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Reducing catheter-associated urinary tract infection in high dependency unit: an eighteen-month quality improvement intervention study period

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SUMMARY

Background: The urinary catheter usually leads to a catheter-associated urinary tract infection (CAUTI) contributing to further morbidity and mortality. There is very limited data on the CAUTI incidence rate in high-dependency units (HDUs) in the Kingdom of Saudi Arabia. The institutional CAUTI incidence rate in HDU was six times higher compared to the United States National Healthcare Safety Network (US–NHSN) in 2021.

Objective: To reduce 50% CAUTI incidence rate by the end of 2022.

Method: A prospective study was conducted in tertiary HDU from January 2022 to June 2023. A gap analysis was assessed between the hospital practices and the Society Healthcare Epidemiology of America/Infectious Diseases Society of America (SHEA/IDSA) basic recommendations. The Kotter and Rathgebers' changing behavior model was applied at the beginning of the project. Formal education and prevention of CAUTI were applied using the National Strategy Model. Surveillance and statistical data analysis were carried out using US–NHSN guidelines.

Results: The overall CAUTI incidence rate declined from 7.07- to 3.57/1000 urinary catheter days despite of significant increase in the utilization ratio from 0.79 to 0.94 (P value 0.0001). The compliance rate of the bundle CAUTI prevention was improved and sustained above 90%. A CAUTI incidence rate reduction was observed following the combination of the changing behavior and SHEA/IDSA of CAUTI prevention models over 18 months.

Conclusion: We assumed the combination of the changing behavior and the prevention models for a long period is useful in reducing the CAUTI incidence rate and possibly applied to reduce other healthcare-associated infections.

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Background

Patients may acquire an infection during hospitalization through medical instruments for patient care. The urinary catheter is indicated for patients with acute urinary retention, obstruction, perioperative applications in selected procedures, and measurement of urine output for critically ill patients [1]. However, these procedures usually lead to a catheter-associated urinary tract infection (CAUTI) contributing to further morbidity and mortality, especially in patients with long-term catheterization or severe underlying disease [2,3]. High-dependency unit (HDU), also called a step-down unit, is exclusively for patients requiring intensive monitoring and treatment, provides more extreme nursing care to the patients compared to the general ward, is considered a transition area between ICU and general ward admission, and provides non-invasive ventilation to the required patients [4]. The case definition of CAUTI is the patient should not been infected on admission or under incubation period and the patient must meet the three following criteria: 1. The patient had an indwelling urinary catheter that had been in place for more than 2 consecutive days, 2. the patient has at least one of the following signs or symptoms: fever ($>38.0^{\circ}\text{C}$), suprapubic tenderness, costovertebral angle pain or tenderness, urinary urgency, urinary frequency and dysuria, and 3. the patient has a urine culture with no more than two species of organisms identified with colony count $> 10^5/\text{ml}$. This case definition for surveillance and benchmarking is applied in all National Ministry of Health (MOH) and Gulf County Council (GCC) hospitals as well.

The CAUTI incidence rates in ICUs are estimated from 6.3- in developing countries to 3.3/1000 urinary catheter days in the United States [5].

The Institute for Health Improvement (IHI) introduced a bundle of CAUTI prevention that impacted positively in reducing CAUTIs [6,7] An interesting study introduced small tests of change in CAUTI incidence rate using Plan-Do-Check-Act (PDCA) cycle tools in one ward for 10 weeks. Despite the variation, CAUTI incidence rates are relatively low [8]. In the Kingdom of Saudi Arabia, the CAUTI incidence rates in ICUs among 15 governmental hospitals between 2018 and 2019. The overall CAUTI rate was 1.68/1000 urinary catheter days with a utilization ratio was 0.624. These data indicated that the CAUTI standardized infection ratios (SIRs) among selected governmental hospitals were 16-, 47- and 69% lower than US-NHSN, GCC, and International Nosocomial Infection Control Consortium (INICC) hospitals, respectively. Similarly, the urinary catheter SIRs were 15%

higher than NHSN hospitals, 9% higher than INICC hospitals, and 13% lower than GCC hospitals [9].

At the local level, the institute has successfully reduced the CAUTI incidence rate following the application of the Society Healthcare Epidemiology of America/Infectious Diseases Society of America (SHEA/IDSA) basic recommendations in medical and surgical wards [10]. However, no CAUTI incidence rate study has been conducted in HDUs among Governmental hospitals to date. In 2022, the institutional incidence rate of CAUTI in HDU was 7.21/1000 urinary catheter days with a utilization ratio of 0.8 indicating much higher benchmarking to US-NHSN (1.7/1000 urinary catheter days and 0.24, respectively) (data not published). In addition, most of the CAUTIs occurred following two weeks of catheter insertion assuming the bundle prevention should be monitored and implemented. Therefore, the hospital planned to reduce 50% CAUTI incidence rate in HDU by the end of 2022 by applying SHEA/IDSA basic recommendations.

Methods

Regional ethical approval was taken (Reference Number: 836) to proceed with the study at a tertiary hospital, Taif in the Kingdom of Saudi Arabia. The hospital is a tertiary referral with a 300-bed capacity serving 803,174 Taif region population [11]. A multimode intervention was considered including behavior change, applying SHEA/IDSA basic recommendations, and the PDSA cycle. We applied Kotter and Rathgeber's eight-step processes for successfully changing behavior: 1. create a sense of urgency, 2. pull together the guiding team, 3. develop the change vision and strategy, 4. communicate for understanding and buy-in, 5. empower others to act, 6. produce short-term wins, 7. don't let up and 8. create a new culture [12]. The hospital organized multi-disciplinary teamwork to improve HDU services. A vision statement has been developed to reduce 50% of the CAUTI incidence rate by the end of 2022.

Gap analysis

A gap analysis was performed to understand the variation practices between the hospital and SHEA/IDSA basic recommendation, followed by meeting challenges, and testing of changes throughout three months under the PDSA testing improvement using the timetable action plan (Table 1). The SHEA/IDSA basic recommendation for CAUTI prevention strategy was reviewed [13] and all basic recommendations were

Table 1
The first tire action plan (April to June 2022)

Item	Task force	Leader	April	May	June
1	Organize a team	HDU Link Nurse	X		
2	Practices Assessment	The team	X		
3	Formal Training and Education Program	The team	X	X	X
4	Monitoring Bundle Compliance Rate	HDU Link Nurse and Infection Preventionists	X	X	X
5	Developing Depended HDU	Hospital Director	X		
6	Reminder of Remove Unnecessary Urinary Catheter	HDU Link Nurse		X	X
7	Feedback Surveillance Reports	Infection Control Director		X	X

listed in the modified practice risk assessment form and matched with real hospital practices (3). The assessment was conducted in April 2022 by "The CAUTI Prevention Team" (CPT) members who have the knowledge and are trained with long hospital experience (Table II) (available in the supplementary).

Training and education program

The hospital introduced a multidisciplinary approach I-ACT program (Interdisciplinary Academy for Coaching and Teamwork) as noted by Wendy Nickle and colleagues [14]. A formal educational program based on the I-ACT model was organized during the month of April. The program included lectures, workshops, and competency tests for each participant. The multidisciplinary educational program was organized in weekly-based starting from the second week of April until June (Table III) (available in the supplementary).

Bundle prevention monitoring strategy

The hospital implemented the Institute for Health Improvement (IHI) bundle of CAUTI prevention including 1. avoiding unnecessary urinary catheters, 2. inserting urinary catheters using an aseptic technique, 3. maintaining urinary catheters based on recommended guidelines, and 4. reviewing urinary catheter necessity daily and removing promptly [15]. Urinary catheter maintenance includes the following: 1. closed drainage system, 2. maintaining unobstructed urine flow, 3. the collecting bag below the level of the bladder at all times, 4. the catheter and collecting tube free from kinking, 5. empty the collecting bag regularly using a separate collecting container for each patient, 6. keep the catheter properly secured to prevent movement and urethral traction, and 7. maintain patient hygiene. In addition, collection of a small sample by aspirating urine from the needleless sampling port with a sterile syringe/cannula adaptor after cleansing the port with disinfectant, and obtaining larger volumes of urine for special analyses aseptically from the drainage bag should be considered when sampling collection aseptically technique [13,16]. The formula calculation for measuring the compliance rate is "patients with urinary catheter compliant to applicable bundle components (opportunity) divided by the total number of patients with urinary catheter reviewed for that bundle component compliance (action) to time 100" [16].

Surveillance and feedback to relevant stakeholders

The CAUTI incidence rate formula is "the number of CAUTIs for a location divided by The number of urinary catheter days for that location to time 1000". The urinary catheter utilization ratio is "the number of urinary catheter days for a location divided by the number of patient days for that location" [16]. The hospital CAUTI incidence rate and utilization ratio indicators in HDU were matched by the US-NHSN [17]. Following interventions, all these documents were feedback to relevant stakeholders.

PDSA cycle

PDSA was introduced to test small changes in the quality improvement project. Plan: planning the details of the test and

making predictions about the outcome, do: putting the changes in place, study: learning from comparing the predictions to the results of the test, and act: taking action based on the new knowledge [18].

Statistical analysis

Fisher Exact was used for chi-square and *P-value* calculation [19].

Results

The gap analysis scored 11 of 26 items that did not meet SHEA/IDSA basic recommendations with quality of evidence level III. The hospital organized intensive formal full-day training and education targeting all of the HDU department nurses (Table III) (available in the supplementary). Unfortunately, a competency assessment was not done to confirm the effectiveness of the educational event. The hospital developed a urinary catheter prevalence checklist including all requirements based on the recommendation (Figure 1) (available in the supplementary). Following the intervention, all recommendations and bundle prevention of CAUTI compliance rates were scored above 90% except physician compliance to the catheter indication (177/225, 78.6%). the compliance rate on urinary catheter indications was elevated from 74- to 89% during the first to the second quarter of 2022 but unfortunately declined again from 78-72% in the first quarter to the second quarter of 2023. The compliance rate on inserting urinary catheters using an aseptic technique gradually increased from 93% during the first quarter of 2022 to 97% during the second quarter of 2023. However, there was a 100% compliance rate before intervention in January and March 2022 before and after intervention in January, April, and June 2023. The maintenance urinary catheters based on recommended guidelines were not assessed before intervention. Following intervention in 2023, the hand hygiene before insertion of a catheter compliance rate was not constant. It was reported 100% on January, April, and June 2023 only. Daily maintenance review compliance rate ranged from 85-98% during the first half of 2023 (Table IV: A, B, C, and D). There was systematic surveillance and indicators based on US-NHSN definition reports and feedback to HDU regularly. The using of small catheters as possible was 100% before intervention in January 2022 and sustained periodically following intervention in January, February, March, and June 2023. However, we are not sure about the regular supply of the appropriate urinary catheter size for the patient's needs.

The CAUTI incidence rate declined 28% from 8.39- to 5.99/1000 urinary catheter days (*P* value = 0.60) with a significant increase in the utilization ratio from 0.67 to 0.92 (*P* value is less than 0.0001) during the first quarter before intervention compared to the second quarter 2022 after intervention, respectively. Similarly, the CAUTI incidence rate gradually decreased from 5.99- to 3.85/1000 urinary catheter days (*P* value = 1) with an increase in the utilization ratio from (urinary catheter days (*P* value 0.10) with a significant increase from 0.79 to 0.94 (*P* value 0.0001) during the first half of 2022 compared to the first half of 2023 (Table V: A and B, Figure 2).

Discussion

Urinary catheter is intended for many clinical purposes such as 1) perioperative use for selected surgical procedures, 2) urine

Table II
CAUTI infection prevention risk practice assessment Form

Clinical care:		Service: Invasive procedures	Procedure:
Date of first assessment:		Date of second assessment:	
Risk practice (SHEA/IDSA basic recommendations) Tick where the high-risk practice is found (X)		Suggested risk reduction method	Comments/ revised score Tick if high-risk practice remains unchanged (X)
1	Provide and implement written guidelines for catheter use, insertion, and maintenance (quality of evidence: III).		
2	Ensure that only trained, dedicated personnel insert urinary catheters (quality of evidence: III)	X	Training and education with competency testing.
3	Ensure that supplies necessary for an aseptic technique for catheter insertion are available and conveniently located (quality of evidence: III)		
4	Implement a system for documenting the following in the patient record: physician order for catheter placement, indications for catheter insertion, date and time of catheter insertion, name of the individual who inserted the catheter, nursing documentation of placement, daily presence of a catheter and maintenance care tasks, and date and time of catheter removal. Record criteria for removal and justification for continued use (quality of evidence: III)	X	Need to organize official forms for documentation.
5	Ensure that there are sufficient trained personnel and technology resources to support surveillance for catheter use and outcomes (quality of evidence: III)	X	Need to involve surveillance and feedback reports.
6	Identify the patient groups or units in which to conduct surveillance on the basis of risk assessment, considering the frequency of catheter use and potential risk (eg, types of surgery, obstetrics, critical care; quality of evidence: III)		
7	Use standardized criteria, such as NHSN definitions, to identify patients who have a CAUTI (numerator data; quality of evidence: III)	X	Need to set data collection, analysis, and indicators benchmarking to US-NHSN.
8	Collect information on catheter days and patient days (denominator data) and indications for catheter insertion for all patients in the patient groups or units being monitored (quality of evidence: III)	X	Need to set data collection, analysis, and indicators benchmarking to US-NHSN.
9	Calculate CAUTI rates and/or standardized infection ratio (Rosenthal <i>et al.</i>) for target populations (quality of evidence: III)	X	Need to set data collection, analysis, and indicators benchmarking to US-NHSN.
10	Use surveillance methods for case finding that are documented to be valid and appropriate for the institution (quality of evidence: III)	X	Need to involve surveillance and feedback reports.

11	Consider providing unit-specific feedback (quality of evidence: III)	X	Need a detailed feedback report regularly.
12	Educate healthcare personnel involved in the insertion, care, and maintenance of urinary catheters about CAUTI prevention, including alternatives to indwelling catheters, and procedures for catheter insertion, management, and removal (quality of evidence: III)	X	Training and education with competency testing.
13	Assess healthcare professional competency in catheter use, catheter care, and maintenance (quality of evidence: III)	X	Training and education with competency testing.
14	Insert urinary catheters only when necessary for patient care and leave them in place only as long as indications remain (quality of evidence: II)		
15	Consider other methods for bladder management, such as intermittent catheterization, where appropriate (quality of evidence: II)		
16	Practice hand hygiene (based on CDC or World Health Organization guidelines) immediately before insertion of the catheter and before and after any manipulation of the catheter site or apparatus (quality of evidence: III)		
17	Insert catheters following the aseptic technique and using sterile equipment (quality of evidence: III)		
18	Use sterile gloves, drape, and sponges; a sterile or antiseptic solution for cleaning the urethral meatus; and a sterile single-use packet of lubricant jelly for insertion (quality of evidence: III)		
19	Use as small a catheter as possible consistent with proper drainage, to minimize urethral trauma (quality of evidence: III)	X	Need to increase the small-size catheters.
20	Properly secure indwelling catheters after insertion to prevent movement and urethral traction (quality of evidence: III)		
21	Maintain a sterile, continuously closed drainage system (quality of evidence: III)		
22	Replace the catheter and the collecting system using an aseptic technique when breaks in the aseptic technique, disconnection, or leakage occur (quality of evidence: III)		
23	For examination of fresh urine, collect a small sample by aspirating urine from the needleless sampling port with a sterile syringe/cannula adaptor after cleansing the port with disinfectant (quality of evidence: III)		
24	Obtain larger volumes of urine for special analyses aseptically from the drainage bag (quality of evidence: III)		
25	Maintain unobstructed urine flow (quality of evidence: III)		
26	Employ routine hygiene; cleaning the meatal area with antiseptic solutions is unnecessary (quality of evidence: III)		

Table II (continued)

Clinical care:	Service: Invasive procedures	Procedure:
Date of first assessment:		Date of second assessment:
Risk practice (SHEA/IDSA basic recommendations)	Suggested risk reduction method	Comments/ revised score
Tick where the high-risk practice is found (X)		Tick if high-risk practice remains unchanged (X)
The total number of high-risk practices identified in baseline assessment:		
11/26		The total number of high-risk practices remaining after risk reduction initiatives:
Approval Statement		The risk assessment is undertaken by:
The risk assessment is undertaken by:		Name:
Name:		Date:
Signature:		Signature:
Reviewed by:		Reviewed by:
Name:		Name:
Date:		Date:
Signature:		Signature:
Approved by:		Reviewed by:
Name:		Name:
Date:		Date:
Signature:		Signature:

Adopted from (13)

output monitoring in critically ill patients, 3) management of acute/chronic urinary retention and urinary obstruction, 4) assistance in pressure ulcer healing for incontinent patients, 5) patient requests to improve comfort, 6) comfort during end-of-life care, 7) neurogenic bladder dysfunction, 8) chemotherapy drug delivery, 9) bladder irrigation, 10) measurement of urodynamic, 11) sample collection for urinalysis and 12) radiographic studies [5,20,21]. However, there are some contraindications such as: 1) Blood at the meatus. Insertion of the catheter can worsen an underlying injury, 2) gross hematuria, 3) evidence of urethral pain, discomfort, or infection, 4) low bladder volume/compliance, and 5) patient refusal [20]. CAUTI can lead to such complications as discomfort to the patient, prolonged hospital stay, and increased cost and mortality, especially in the ICU [21]. HDU is considered a transition area between ICU and general ward admission [4]. The institutional CAUTI incidence rate in HDU reported six times higher benchmarking to the US-NHSN during the first quarter of 2022 (8.39- vs 1.70/1000 urinary catheter days) with about three times higher utilization ratio (0.67 vs 0.24).

Many reasons contributed to the increase in the CAUTI incidence rates in hospital HDU: 1. nurse-patient ratio was 1:6, usually occupied by mostly chronic patients, 2. no reporting feedback to the relevant stakeholder about the surveillance and CAUTI bundle prevention compliance rate, and 3. most of the CAUTIs occurred following two weeks of catheter insertion assuming the bundle prevention should be monitored and implemented. Therefore, the hospital introduced a quality improvement project to reduce the CAUTI incidence rate by the end of 2022 using the application of SHEA/IDSA basic recommendations.

Kotter and Rathgeber introduced a step-by-step process for successfully changing behavior [12]. Therefore, it is very important to start with the first three steps listed above before introducing the prevention strategic plan. The institutional CAUTI incidence rate in HDU is seven times higher benchmarking to US-NHSN (7.21- vs 1.70/1000 urinary catheter days) which is against to hospital's mission, public health thrust, and patient safety. The hospital organized multi-disciplinary teamwork to improve HDU services. In addition, a vision statement has been developed to reduce 50% of the CAUTI incidence rate by the end of 2022. The first administration action step was taken to improve human resources and management with professional supervision of patient care may also contribute to reducing the CAUTI infection rate. The hospital director assigned a specialist physician part-time to facilitate and manage care supervision between the ICU and another clinical department. The HDU nurse supervisor is dedicated as a link nurse for improving nurses' skills and effective communication between the department and the infection prevention and control department. Link nurse enables better compliance with infection control policies and support with inspiration from other hospital staff including the infection control department that could have impactful initiatives to improve practice. Two nurses were moved from the medical/surgical department to HDU to become a total of eighteen nurses covering sixteen patients to increase the nursing staff. There is a hospital staffing plan but recruitment of healthcare workers takes a long time with very low employment. Therefore, achieving an international nurse-to-patient ratio is still the most challenging. The hospital transferred three patients from the HDU to the medical/surgical unit and two patients were

Table IV-A

Bundle compliance rate on CAUTI prevention in HDU before intervention

Components	Months 2022									Total		
	January			February			March			Act.	Opp.	%
	Act.	Opp.	%	Act.	Opp.	%	Act.	Opp.	%			
Avoid unnecessary urinary catheters	10	10	100	9	24	38	25	25	100	44	59	74
Insert urinary catheters using an aseptic technique	10	10	100	20	24	83	25	25	100	55	59	93
Maintain urinary catheters based on recommended guidelines	Not Done.											
Review urinary catheter necessity daily and remove promptly (Patient-days)	261	275	97	395	399	99	511	511	100	1167	1185	98

Table IV-B

bundle compliance rate on CAUTI prevention in HDU following intervention

Components	Months 2022									Total		
	April			May			June			Act.	Opp.	%
	Act.	Opp.	%	Act.	Opp.	%	Act.	Opp.	%			
Avoid unnecessary urinary catheters	23	25	92	28	31	90	20	24	83	71	80	89
Insert urinary catheters using an aseptic technique	23	25	92	30	31	97	23	24	96	76	80	95
Maintain urinary catheters based on recommended guidelines	Not Documented.											
Review urinary catheter necessity daily and remove promptly (Patient-days)	451	455	99	588	544	90	475	484	98	1387	1454	95

Opp.: Opportunity (the correct moment of bundle component), Act.: Action, (the application moment of the bundle component) %: Percentage.

Table IV-C

Bundle compliance rate on CAUTI prevention in HDU following long time Intervention

Components	Months 2023									Total		
	January			February			March			Act.	Opp.	%
	Act.	Opp.	%	Act.	Opp.	%	Act.	Opp.	%			
Urinary catheter indication	9	16	56	8	11	73	24	25	96	41	52	78
Use sterile equipment	16	16	100	10	11	91	24	25	96	50	52	96
Use of small catheter as possible	16	16	100	11	11	100	24	25	96	51	52	98
Hand hygiene before insertion of a catheter	16	16	100	10	11	91	21	25	84	47	52	90
Daily maintenance review (Patient-days)	467	470	98	75	77	97	224	228	98	766	775	98

Table IV-D

Bundle compliance rate on CAUTI prevention in HDU following longer time intervention

Components	Months 2023									Total		
	April			May			June			Act.	Opp.	%
	Act.	Opp.	%	Act.	Opp.	%	Act.	Opp.	%			
Urinary catheter indication	28	34	82	23	25	92	11	27	41	62	86	72
Use sterile equipment	34	34	100	23	25	92	27	27	100	84	86	97
Use of small catheter as possible	34	34	100	23	25	92	27	27	100	84	86	97
Hand hygiene before insertion of a catheter	34	34	100	23	25	92	27	27	100	84	86	97
Daily maintenance review (Patient-days)	550	558	98	455	634	85	487	550	88	1492	1642	90

Opp.: Opportunity (the correct moment of bundle component), Act.: Action, (the application moment of the bundle component) %: Percentage.

ment feeds back to the HDU and the Quality Departments as well. Evidence reports showed the same observation that noted no proper prevention measures implementation, poor support from hospitals, insufficient enforcement by infection control teams, and lack of cooperation with surgeons when no feedback report of HAI surveillance to the concerned professional staff

[23]. A study noted HAI surveillance should be considered as a mechanism to facilitate performance improvement and infection control activities as well [24]. HAI surveillance data can be used to monitor trends, evaluate preventive efforts, and improve practices [25]. SHEA/IDSA released their recommendations on CAUTI prevention including performing

Table V-A

Incidence rates and the utilization ratio of CAUTI in HDU during the first half of 2022

	Month/2022								Hospital 1 st half 2022	US-NHSN 2013 ^a
	Before intervention				After intervention					
	January	February	March	1at quarter	April	May	June	2 nd quarter		
CAUTI Event	1	3	4	8	3	3	1	7	15	1403
Catheter Days	403	136	414	953	361	401	406	1168	2121	813481
Patient days	498	448	463	1409	416	434	406	1265	2674	3426592
Incidence Rate	2.48	6.69	8.63	8.39	7.21	6.91	2.46	5.99	7.07	1.7
Utilization Ratio	0.80	0.30	0.89	0.67	0.86	0.92	1.0	0.92	0.79	0.24

Table V-B

Incidence rates and the utilization ratio of CAUTI in HDU during the first half of 2023 (long time intervention)

	Month/2023								Hospital 1 st half 2023	US-NHSN 2013 ^a
	Long-time interventions									
	January	February	March	1at quarter	April	May	June	2 nd quarter		
CAUTI Event	1	0	3	4	2	1	2	5	9	1403
Catheter Days	350	384	487	1221	443	496	360	1299	2520	813481
Patient days	474	411	478	1363	453	496	360	1309	2672	3426592
Incidence Rate	2.8	0	6.27	3.27	4.51	2.01	5.55	3.85	3.57	1.70
Utilization Ratio	0.73	0.93	0.98	0.89	0.97	1.0	1.0	0.99	0.49	0.24

^a Adopted from (17).

surveillance using standardized criteria with providing unit-specific feedback [13]. Therefore, the feedback report was considered during the beginning of the intervention period. The hospital applied and monitored compliance with the CAUTI bundle in all clinical departments but did not include the “maintaining urinary catheter based on recommended guidelines” which included seven items. Following the intervention, the hospital updated the CAUTI bundle, implemented,

recorded, and feedback to the department for proving and taking action as needed. The overall data showed no significant difference in CAUTI bundle component components with variation in compliance rate before and after interventions due to variations in the knowledge and practices of nurses and physicians in the HDU.

Before considering urinary catheterization, physicians should consider thinking about alternative catheterization;

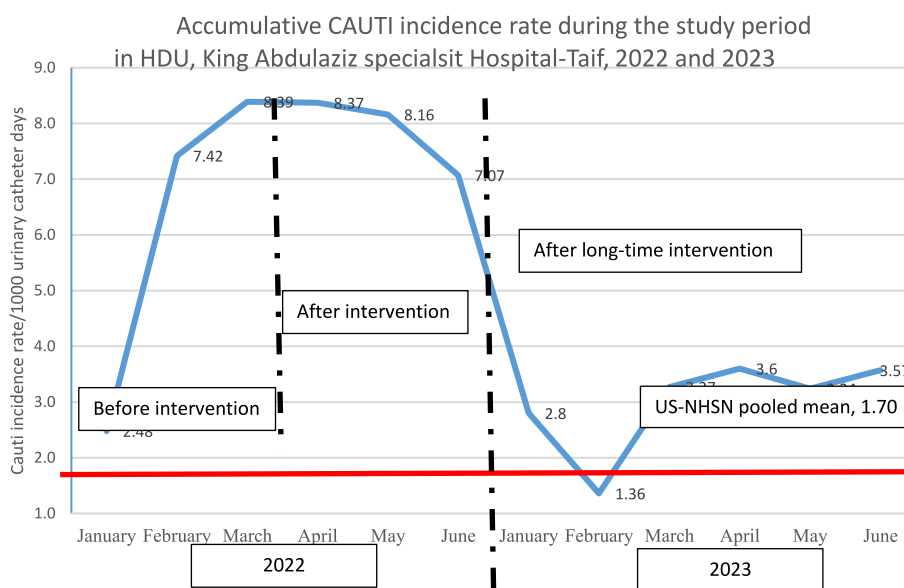


Figure 2. Accumulative of CAUTI incidence rate in HDU during the study period. The CAUTI incidence rates were gradually increased from 2.48 in January 2022 to 8.63 in March 2022. Following intervention, the CAUTI incidence rates were gradually decreased from 8.37 in April 2022 to 1.36 in February 2023 but again increased gradually to 3.57 in June 2023.

external catheters for men (sheath/condom urinary sheaths) or intermittent (“in-and-out” or “straight”) catheterization or go for programmed toileting. In addition, Appropriate catheter type and size should be planned based on the patient’s status [26]. Therefore, we included the note of “alternative catheterization” to the urinary catheter request form and added catheter type and size to the urinary catheter prevalence form as a reminder for physicians and/or in-charge nurses.

The compliance rate on urinary catheter indications was not improved following long time observation (from 74% before intervention in 2022 to 72% after intervention in 2023) due to gap variations between physicians who requested urinary catheters and missed checks at the CAUTI bundle form. We recommended that the nurse should not proceed with catheterization without check on the indication or inform the physician for the indication purpose. The compliance rates on inserting urinary catheters using an aseptic technique were acceptable throughout the study period. One to two actions were missed due to not completing the CAUTI bundle form. Nurses should be strict with the CAUTI bundle form. Similarly, the using of the small catheter as possible was acceptable throughout the study period, however, supplies of appropriate catheter sizes should be always available for all patients. Hand hygiene compliance rates were acceptable most of the time, however, hand hygiene must be conducted before the insertion of a catheter and the nurse should have the authority to stop the procedure and remind the healthcare provider to perform hand washing/hand rub. Therefore, the hand hygiene compliance rate should be 100%. The Daily maintenance review compliance rate was acceptable, however, the nurse should complete all data required in the CAUTI bundle form indicating which of the daily maintenance recommendation items were not checked and do notes and action plans for it.

I-CAT, developed by Wendy Nickle, is an intensive educational course for one day [14]. Unfortunately, only a few HDU staff have joined the event due to a shortage number of nursing staff during the month of April. There was a general written and practical observational assessment hospital-wide competency assessment including CAUTI prevention. The competency test was assessed for all new nurses and periodically based on the department clinical instructor nurse demand. However, the competency content should be updated based on the bundle preventions and other patient safety considerations such as patient education and identification. Unfortunately, re-competency assessment to prove the impact of training and education was not documented following the completion of the educational program. However, the HDU supervisor was responsible for monitoring compliance with the CAUTI prevention measures and noted all nurses fully understood and applied CAUTI prevention measures as required.

PDSA was introduced to test small changes in the quality improvement project. Plan; The application of the SHEA/IDSA basic recommendation was assessed (Table II) (available in the supplementary) and revealed eleven items did not meet the recommendation. The action plan to meet challenges was addressed accordingly as the plan in Table I. Do; Formal education was conducted (Table III) (available in the supplementary), proper surveillance and feedback to the stockholders were addressed, an increased number of staff was taken immediately and proper bundle prevention of CAUTI was

implemented. The study, the test small changes during the second quarter of 2022 showed positive changes and reflected in the reduction of the CAUTI incidence rate during the second quarter of 2022 (5.99/1000 urinary catheter days) and continuously reduced to 3.58/1000 urinary catheter days. Act; there was a successful reduction in the CAUTI incidence rate despite of increase in the utilization ratio. However, the hospital did not achieve the US-NHSN benchmark, therefore, a second cycle is probably needed to observe the risk factors contributing to CAUTI.

The short-period change was achieved by a 28% reduction in the CAUTI incidence rate despite of significant increase in the utilization ratio. In addition, there was also a gradual decrease in the CAUTI incidence rate with an increase in the utilization ratio following a long time in intervention and monitoring indicating the right track to target 50% reduction as planned. There is a reduction in the CAUTI incidence rate from 8.39-before intervention during the first quarter of 2022 to 3.85/1000 urinary catheter days following long-term intervention during the second quarter of 2023 (*P* value 0.17) despite of significant increase in the utilization ratio from 0.67 before intervention during the first quarter 2022 to 0.92 following long intervention during the second quarter 2023 (*P* value 0.0001).

Limitations

There is no competency test assessment following formal education. There is no daily monitoring assessment document to prove performance ideally as the bundle stated. There is no demographic patient data such as gender, clinical risk factor for each CAUTI case, and clinical status as a chronic or acute case. External validation surveillance was not assessed to prove over or under-reporting.

Conclusion

Implementation of the SHEA/IDSA basic recommendations could be useful for the CAUTI prevention model. Despite of high urinary catheter utilization ratio with poor compliance to urinary catheter indications, there was a reduction in the CAUTI incidence rate using multimodal interventions. The study did not specify which intervention was the major effective measure due to the limitations in clinical data collection. However, the implementation of daily maintenance bundle prevention measures played a significant in reducing the CAUTI incidence rate as reported during the long period (Table IV C and D). Kotter and Rathgeber’s changing behavior model is useful in quality improvement projects. It is reflected through administrative leader support in facilitating solution challenges, especially with the availability of human and financial resources. Therefore, we assumed the combination of the changing behavior and the prevention models for a long period is useful in reducing the CAUTI incidence rate and could reduce other healthcare-associated infections. The National MOH hospitals reported low CAUTI incidence rates in ICUs of MOH hospitals and it is time to extend interventions out of the ICUs as well.

Conflict of interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.infpip.2024.100362>.

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