of the rounds determined by the Associate Chief Medical Officer and Associate Chief Nursing Office. 	Incidence of CAUTI; CAUTI rate per 100 catheter-days;	<p>Decrease from pre-intervention incidence of CAUTI of 86 to post-intervention incidence of 30.</p> <p>Decrease from pre-intervention CAUTI rate per 1,000 catheter-days of 3.1 to post-intervention rate of 1.4.</p>

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 3. Rounds and interdisciplinary team meetings taking place on a daily basis: various staff invited to the rounds together with leaders. 4. Rounds involving sharing of data regarding current performance and the 12-month trend. 5. Identifying staff groups or individuals needing further support. 6. Support from chair of each department to ensure compliance with protocols. 		
Rhee Ch and others (2016) (35)	USA; academic medical centre; nurses and physicians	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter removal. 	<ol style="list-style-type: none"> 1. Brainstorming sessions with front line staff in order to choose interventions readily accepted. 2. Development of a streamlined policy with indications for insertion, continuation and removal of catheter. 3. Development of a decision tree for staff to use as a decision aid for when to insert a catheter and when to refer to a urologist group. 4. Standardisation of catheters across hospitals. 5. Making the process of bulk ordering of nonstandard equipment more difficult. 6. Creation of exceptions when catheter might be needed. 7. Education of staff on the new policy and decision tree. 8. Design of the electronic health records to embed the documentation and the clinical decision support system with indications for insertion, continuation and discontinuation of catheters; this forced staff to assess the indications for catheter on a daily basis. 9. Elimination of unnecessary fields in the electronic health records and simplification of documentation. 10. Allowing nurses to remove catheters when there was no indication for the catheter allowing nurses and physicians to work within guidelines. 11. Trained observers verifying catheter practices and bundle compliance before and after training videos 	Incidence of CAUTI;	Decrease from pre-intervention CAUTI incidence of 135 to 74 (year 1), 59 (year 2) and 25 (year 3).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
Rhone C and others (2017) (36)	USA; Emergency Department in a private general hospital; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter insertion technique. 	<ol style="list-style-type: none"> 1. Insertion of catheter requiring 2 licensed personnel involving a safety time-out consisting of a pause before inserting the indwelling urinary catheter to confirm catheter appropriateness and review of the proper steps for insertion; catheter inserted by one person while the other responsible for assuring compliance with proper aseptic technique. 2. Engagement of staff by presentations on the scope of CAUTIs, including the implications to both patients and to the health care system as a whole, from a local (hospital) and a national perspective. 3. Education of staff by outlining the new process in ED staff education sessions, as well as through handouts, emails, and during shift change huddles. 4. Introduction of checklist for following proper aseptic technique and reminders of the intent of the project. 5. Compliance rates monitored and analysis of improvements conducted; staff informed of compliance rates and progress of the project by weekly email updates and periodically in daily huddles. 6. Motivating staff to action in order to deliver the highest quality of care to patients. 7. Staff accountability encouraged by having the staff sign the checklist used in the new process. 8. Timely feedback of data to frontline staff to show whether the goal was being met. 9. Feedback from weekly PDSA rapid cycles and constant reinforcement that all insertions must involve 2 personnel. 10. Agreement amongst the staff and leadership to keep patients safe and deliver high quality care. 11. Exemplified by explaining the initiative clearly to each patient and their family and allowing for any questions. 	Incidence of CAUTI; CAUTI rate per 1,000 catheter-days	<p>Decrease from pre-intervention incidence rate of 10 to post-intervention incidence rate of 2 and 3 (year 1 and 2).</p> <p>Decrease from pre-intervention CAUTI rate per 1,000 catheter-days of 6.9 to post-intervention rate of 1.7 (p=0.05); and 1.6 (p,0.01).</p>
Richards B and others (2017) (37)	USA; an 18-bed ICU unit in a teaching hospital;	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter insertion. 3. Timely catheter removal. 	<ol style="list-style-type: none"> 1. Creation of 'CAUTI Arrest Team' (nurse champions) responsible for implementing the intervention (name to reinforce the seriousness of the problem). 2. Nurse champions offering reassurance to staff nurses and addressing their concerns about deficits in care. 	Incidence of CAUTI; Standardised Infection Ratio (SIR)	Decrease from pre-intervention incidence rate of 40 and 38 (2-year period) to post-intervention rate of 15.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
	nurses		4. Appropriate catheter maintenance	<ul style="list-style-type: none"> 3. Education on importance of daily measurement of body weight to estimate fluid imbalance. 4. Nurse champions acknowledging that transition to catheter-free care as difficult and offering support. 5. Nurses reassured about no individual penalties for occurrences of CAUTI. 6. Introduction of the programme to staff during 'go-live' staff breakfast. 7. Daily chart audits conducted by charge nurses with help from CAUTI arrest team. 8. Review of electronic records for all catheterised patients for current physician orders. 9. Chart audits to check for documentation of perineal and catheter care and daily assessment of catheter. 10. Implementation of an 'auto-stop' feature for catheters after 3 days. 11. Root-case analysis performed for every incidence of CAUTI by CAUTI arrest team with help from infection control nurse. 12. Education of staff nurses about best practices. 13. Review of CAUTI incidences during staff meetings. 14. In-service education about proper insertion techniques including observation of and assistance with insertions. 15. Education to staff in operation theatre (also including observation and training). 16. Purchase of incontinence products and new stool diversion products to replace traditional catheters (with education about it). 17. Increased supply to barrier protection products and staff education about it. 18. Weekly audits identified nurses compliant with interventions - nurses rewarded with gift cards. 19. Non-compliant nurses provided privately with education but not singled out or penalised. 		Decrease from pre-intervention SIR of 2.02 (95% CI, 1.456 to 2.775) and 2.34 (95% CI, 1.522 to 3.312) to post-intervention of 1 (Ci 95%, 0.685-1.900); p<0.05, CI 95%, 0.271 to 0.902.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
Saint and others (2016) (38)	USA and Puerto Rico; 926 inpatient units in 603 inpatient units (ICU and non-ICU); all staff	Pre-post test	<ol style="list-style-type: none"> 1. Review of catheter use. 2. Avoidance of catheter use. 3. Appropriate aseptic technique. 4. Appropriate catheter maintenance. 	<p>National Comprehensive Unit-based Safety programme:</p> <ol style="list-style-type: none"> 1. Conducting a daily assessment of the presence and necessity of an indwelling catheters. 2. Promoting the use of condom catheters, bladder scanners; Intermittent straight catheterization, and accurate measurement of daily weight (all in lieu of indwelling urinary catheters). 3. Providing feedback to the unit's nurses and physicians on catheter use and CAUTI rates. 4. Providing training about any identified gaps in knowledge (tailored training) on urinary management processes (that is, proper insertion and maintenance using a variety of methods including bedside and electronic (nurses), formal presentations and meetings with one-to-one- discussions for physicians with high use. 5. Tools, manuals and checklists provided to help implement the programme. 6. Education on the prevention of CAUTIs provided through in-person meetings and webinars (3 over the course of the programme); and coaching calls (on a monthly basis) to provide education, to review data trends, discuss unit specific issues and share best practice. 7. Emphasising the importance of aseptic technique and proper maintenance. <p>All programmes were customised to each site.</p>	Reduction in CAUTI rates; CAUTI rate per 1,000 catheter days	CAUTI rate decrease by 22.3%. Decrease from pre-intervention CAUTI rate per 1,000 catheter-days of 2.4 to post-intervention rate of 2.05 (incidence rate ratio, 0.86; 95% CI, 0.76 to 0.96; p=0.009).
Sampathukamar P and others (2016) (39)	USA; a 213-bed ICU in an academic medical centre; nurses and physicians	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter insertion. 3. Appropriate order of urine culture. 4. Appropriate use of bladder scanners. 	<ol style="list-style-type: none"> 1. Creation of '6 Cs' to make the bundle easy to remember. 2. Staff encouraged to consider alternatives to catheters each day. 3. Staff educated on how to select a securement device. 4. Staff re-educated on the importance of perineal care. 5. Some units creating bath kits. 6. Nursing staff reminded about the need to use for catheter system only when medically necessary. 7. Physicians, nurses and urology staff educated on the use of bladder scanner. 	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 2 to post-intervention rate of 0.6 (70% decrease).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 8. Team creating indications for obtaining urine culture, gaining buy-in from physician leaders and creating educational PowerPoint distributed to all physicians. 9. Indications for urine culture ordering added to the electronic health records; indications also reiterated to nurses; cards with indications available on all the units. 10. Nurses handing out card with urine culture indications to trainees when inappropriate cultures ordered. 11. Standardisation of documentation of catheter or perineal care. 12. Implementation of a protocol for ordering bladder scans. 13. Staff having to select from a list of appropriate indications for urine culture when placing an order. 14. CAUTI bundle described and promoted via print, video and online learning. 15. The campaign's style and colour scheme repeated throughout each educational component to reinforce the education. 16. Video with CAUTI champion providing education, able to detect deviation from best practice and offer ways to correct the defect. 17. Mandatory education of all ICU physicians and all trainees through a PowerPoint presentation; additional in-person CAUTI education at staff meetings. 18. A toolkit collating all the resources posted on the Infection Prevention and Control (IPAC) website. 		
Scanlon and others (2017) (40)	USA; a 814-bed teaching hospital; nurses, hospital physicians and support staff (patient care assistants, technicians, physical therapists, and patient transporters)	Pre-post test	<ol style="list-style-type: none"> 1. Early removal of catheter. 2. Prevention of re-insertion. 3. Appropriate maintenance and insertion technique. 	<ol style="list-style-type: none"> 1. Identification and development of CAUTI ambassadors; each ambassador completing education and validation on insertion techniques with demonstration on mannequins; additional instruction on perineal care, maintenance of drainage bags, securing catheter and validating staff on new protocols. 2. Education of CAUTI ambassadors and staff on best practice insertion and maintenance guidelines. 3. Implementation of a nurse-driven straight catheterisation algorithm card. 	Incidence of CAUTI	Decrease in CAUTI incidence by 46% at 12 months and 89% at 18 months.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<p>4. Interdisciplinary rounds on all patients with catheters in real time to discuss catheter status, opportunities for removal and learning opportunities.</p> <p>5. Education of supportive staff including patient care assistants, technicians, physical therapists and patient transporters on best practice catheter maintenance</p> <p>Guidance</p> <p>6. Educational program for hospital physicians, advanced practice providers, nursing leadership and staff to address CAUTI best practice standards.</p> <p>7. Monthly analysis and evaluation of every CAUTI case to identify opportunities for improvement; data presented at nursing leadership, quality, and unit-level meetings in a non-threatening environment.</p> <p>8. Implementation of CAUTI acronym (C - cause or indication; A - assess for necessity; U - utilise infection prevention measures; T - teach patient and family; I - informatics).</p> <p>9. Purchase of bladder scanners to support implementation of to support nurse to use the algorithm and communicate their findings to provider about patient's plan of care.</p> <p>10. Support from senior leadership to implement emerging best practice from staff.</p> <p>11. Consistent access to best practice products assured by supplies service.</p> <p>12. Implementation of catheter protocol.</p>		
Sutherland T and others (2015) (41)	USA; tertiary medical centre; nurses and physicians	Pre-post test	<p>1. Appropriate catheter use.</p> <p>2. Appropriate catheter removal.</p>	<p>1. Measuring catheter use and CAUTI rates for the hospital and later on the individual unit basis; the results recorded and distributed to task force leaders.</p> <p>2. Education program for providers.</p> <p>3. Implementation of new electronic order set with a decision support.</p> <p>4. Provision of daily reminders for catheter removal.</p> <p>5. Revision of CAUTI guidelines and instructions.</p>	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 5.4 to post intervention rate of 1.5 (year 1).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
Ternavasio and others (2016) (42)	Spain; internal medicine department in a university hospital; medical staff, nursing staff and nursing assistants	Pre-post test;	<ol style="list-style-type: none"> 1. Appropriate use of catheter. 2. Appropriate catheter placement, maintenance and timely removal. 	<ol style="list-style-type: none"> 1. Training sessions for the medical staff, nursing staff and nursing assistants on the use of catheters; these sessions included: dissemination of the results obtained during pre-intervention phase; adequate and inadequate indications for the use of UCs; appropriate techniques for placement, maintenance, and timely removal of catheters; and information on the study protocol and the implementation of record-keeping and reminder systems to be implemented during the intervention stage. 2. Daily observation of patients with catheters. 3. Placement of reminder of catheter presence in the patient's progress and treatment record. 4. Campaign for health care staff with posters and leaflets on ways to optimise the use of catheters and other recommendations. 5. Feedback of the results through meetings and report. 	Risk of CAUTI; CAUTI rate per 1,000 patients	<p>Decrease in risk of CAUTI (RR: 0.53; 95% CI: 0.30-0.93); p<0.0001.</p> <p>Decrease of CAUTI rate per 1,000 patients (RI: 0.52; 95% CI: 0.28-0.94); p= 0.028.</p>
Thomas K. (2016) (43)	USA; cardiac intensive care and step-down unit in a 536-bed teaching hospital	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter insertion. 3. Appropriate catheter maintenance. 	<ol style="list-style-type: none"> 1. Skills fair to educate nurses about insertion technique, proper care and indications for catheter use. 2. Development of nursing round sheet for catheter tracking; nursing rounds taking place 3 times daily. 3. Feedback to staff and patients summarising the number of CAUTIs and indwelling catheter days; data also shared at monthly staff meetings. 	Median number of CAUTIs; CAUTI rate	<p>Decrease from pre-intervention median number of CAUTIs of 2 to post-intervention of 0 (p=0.009).</p> <p>Decrease from pre-intervention CAUTI rate of 10.31 to post intervention of 0 (p=0.005).</p>
Tuttle J (2017) (44)	USA; two ICU units in a 600-bed tertiary care hospital; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Timely catheter removal by nurses. 	<ol style="list-style-type: none"> 1. Implementation of a nursing driven protocol; nurses empowered to use this tool. 2. Education to nurses via emails, posters on the unit and discussions about appropriate indications for catheter during bedside conversations using audit tool. 3. Daily questioning of the need for patient catheter during audit led by unit manager, nurse champion and bedside nurse. 4. CAUTI prevention lecture delivered by chief nursing officer. 5. Education of physicians who ordered catheters. 6. Additional questions in the audit tool enabling tracking catheter orders. 	Incidence of CAUTI	Decrease from pre-intervention CAUTI incidence from 19 to 10 in year 2 to 3, and 3 in year 4.

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ul style="list-style-type: none"> 7. Education and discussions with other departments (ED and surgery) about CAUTI reduction strategies and ensuring standardised use of products. 8. Monthly CAUTI team meetings to review data, opportunities for improvement and conduct root cause analysis; these findings shared in staff meetings, newsletters and quality bulletin boards. 9. Celebration of zero CAUTI at the unit. 10. Tokens given to staff removing catheters which could be exchanged for snacks in the cafeteria. 11. Provision of alternative to catheter products. 12. Showing evidence to nurses that incontinence not leading to negative patient outcomes. 13. Clear guidelines on severely ill patients. 14. Daily conversation with nurses and surgeons at the bedside in order to remove catheter. 		
Tyson and others (2018) (45)	USA; 29-bed Surgical Trauma ICU; nurses, health care technicians	Pre-post test	1. Appropriate catheter removal.	<ul style="list-style-type: none"> 1. Unit and nursing ownership of the urinary catheter protocol achieved by implementation of twice-daily CAUTI rounds during which each patient with catheter was evaluated. 2. Feedback given by peers through the auditing process where opportunities for earlier catheter removal were noted; audit results presented monthly to facility leaders to aid with accountability. 3. Nurses and physicians education on urine culture stewardship. 4. Adoption of grey top preservative-containing collection tubes for urine cultures to prevent bacterial overgrowth in the sample. 	CAUTI rate per 1,000 catheter-days; Incidence of CAUTI	<p>Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 5.1 to post-intervention rate of 2.0 (p,0.01; RR: 0.38, 95% CI: 0.21 to 0.65).</p> <p>Decrease from 59 CAUTIs in pre-intervention to 16 in the post-intervention.</p>
Umer A and others (2016) (46)	USA; hospital; physicians	Pre-post test	<ul style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter insertion. 	<ul style="list-style-type: none"> 1. Implementation of a catheter protocol. 	CAUTI rate	Decrease from pre-intervention CAUTI rate of 2.6% to post-intervention rate of 1.5% (p<0.05).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
Quinn P (2016) (34)	USA; hospital; nurses and physicians		<ol style="list-style-type: none"> 1. Appropriate use of catheters. 2. Removal of unnecessary catheters. 	<ol style="list-style-type: none"> 1. Implementation of 'Question the Foley' – a framework to assess the need for a catheter use by nurses complemented by an algorithm for specific patient circumstances. 2. Daily assessment of catheter done during day shift. 3. Chief medical officer approving the plan and being a liaison between nursing and medical staff (for physicians who were not willing to comply with the process). 4. Chief of infectious diseases becoming a physician champion – this involved educating physicians about the need to reduce CAUTI; also review of medical. 5. Design of nurses' documentation, including the criteria for catheter use, in electronic records. 6. Nurses having access to customised report showing list of all patients with catheters – used for tracking patients on a daily basis. 7. Design of physician documentation and ordering to reflect the nurses' criteria. 8. Reminder message for physicians after 48 hours (and then every 24 hours) to review the catheter use. 9. Targeted education for nurses including large and small group sessions or daily briefing sessions. These included: <ol style="list-style-type: none"> a. identifying patients with a catheter on the unit and reviewing key strategies for CAUTI reduction b. reports on high incidence of CAUTI across hospital c. case presentations including role plays for nurses 10. Physicians were provided information about the programme, including reasons for it and what was expected from them, via email and meetings. 11. Daily monitoring of documentation- in case of missing documentation emails sent to nursing manager and the nurse counselled. 12. Report of suspected CAUTIs with tracking when and where the infection was contracted. Each nurse involved in care of that patient sent a letter from the director of 	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 4.9 to post-intervention rate of 3.9 (year 1), and 0.2 (year 5).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<p>nursing informing them that the patient contracted an infection and inviting her to a root analysis meeting. During the meeting each nurse encouraged to identify barriers in or breaks to the prevention initiative.</p> <p>13. Use of silver alloy catheters, implementing the use of securing devices and adherence to proper drainage tube placement.</p> <p>14. Educational sessions in large and small group formats including opportunities for staff to identify patients with catheters and review one or 2 strategies for CAUTI reduction; information about high incidence of CAUTI in the hospital and presentations demonstrating the process of assessing patients, role playing a conversation between a nurse and a physician.</p> <p>15. Nurse able to speak to physician if uncertain whether to remove protocol.</p> <p>16. Daily assessment of catheter done during day shift to eliminate the phone calls to physicians during off hours.</p>		
Youngerman and others (2018) (47)	USA; a 2,600-bed academic medical centre; nurses and physicians	Pre-post test	<ol style="list-style-type: none"> Appropriate placement of catheters. Timely removal of catheters. 	<ol style="list-style-type: none"> Training initiative led by the representatives from nurse management and hospital epidemiology to reinforce best practices for proper placement and maintenance of catheters according to guidelines. Custom module build in electronic records requiring nurses to document the presence and maintenance of catheter every 12 hours; catheter order or nurse opening an electronic flowsheet to document urinary output triggered the module. Implementation of real-time electronic tracking of catheters for clinicians (as an optional checklist tool); clinicians able to update the status of each catheter from a drop-down menu with the options: 'maintain', 'already removed' and 'remove today'. In later phase, the real time electronic tracker becoming a triggered pop-up reminder that needed to be viewed and assessed by a clinician daily; the pop-up was linked to the initiation of a daily progress notes; clinicians not able to complete daily progress note until they have updated the catheter status. 	CAUTI rate per 10,000 patient days; CAUTI rate per 1,000 catheter days	<p>Decrease from phase 1 intervention in CAUTI rate per 10 000 patients of 9.06 to post-intervention rate of 1.65 (phase 4); overall decline of 88%.</p> <p>Decrease from phase 1 intervention in CAUTI rate per 1,000 catheter days of 4.67 to post-intervention of 1.17 (phase 4) overall decline 74.8%.</p>

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 5. Catheter order expiring triggering catheter removal by nurses or the need for obtaining a renewal order from physician. 6. Implementation of a new catheter order requiring clinicians to consider catheter alternatives and to select appropriate criteria for catheter placement; clinicians were guided by the branch logic to navigate their decision making process. 		
Zubkoff L and others (2016) (48)	USA; 18 Veteran Health Administration facilities nationwide; all staff	Pre-post test	<ol style="list-style-type: none"> 1. Avoiding catheter use. 2. Appropriate catheter use. 3. Appropriate insertion technique. 4. Appropriate catheter maintenance. 5. Timely removal of catheter. 	<ol style="list-style-type: none"> 1. Implementation of CAUTI bundle focusing on avoiding catheter use; appropriate catheter use; appropriate insertion technique; appropriate catheter maintenance and timely removal of catheter. 2. Education of staff via phone, web-based or email on topics including key elements of the bundle, data collection and documentation, lessons learned and best practices, patient engagement and education and barriers to implementing evidence-based intervention. 3. Teams requiring submission of a senior leader progress report that included overall aims of the project, specific changes implemented during the month and measures of outcome and process being tracked. 4. Team cohorts assigned Implementation Coach (quality improvement knowledge) and Clinical Coach (expertise in preventing CAUTI); coaches conducting small-group calls monthly in order to share the completed work and review senior leaders reports, share feedback how to eliminate barriers; feedback from coaches sent to the entire team, including senior leaders. 	CAUTI rate per 1,000 catheter-days	Decrease from pre-intervention CAUTI rate per 1,000 catheter days of 2.37 to post-intervention rate of 1.06 (p<0.01).
Zurmehly J (2017) (49)	USA; long-term acute care hospitals; nurses and physicians	Pre-post test	<ol style="list-style-type: none"> 1. Appropriate catheter use. 2. Appropriate catheter maintenance. 3. Timely removal of catheter. 4. Appropriate post-removal assessment. 	<ol style="list-style-type: none"> 1. Implementation of nurse-driven urinary catheter protocol helping nurses to determine the need for the catheter and help with next steps. 2. Education of nurses about the protocol using emails and posters placed in the break area, monthly meetings. 3. Nurses completing pre-intervention knowledge questionnaire with feedback received during staff meetings and weekly emails. 	Incidence of CAUTI; CAUTI rates per 1,000 catheter-days	Decrease from pre-intervention CAUTI incidence of 13 to post-intervention of 3 (77%); p<0.03. Decrease from pre-intervention CAUTI rate per 1,000 catheter-days from 4.82 to post-intervention rate of 1.24 (74%).

Reference	Country; Target group; Setting	Study design	Target behaviour	Intervention	Outcome	Effectiveness
				<ol style="list-style-type: none"> 4. Reminders for nurses in the electronic health records every 12 hours to determine whether criteria for catheter use still met. 5. Education of nurses using online self-study module; unit manager responsible for staff education and administrative support of implementation. 6. System-wide mandatory sessions for all nurses; weekly emails sent until education completed. 7. Study materials also available in education centre. 8. Nurses receiving quick reference pocket guide including CAUTI epidemiology, risk factors, definitions, strategies to reduce CAUTI and the new protocol. 		

References

13. Bell MM, Alaestante G, Finch C. 'A multidisciplinary intervention to prevent catheter-associated urinary tract infections using education, continuum of care, and systemwide buy-in.' *The Ochsner Journal* 2016: volume 16, issue 1, pages 96-100
14. Carr AN, Lacambra VW, Naessens JM, Monteau RE, Park SH. 'CAUTI prevention: Streaming quality care in a progressive care unit.' *MedSurg Nursing* 2017: volume 26, issue 5, pages 306-310
15. Cartwright A. 'Reducing catheter-associated urinary tract infections: standardising practice.' *British Journal of Nursing* 2018: volume 27, issue 1, pages 7-12
16. Cho HJ, Khalil S, Poeran J, Mazumdar M, Bravo N, Wallach F and others. "Lose the Tube": A choosing wisely initiative to reduce catheter-associated urinary tract infections in hospitalist-led inpatient units.' *American Journal of Infection Control* 2017: volume 45, issue 3, pages 333-335
17. Davies PE, Daley MJ, Hecht J, Hobbs A, Burger C, Watkins L and others. 'Effectiveness of a bundled approach to reduce urinary catheters and infection rates in trauma patients.' *American Journal of Infection Control* 2018: volume 46, issue 7, pages 758-63
18. Dawson CH, Gallo M, Pevc K. 'TWOC around the clock: a multimodal approach to improving catheter care.' *Journal of Infection Prevention* 2017: volume 18, issue 2, pages 57-64
19. Dy S, Major-Joynes B, Pegues D, Bradway C. 'A nurse-driven protocol for removal of indwelling urinary catheters across a multi-hospital academic healthcare system.' *Urologic Nursing* 2016: volume 36, issue 5, page 243
20. Halperin JJ, Moran S, Prasek D, Richards A, Ruggiero C, Maund C. 'Reducing hospital-acquired infections among the neurologically critically ill.' *Neurocritical care* 2016: volume 25, issue 2, pages 170-177
21. Johnson P, Gilman A, Lintner A, Buckner E. 'Nurse-driven catheter-associated urinary tract infection reduction process and protocol: Development through an academic-practice partnership.' *Critical Care Nursing Quarterly* 2016: volume 39, issue 4, pages 352-362
22. Kachare SD, Sanders C, Myatt K, Fitzgerald TL, Zervos EE. 'Toward eliminating catheter-associated urinary tract infections in an academic health center.' *Journal of Surgical Research* 2014: volume 192, issue 2, pages 280-285
23. Maxwell M. 'Changing ICU culture to reduce catheter-associated urinary tract infections.' *Canadian Journal of Infection Control* 2018: volume 336, pages 39-43
24. McCalla S, Reilly M, Thomas R, McSpedon-Rai D, McMahon LA, Palumbo M. 'An automated hand hygiene compliance system is associated with decreased rates of health care-associated infections.' *American Journal of Infection Control* 2018: volume 46, issue 12, pages 1,381-1,386
25. Miller K, Briody C, Casey D, Kane JK, Mitchell D, Patel B and others. 'Using the comprehensive unit-based safety program model for sustained reduction in hospital

- infections.' American Journal of Infection Control 2016: volume 44, issue 9, pages 969-976
26. Mody L, Greene MT, Meddings J, Krein SL, McNamara SE, Trautner BW and others. 'A national implementation project to prevent catheter-associated urinary tract infection in nursing home residents.' JAMA Internal Medicine 2017: volume 177, issue 8, pages 1,154-1,162
 27. Mody L, Krein SL, Saint S, Min LC, Montoya A, Lansing B and others. 'A targeted infection prevention intervention in nursing home residents with indwelling devices: a randomized clinical trial.' JAMA Internal Medicine 2015: volume 175, issue 5, pages 714-723
 28. Mori C. 'Avoiding catastrophe: implementing a nurse-driven protocol.' Medsurg Nursing: official journal of the Academy of Medical-Surgical Nurses 2014: volume 23, issue 1, pages 15-21, 8
 29. Mullin KM, Kovacs CS, Fatica C, Einloth C, Neuner EA, Guzman JA and others. 'A multifaceted approach to reduction of catheter-associated urinary tract infections in the intensive care unit with an emphasis on "Stewardship of Culturing".' Infection Control and Hospital Epidemiology 2017: volume 38, issue 2, pages 186-188
 30. Nealon SW, Hale AL, Haynes E, Hagood-Thompson C, Marguet CG, Ewing JA and others. 'Improving patient outcomes and health care provider communication with a small, yellow plastic band: the Patient URinary Catheter Extraction (PURCE) Protocol©.' Urology Practice 2018: volume 5, issue 1, pages 1-6
 31. Pashnik B, Creta A, Alberti L. 'Effectiveness of a nurse-led initiative, peer-to-peer teaching, on organizational CAUTI rates and related costs.' Journal of Nursing Care Quality 2017: volume 32, issue 4, pages 324-330
 32. Purvis S, Gion T, Kennedy G, Rees S, Safdar N, VanDenBergh S and others. 'Catheter-associated urinary tract infection: a successful prevention effort employing a multipronged initiative at an academic medical center.' Journal of Nursing Care Quality 2014: volume 29, issue 2, pages 141-148
 33. Purvis S, Kennedy GD, Knobloch MJ, Marver A, Marx J, Rees S and others. 'Incorporation of leadership rounds in CAUTI prevention efforts.' Journal of Nursing Care Quality 2017: volume 32, issue 4, pages 318-323
 34. Quinn P. 'Chasing zero: a nurse-driven process for catheter-associated urinary tract infection reduction in a community hospital.' Nursing economic\$ 2015: volume 33, issue 6, pages 320-325
 35. Rhee C, Phelps ME, Meyer B, Reed WG. 'Viewing prevention of catheter-associated urinary tract infection as a system: using systems engineering and human factors engineering in a quality improvement project in an academic medical center.' Joint Commission Journal on Quality and Patient Safety 2016: volume 42, issue 10, pages 447-471
 36. Rhone C, Breiter Y, Benson L, Petri H, Thompson P and Murphy C. 'The impact of two-person indwelling urinary catheter insertion in the emergency department using technical and socioadaptive interventions.' Journal of Clinical Outcomes Management 2017: volume 24, issue 10

37. Richards B, Sebastian B, Sullivan H, Reyes R, D'Agostino JF, Hagerty T. 'Decreasing catheter-associated urinary tract infections in the neurological intensive care unit: One unit's success.' *Critical Care Nurse* 2017: volume 37, issue 3, pages 42-48
38. Saint S, Greene MT, Krein SL, Rogers MAM, Ratz D, Fowler KE and others. 'A program to prevent catheter-associated urinary tract infection in acute care.' *New England Journal of Medicine* 2016: volume 374, issue 22, pages 2,111-2,119
39. Sampathkumar P, Barth JW, Johnson M, Marosek N, Johnson M, Worden W and others. 'Mayo Clinic reduces catheter-associated urinary tract infections through a bundled 6-c approach.' *Joint Commission Journal on Quality and Patient Safety* 2016: volume 42, issue 6, pages 254-261
40. Scanlon K, Wells C, Woolforde L, Khameraj A and Baumgarten J. 'Saving lives and reducing harm: a CAUTI reduction program.' *Nursing Economic\$* 2017: volume 35, issue 3, pages 134-141
41. Sutherland T, Beloff J, McGrath C, Liu X, Pimentel MT, Kachalia A and others. 'A single-center multidisciplinary initiative to reduce catheter-associated urinary tract infection rates: quality and financial implications.' *The Health Care Manager* 2015: volume 34, issue 3, pages 218-124
42. Ternavasio-de la Vega HG, Barbosa Ventura A, Castaño-Romero F, Sauchelli FD, Prolo Acosta A, Rodríguez Alcázar FJ and others. 'Assessment of a multi-modal intervention for the prevention of catheter-associated urinary tract infections.' *Journal of Hospital Infection* 2016: volume 94, issue 2, pages 175-181
43. Thomas KL. 'Reduction of catheter-associated urinary tract infections through the use of an evidence-based nursing algorithm and the implementation of shift nursing rounds: a quality improvement project.' *Journal of Wound, Ostomy and Continence Nursing: official publication of The Wound, Ostomy and Continence Nurses Society* 2016: volume 43, issue 2, pages 183-187
44. Tuttle JC. 'Cutting CAUTIs in critical care.' *Journal of Clinical Management Outcomes* 2017: pages 267-72
45. Tyson AF, Campbell EF, Spangler LR, Ross SW, Reinke CE, Passaretti CL and others. 'Implementation of a nurse-driven protocol for catheter removal to decrease catheter-associated urinary tract infection rate in a surgical trauma ICU.' *Journal of Intensive Care Medicine* 2018: 885066618781304
46. Umer A, Shapiro DS, Hughes C, Ross-Richardson C, Ellner S. 'The use of an indwelling catheter protocol to reduce rates of postoperative urinary tract infections.' *Connecticut Medicine* 2016: volume 80, issue 4, pages 197-203
47. Youngerman BE, Salmasian H, Carter EJ, Loftus ML, Perotte R, Ross BG and others. 'Reducing indwelling urinary catheter use through staged introduction of electronic clinical decision support in a multicenter hospital system.' *Infection Control and Hospital Epidemiology* 2018: volume 39, issue 8, pages 902-908
48. Zubkoff L, Neily J, Quigley P, Soncrant C, Young-Xu Y, Boar S and others. 'Virtual breakthrough series, part 2: Improving fall prevention practices in the veterans health

- administration.' Joint Commission journal on quality and patient safety 2016: volume 42, issue 11, page 497-ap12
49. Zurmehly J. 'Implementing a nurse-driven protocol to reduce catheter-associated urinary tract infections in a long-term acute care hospital.' Journal of Continuing Education in Nursing 2018: volume 49, issue 8, pages 372-377