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Implementation of a multifaceted nurse-led intervention to reduce indwelling urinary catheter use in four Australian hospitals: A pre- and postintervention study

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Abstract

Aims and objectives: This study aimed to reduce indwelling urinary catheter (IDC) use and duration through implementation of a multifaceted "bundled" care intervention.

Background: Indwelling urinary catheters present a risk for patients through the potential development of catheter-associated urinary tract infection (CAUTI), with duration of IDC a key risk factor. Catheter-associated urinary tract infection is considered preventable yet accounts for over a third of all hospital-acquired infections. The most effective CAUTI reduction strategy is to avoid IDC use where ever possible and to remove the IDC as early as appropriate.

Design: A cluster-controlled pre- and poststudy at a facility level with a phased intervention implementation approach.

Methods: A multifaceted intervention involving a "No CAUTI" catheter care bundle was implemented, in 4 acute-care hospitals, 2 in metropolitan and 2 in rural locations, in New South Wales, Australia. Indwelling urinary catheter point prevalence and duration data were collected at the bedside on 1,630 adult inpatients at preintervention and 1,677 and 1,551 at 4 and 9 months postintervention. This study is presented in line with the StaRI checklist (see Appendix S1).

Results: A nonsignificant trend towards reduction in IDC prevalence was identified, from 12% preintervention to 10% of all inpatients at 4 and 9 months. Variability in preintervention IDC prevalence existed across hospitals (8%–16%). Variability in reduction was evident across hospitals at 4 months (between −2% and 4%) and 9 months (between 0%–8%). Hospitals with higher preintervention prevalence showed larger decreases, up to 50% when preintervention prevalence was 16%. Indwelling urinary catheter duration increased as more of the short-term IDC placements were avoided.

Trial registration: ACTRN12617000090314. Registered 17 January 2017. Retrospectively registered.

Conclusions: Implementation of a multifaceted intervention resulted in reduced IDC use in four acute-care hospitals in Australia. This result was not statistically significant but did reflect a positive trend of reduction. There was a significant reduction in short-term IDC use at 9 months postintervention.
Relevance to clinical practice: Clinical nurse leaders can effectively implement change strategies that influence patient outcomes. Implementation of the evidence-based "No CAUTI" bundle increased awareness of appropriate indications and provided nurses with the tools to inform decision-making related to insertion and removal of IDCs in acute inpatient settings. Working in partnership with inpatients and the multidisciplinary team is essential in minimising acute-care IDC use.

KEYWORDS
bundle, catheter-associated urinary tract infection, evidence-based practice, implementation, intervention, patient safety, point prevalence, urinary catheter

1 | INTRODUCTION

Indwelling urinary catheters (IDCs) present a risk to patient safety through the potential development of catheter-associated urinary tract infections (CAUTIs) (Gould et al., 2010) and other complications (Saint et al., 2018). The risk of IDC complications increases with duration of urinary catheterisation (Association for Professionals in Infection Control and Epidemiology, 2014). Reduction in IDC use and IDC duration is known to be key factors in preventing CAUTIs (Meddings et al., 2014). Although multifaceted or bundled interventions have also been proven effective in reducing IDC use and CAUTI in the USA (Meddings et al., 2014), similar studies aimed at reducing IDC use and CAUTIs in Australia are limited. This paper addresses this gap by reporting the findings of a multifaceted intervention strategy designed to reduce IDC use and duration for inpatients in four Australian acute-care hospitals.

What does this paper contribute to the wider global community?

- Increase clinicians' awareness of appropriate indications for catheterisation
- Increase clinicians' knowledge and competency
- Reduce avoidable IDC use
- Reduce the risk to patient safety

2 | BACKGROUND

Catheter-associated urinary tract infections are the most common and one of the most preventable healthcare-associated infections (HAIs) (Umscheid et al., 2011; World Health Organisation, 2011), impacting patient safety, length of hospital stay and the cost of care (Mitchell, Ferguson, Anderson, Sear, & Barnett, 2016). Along with CAUTI, IDC use can cause patient distress, embarrassment, discomfort, pain and activity restrictions (Saint, Lipsky, & Dorr Goold, 2002; Yiou et al., 2015). Up to 70% of CAUTIs may be preventable (Umscheid et al., 2011). The most effective CAUTI reduction strategies are to avoid IDC use wherever possible and to remove the IDC as early as appropriate (Meddings et al., 2014).

Between 12%–16% of inpatients receive an IDC during the course of their hospital admission (Association for Professionals in Infection Control and Epidemiology, 2014). The daily risk of developing bacteriuria increases to 3%–7% when a patient has an IDC in situ (Lo et al., 2014). Urinary tract infection (UTI) point prevalence rates for all hospitalised patients are reported at between 1.3%–1.73% with increase in a patients length of stay of up to 4 days (Mitchell, Anderson, & Ferguson, 2017; Mitchell, Fasugba, Beckingham, Bennett, & Gardner, 2016; Zarb et al., 2012) and estimated costs of an additional 24 million AUD to the Australian healthcare system (Jackson, Nghiem, Rowell, Jorm, & Wakefield, 2011).

An integrative literature review identified that intervention "bundles" are a common and effective strategy used to reduce IDC use and CAUTI (Meddings et al., 2014). Such bundles combine a number of evidence-based practices or steps vital to achieving improvement in clinical outcomes (Institute for Healthcare Improvement, 2011). The most well-known bundle designed to reduce IDC use is the "bladder bundle," which is predominantly nurse driven with emphasis on continual assessment and IDC removal as soon as possible and includes a nurse-initiated IDC removal protocol, IDC reminders and removal prompts, portable bladder ultrasound monitoring, and IDC insertion care and maintenance (Saint et al., 2009). However, despite the many tools provided through the development of the "bladder bundle," implementation across multiple sites remains a constant challenge as some hospitals need more explicit guidance and context-specific strategies to promote its effective use (Saint et al., 2009).

Particular nursing practices significantly impact the risk of a patient developing CAUTI. These include appropriate securement of the IDC, care of the IDC and drainage bag, documentation through to skilled patient assessment and critical decision-making in regard to IDC insertion and removal (Durant, 2017). These practices need to be considered when developing evidence-based IDC care bundles.

In line with this central role played by nurses, nurse-led interventions have been effective in reducing IDC use, duration and CAUTI (Durant, 2017; Meddings et al., 2014). Durant (2017) conducted a systematic review of nurse-led protocols (where nurses make decisions on appropriate catheter insertion and removal) to reduce the risk of CAUTI in the USA. This review identified 29 studies, which were case-controlled with pre- and postdesign, and all yielded reductions in IDC use or CAUTI rates (Durant, 2017).

There are limited published intervention or implementation studies describing IDC reduction intervention studies in Australia. Although attempts to prevent CAUTI have been led at a state level in New South Wales (NSW), including a suite of resources, individual units/facilities had control over use of the resources, and there has been no formal implementation strategy or planned evaluation (Clinical Excellence Commission, 2015).

Rhodes et al. (2014), an Australian study, implemented a multimodal strategy in one 860-bed hospital, including an education programme (focusing on UTI risks, staff training on IDC insertion and management, and correct CSU collection), resource development (brochures for staff and patients and an electronic learning package) and identification of champions. The intervention led to improved documentation and a reduction in CAUTIs. Rates of IDC use, however, were only calculated for the ICU (statistical significance not reported), which reduced in the early postintervention phase, but was not sustained.

Whilst not specifically aiming to reduce IDC use, another Australian study piloted a decision-support tool for urine specimen collection and found that use of the tool reduced catheter days and catheter utilisation (Gralton et al., 2017). A catheter reminder intervention was recently evaluated in an Australian hospital, which found a reduction in IDC duration in non-ICU patients (Mitchell et al., 2019).

The study reported in this paper builds on the results of a feasibility study where the systematic implementation of a multifaceted intervention resulted in significant reductions in IDC insertion rates and reduced IDC duration (Agency for Clinical Innovation, 2016; Giles et al., 2015).

3 | AIM

The primary aim of the study was to reduce IDC use and duration through implementation of a multifaceted "bundled" care intervention.

The research question is "Does implementation and adherence to the multifaceted 'bundled' intervention reduce IDC use?"

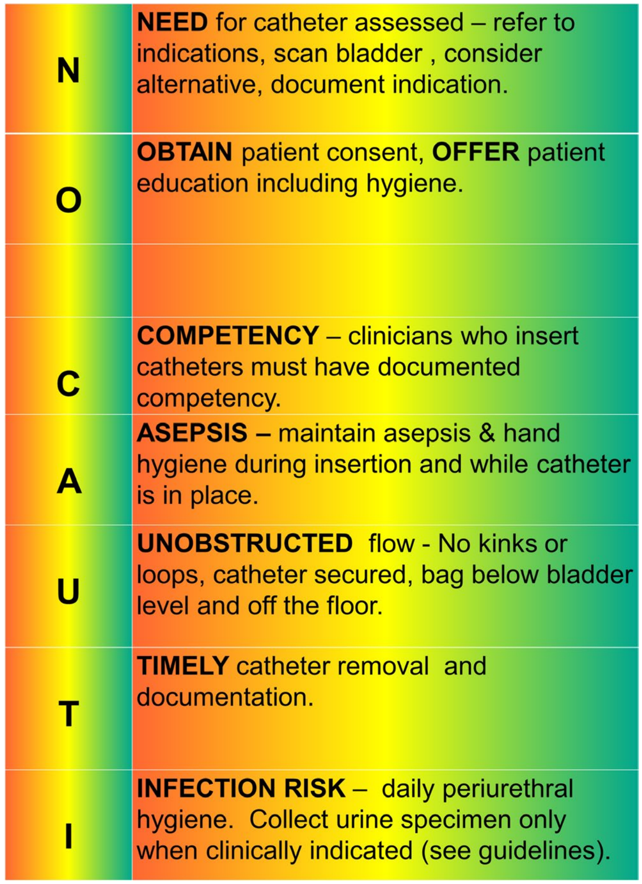

FIGURE 1 "NO CAUTI" catheter care bundle (Parker et al., 2017). Originally published by BMC Health Services

4 | METHOD

The study employed a cluster-controlled pre- and postdesign at a facility level with a phased intervention implementation approach and is described in detail in the study protocol paper (Parker et al., 2017). This study is presented in line with the Standards for Reporting Implementation Studies (StaRI) checklist (Pinnock et al., 2017) (see Appendix S1).

The study was conducted in four public hospitals in two local health districts in NSW, Australia. Two hospitals in one LHD were categorised as being located in metropolitan and two in the other LHD were rural locations according to the rural, remote and metropolitan areas classification (Australian Institute of Health and Welfare 2004). Hospitals were purposively selected, matched on total bed numbers, activity type and activity levels. In Australia, ICU levels are categorised according to their level of service delivery with level 6 being the highest care level (Intensive Care & Coordination Monitoring Unit, 2015). The two rural hospitals had 360 and 260 beds, the larger one having a Level 5 ICU, the smaller, a level 3 high dependency unit (HDU). The two metropolitan hospitals had 550 and 318 beds, both with an ICU, one a level 5 and the other level 4.

All adult inpatients across the four hospitals were included in the data collection, excluding day only patients, and patients in the ED.

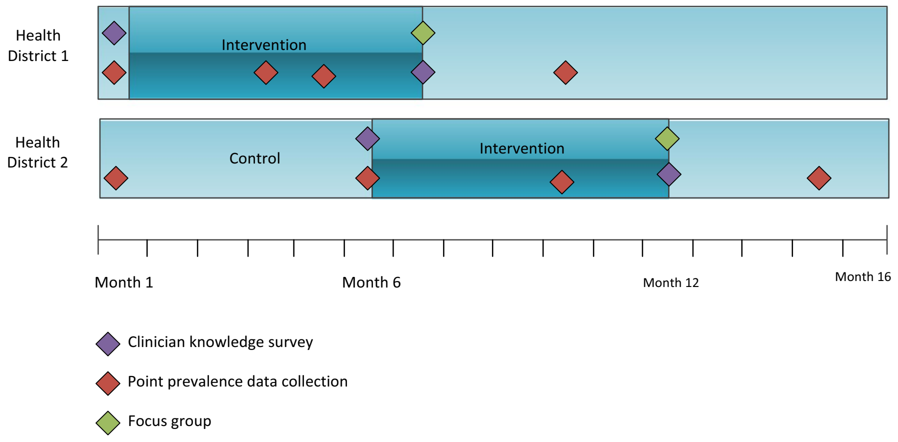

FIGURE 2 Study design. Data collection points are indicated by diamonds on the timeline (Parker et al., 2017). Originally published by BMC

Patients in mental health wards and inpatients with suprapubic catheters were included in point prevalence data collection but excluded from final analysis.

The multifaceted intervention consisted of four evidence-based components.

- IDC insertion criteria guidelines
- An insertion and maintenance care bundle shown in Figure 1
- A nurse-led IDC removal protocol
- Clinician competency assessment framework

To assist with implementation of the practice change and bundle compliance, a standardised reduced cost generic IDC insertion pack (including all equipment required for catheterisation, documentation stickers and securing devices) was developed and distributed for use across both LHDs in all specialty areas.

Electronic data collection tools were developed to streamline point prevalence and practice adherence auditing processes. In addition, clinician and patient educational resources (including a poster with insertion guidelines, "No CAUTI" bundle, and removal guidelines, patient information sheets) were developed. Figure 1 shows the "No CAUTI" catheter care bundle used in the implementation, as described in the published study protocol (Parker et al., 2017).

Implementation of a bundled intervention requires the development and mobilisation of a comprehensive and complementary set of socio-adaptive strategies such as education, engagement of champions and opinion leaders, monitoring and feedback mechanisms as well as the development and deployment of resources (Johnson & May, 2015). Implementation details are provided in a protocol paper (Parker et al., 2017).

Implementation was staged by convenience across the two LHDs 4 months apart as per Figure 2. The "No CAUTI" multifaceted intervention was implemented over a 6-month period in the hospitals using the following strategies:

- Intensive education over a 2-week period including 3-hr train-the-trainer workshops and ward in-services
- Champion meetings
- Practice adherence audits and feedback

Implementation strategies are further described in the published study protocol (Parker et al., 2017).

4.1 | Data collection

The primary outcome was inpatient prevalence of IDCs, with duration of IDC (from date of insertion to survey date) a secondary outcome.

Indwelling urinary catheter point prevalence data were collected preintervention, 4 months after intervention and 9 months after intervention at each hospital via a firewall-protected online data collection survey. Each time-point included two data collection days at least 10 days apart, to ensure adequate sample size and reduce duplication of inpatients. Indwelling urinary catheter point prevalence data collection was completed by teams consisting of a research team member and a clinical nurse or midwife. Each team was allocated a number of wards and adult inpatients in all inpatient wards were surveyed. Data were collected from the patient's bedside, admission history notes and from electronic clinical systems. The teams recorded whether the inpatient had an IDC in situ, IDC insertion information such as indication, date of insertion, insertion location and staff designation of inserter. Inpatient demographics (facility, ward, patient age, patient gender, date of admission) were extracted from electronic medical records for linking with survey data.

4.2 | Process evaluation

Compliance with the "No CAUTI" catheter care bundle was measured through practice adherence audits completed for 6 months from the commencement of the implementation. The practice adherence audit was designed to measure practice adherence with the "No CAUTI" catheter care bundle and comprised 27 items related to documentation, IDC indication, patient education/consent and catheter maintenance. The practice adherence audit was administered using a firewall-protected online survey tool. The audits were completed by nurses and midwives on all wards where there were IDCs. Audits were completed weekly for 6 weeks and then monthly for the remainder of the 6-month implementation period.

4.3 | Ethics

The study was granted ethical approval through the Human Research Ethics Committees of two Local Health Districts' (references 16/10/19/5.09 and 1016-097C).

4.4 | Data analysis

A sample size calculation based on a 12% baseline IDC prevalence (Association for Professionals in Infection Control and Epidemiology, 2014) indicated that 1,600 inpatients at each time-point would be sufficient to detect a 3% fall in absolute IDC insertion rates (i.e. from 12%–9%) with a power of 0.8 and alpha 0.05.

The primary outcomes were inpatient prevalence of IDCs and duration of IDC (from date of insertion to survey date).

Indwelling urinary catheter point prevalence and duration data were linked with electronically extracted inpatient demographic data into statistical package Stata 14.1 (StatCorp, 2015) for analysis.

Frequencies and percentages are presented for categorical variables of interest: hospital (Metro A, Metro B, Rural A and Rural B), region (Metro or Rural), gender, age, specialty, indication for IDC, clinician inserting IDC and where IDC was inserted. A summary of the practice adherence audit is also presented. Means were calculated for inpatient age; means and medians were calculated for IDC duration.

Inpatients with an IDC in situ for greater than 60 days were excluded to remove outliers. Demographics were compared pre- and postintervention to ensure similar populations were being analysed at each time-point.

Univariate analyses were undertaken to determine associations of variables of interest with IDC prevalence rates and IDC duration. A multivariable mixed model was constructed, adjusting for region, specialty, gender and age, to compare IDC prevalence pre- and postintervention to determine whether there was a reduction in IDC usage. A multivariable negative binomial model was constructed to compare IDC duration pre- and postintervention to determine whether a reduction in duration was evident. The model was adjusted for region, specialty, gender and age.

Indwelling urinary catheter duration was dichotomised into short term (≤3 days) and longer term (>3 days), and a trend analysis was carried out to detect changes in IDC duration pre- and postintervention for short-term and long-term IDCs.

The practice adherence audit periods were defined as early or late. Early audit was defined as the weekly audits in the first 6 weeks, while the monthly practice adherence audits became the late period. Responses were categorised as adhering or not adhering to the bundle, and changes in adherence over the 2 periods were assessed.

5 | RESULTS

There were a total of 1,630 inpatients surveyed at preintervention, 1,677 inpatients at 4 months postintervention and 1,551 inpatients at 9 months postintervention for presence of a urinary catheter and duration. Indwelling urinary catheters were evident in 195 inpatients at preintervention, 166 inpatients at 4 months postintervention and 158 inpatients at 9 months postintervention (Table 1). Indwelling urinary catheter duration was unable to be calculated (due to missing dates of IDC insertion) for 10 observations at preintervention, 13 observations at 4 months postintervention and 15 observations at 9 months postintervention.

Missing documentation for IDC indication was common and did not improve in the postintervention period, with 49 (25%) missing at preintervention, 36 (22%) missing at 4 months postintervention and 59 (37%) missing at 9 months postintervention (as indicated in Table 3). Similarly, documentation of the location of IDC insertion did not improve with 38 (19%) of preintervention IDC insertions missing a location, 48 (25%) at 4 months postintervention and 36 (18%) at 9 months postintervention.

5.1 | Patient characteristics

For all inpatients and for inpatients with an IDC in situ, there were no significant differences between the 3 time-points for demographic and location variables (gender, age, hospital, region, ICU status and specialty area).

Of all inpatients assessed, 54%, 57% and 54% were female while 46%, 43% and 46% were male (at preintervention, 4 months postintervention and 9 months postintervention, respectively). Of 519 inpatients with IDCs in situ, the percentages across the three time-points were (females 50%, 53% and 41%; with males 50%, 47% and 59%). See Table 1.

The mean age of all inpatients was 67 years, varying only slightly across the three time-points (Table 2). The mean age of inpatients with an IDC in situ was 69 years at preintervention, 70 years at 4 months postintervention and 69 years at 9 months postintervention. At each time-point, the mean age for females was lower than for males for all inpatients and for inpatients with an IDC in situ. In addition, at each time-point, the mean age for inpatients in rural hospitals was lower than for inpatients in metropolitan hospitals. See Table 2.

5.2 | IDC indications

At all point prevalence time-points, one of the most common indications for IDC insertion was urinary retention, this indication increasing substantially from 29% (n = 43) preintervention to 41% (n = 41) of all documented indications for IDC insertion by 9 months

TABLE 1 Frequencies of all inpatients and IDC inpatients, with IDC prevalence, by intervention time-points

		Preintervention				Postintervention 4 months
		All inpatients	IDC inpatients	*p*-value*	IDC Prevalence	All inpatients
		Freq (col %)			[95% CI]	Freq (col %)
Overall		1,630	195		12% [10%, 14%]	1,677
Hospital	Metro A	669 (41%)	86 (44%)	.30	13% [10%, 15%]	721 (43%)
	Metro B	440 (27%)	46 (24%)		10% [8%, 13%]	428 (26%)
	Rural A	275 (17%)	43 (22%)		16% [11%, 20%]	278 (17%)
	Rural B	246 (15%)	20 (10%)		8% [5%, 12%]	250 (15%)
	Total	1,630	195			1,677
Region	Metro	1,109 (68%)	132 (68%)	.91	12% [10%, 14%]	1,149 (69%)
	Rural	521 (32%)	63 (32%)		12% [9%, 15%]	528 (31%)
	Total	1,630	195			1,677
Specialty	Medical	733 (45%)	64 (33%)	.03	9% [7%, 11%]	787 (47%)
	Surgical	499 (31%)	63 (32%)		13% [10%, 16%]	490 (29%)
	Critical care	101 (6%)	42 (22%)		42% [32%, 51%]	101 (6%)
	Rehabilitation	179 (11%)	11 (6%)		6% [3%, 10%]	147 (9%)
	Obstetrics	118 (7%)	15 (8%)		13% [7%, 19%]	152 (9%)
	Total	1,630	195			1,677
Gender	Female	874 (54%)	98 (50%)	.31	11% [9%, 13%]	949 (57%)
	Male	755 (46%)	97 (50%)		13% [10%, 15%]	727 (43%)
	Total	1,629	195			1,676
Age group	<50	303 (19%)	33 (17%)	.39	11% [7%, 14%]	265 (20%)
	50-<70	420 (26%)	52 (27%)		12% [9%, 16%]	296 (23%)
	70-<80	382 (23%)	40 (21%)		10% [7%, 14%]	307 (24%)
	80+	521 (32%)	70 (36%)		13% [11%, 16%]	431 (33%)
	Total	1,626	195			1,299

**p*-value is difference between all patients and patients with IDCs in situ.

postintervention (see Table 3). At preintervention, postsurgical management was also at 29% (n = 43), but trended down postintervention to 25% (n = 32) of all documented indications at 4 months and 21% (n = 21) at 9 months postintervention. In addition, IDC insertion for urinary monitoring increased postintervention and all other categories, including sepsis, decreased in the postintervention time-points. In addition, over the 3 time-points, the percentage of IDCs inserted in the operating suite decreased from 26% (n = 41) preintervention to 16% (n = 20) at 9 months postintervention and the percentage of IDC insertions in ICU increased from 4%–11%.

5.3 | IDC prevalence

Inpatient IDC prevalence was 12% at preintervention, 10% at 4 months postintervention and 10% at 9 months postintervention. A regression, adjusted for region, age, gender and specialty demonstrated a nonsignificant trend towards IDC prevalence reduction (p = .1). However, preintervention IDC prevalence varied greatly between hospitals. Preintervention IDC rates at each hospital ranged from 8%–16%. This range had narrowed at 4 months postintervention to between 8%–12%. At 9 months postintervention, the hospital that started with 16% had reduced by 50%. See Table 1.

Indwelling urinary catheter prevalence varied greatly between specialties within each time-point. All non-ICU wards had an IDC prevalence of less than 13% across all the time-points. The patterns of IDC prevalence by specialty were similar across the three time-points (Figure 3).

Indwelling urinary catheter prevalence was higher in males than in females at all time-points (13% vs. 11% at preintervention, 11% vs. 9% at 4 months postintervention and 13% vs. 8% at 9 months postintervention). By 9 months postintervention, the reduction in IDC use was more marked in female inpatients than in males, reducing from 50% of all inpatient IDCs preintervention to 41%. In contrast, IDC prevalence in male inpatients increased overall from a preintervention rate of 50%–59% at 9 months postintervention.

Table 1 shows inpatient IDC prevalence at each time-point for demographic and location variables.

There was a nonsignificant trend towards reduction in inpatient IDC prevalence across the three time-points with a decrease

			Postintervention 9 months			
IDC inpatients	*p*-value*	IDC Prevalence	All inpatients	IDC inpatients	*p*-value*	IDC Prevalence
		[95% CI]	Freq (col %)			[95% CI]
166		10% [8%, 11%]	1,551	158		10% [9%, 12%]
72 (43%)	.63	10% [8%, 12%]	680 (44%)	74 (47%)	.10	11% [9%, 13%]
36 (22%)		8% [6%, 11%]	384 (25%)	46 (29%)		12% [9%, 15%]
32 (20%)		12% [8%, 15%]	287 (19%)	22 (14%)		8% [5%, 11%]
26 (15%)		10% [7%, 14%]	200 (13%)	16 (10%)		8% [4%, 12%]
166			1,551	158		
108 (65%)	.31	9% [8%, 11%]	1,064 (69%)	120 (76%)	.04	11% [9%, 13%]
58 (35%)		11% [8%, 14%]	487 (31%)	38 (24%)		8% [5%, 10%]
166			1,551	158		
45 (27%)	.01	6% [4%, 7%]	761 (49%)	47 (30%)	<.01	6% [4%, 8%]
61 (37%)		12% [10%, 15%]	448 (29%)	51 (32%)		11% [8%, 14%]
39 (24%)		39% [29%, 48%]	96 (6%)	42 (27%)		44% [34%, 54%]
11 (7%)		7% [3%, 12%]	138 (9%)	12 (8%)		9% [4%, 13%]
10 (6%)		7% [3%, 11%]	108 (7%)	6 (4%)		6% [1%, 10%]
166			1,551	158		
88 (53%)	.32	9% [7%, 11%]	835 (54%)	65 (41%)	<.01	8% [6%, 10%]
78 (47%)		11% [8%, 13%]	716 (46%)	93 (59%)		13% [11%, 15%]
166			1,551	158		
19 (15%)	.03	7% [4%, 10%]	287 (19%)	26 (16%)	.46	9% [6%, 12%]
27 (21%)		9% [6%, 12%]	392 (25%)	38 (24%)		10% [7%, 13%]
33 (25%)		11% [7%, 14%]	360 (23%)	41 (26%)		11% [8%, 15%]
52 (40%)		12% [9%, 15%]	507 (33%)	53 (34%)		10% [8%, 13%]
131			1,546	158		

of 2% overall observed in IDC prevalence from preintervention to 4 months and from preintervention to 9 months.

Univariate regressions for IDC prevalence found the following significant results. Indwelling urinary catheter prevalence for the Rural A hospital showed a significant decrease from preintervention to 9 months postintervention (16%–8%, $p < .01$). There were significant decreases in IDC prevalence from preintervention to 4 months postintervention for medical wards ($p = .02$) and from preintervention to 9 months postintervention for critical care wards ($p = .05$). A significant decrease in IDC prevalence between preintervention and 9 months postintervention was also evident for females ($p = .015$).

5.4 | IDC duration

The distribution of IDC duration ranged from 1 day to 52 days and was highly right-skewed, with over 50% of inpatients having an IDC for 3 days or less. Table 4 shows that for IDC duration of 1–3 days, there was a significant downward trend from preintervention to 9 months postintervention ($p = .02$). In contrast, in the >3 days IDC duration group there was no change from across this timeframe. The overall mean IDC duration (in days) was 6.1 [95% CI: 5, 7.3] at preintervention, 5.4 [95% CI: 4.5, 6.2] at 4 months postintervention and 8.3 [95% CI: 6.7, 9.9] at 9 months postintervention. Median IDC duration was 3 days at preintervention and 4 months postintervention and increased to 4 days at 9 months postintervention. Analysis showed that, as more of the short-term IDC placements were avoided, duration of IDCs increased over time. See Figure 4.

Table 5 shows the overall mean and median IDC duration (in days) and mean by hospital, region, specialty, ICU status, gender and age group. Table 6 presents the overall mean for IDC indication. Urinary retention had the longest mean IDC duration at 8.4 days with post-surgical management showing the lowest duration with 4.6 days.

5.5 | Practice adherence

There were 689 practice adherence audits attended, with 277 in the early audit (6 weeks postintervention) and 412 in the later audit (6 weeks to 6 months postintervention). Table 7 shows practice

TABLE 2 Mean inpatient age [95% CI]

		Preintervention	Postintervention 4 months	Postintervention 9 months
All inpatients	(*N* = 4,474)	67 [66, 68]	67 [66, 68]	67 [66, 68]
IDC inpatients	(*N* = 484)	69 [66, 71]	70 [67, 74]	69 [67, 72]
Gender				
All inpatients	Female	66 [64, 67]	65 [63, 66]	65 [64, 67]
	Male	69 [68, 70]	70 [68, 71]	70 [69, 71]
IDC inpatients	Female	66 [62, 70]	68 [62, 73]	64 [59, 69]
	Male	71 [68, 74]	73 [70, 76]	73 [70, 76]

TABLE 3 IDC insertion documentation

	Preintervention	Postintervention 4 months	Postintervention 9 months	*p*-value**
IDC indication				
Urinary retention	43 (29%)	38 (29%)	41 (41%)	.13
Urinary monitoring	38 (26%)	32 (25%)	31 (31%)	
Sepsis	11 (8%)	13 (10%)	2 (2%)	
Postsurgical management	43 (29%)	32 (25%)	21 (21%)	
Other	11 (8%)	15 (12%)	4 (4%)	
Total	146	130	99	
Not documented	49 (25%)	36 (22%)	59 (37%)	
Location of IDC insertion				
ED	44 (28%)	40 (34%)	42 (34%)	.08
ED other hospital	9 (6%)	3 (3%)	4 (3%)	
Ward	55 (35%)	46 (39%)	43 (35%)	
Operating suite	41 (26%)	18 (15%)	20 (16%)	
ICU	7 (4%)	10 (8%)	13 (11%)	
Community	1 (1%)	1 (1%)	0 (0%)	
Total	157	118	122	
Not documented	38 (19%)	48 (25%)	36 (18%)	
Designation of IDC inserter				
Medical officer	53 (48%)	26 (28%)	28 (35%)	.08
RN	53 (48%)	57 (62%)	52 (64%)	
RM	3 (3%)	8 (9%)	1 (1%)	
EN/EEN/Community	2 (2%)	1 (1%)	0 (0%)	
Total	111	92	81	
Not documented	84 (43%)	74 (38%)	77 (39%)	

**Significance between phases.

adherence percentages at the early and later audits. Adherence was consistently high across both audits and mostly remained constant or increased by the later audit. There were significant improvements in adherence rates over the duration in five elements of the audit. These are marked in the table with the % increase and the *p*-value.

6 | DISCUSSION

The findings from this study support use of the "NO CAUTI" bundled intervention in an Australian acute healthcare setting. Implementation of a multifaceted intervention resulted in a non-significant trend towards reduction in IDC prevalence from 12%–10%. Findings point to a greater reduction in IDC prevalence in hospitals that start with higher baseline as demonstrated in rural hospital A, where rates reduced from 16% at baseline to 8% at 9 months postintervention. When applied to all public hospital admissions in Australia (6.6 million annually) (Australian Institute of Health and Welfare (AIHW), 2018), this 2% reduction has the potential to avoid approximately 131,746 IDC insertions. These findings build on the existing evidence base that multifaceted and bundled interventions are effective in reducing IDC use (Meddings

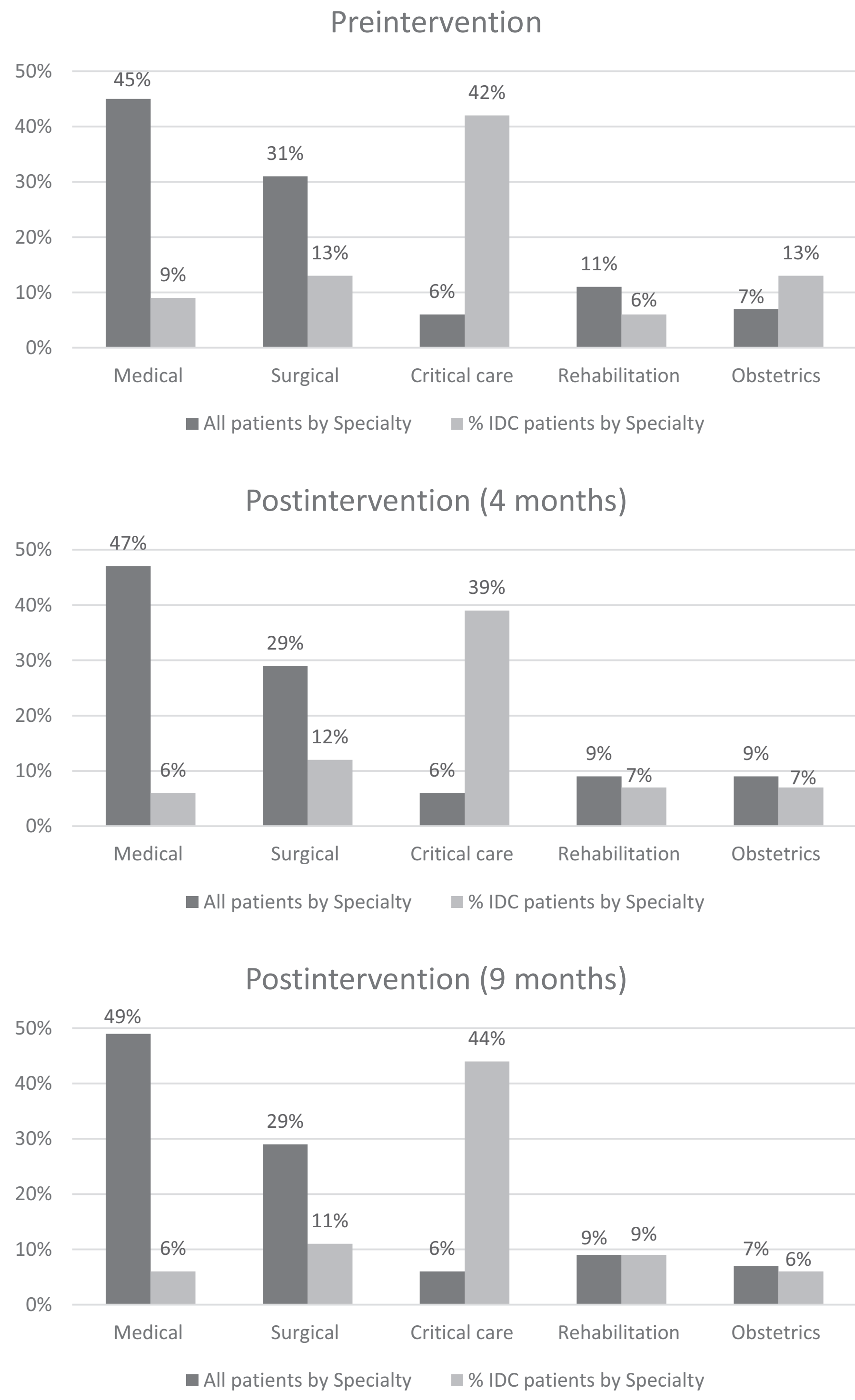

FIGURE 3 Frequency (%) of inpatients per specialty, by time-point, with IDC prevalence at each time-point

et al., 2014). Our study is the largest multifaceted CAUTI prevention intervention to be evaluated in Australia. The "NO CAUTI" care bundle used in the intervention is similar to other CAUTI bundles, with each element having its own robust evidence base; however, our approach to education and the requirement for patient consent are relatively novel.

Specialty areas with the greatest reduction in IDC prevalence were medical and obstetrics, where IDC use reduced from 9%–6% and 13%–11%, respectively, from preintervention to 9-months postintervention (as shown in Figure 3). Indwelling urinary catheter use in critical care, however, remained similar across the 3 time-points (42%, 39% and 44% at preintervention and 4 and 9 months postintervention, respectively). Improvements in non-ICU wards, with no change in ICUs, have been found previously in a large national USA CAUTI prevention programme (Saint et al., 2016) and also with a reminder intervention in an Australian hospital (Mitchell et al., 2019). Limited success of CAUTI prevention interventions in ICUs may be explained by inpatients in ICUs being

TABLE 4 Trend analysis for proportion of IDC duration, in days, by Phase

	Pre-int	Post 4 months	Post 9 months	Total
1–3 days	101 (55%)	80 (52%)	60 (42%)	241
>3 days	84 (45%)	73 (48%)	83 (58%)	240
Total	185	153	143	481

Note: For 1–3 days: slope = −0.6, χ^2 = 5.15, *p*-value = .0232.

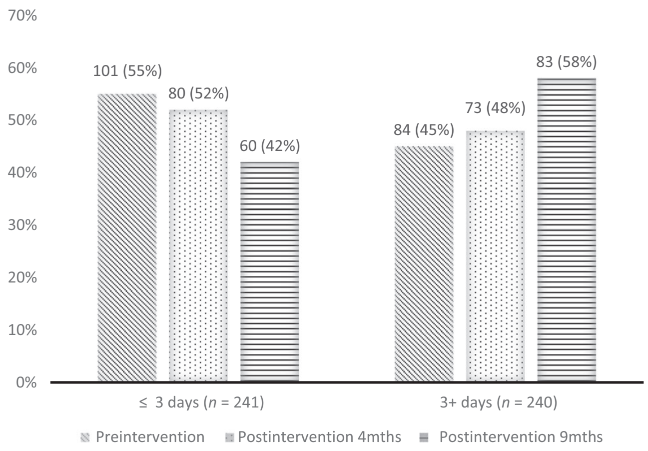

FIGURE 4 Categories of IDC duration by Phase

ill enough to have clear and appropriate need for an IDC insertion (Saint et al., 2016). Interventions focused specifically in ICUs which aim to change such mindsets, such as that implemented by Gupta et al. (2017), including a multidisciplinary team, nurse IDC removal protocol and bladder scanning, may be needed to reduce IDC use in ICUs.

The overall results on IDC duration showed no significant impact, appearing to increase at 9 months following the intervention. However, when IDC duration was dichotomised into short term (≤3 days) and longer term (>3 days), there was a significant reduction in the short-term IDC group (Table 4). The intervention had a clear impact on short-term IDC prevalence, which were far more responsive to the intervention than the longer-term IDC prevalence and this was maintained at 9 months postintervention. In addition, indications for IDC insertion changed from preintervention to 9-months postintervention in that the IDC indication of urinary retention increased from 29%–41%, whereas postsurgical management IDC decreased from 29%–21%. Given the IDC duration for urinary retention was higher than all other indications, this may account for the overall increased duration from preintervention–9-months postintervention. This may indicate that avoidable IDC use decreased, whereas those inpatients that required an IDC for appropriate indications for longer durations (e.g. urinary output monitoring, urinary retention) increased.

There was some variance in IDC prevalence and duration for males and females. For females, IDC prevalence decreased from 11% preintervention to 8% 9 months postintervention, but duration increased from 4.9–9 days. For males, IDC prevalence remained at 13% preintervention and 9-months postintervention, and duration remained relatively stable (7.5 days preintervention to 7.9 days 9 months post). A possible explanation for the prevalence decreasing, yet duration increasing for female inpatients with an IDC, is that avoidable IDC placements decreased following the intervention, which would mean that those females requiring an IDC had a clinical indication for the IDC to be in for a longer duration.

Development of a documentation protocol for catheter insertion (including indication for catheterisation) was central to understanding the impact of the intervention. This also formed part of the education, practice adherence auditing and ongoing feedback to staff. It was anticipated that documentation of catheterisation would improve following implementation of the intervention. However, rates of missing documentation of IDC indication did not decrease during or following the intervention. One possible reason for lack of improvement is that around one third of IDCs were inserted in EDs, and the intervention did not directly target ED. This study, along with other study findings, highlights the need for future interventions purposively targeted at EDs, taking into account specific contextual practices and reasons for insertion, which differ from other contexts (Fakih et al., 2014; Gokula, Smith, & Hickner, 2007; Mulcare et al., 2015). Whilst the point prevalence data did not reveal an improvement in documentation of indication for IDC insertion, the practice adherence audits did show a significant increase in documentation of indication from the first period of the intervention as compared with the remainder of the intervention period (81%–88%). This may reflect improvement in documentation in specific clinical areas where the audits were completed. The practice adherence audits, however, revealed low rates of documentation of an IDC removal/change date and review for continued need for an IDC, both factors that are vital in prompt removal of IDCs.

Rates of catheter care were high from the start of the intervention throughout the practice adherence auditing phase, for example, rates of over 95% practice adherence for the whole period were recoded for catheter bag less than ¾ full, catheter bag off the floor, tubing off the floor, bag below bladder level, tube free of loops and kinks. Catheter care practices significant improvements from the initial intervention period to late intervention period. These high rates of catheter care throughout the intervention may reflect impact of the education and "NO CAUTI" bundle resources. Rates of knowledge from the preintervention staff survey also reflected high knowledge of clinician knowledge around practices for IDC care, so IDC care may have been high prior to implementation.

Patient education around catheterisation and IDC care is an important aspect of CAUTI prevention, and this aspect is included in CAUTI prevention guidelines (e.g. Lo et al., 2014; Loveday et al., 2014). Studies have shown that around 20% of patients in hospital may not know the indication for their IDC (Darbyshire, Rowbotham, Grayson, Taylor, & Shackley, 2016; Laan, Nieuwkerk, & Geerlings, 2019), which was similar to the rate found in the initial practice adherence audits in the present study. In the present study, patient understanding of IDC indication improved significantly during the

TABLE 5 Median and mean IDC duration, in days (mean with 95% CI)

		Preintervention	Postintervention 4 months	Postintervention 9 months
Overall median		3	3	4
Overall mean		6.1 [5, 7.3]	5.4 [4.5, 6.2]	8.3 [6.7, 9.9]
Hospital	Metro A	6.6 [4.7, 8.4]	6.3 [4.7, 7.9]	9.5 [7, 11.9]
	Metro B	6.2 [4.1, 8.3]	5.9 [4.2, 7.6]	7.6 [4.9, 10.2]
	Rural A	5.1 [3, 7.2]	4.1 [2.7, 5.6]	7.8 [3.5, 12]
	Rural B	6.3 [2.5, 10]	3.6 [2.6, 4.6]	5.3 [0.4, 10.2]
Region	Metro	6.4 [5.1, 7.8]	6.2 [5, 7.3]	8.8 [6.9, 10.6]
	Rural	5.5 [3.6, 7.3]	3.9 [3, 4.8]	6.6 [3.5, 9.8]
Hospital ICU status	Without ICU	6.3 [2.5, 10]	3.6 [2.6, 4.6]	5.3 [0.4, 10.2]
	With ICU	6.1 [5, 7.3]	5.7 [4.7, 6.7]	8.6 [7, 10.3]
Specialty area	Medical	6.6 [4.9, 8.3]	5.8 [4.1, 7.6]	8.5 [5.8, 11.2]
	Surgical	5.8 [3.9, 7.7]	4.9 [3.7, 6]	6.9 [4.8, 9.1]
	Critical care	4.8 [3.2, 6.5]	5.3 [3.4, 7.1]	8.9 [5.1, 12.7]
	Rehabilitation	17.5 [7.5, 27.5]	9.4 [5.2, 13.5]	15.5 [7.6, 23.5]
	Obstetrics	1.7 [1.4, 2]	2.2 [1.6, 2.8]	1.3 [0.9, 1.8]
Gender	Female	4.9 [3.7, 6.1]	5.5 [4.4, 6.7]	9 [5.9, 12]
	Male	7.5 [5.6, 9.3]	5.2 [3.9, 6.5]	7.9 [6.1, 9.6]
Age group	<50	4.7 [1.7, 7.7]	4.9 [2.5, 7.4]	6.3 [2.7, 9.9]
	50–<70	5.3 [3.5, 7.1]	5.4 [2.8, 8]	10.6 [6.2, 15.1]
	70–<80	8.3 [5.6, 11.1]	4.6 [3.1, 6]	9.7 [6.3, 13.1]
	80+	6.3 [4.4, 8.1]	5 [3.8, 6.2]	6.5 [5.2, 7.9]

TABLE 6 Mean IDC duration, in days, by phase and indication for IDC insertion (mean with 95% CI)

	Preintervention (n = 144)	Postintervention 4 months (n = 124)	Postintervention 9 months (n = 94)	Overall (n = 362)
Urinary retention	8.4 [5.4, 11.4]	5.6 [4.1, 7.0]	11.1 [7.4, 14.8]	8.4 [6.7, 10.1]
Urinary monitoring	6.3 [4.1, 8.5]	6.1 [3.9, 8.4]	8.1 [4.6, 11.6]	6.8 [5.3, 8.3]
Sepsis	6.4 [4.1, 8.7]	5.8 [3.1, 8.4]	6.0 [2.0, 10.0]	6.0 [4.5, 7.6]
Postsurgical management	4.4 [1.9, 6.9]	4.5 [2.6, 6.5]	5.0 [2.2, 7.7]	4.6 [3.1, 6.0]
Other	4.7 [2.7, 6.7]	5.1 [1.7, 8.6]	12.8 [3.1, 22.4]	6.0 [3.7, 8.3]

intervention period, from 78%–89%, with the implication being that improved patient education empowers patients to ask clinicians about the continued need for their IDC, potentially leading to earlier removal of IDC and reduced CAUTI risk.

The introduction of the intervention included education at a hospital and ward level, champion meetings, and weekly practice adherence audits and feedback (Parker et al., 2017). Other aspects of the study may have indirectly influenced the intervention, including the point prevalence data collection being conducted in all wards (excepting EDs) and completion of the online staff survey, by increasing clinicians' awareness of the intervention. Following the first month of the intervention, education ceased, and practice adherence audits and feedback became less frequent.

Practice adherence audits commenced immediately following the delivery of educational components of the implementation and were carried out for 6 months (weekly for 6 weeks followed by monthly). However, it is unknown what feedback mechanisms were used in each hospital, and this may have impacted their effectiveness. Effectiveness of practice adherence audits and feedback is dependent on the initial performance level, the person providing the feedback, and the format of the feedback, for example verbal or written (Ivers et al., 2012). These factors were not monitored in the study.

Rates of education of nurses and midwives increased postintervention, suggesting that the education was well attended during the implementation process. Knowledge of IDC risks did not significantly increase postintervention; however, knowledge rates were reasonably high preintervention. Another aspect of the staff survey which was completed pre- and postimplementation was ward and unit culture towards CAUTI prevention. This was found to significantly increase postintervention, suggesting that there

TABLE 7 Practice adherence audit results

Question	Compliant responses (%)		
	Early audit	Later audit	Increase/decrease (*p*-value)
Was the catheter gauge documented?	196 (71%)	300 (73%)	Increase 2% (non-sig)
Was the catheter inserter's name & designation documented?	184 (66%)	288 (70%)	Increase 4% (non-sig)
Was the catheter insertion date documented?	220 (79%)	337 (82%)	Increase 3% (non-sig)
Was the catheter insertion time documented?	170 (61%)	274 (67%)	Increase 6% (non-sig)
Was bladder scan documented prior to catheter insertion?	69 (27%)	103 (28%)	Increase 1% (non-sig)
Has a catheter removal or change date been documented?	66 (27%)	95 (27%)	No change
Was patient consent documented?	61 (22%)	108 (26%)	Increase 4% (non-sig)
Was peri-urethral hygiene documented in the last 24 hr?	64 (23%)	114 (28%)	Increase 5% (non-sig)
Was review of need to continue catheter documented in last 24 hr?	112 (47%)	174 (52%)	Increase 5% (non-sig)
Does indication for catheter insertion comply with guidelines?	250 (97%)	376 (98%)	Increase 1% (non-sig)
Is the drainage bag volume less than ¾ full?	259 (94%)	387 (96%)	Increase 2% (non-sig)
Is the drainage bag outlet off the floor?	261 (95%)	385 (96%)	Increase 1% (non-sig)
Is the drainage bag below bladder level?	273 (99%)	400 (99%)	No change
Is drainage tubing free of kinks?	272 (99%)	403 (100%)	Increase 1% (non-sig)
Is drainage tubing free of loops?	271 (99%)	400 (99%)	No change
Was patient/carer education/information given?	99 (60%)	121 (54%)	Decrease 6% (non-sig)
Was there documentation of CSU collection?	85 (84%)	113 (78%)	Decrease 6% (non-sig)
Was the clinical indication for CSU collection documented?	65 (65%)	87 (60%)	Decrease 5% (non-sig)
Was there documentation of alternative options considered?	52 (20%)	56 (16%)	Decrease 4% (non-sig)
Was patient education/information documented?	36 (13%)	50 (12%)	Decrease 1% (non-sig)
Was a CSU collected?	88 (32%)	126 (31%)	Decrease 1% (non-sig)
Is catheter correctly secured to patient's thigh with recommended catheter securing device?	194 (70%)	283 (69%)	Decrease 1% (non-sig)
Is the drainage tubing off the floor?	259 (94%)	394 (98%)	Increase 4% (0.02)
Was the indication for catheter insertion documented?	225 (81%)	362 (88%)	Increase 7% (0.02)
Was the patient/carer able to explain the reason for the catheter?	143 (78%)	222 (86%)	Increase 8% (0.02)
Was the balloon filling volume documented?	127 (46%)	226 (55%)	Increase 9% (0.02)
Was daily peri-urethral hygiene attended?	159 (77%)	262 (89%)	Increase 12% (<0.01)

was some attitudinal change in the intervention facilities. Effecting practice change in healthcare environments requires complex socio-adaptive and technical changes, with change needing to come from all levels, including clinicians and management (Braithwaite, Marks, & Taylor, 2014). These socio-adaptive elements have been identified as impacting CAUTI prevention interventions (Krein & Saint, 2014).

Sustainability of interventions is a key consideration and challenge in implementation science (Doyle et al., 2013) and requires further consideration with regard to implementing CAUTI prevention interventions. Saint et al. (2016) had success with a multisite CAUTI prevention initiative, with results sustained over an 18-month period. Similar to this study, Saint et al. (2016) intervention included ongoing education, which may have contributed to the sustained impact. Study findings point to the need for further research into interventions that also impact on longer-term IDC prevalence rates.

6.1 | Limitations

The study was conducted in four hospitals across two LHDs in one state in Australia. This limits generalisability to other States within Australia. However, strengths of the study include inclusion of both metropolitan and rural hospitals, and hospitals with and without an ICU. Due to the high numbers of missing documentation, it was not possible to evaluate whether indications for IDC use were appropriate or inappropriate.

The present study did not directly track fidelity of implementation, which limits the ability to evaluate which aspects of the implementation were effective.

6.2 | Recommendations

Implementation of a multifaceted "NO CAUTI" intervention is recommended in Australian acute-care hospitals. An implementation and sustainability plan are required to embed the intervention into practice, and this may involve employing dedicated staff, as has been done in other projects (e.g. Knoll et al., 2011). Addition of a reminder system (e.g. Mitchell et al., 2019) also has the potential to maintain results.

The current study findings highlight the success in reducing IDC duration in the short-term IDC group, but with no reduction realised in the longer-term IDCs group. This finding reflects the need for further research aimed at reducing IDC use in inpatients requiring longer-term IDC use. Sustained improvement in IDC practices is dependent on utilising strategies to embed practice change initiatives. These strategies may include champions that have managerial support, as well as ongoing education. Additional strategies may include reminder systems, which have been found to be effective in reducing CAUTI rates (Meddings et al., 2014).

7 | CONCLUSION

Implementation of a multifaceted intervention including a care bundle resulted in a reduction of IDC use in four acute-care hospitals in Australia over three time-points. This adds to the evidence base for CAUTI prevention interventions in an Australian context. Further research examining interventions that impact on longer-term IDC use and the development of strategies regarding scalability of the intervention to larger populations is the next logical step. Implementation strategies used, including education and audit and feedback, appeared to be effective based on initial improvements in IDC rates. This will require support and commitment from an executive level from the outset of the programme. Strategies to measure the fidelity of implementation strategies would also strengthen further research and interventions.

8 | RELEVANCE TO CLINICAL PRACTICE

Catheter-associated urinary tract infections are highly preventable. Clinical nurse leaders can effectively implement change strategies that influence patient outcomes. In this study, implementation of the evidence-based "No CAUTI" bundle increased awareness of the appropriate indications for catheterisation evidenced through the reduction in avoidable IDC use. Regular practice adherence audits were key maintaining a high standard of patient care and reducing the risk to patient safety. Regular feedback to clinicians highlights the benefits of best practice catheter care and management and may identify opportunities for further improvement.

Nurses are most often the clinician responsible for insertion, care and maintenance of IDCs. The nurse-led intervention presented in this paper provided clinicians with the tools to assist with effective clinical decision-making. The proportion of nurses inserting IDCs increased which suggests that the use of the "No CAUTI" care bundle increased knowledge and competency. Understanding the catheterisation pathway empowers nurses to challenge unsafe practices and advocate timely IDC removal. Furthermore, empowering patients to ask clinicians about the continued need for their IDC through improved patient education, potentially leads to earlier removal of IDC and reduced CAUTI risk. Working in partnership with patients and the multidisciplinary team is essential in minimising IDC use in acute care and is a pillar of person-centred care.

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CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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