Research Article

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Does Consciousness Level Determine the Timing of Successful Removal of Urinary Catheters at Neurosurgery Intensive Care Unit-Implication to Nosocomial Infection Prevention

Jui-Kuang Chen[1,2,3], Huey-Shyan Lin[3], Chao-Li Hsiao[4], Wei-Chuna Liao[5,6], Hung-Chin Tsai[1,5], Yao-Shen Chen[1,5] and Wei-Chuan Chen[7,8,9*]

[1]*Division of Infectious Diseases, Department of Internal Medicine, Kaohsiung Veterans General Hospital, Taiwan*

[2]*Department of Internal Medicine, National Defense Medical Center, Taiwan*

[3]*School of Nursing, Fooyin University, Taiwan*

[4]*Department of Nursing, Kaohsiung Veterans General Hospital, Taiwan*

[5]*School of Medicine, National Yang-Ming University, Taiwan*

[6]*Division of neurosurgery, Department of surgery, Kaohsiung Veterans General Hospital, Taiwan*

[7]*Department of Medical Education and Research, Kaohsiung Veterans General Hospital, Taiwan*

[8]*School of Medicine, College of Medicine, I-Shou University, Taiwan*

[9]*Department of Pharmacy and Master Program, Tajen University, Taiwan*

[*]Corresponding Author
Wei-Chuan Chen, Department of Medical Education and Research, Division of Urology, Department of Surgery, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan.

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Abstract

Objective

This study aimed to investigate whether the level of consciousness can be used as an indicator to determine the successful removal of urinary catheters in post-stroke patients admitted to the neurosurgical intensive care unit (NICU).

Methods

The study included 97 patients who had urinary catheters in NICU and were divided into three groups based on their level of consciousness. Our analyses was performed by various statistical methods, including the chi-square test, one-way ANOVA, univariate and multivariate regression.

Results

The overall success rate of catheter removal was found to be 62.9%. On average, the catheters were retained for 6.3 ± 3.6 days. The presence of diabetes mellitus was identified as the only factor that significantly influenced the successful removal of catheters (Adjusted Odds Ratio = 0.236, p = 0.035). No significant differences were observed among patients with different degrees of consciousness impairment. Implementing a nursing-driven circle strategy and bladder sonography scan protocol significantly could decrease the catheter-associated urinary infection (CAUTI) rate from 10.25/1,000 catheter days to 6.69/1,000 catheter days.

Conclusions

Based on our findings, we recommend removing urinary catheters five days after initial placement for patients with a Glasgow Coma Scale (GCS) score greater than eight and for non-intubated patients, as well as for intubated patients and aphasic patients in the NICU with a GCS score greater than 4. This protocol can potentially prevent CAUTI cases resulting from delayed UC removal.

1. Backgrounds

Urinary retentions were common in post-stroke patients with an incidence from 19-47% and indwelling urinary catheters were usually necessary [1-3]. Catheter-associated urinary tract infections (CAUTIs) were a prevalent hospital-acquired infection at intensive care units (ICUs), causing higher costs, longer stays, and patient morbidity [4, 5]. The duration of indwelling urinary catheterization is a significant risk factor for developing urinary tract infections [5]. Therefore, removing urinary catheters as soon as possible is recommended if there are no longer any indications for their use, such as ongoing urinary retention [6]. The Surgical Care Improvement Project (SCIP) suggests that urinary catheters should ideally be removed within 48 hours after surgery to prevent catheter-associated urinary infection (CAUTI) [7]. In Taiwan, a program was implemented to reduce the occurrence of catheter-associated urinary tract infections. The results showed significant reduction rates in medical centers, regional hospitals, and district hospitals, ranging from 18.4% to 54%. Overall, there was a 22.7% reduction in the CAUTI by implementing this program [8]. In patients with acute stroke, the timing of removal of urinary catheters (UCs) varied significantly, ranging from 3.8 days to 18 days [9,10]. Delayed removal of UCs can increase the incidence of CAUTI. Several risk factors contribute to the failure of timely UC removal, including lower body mass index, benign prostatic hypertrophy, hemorrhagic stroke, lower levels of physical function, cognitive impairment, and diabetes mellitus (DM) [1,9-12]. Neurosurgeons often refrained from UCs in patients with impaired consciousness due to concerns that urine retention could negatively impact post-operative outcomes by increasing intracranial pressure (IICP). The decision surrounding UC removal posed a challenge in the neurological intensive care units (NICUs). The implementation of the Nursing-driven circle strategy (NDS) and bladder sonography scan protocol (BSP) were used to reduce the incidence of CAUTI has been carried out [1,13]. In our hospital's intensive care unit (ICU), the hospital information system (HIS) reminded the removal of UCs on day five has been automatic since 2002 [14]. Despite these measures, the CAUTI rate has increased from 4.9 to 12.4 cases per 1,000 catheter days between 2003 and 2012. This surprising outcome suggested that the NICU physicians should reevaluate the CAUTI measures. Therefore, this study aimed to reconsider the timing in determining the successful removal of urinary catheters in patients at the neurological intensive care unit (NICU).

2. Material and Method

A quasi-experimental design trial was conducted in the NICU to assess the impact of urinary catheterization on patients. A total of 142 patients who had UCs were included in the study and were divided into three groups based on their level of consciousness. For the non-intubated group, a normal level of consciousness was defined as 15, with a mild alteration in consciousness noted for Glasgow Coma Scale (GCS) scores ranging from 12 to 14. A moderate change in consciousness was defined as scores between 8 and 11, and a score of less than 7 indicated a severe change in consciousness. On the other hand, for the intubated group or patients with aphasia, the normal level of consciousness was 11. A mild change in consciousness was observed for scores between 8 and 10. A moderate change in consciousness was defined as scores between 4 and 7, and a score of less than 3 indicated a severe change in consciousness. The rates of CAUTI in our hospital were compared between May 2014 - April 2016 and May 2016 - August 2018. Patients with spinal diseases, a history of prostate cancer, or benign prostatic hyperplasia (BPH), and those who surgeons declined were excluded from the study.

The indications for the placement of urinary catheters are as follows: (1) patients in critical condition with unstable hemodynamics; (2) postoperative monitoring of urine output; (3) specific surgical procedures requiring urinary catheterization (such as thoracic and pelvic surgery); (4) presence of an open wound around the sacral or perineal area; (5) acute urinary retention; and (6) reaching a consensus among hospice care providers to relieve discomfort through the use of indwelling urinary catheters [15,16].

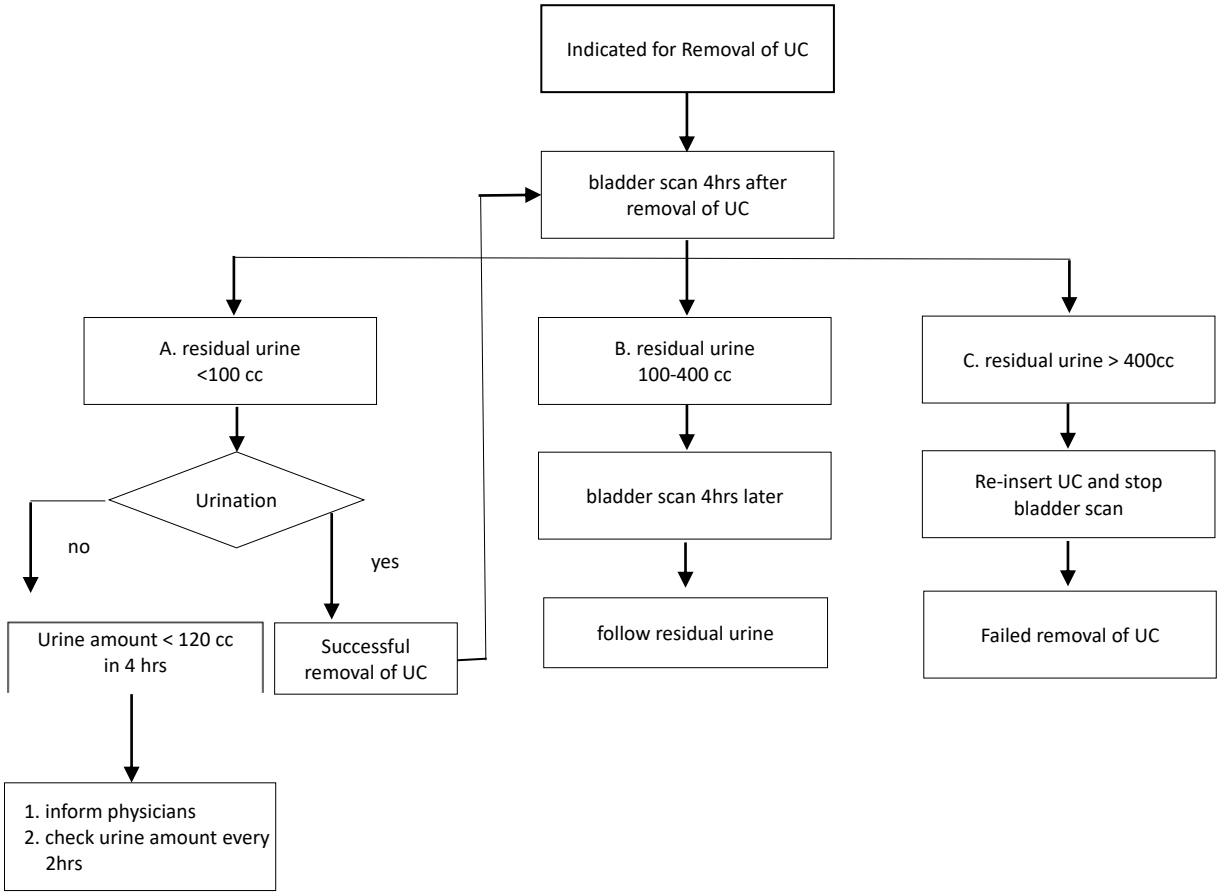


Figure 1: Protocol of removal and reinsertion of urinary catheters

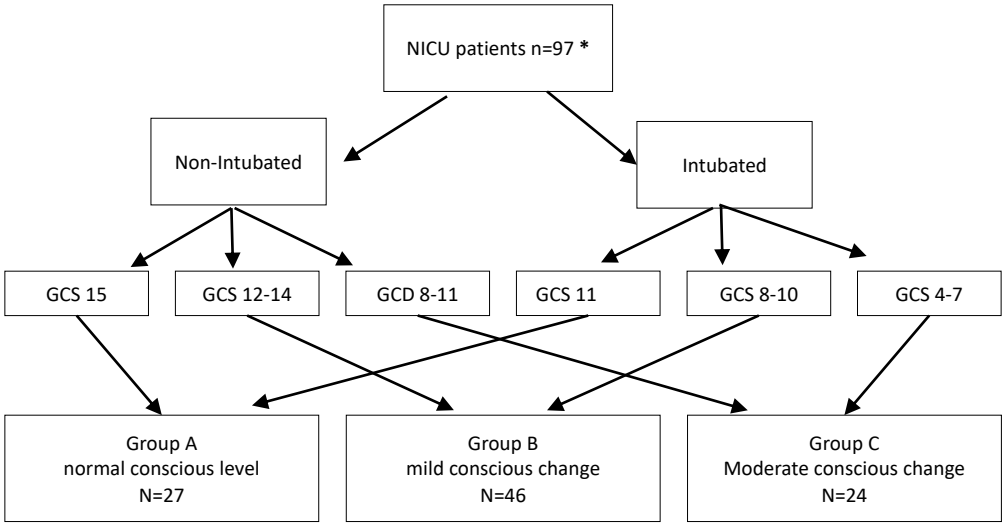
The decision to remove and reinsert UCs was made by NDS and BSP.

NDS was determined through a collaborative effort of surgeons and nurses. On day five of UCs, the nurse leader and registered nurses would meet to discuss the removal timing, with a reminder provided by the ICU's information system. Following this discussion, the decision to remove the UCs was ultimately made by the surgeons.

The successful removal of UCs was determined by the absence that required another UC to be inserted within 48 hours after the previous UC was removed. The incidence of CAUTIs was calculated according to the guidelines established by the Infectious Diseases Society of America (IDSA) and expressed as the number of CAUTI cases per 1,000 catheter days [15,17]. Our analysis used various statistical methods, including one-way ANOVA, univariate and multivariate regression. These methods were employed to analyze both categorical and numerical variables. A p-value of less than 0.05 was considered statistically significant. IBM SPSS 26.0 (IBM Corp., Armonk, NY) was used for all statistical analyses.

3. Results

Ninety-seven patients were included in the study, excluding those with benign prostate hyperplasia (BPH), prostate cancer, severe spinal stenosis, and those declined by the surgeon. Based on the definitions of consciousness levels, Group A consisted of 27 patients, accounting for 27.8% of the total. Group B comprised 46 patients, representing 47.4% of the total. There were 24 patients in Group C, making up 24.7% of the total (Fig.2).



*Exclusion:
1. patients with history of prostate cancer or BPH: 5
2. spine diseases: 4
3. patients didn't meet BSP: 26
4.excluded by neurosurgeon: 10

Figure 2: Patient groups by level of consciousness

The characteristics of the patients with different levels of consciousness were not statistically significant, except APACHE II score, and calcium channel blocker CCB medication (Table 1). The factors influencing the successful removal of UCs were analyzed using univariate and multivariate analyses. Diabetes mellitus was found to be the only factor significantly impacting the successful removal of UCs (adjusted odds ratio = 0.236, $p < .05$). There were no significant differences observed among the three groups (Tables 2 and 3). The rate of CAUTIs significantly decreased before and after the implementation of NSD and BSP (10.25/1,000 vs. 6.69/1,000 catheter-day) ($p < .05$). The median duration of catheterization in our intensive care unit is 6.0 days, with an interquartile range (IQR) 5-8 days. Out of 97 patients, the overall success rate of UCs through BSP was 62.9% (61 patients). For the 36 patients in whom the BSP was unsuccessful, re-insertion of the urinary catheter was performed within 6 hours. These patients had a median residual urine volume of 510 mL (IQR: 365-600 mL). Significantly, none of these patients developed increased intracranial pressure.

	Total (N=97)	**Normal A (N =27)**	**Mild B (N =46)**	**Moderate C (N = 24)**	***p* value**	**Post-hoc test**
Age(mean ± SD)	60.3±16.9a	51.3±19.3	62.4±16.1	66.3±11.3	0.003	A<B A<C
Age (N/%)					**0.064**	
<50	23(23.7)	11(11.3)	10(10.3)	2(2.1)		
51-70	41(42.2)	11(11.3)	19(19.6)	11(11.3)		
>70	33(34.0)	5(5.2)	17(17.5)	11(11.3)		
Male(N/%)	52(53.6)	14(51.9)	25(54.3)	13(54.2)	0.977	
BMI	97(100)	25.3±4.22	23.54±5.00	24.83±4.97	0.277	
DM	21 (21.8)	6 (22.2)	9 (19.6)	6 (25)	0.869	
Diagnosis(N/%)					0.058	
Brain tumor	13(13.4)	7(25.9)	4(8.7)	2(8.3)		
ICH/SAH/SDH/						

aneurysm rupture	67(69.1)	12(44.4)	37(80.4)	18(75)		
Ischemic infarction n	5(5.2)	2(7.4)	1(2.2)	2(8.3)		
others	12(12.4)	6(22.2)	4(8.7)	2(8.3)		
APACHE II score	16.6±4.66 a	14.2±4.4	16.6±4.6	19.2±3.2	<0.001***	A<C
Surgery(N/%)	77(79.4)	19(70.4)	36(78.3)	22 (91.7)	0.166	
CCB	71 (73.2)	16(59.3)	33(71.7)	22(91.7)	0.032*	
CTM	13(13.4)	4(14.8)	7(15.2)	2(8.3)	0.702	
Haldol	11(11.3)	2(7.4)	7(15.2)	2(8.3)	0.517	
Sedatives	7(7.2)	2(28.6)	4(57.1)	1(14.3)	0.886	
Anti-epilepsy	33 (34)	8(29.6)	18 (39.1)	7(21.2)	0.601	

ICH: intracranial hemorrhage, SAH: subarachnoid hemorrhage, SDH: subdural hemorrhage, CC: consciousness change, CCB: calcium channel blocker, CTM: chlorpheniramine, Hadol: haloperidol, p <.05*, p<.01**, p<.001***

Table 1: The characteristics of the patients with different consciousness level

	Successful (N=61)	Failed (N=36)	OR	p value
Age			(vs <50)	0.77
<50	15 (24.6)	8 (22.2)	1	
51-70	24 (39.3)	17 (47.2)	0.81 (0.28,2.4)	
>70	22 (36.1)	11 (30.1)	1.1 (0.81, 25.2)	
Gender			(vs female)	0.53
Female	27 (44.3)	18 (50.0)	1	
Male	34 (55.7)	18 (50.0)	1.31 (0.57, 3.00)	
BMI			0.95 (0.86, 1.04)	0.24
ICL			(vs normal)	0.43
Normal	20 (32.8)	7 (19.4)	1	
Mild	27 (44.3)	19 (52.8)	0.52 (0.18, 1.49)	
Moderate	14 (23.0)	10 (27.8)	0.52 (0.16, 1.69)	
DM	9 (14.8)	12 (33.3)	0.35 (0.13, 0.95)	0.04
Admission diagnosis			(vs brain tumor)	0.99
Brain tumor	8 (13.1)	5(13.9)	1	
ICH/SAH/SDH/aneurysm				
rupture	42 (68.9)	25 (69.4)	1.03 (0.30, 3.48)	0.97
Ischemic infarction	3 (60)	2 (40)	0.94 (0.11, 7.73)	0.95
Others	8 (4.9)	4(11.1)	1.25 (0.24, 6.44)	0.79
Brain surgery	49 (80.3)	28 (77.8)	1.27 (0.46, 3.54)	0.64
Admission APACHE II			0.93 (0.85, 1.02)	0.14
CCB	46 (75.4)	25 (69.4)	1.45 (0.57, 3.66)	0.44
CTM	7 (11.5)	6 (16.7)	0.66 (0.20,2.15)	0.49
Haldol	6 (9.8)	5(13.9)	0.70(0.19, 2.44)	0.56
Sedatives	2 (3.3)	5(13.9)	4.68 (0.86, 25.5)	0.08
Anti-epilepsy	20 (32.8)	13 (36.1)	1.13 (0.48, 2.69)	0.78
Day of catheterized (mean ± SD)	6.26±3.64	7.13±2.47		0.204

BMI: body mass index, ICL: Impaired consciousness level, CCB: calcium channel blocker, CTM: chlorpheniramine, Hadol: haloperidol, OR: odds ratio, OR: odd ratio

Table 2: Univariate analyses of factors influencing removal of UC (N=97)

	AOR	OR	p value
ICL		(vs normal)	0.25
Mild	0.324	(0.154, 1.821)	0.12
Moderate	0.277	(0.050, 1.524)	0.14
Severe	NA	NA	NA
Age		(vs <50)	0.08
51-70	0.940	(0.224, 3.946)	0.93
>70	4.514	(0.810, 25.16)	0.09
Gender		(vs female)	0.16
Male	2.319	(0.717, 7.500)	0.16
DM	0.236	(0.062, 0.904)	0.04
BMI	0.908	(0.807, 1.023)	0.11
Admission diagnosis		(vs brain tumor)	0.98
ICH/SAH/SDH/aneurysm rupture	1.061	(0.092, 12.257)	0.96
Ischemic infarction	1.614	(0.133, 19.616)	0.71
Others	1.061	(0.092, 12.257)	0.96
Brain surgery	1.452	(0.392, 5.374)	0.58
Admission APACHE II	0.928	(0.797, 1.081)	0.34
APACHEII score when removing catheter	0.933	(0.840, 1.082)	0.36
CCB	3.354	(0.874, 12.873)	0.08
CTM	0.769	(0.148, 3.991)	0.75
Haldol	2.054	(0.364, 11.575)	0.42
Sedatives	12.764	(0.906, 179.859)	0.06
Anti-epilepsy	1.608	(0.531, 4.872)	0.40

CC: consciousness change, CCB: calcium channel blocker, CTM: chlorpheniramine, Hadol: haloperidol, AOR: adjusted odds ratio ICL: Impaired consciousness level

Table 3: Multivariate analyses of factors influencing removal of UC (N=97)

4. Discussion

Urinary tract infections associated with catheter use were frequently observed in ICUs and resulted in increased morbidity and healthcare costs [15,16]. To prevent CAUTI, it was recommended to remove UCs as early as possible [18,19]. Multiple interventions were implemented to decrease CAUTI rates, including proper indications for catheterization, appropriate care of UCs, reminders for UCs stay, and reporting of CAUTI rates [19-21]. The NDS was recognized as one of the critical components in preventing CAUTIs [18,22,23]. Despite ongoing discussions, medical professionals had no agreement regarding the recommended approach for UCs in patients with altered consciousness. Neurosurgeons were hesitant to remove UCs due to potential complications related to urinary retention, which could be caused by IICP. The optimal timing for UCs removal continued to be a challenging decision.

Our study found that the overall success rate for UCs was 62.9%, with a median catheterization duration of 6.0 days (Interquartile range, IQR 5-8 days). There was no statistically significant difference in outcomes between patients with mild consciousness and those with moderate impairment. The rate of CAUTIs decreased significantly after the introduction of NSD and BSP. Before implementation, the CAUTI rate was 10.25 per 1,000 catheter days, while after implementation, it dropped to 6.69 per 1,000 catheter days ($p < .05$). We observed successful removal of urinary catheters in non-intubated patients with a GCS score of greater than eight and in intubated or aphasic patients with a GCS score of greater than four. In short, these findings suggest that the removal of urinary catheters can be recommended on the sixth day after surgery for patients in the NICU who have indwelling UCs.

The prolonged placement of UCs for more than six days increases the risk of developing urinary tract infections [24,25]. Diabetic patients with urinary catheters in place for an extended period have a higher one-year mortality rate compared to diabetic patients without catheters (48.9% vs. 19.1%) [26]. The development of diabetic cytopathy is characterized by dysfunction of the peripheral and autonomic nerves, resulting in decreased bladder muscle activity and then urinary retention [27]. In our study, we found that DM was the sole risk factor affecting the outcome of

the successful removal of UCs. This highlights the importance of conducting a routine urodynamic analysis in diabetic patients who have experienced cerebral infarction or hemorrhage before proceeding with UC removal.

Since there is no definitive guideline on when to UCs in post-stroke patients, we conducted a study to develop a protocol that combines NDS and BSP to reduce CAUTIs in these patients. This protocol could also be implemented in regular ward care for patients with temporary UCs who are not experiencing altered consciousness. The study was conducted using a quasi-experimental design. We must carry out randomized controlled and multi-center trials to further confirm our findings.

5. Conclusions

To our knowledge, this is the first study to investigate the timing of UCs in patients with impaired consciousness in the NICU. Our results indicate that it is recommended to remove UCs five days after they are initially inserted for patients with a GCS score higher than eight who are not intubated and for patients with a GCS score higher than four who are intubated or aphasic. Further randomized clinical trials should be conducted to verify our results.

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Ethics Approval and Consent to Participate

Provide the ISRCTN registration (ISRCTN11643929) for declarations.

Competing Interests

The authors declare that they have no competing interests.

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