



Adherence to the Catheter-Associated Urinary Tract Infection Prevention Bundle in the ICU

Adesão ao bundle de prevenção de infecção do trato urinário associada a cateter em UTI
Adhesión al bundle de Prevención de Infección del Tracto Urinario Asociada a Catéter en la UCI

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ABSTRACT

Background and Objectives: Catheter-Associated Urinary Tract Infections (CAUTI) have a high prevalence in Intensive Care Units (ICUs), representing a challenge to patient safety. The use of bundles has proven to be an effective strategy for preventing these infections. The objective of this study was to evaluate adherence to insertion and maintenance bundles of indwelling urinary catheters (IUC) for the prevention of CAUTI in ICUs, based on the analysis of three distinct periods: pre-intervention, post-intervention, and observation. **Methods:** A quasi-experimental before-and-after study was conducted in two ICUs of a public hospital in the Central-West region of Brazil, from January 2019 to March 2020. A total of 118 insertion and 767 maintenance checklists of IUC were analyzed across three phases: pre-intervention, post-intervention, and observational. Descriptive statistics, association tests (Chi-square and Fisher's Exact), and Carter's Positivity Index were used to assess compliance. **Results:** Adherence to the insertion bundle reached 87.29%, indicating safe care. In contrast, adherence to the maintenance bundle was 54%, below the expected level, with lower compliance for items such as recording the insertion date, performing meatal hygiene, and documenting daily medical progress notes. **Conclusion:** Adherence to the insertion bundle was satisfactory, whereas the maintenance bundle showed low compliance, highlighting the need for continuous educational and monitoring strategies to improve adherence and reduce CAUTI in ICUs.

Keywords: Patient Care Bundles. Intensive Care Units. Infection Control. Urinary Catheterization.

RESUMO

Justificativa e Objetivos: As Infecções do Trato Urinário Associadas ao Cateter Vesical de Demora (ITU-CVD) apresentam alta prevalência em Unidades de Terapia Intensiva (UTI), configurando-se como um desafio para a segurança do paciente. A utilização de *bundles* tem se mostrado uma estratégia eficaz na prevenção dessas infecções. O objetivo deste estudo foi avaliar a adesão aos *bundles* de inserção e manutenção do cateter vesical de demora (CVD) para prevenção de ITU-CVD em UTI, a partir da análise de três períodos distintos: pré-intervenção, pós-intervenção e observação. **Métodos:** Estudo quase-experimental, do tipo antes e depois, realizado em duas UTI de um hospital público da Região Centro-Oeste do Brasil, entre janeiro de 2019 e março de 2020. Foram analisados 118 checklists de inserção e 767 de manutenção do CVD, distribuídos em três fases: pré-intervenção, pós-intervenção e observacional. Utilizaram-se estatística descritiva, testes de associação (Qui-quadrado e Exato de Fisher) e o Índice de Positividade de Carter para avaliar a conformidade. **Resultados:** A adesão ao *bundle* de inserção apresentou conformidade de 87,29%, caracterizando assistência segura. No *bundle* de manutenção, o índice geral foi de 54%, abaixo do esperado, com menor adesão em itens como registro da data de inserção, higiene do meato urinário e evolução médica diária. **Conclusão:** A adesão ao *bundle* de inserção mostrou-se satisfatória, enquanto o de manutenção apresentou baixa conformidade, indicando a necessidade de estratégias educativas permanentes e de monitoramento contínuo para melhorar a adesão e reduzir as ITU-CVD em UTI.

Descritores: Pacotes de Assistência ao Paciente. Unidades de Terapia Intensiva. Controle de Infecções. Cateterismo Urinário.

RESUMEN

Justificación y Objetivos: Las Infecciones del Tracto Urinario Asociadas a Catéter Vesical Permanente (ITU-CVD) presentan alta prevalencia en las Unidades de Cuidados Intensivos (UCI), lo que constituye un desafío para la seguridad del paciente. El uso de *bundles* ha demostrado ser una estrategia eficaz en la prevención de estas infecciones. El objetivo de este estudio fue evaluar la adherencia a los *bundles* de inserción y mantenimiento del catéter vesical permanente (CVP) para la prevención de ITU-CVD en UCI, a partir del análisis de tres períodos distintos: preintervención, posintervención y observación. **Métodos:** Estudio cuasiexperimental, del tipo antes y después, realizado en dos UCI de un hospital público de la Región Centro-Oeste de Brasil, entre enero de 2019 y marzo de 2020. Se analizaron 118 checklists de inserción y 767 de mantenimiento del CVP, distribuidos en tres fases: preintervención, postintervención y observacional. Se utilizaron estadística descriptiva, pruebas de asociación (Chi-cuadrado y Exacta de Fisher) y el Índice de Positividad de Carter para evaluar la conformidad. **Resultados:** La adherencia al *bundle* de inserción alcanzó 87,29%, caracterizando una atención segura. En el *bundle* de mantenimiento, la conformidad general fue de 54%, por debajo de lo esperado, con menor adherencia en ítems como el registro de la fecha de inserción, la higiene del meato urinario y la evolución médica diaria. **Conclusión:** La adherencia al *bundle* de inserción fue satisfactoria, mientras que el de mantenimiento presentó baja conformidad, lo que evidencia la necesidad de estrategias educativas permanentes y de monitoreo continuo para mejorar la adherencia y reducir las ITU-CVD en las UCI.

Palabras Clave: Paquetes de Atención al Paciente. Unidades de Cuidados Intensivos. Control de Infecciones. Cateterismo Urinario.

INTRODUCTION

Healthcare-Associated Infections (HAIs) constitute a major public health problem, especially in developing countries, generating a high impact on morbidity and mortality, an increase in the length of hospital stays, and in health care-related costs.¹

HAIs are intrinsically associated with the various procedures performed in the different hospital settings.² However, as highlighted by Morais et al., the incidence of these infections is particularly high in Intensive Care Units (ICUs), owing to the complexity of the care provided to critically ill patients.³ Device-related HAIs contribute significantly to mortality in the ICU.^{3,4}

Among the main sites reported in the ICU, the Urinary Tract Infection associated with the use of an indwelling urinary catheter (CAUTI) stands out, accounting for approximately 75% of HAIs in hospitalized adult patients.⁵ This high percentage is directly related to the frequent use of the indwelling urinary catheter (IUC), one of the most widely used invasive devices in this context. Both the inadequate insertion and maintenance of the IUC contribute significantly to the increased incidence of these infections.

Patients undergoing IUC use have an estimated risk of 3% to 8% of developing a UTI per day of catheterization. Among the risk factors, the catheter dwell time proves to be a determinant for the development of CAUTI.⁶ In addition, biofilm formation, which begins immediately after IUC insertion, constitutes another critical factor, since it is associated with microbial resistance.^{7,8} It is estimated that 65 to 80% of CAUTI are related to the presence of biofilms.⁹

HAIs are, to a large extent, preventable. Specifically regarding the reduction of CAUTI rates, the implementation of *bundles* has demonstrated the capacity to reduce these infections by up to 88%.^{10,11} In this context, the present study aimed to evaluate adherence to the insertion and maintenance *bundles* of the IUC for the prevention of CAUTI in the ICU, considering three analysis periods: pre-intervention, post-intervention, and an observation phase.

METHODS

Study type and design

A quasi-experimental, before-and-after study conducted in two adult ICUs, one medical and one surgical, of a public teaching hospital located in the Central-West region of Brazil. The units total 14 beds, eight of which are intended for patients in the postoperative period of major surgeries and six for clinical patients. It is a high-complexity service that cares for critically ill patients, frequently undergoing multiple invasive procedures, including the use of an IUC, mechanical ventilation, and other devices. The

patient profile includes individuals with hemodynamic instability, requiring continuous monitoring and intensive support.

The institution is characterized as a teaching hospital, with integrated activity of health professionals and students, which implies a care dynamic associated with formative practice. The service has a multiprofessional team and a structure aimed at intensive care, including technological support and the activity of the Healthcare-Associated Infection Control Service (SCIRAS).

The design allowed for the evaluation of adherence to the *bundles* across three distinct periods (pre-intervention, post-intervention, and observation), including the implementation of an educational intervention.

Study period

The study took place between January 2019 and March 2020, comprising three phases: Phase 1: Pre-intervention: January to May 2019; Phase 2: Post-intervention: June to December 2019; and Phase 3: Observation: January to March 2020.

The observation phase aimed to evaluate the maintenance of adherence to the *bundles* after the implementation of the educational interventions. During this period, no new educational actions were carried out, maintaining only the usual care practices of the units. Data collection followed the same procedure as the previous phases, based on the institutional *checklists* routinely completed by the care team, allowing for the analysis of adherence under real practice conditions, without continuous educational reinforcement.

Population and sample

The population consisted of adult patients admitted to the studied ICUs who used an IUC. The sample was made up of the institutional insertion and maintenance *checklists* of the CAUTI prevention *bundle* available during the period. All records in which the *checklists* had completed the items comprising the insertion and maintenance *bundles* of the IUC were included — including information related to care practices, such as insertion identification, catheter fixation, urethral meatus care, and clinical progress — and duplicate and incomplete records, records with these items left blank, or those presenting inconsistencies and errors that rendered the compliance analysis unfeasible were excluded.

Variables and data collection instruments

The data were obtained from the insertion and maintenance *checklists* of the IUC, routinely completed by the care team, and from the SCIRAS epidemiological surveillance records.

The dependent variable was the overall adherence to the *bundle*, defined as full compliance with all items of the *checklist*. Independent variables included: type of

ICU (medical or surgical), study period (pre, post, observation), and adherence by indicator.

Adherence by indicator refers to the individual analysis of each item comprising the insertion and maintenance *checklists* of the IUC, such as recording the insertion date, performing urethral meatus hygiene, and daily assessment of the need for catheter permanence. This approach made it possible to identify the specific compliance of each care practice.

The quality of care was measured using Carter's Positivity Index (PI), calculated as the ratio between compliant responses and the total responses evaluated, multiplied by 100.¹² Compliance was considered as PI ≥ 80%.

Intervention

In the post-intervention period, educational actions were implemented, aimed at the ICU health professionals and conducted by the SCIRAS and continuing education teams. The activities included theoretical and practical training on the safe insertion and maintenance of the IUC, *feedback* on adherence results, and the provision of educational materials.

Collection and analysis procedures

The data were extracted from institutional records by a trained team, organized in an electronic spreadsheet (Microsoft Excel® 2010), and analyzed using the *software* R (version 4.0.3).

In the descriptive analysis, absolute and relative frequencies were used for categorical variables, and measures of central tendency and dispersion for continuous variables. For comparison between groups, the chi-square test or Fisher's exact test was applied, according to the data distribution. For the comparison of means, *Student's t-test* was used for normal data and the *Mann-Whitney* test for non-normal distributions. A significance level of 5% ($p < 0.05$) was adopted.

In order to minimize possible information biases, the data were obtained from a standardized checklist and

collected by a previously trained team, following previously established criteria for the eligibility and consistency of the records.

Ethical aspects

The study was conducted in accordance with Resolutions No. 466/2012 and No. 518/2018 of the National Health Council, and was approved by the Research Ethics Committee of the Hospital das Clínicas of the Universidade Federal de Goiás, under Opinion No. 3,114,433 and CAAE: 48765815.0.0000.5078, approved on January 16, 2019. The confidentiality and secrecy of the data were guaranteed.

RESULTS

A total of 118 checklists referring to the IUC insertion *bundle* were analyzed, from January 2019 to March 2020. Of these, 45 (38.14%) were from the Surgical ICU and 73 (61.84%) from the Medical ICU.

The overall adherence to the insertion *bundle* showed a compliance of 90.18% in the pre- and post-intervention periods, being classified as adequate care. In the observation period, six months after the last intervention, adherence decreased to 87.29%, characterizing safe care. It was observed that adherence in the observational period was lower than in the previous periods, with a reduction of 94.27% (95% CI = 0.0047–0.4494).

The following table presents the analysis of adherence to the CVC insertion *bundle* across the three evaluated periods, including the distribution of absolute and relative compliance frequencies, as well as measures of association (OR and *p*-values). Overall, high adherence is observed during the pre- and post-intervention periods, with a decline during the observation period, indicating a possible failure to sustain practices over time (Table 1).

Table 1. Overall adherence to the IUC insertion *bundle*, according to the analyzed periods. Goiânia, Goiás, Brazil.

Pre-intervention Period				
Variables	No (%)	Yes (%)	p-value	OR (95% CI)
Adherence to the <i>bundle</i> Insertion, without observation				
No	5 (9.62)	6 (10.00)	1	0.9578 (0.2163- 4.0396)
Yes	47 (90.38)	47 (90.38)		
Post-intervention Period				
Variables	No (%)	Yes (%)	p-value	OR (95% CI)
Adherence to the <i>bundle</i> Insertion				
No	5 (9.62)	10 (15.15)	0.4173	0.5983 (0.1496- 2.0857)
Yes	47 (90.38)	56 (84.86)		
Observation Period				
Variables	No (%)	Yes (%)	p-value	OR (95% CI)
Adherence to the <i>bundle</i> Insertion				
No	11 (9.82)	4 (66.67)	0.0023	0.0573 (0.0047- 0.4494)
Yes	101 (90.18)	2 (33.33)		

Abbreviation: OR = odds ratio.

In the analysis by ICU, there was no significant difference between the periods in the Surgical ICU.

However, in the medical ICU, adherence was lower in the observation period compared to the pre- and post-intervention periods (Table 2).

Table 2. Association of adherence to the IUC insertion *bundle*, according to the analyzed periods for each ICU. Goiânia, Goiás, Brazil.

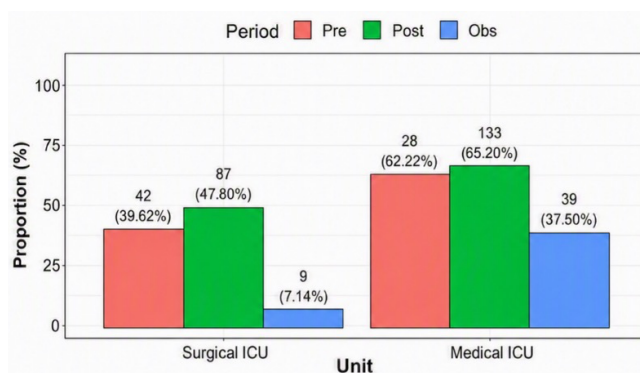
ICU	Variables	Pre-intervention Period			OR (95% CI)
		No (%)	Yes (%)	p-value	
Surgical	Adherence (without observation)				
	No	4 (14.81)	0 (0.00)	0.2795	Inf (0.4008; Inf)
	Yes	23 (85.19)	16 (100.00)		
Medical	Adherence (without observation)				
	No	1 (4.00)	6 (13.64)	0.4086	0.2680 (0.0055- 2.4244)
	Yes	24 (96.00)	38 (86.36)		
Post-intervention Period					
Surgical	Adherence				
	No	4 (14.81)	1 (5.56)	0.6337	2.8944 (0.2553- 153.8935)
	Yes	23 (85.19)	17 (94.44)		
Medical	Adherence				
	No	1 (4.00)	9 (18.75)	0.149	0.1838 (0.0040- 1.4743)
	Yes	24 (96.00)	39 (81.25)		
Observation Period					
Surgical	Adherence				
	No	4 (9.30)	1 (50.00)	0.2121	0.1132 (0.0013- 10.0498)
	Yes	39 (90.70)	1 (50.00)		
Medical	Adherence				
	No	7 (10.14)	3 (75.00)	0.0071	0.0412 (0.0007- 0.5869)
	Yes	62 (89.86)	1 (25.00)		

Abbreviation: OR = odds ratio.

Regarding the IUC maintenance *bundle*, 767 *checklists* were analyzed between January 2019 and March 2020, with 414 (53.98%) from the Surgical ICU and 353 (46.02%) from the Medical ICU.

The total compliance with the maintenance *bundle* was 54% in the pre- and post-intervention periods, classified as undesirable/poor care. In the observation period, adherence dropped to 45%, remaining as undesirable care.

The analysis showed that in all periods and ICUs there was low adherence to the maintenance *bundle*, with the worst performance in the observation period, particularly in the Surgical ICU (7.14%). The comparison between periods revealed a 77.49% reduction in adherence during the observational period (95% CI = 0.1533–0.3259) (Figure 1).

**Figure 1.** Adherence to the IUC maintenance *bundle*, according to the ICU and the analyzed periods. Goiânia, Goiás, Brazil.

In both ICUs, the lowest adherence was recorded during the observation period; however, the Surgical ICU showed a lower adherence rate than the Medical ICU. This finding is further illustrated in the following table, where adherence is proportionally lower during the observation period compared to the pre- and post-intervention periods (Table 3).

Table 3. Overall adherence to the maintenance *bundle* of the indwelling urinary catheter, according to the analyzed periods. Goiânia, Goiás, Brazil.

Pre-intervention Period				
Variables	No (%)	Yes (%)	p-value	OR (95% CI)
Adherence (without observation)				
No	81 (53.64)	166 (43.01)	0.0272	1.5323 (1.0323- 2.2792)
Yes	70 (46.36)	220 (56.99)		
Post-intervention Period				
Adherence				
No	81 (53.64)	348 (56.49)	0.5833	0.8913 (0.6139- 1.2960)
Yes	70 (46.36)	268 (43.51)		
Observation Period				
Adherence				
No	247 (46.00)	182 (79.13)	<0.001	0.2251 (0.1533- 0.3259)
Yes	290 (54.00)	48 (20.87)		

Abbreviation: OR = odds ratio.

DISCUSSION

The findings of this study showed that adherence to the IUC insertion *bundle* presented satisfactory rates, classified as safe care, with an overall compliance greater than 87%. However, a reduction in adherence was found in the observational period, especially in the medical ICU, suggesting a loss of effectiveness of the educational interventions over time. This decline is consistent with the literature, which points to the need for continuous reinforcement strategies, periodic audits, and systematic feedback, otherwise the initial educational actions lose sustainability.⁹

A prospective, before-and-after study conducted in an ICU of a hospital in Hungary reinforced this trend by showing a progressive decline in adherence after the end of the training sessions, highlighting the central role of periodic monitoring.¹³ The finding in Nepal broadens this discussion by indicating that non-adherence does not result only from knowledge gaps, but also from the difficulty in modifying ingrained practices, which suggests that training alone, although necessary, is not sufficient to guarantee lasting change.¹⁴

The high adherence observed in the post-intervention period, especially in the insertion *bundle*, corroborates studies that highlight the greater impact of educational measures in the initial stages of implementation. However, the experience of the multicenter study conducted in six hospitals in the Persian Gulf shows that, although preventive interventions can drastically reduce the rates of CAUTI (from 3.2 to 0.3 per 1,000 catheter-days in 2011, and remaining at low levels in subsequent years), such results were only possible thanks to the maintenance of systematic strategies for surveillance and reassessment of the practices.¹⁵ That is, the initial effectiveness does not, by itself, guarantee long-term sustainability.

This argument is reinforced by a review study conducted in Saudi Arabia, which shows how well-established practices - hand hygiene, aseptic insertion, daily assessment of need, and early removal - reduce the rates of CAUTI, but whose effectiveness depends on the standardization of protocols and the institutionalization of continuous education and surveillance programs. The case of the Al Khobar university hospital, which reduced its rates from 3.73 to 1.75 per 1,000 catheter-days, illustrates that maintaining the gains requires multimodal and systematic interventions, not just isolated efforts.¹⁶

Regarding the maintenance *bundle*, the results of this study pointed to unsatisfactory rates in all periods, with an overall compliance of only 54% and a drop to 45% in the observational period. This finding reinforces the evidence that the maintenance phase represents the greatest challenge in the prevention of CAUTI,

especially after the initial consolidation of the protocol. The discrepancy between the insertion and maintenance rates suggests that, while the initial practices can be more easily standardized, maintenance requires a continuous effort of supervision and team engagement, often hindered by the care overload and by weaknesses in the organizational culture.

Studies carried out for quality improvement in a university hospital in the United States demonstrated that maintenance *bundles* can reduce the rates of CAUTI, but reiterate that their sustainability is conditioned on regular audits, *feedback* to the teams, and constant reinforcement of the practices.¹⁷ In the same sense, a study was conducted in a tertiary hospital located in Taif, in the Kingdom of Saudi Arabia, belonging to the *Taif Health Cluster*, which demonstrated the effectiveness of a quality improvement model over 18 months.¹⁸ However, they warn that without continuous surveillance, periodic training, and institutional commitment, the results tend to decline progressively. Thus, the findings of this study align with the literature by showing that the absence of sustaining strategies compromises the effectiveness of the measures in the medium and long term.¹⁷

Studies show that structural and organizational barriers, such as resource scarcity, high team turnover, knowledge gaps, and weaknesses in the institutional safety culture, significantly compromise adherence to the *bundles*.¹⁹ It is necessary not only to have continuous training, but also the adoption of sustainable institutional policies, capable of guaranteeing favorable conditions for the consolidation of preventive practices. In this scenario, *Nurse-Driven Protocols* (NDPs) emerge as a promising strategy to address these limitations.²⁰

The meta-analysis of 10 studies, involving 58,195 patients, demonstrated that NDPs significantly reduced both the catheter utilization rate (34.8% vs. 49.4%) and the incidence of CAUTI (2.9% vs. 6.5%). There was a 55.9% reduction in the risk of infection and of almost 30% in catheter use. The effective implementation of NDPs requires investment in continuing education, strengthening of nursing leadership, and institutional support for autonomous decision-making.²⁰

The results point to the need for the implementation of continuous models of ongoing education, regular audits with structured *feedback* and strengthening of the safety culture, with emphasis on the leading role of nursing in conducting care protocols. The implementation of strategies, such as nurse-led protocols and the active monitoring of indicators, can help to reduce the inconsistency of practices and favor greater adherence to the *bundles*.

The study contributes by showing that the effectiveness of the *bundles* should not be analyzed only in terms of overall adherence, but also considering the

maintenance of the interventions and the differences between their constituent stages. In addition, it reinforces the importance of investigations that explore contextual and behavioral determinants of adherence, broadening the understanding of the mechanisms that influence the implementation of evidence-based practices.

As a limitation of this study, it should be noted that the analysis was based on institutional *checklists*, subject to biases arising from completion by the care team, such as underreporting or incomplete records of the practices performed. In addition, the observation period was relatively short and was interrupted during the Covid-19 pandemic, which restricted the evaluation of the sustainability of the interventions over time.

Despite these limitations, the research showed that adherence to the IUC insertion *bundle* reached satisfactory levels, constituting safe care for the critically ill patient in the ICU. On the other hand, adherence to the maintenance *bundle* proved to be unsatisfactory, with rates below expectations, which represents a continuous challenge for the prevention of CAUTI. These findings, associated with the methodological restrictions mentioned, reinforce the importance of permanent educational strategies, regular audits, and systematic monitoring, capable of sustaining and expanding safe practices in the medium and long term.

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AUTHORS' CONTRIBUTIONS

Júlio César Coelho do Nascimento contributed to the bibliographic research, writing of the abstract, introduction, methodology, discussion, interpretation and description of the results, table preparation, conclusions, review, and statistics.

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João Vitor de Oliveira Silva contributed to the writing of the abstract, methodology, interpretation of the results, conclusions, review, and statistics. **Sergiane Bisinoto Alves**

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All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.

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