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Advantages of bladder ultrasound in measuring urine volume in critically ill patients: an integrative review

Vantagens da ultrassonografia de bexiga na mensuração do volume urinário em pacientes críticos: revisão integrativa

Ventajas de la ecografía vesical en la medición del volumen urinario en pacientes críticos: revisión integradora

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ABSTRACT

Objective: to identify the scientific evidence in the literature regarding the use of bladder ultrasonography to measure urine volume in critically ill adults and elderly hospital in-patients. **Method:** this integrative review based on PRISMA recommendations was conducted in March 2021, using the descriptors "*Urine Retention", "Critical Care", "Intensive Care Unit", "Ultrasonography", "Adult" and "Elderly",* in the Lilacs, PubMed, Scopus, CINAHL, and Web of Science databases. Content analysis was performed. **Results:** in the five articles selected, two categories emerged: advantages of using ultrasound to measure urine volume and the profile of critically ill patients with a predisposition to urine retention in the hospital environment. **Conclusion:** salient advantages included efficiency in measuring urine volume and reduced need to use indwelling urinary catheters. Patient profiling showed that age of 60 years or more and prolonged use of indwelling urinary catheters contributed to urine retention.

Descriptors: Adult; Aged; Critical Care; Urinary Retention; Ultrasonography.

RESUMO

Objetivo: identificar as evidências científicas presentes na literatura quanto ao uso da ultrassonografia de bexiga na mensuração do volume urinário em pacientes críticos adultos e idosos em ambiente intra-hospitalar. **Método:** revisão integrativa baseada nas recomendações PRISMA, realizada em março de 2021, utilizado os descritores *"Retenção Urinária", "Cuidados Críticos", "Unidade de Terapia Intensiva", "Ultrassonografia", "Adulto" e "Idoso*", nas bases Lilacs, PubMed, Scopus, CINAHL, *Web of Science*. Foi realizada análise de conteúdo. **Resultados:** entre cinco selecionados, emergiram duas categorias: vantagens do uso da ultrassonografia para mensuração do volume urinário e perfil dos pacientes críticos com predisposição para manifestação da retenção urinária no ambiente hospitalar. **Conclusão:** dentre as vantagens destacou-se eficiência na mensuração do volume urinário e a redução do uso desnecessário de cateter vesical de demora. Quanto ao perfil dos pacientes, verificou-se que a idade maior ou igual a 60 anos e o uso prolongado de cateter vesical de demora contribuíram para ocorrência de retenção urinária.

Descritores: Adulto; Idoso; Cuidados Críticos; Retenção Urinária; Ultrassonografia.

RESUMEN

Objetivo: identificar las evidencias científicas presentes en la literatura sobre el uso de la ecografía vesical para medir el volumen urinario en pacientes críticos adultos y ancianos en un ambiente intrahospitalario. **Método:** revisión integradora basada en recomendaciones PRISMA, realizada en marzo de 2021, utilizando los descriptores: "*Retención Urinaria", "Cuidados Críticos", "Unidad de Cuidados Intensivos", "Ecografía", "Adulto" y "Anciano"* en las bases Lilacs, PubMed, Scopus, CINAHL y Web of Science. Se realizó análisis de contenido. **Resultados:** entre los cinco artículos seleccionados, surgieron dos categorías: las ventajas de usar ecografía para medir el volumen urinario y el perfil de los pacientes críticos con predisposición a manifestar retención urinaria en el ambiente hospitalario. **Conclusión:** entre las ventajas se destacó la eficiencia en la medición del volumen urinario y la reducción del uso innecesario de catéteres vesicales permanentes. En cuanto al perfil de los pacientes, se encontró que la edad mayor o igual a 60 años y el uso prolongado de catéteres vesicales permanentes contribuyeron a la ocurrencia de retención urinaria.

Descriptores: Adulto; Anciano; Cuidados Críticos; Retención Urinaria; Ultrasonografía.

INTRODUCTION

In an in-hospital environment, and especially in an Intensive Care Unit (ICU) for adults, one of the Nursing procedures most frequently performed by nurses is Urinary Catheterization (UC). It is a common situation in patients whose critical condition exerts a direct influence on urinary control ability. Indwelling Urinary Catheters (IUCs) may be present in approximately 15% to 25% of these patients, due to urine monitoring, bladder irrigation and Urinary Retention (UR) treatment; and despite the assertive indications, the procedure can also cause complications such as Urinary Tract Infection (UTI), trauma during the procedure and urinary retention[1,2].

Paper extracted from the Master's degree Study entitled "Use of ultrasonography in the measurement of urinary volume in adult and aged patients hospitalized in an Intensive Care Unit", presented in 2021 at the Graduate Program in Health Care of *Universidade Federal do Triângulo Mineiro* (Brazil).

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Early removal of the IUC is the main goal to be met within an ICU for the prevention of UTI, and it is necessary for the nurse to have essential knowledge and skills for managing UR after removal of the device. Lack of dexterity in the issue incurs in health problems; it is common to find UR after IUC removal in ICUs, a fact that is probably linked to the lack of skill in applying the physical examination and Nursing diagnosis, as well as to the absence of institutional protocols and professional training for patient monitoring after catheter removal[1,3-5].

UR is defined as the bladder's inability to spontaneously eliminate the urine produced by the kidneys, either partially or completely, as a result of the loss in muscle performance caused by the use of medications such as narcotics; or even caused by presence of bladder and urethral lesions and obstruction due to stenosis[6,7].

Patients with UR generally present signs and symptoms such as tachycardia, hypertension, cardiac arrhythmias, vomiting and pain complaints and, in the most severe forms, formation of kidney stones, UTI and renal failure may occur[1,5-7].

To carry out the initial UR diagnosis, anamnesis and physical examination are adopted; however, these methods are influenced by the patients' clinical conditions, causing precision loss in the Nursing diagnosis. The use of technology contributes to urinary volume analysis; imaging techniques, including bladder ultrasonography (US), are very effective for the use of reliable UR diagnoses in order to prevent unnecessary catheterizations[8,9].

Understanding the entire process that is attributed to Nursing care with patients who use or have used IUCs is indispensable for UR management and the contributing factors that trigger it in critically-ill patients[1].

Bladder ultrasonography is noteworthy for being a quick and non-invasive procedure that offers real-time UR diagnosis at the bedside, leading to fast decision-making and, subsequently, to the adoption of a course of action by health professionals, especially nurses since, with US, it is possible to estimate urinary volume more efficiently and accurately[8-10].

The national scientific productions whose objective is US use by nurses in the in-hospital setting to measure urinary volume are still little explored. This lack of research makes it difficult to understand the advantages of its use by Nursing professionals, generating barriers to adherence in measuring urinary volume through bladder US[6-11]. The publications are related to patients in post-anesthesia recovery rooms and mediate post-operative period[6,12].

The lack of concrete support to manage the UR issue in ICUs can lead to underreporting, as the patients with spontaneous urination may be subjected to post-voiding UR and, for not being monitored by nurses, may frequently be experiencing overflow voiding[12-14].

Overflow voiding can distort the UR problem, that is, nurses consider that the patients present spontaneous urination after IUC removal and, due to a diagnostic deficit, they perpetuate the situation, exposing the patients to recurrent UR. Overflow predisposes patients to UTI, bladder detrusor muscle injury and vesicoureteral reflux, which can even lead to kidney failure[9,10].

Using technologies to facilitate the physical examination is a promising path for Nursing. In 2021, the Federal Nursing Council (*Conselho Federal de Enfermagem*, COFEN) enacted Resolution 679, which approves normalization of US performance at the bedside and in the pre-hospital setting by nurses. In order to observe the regulation, the professionals must be certified with a specific course for ultrasonography handling, but they are not allowed to write reports[15]. The main purpose is to assist the professionals in their decision-making process, as use of the equipment can be considered complementary to the Nursing physical examination.

Therefore, this study aimed at identifying the scientific evidence in the literature regarding the use of bladder ultrasonography in measuring urinary volume in critically-ill adult and aged patients in a hospital environment.

METHOD

This is an integrative literature review, which aims at synthesizing and analyzing the scientific knowledge already produced on a given topic, supported by the Reporting Systematic Reviews and Meta-Analyses of Studies (PRISMA) statement, a theoretical-methodological framework consisting of a 27-item checklist and a four-step flowchart, which supports the quality of review studies[16,17].

It was developed in the following stages: (1) definition of the research question; (2) definition of the inclusion and exclusion criteria for the search in the literature; (3) definition of the information to be extracted from the studies; (4) evaluation of the studies included; (5) interpretation of the results; and 6) synthesis of the data obtained[16].

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The theme was the use of ultrasonography in measuring urinary volume in adult and aged patients with urinary retention and the strategy adopted was Population - Intervention - Comparison - Outcome (PICO).[18].

The letter P for "Population" was represented by critically-ill adult and aged patients, the I for "Intervention" corresponded to using ultrasonography in the measurement of urinary volume, the C for "Comparison" does not apply in this study and the O for "Outcome" is to verify the advantages of using ultrasonography to measure urinary volume, in order to structure the following guiding question: Which is the scientific evidence in the literature on the use of ultrasonography in the measurement of urinary volume in critically-ill adult and aged patients in a hospital environment?

The inclusion criteria were the following: primary studies that answered the research question, with no time frame and without language restrictions. Literature reviews, letters to the editor, editorials, theses, dissertations, opinion articles, comments, previous notes, manuals, books, book chapters and manuscripts whose populations were not adult and aged critically-ill patients were excluded.

The following information sources were used: *Literatura Latino Americana e do Caribe em Ciências da Saúde* (LILACS), US National Library of Medicine National Institutes Database Search of Health (Medline/PubMed®), Scopus, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Web of Science.

The search for data took place in March 2021, combining the elements of the PICO strategy, appropriating the Health Sciences Descriptors (*Descritores em Ciências da Saúde*, DeCS) in a trilingual way, the controlled descriptors from the Medical Subject Headings Section (MeSH) and Boolean operators, emphasizing that each information source employed works in a unique way and responds to different commands, which implies adapting the search strategy for each.

In PubMed®, Scopus, CINAHL and Web of Science, the following controlled descriptors were defined, in the English language: Adult, Aged, Intensive Care Units, Critical Care, Ultrasonography and Urinary Retention, with the following strategy: Adult OR Aged AND Intensive Care Units OR Critical Care AND Ultrasonography AND Urinary Retention.

In LILACS, the controlled descriptors were from the DeCS in Portuguese, with the following crossings: *Adulto* OR *Idoso* AND *Unidades de Cuidado Intensivo* OR *Cuidado Crítico* AND *Ultrassonografia* AND *Retenção Urinária*.

For selection of the studies, repeated articles were excluded and then the titles and abstracts were independently read by two reviewers, with the blinding tool activated in the Rayyan Qatar Computing Research Institute[19] app, a free web review program, of a single version. A third reviewer was available, an expert in the subject matter, to solve any and all divergences in the process.

Subsequently, full reading was conducted, and the final sample was defined. In the third stage, the information that was relevant to the research question was extracted from the studies through a validated instrument, namely: author, year of publication, country of origin, objective, type of study, results/conclusions[20].

The analysis of the level of evidence was classified into seven levels, namely: 1- systematic review, meta-analysis or clinical guidelines from systematic reviews of randomized and controlled clinical trials; 2- evidence of at least one randomized controlled clinical trial; 3- evidence derived from well-designed clinical trials without randomization; 4- evidence from a well-designed cohort and case-control studies; 5- evidence presented from systematic reviews, descriptive and qualitative studies; 6- evidence from a single descriptive or qualitative study; and 7- evidence derived from the opinion of authorities and/or experts committee opinion.[21]

Subsequently, categorization of the findings was carried out through Thematic Analysis, following three stages: pre-analysis, evidenced by fluctuating reading of the evidence and organization of the convergent information; exploration of the material, with grouping of the confluences; and data treatment, listing the possible categories[22].

For fulfillment of the fifth and sixth stages, data analysis was based on the descriptive evaluation of the articles, being possible to observe, describe and order the diverse information so as to group the relevant elements extracted in the review[23], considering the instrument's variables[20]: year of publication, country of origin, type of research, level of evidence, sample, objectives, results and main conclusions.

RESULTS

A priori, 131 studies were identified, and five comprised the final sample of the current research (Figure 1).

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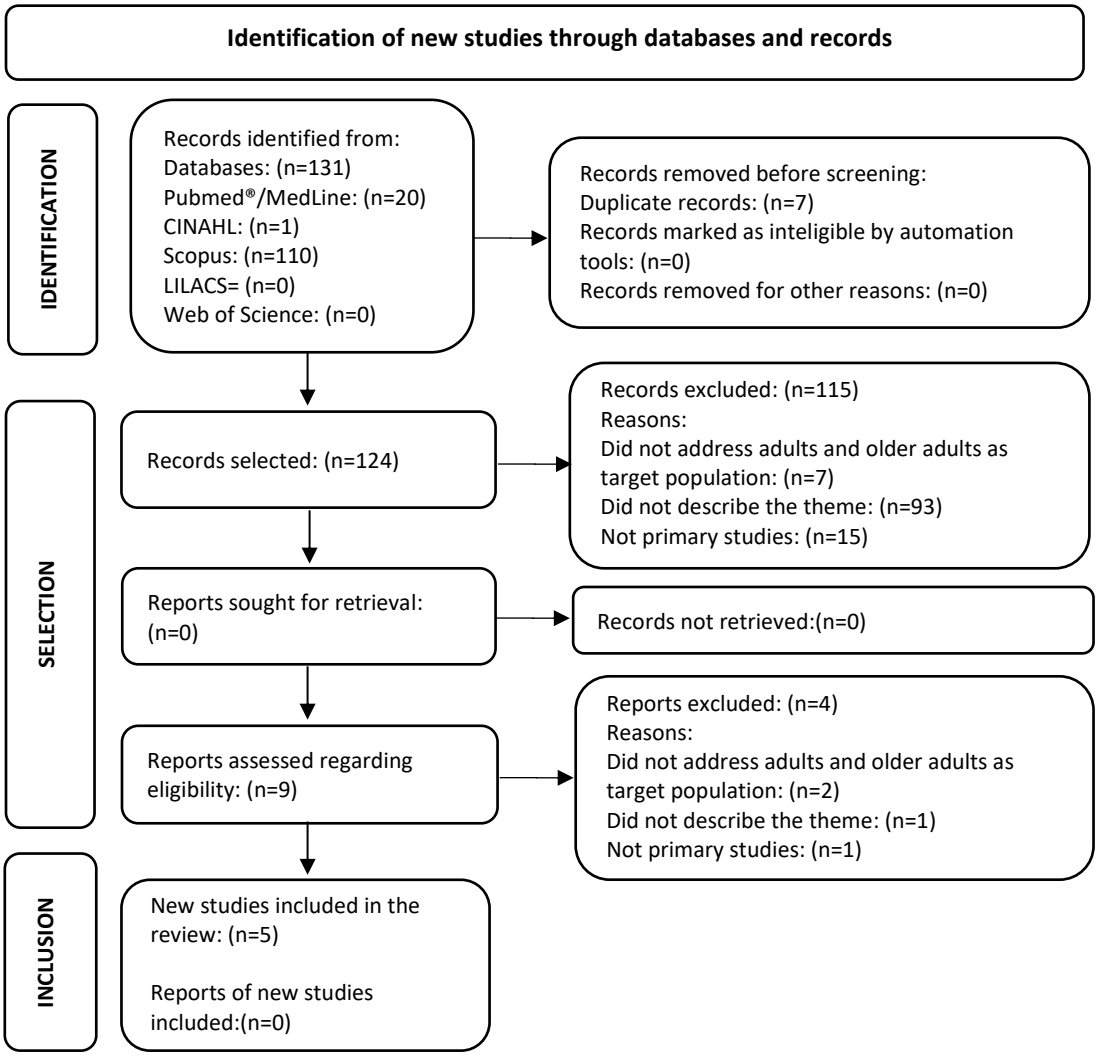

FIGURE 1: Flowchart corresponding to the identification, selection and inclusion of the studies, elaborated based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendation. Uberaba, MG, Brazil, 2021.

In the characterization of the studies that made up the sample, it is observed that the publications occurred between 2007 and 2021, with predominance of international, prospective cohort and level of evidence 4 studies, in addition to observational studies with level of evidence 6 (Figure 2).

Based on the analysis of the studies, two thematic categories were determined: Advantages of using ultrasonography to measure urinary volume in critically-ill adult and aged patients in the hospital environment; and Profile of critically-ill patients with predisposition to present UR in the hospital environment.

Advantages of using ultrasonography to measure urinary volume in critically ill adult and aged patients in the hospital environment

The studies pointed out the following as the main advantages of using bladder US in adult and aged critically ill patients: efficiency in measuring urinary volume[24,25,27]; reduction in unnecessary use of IUCs[24,26,27], decreased risk of urinary tract infection[24,25], early detection of urinary retention[1,24], cost reduction with unnecessary urinary catheterization[26] and diagnosis of IUC occlusion[24].

Profile of the critically ill patients with predisposition to present of UR in the hospital environment

According to the studies selected, the following were listed for the manifestation of UR in critically ill patients: age greater than or equal to 60 years old[24,26], individuals who have used IUCs for a long period of time[1,24], bedridden people[1] and those in use of sedative medications[1].

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Study, year/ Country	Type of research and Level of evidence	Sample (n)	Objectives	Results	Main conclusions
A- 2007[24] China	Quasi-experimental study Level 3	76 and 168 patients included in the control and experimental groups, respectively.	To assess the difference between unnecessary catheterization, urinary retention and urinary tract infection before and after implementing ultrasonography to assess urinary volume.	The unnecessary catheterization rates in the control and experimental groups were 35.3% and 7.0%, respectively. Urine volume (more than 500 ml) in the control and experimental groups was 13.4% and 20.3%, respectively. The experimental group had a mean catheterization volume statistically and significantly lower than the control group (676.9 mL vs. 777.1 mL, t = 1.84, p<0.05). After 6 months, the urinary tract infection rates were reduced to 1.39%.	Ultrasound was successful in measuring the bladder's urinary volume and can be employed to treat patients with urinary disorders in Neurosurgery units.
B - 2015[25] France	Retrospective and observational study Level 6	100 patients were included in the sample.	To determine if post-operative urinary retention can be diagnosed by means of ultrasonography.	In 49 patients, a significant correlation was found between greater cross-sectional diameter and the urinary volumes measured by the two methods (*Bladderscan* and catheterization). Pearson's correlation coefficients were r = 0.80 (95% Confidence Interval [CI]: 0.72-0.86; p<0.001) and r = 0.79 (95% CI: 0.65-0.88; p<0.001), respectively. The areas under the curve for the forecast of bladder volume ≥ 600 mL were 0.94 (95% CI: 0.88-0.98) and 0.91 (95% CI: 0.79-0.97), respectively, for the urinary volumes measured by means of *Bladderscan* and catheterization. The ideal cutoff value was 9.7 cm for both methods. The gray zone was narrow, varying from 9.7 to 10.	Using simple ultrasound measurement of the largest cross-sectional bladder diameter seemed to be useful to exclude or confirm post-operative urinary retention.
C - 2019[1] Brazil	Prospective cohort study Level 4	85 patients.	To determine the incidence and the risk factors for acute urinary retention after removing the indwelling urinary catheter in critically-ill patients.	Most of the patients included were surgical (71.6%). Acute urinary retention was found in 26 patients (30.6%). The use of hypnotics (midazolam or propofol administered as a continuous infusion) [OR: 4.87 (95% CI: 1.32-167.79); p = 0.029], indwelling catheterization for more than 7 days [OR: 9.87 (95% CI: 2.97-32.85); p<0.01] and bed confinement [OR: 9.43 (95% CI: 1.07-83.33); p = 0.043] were all independent risk factors for acute urinary retention.	It is concluded that the incidence of acute urinary retention is high and that the main risk factors for its occurrence are prolonged use of urinary catheter, bed confinement and use of hypnotics.

FIGURE 2: Distribution of the studies according to year, country, type of research, level of evidence, sample, objectives, results and conclusions. Uberaba, MG, Brazil, 2021.
Source: Prepared by the authors, 2021.

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Study, year/ Country	Type of research and Level of evidence	Sample (n)	Objectives	Results	Main conclusions
D - 2020[26] Spain	Retrospective cohort study Level 4	113 patients	To estimate the impact of using ultrasonography on the urinary retention diagnosis in a medical clinic.	The frequency of catheterization due to retention was reduced from 47.5% to 21.4% after introducing the ultrasound exam in the unit. This represents a 50% reduction (adjusted RR = 0.48; 95% CI: 0.27-0.84, p = 0.01) in the urinary catheterization frequency due to suspected urinary retention.	Inclusion of the ultrasound device in the hospitalization units reduced unnecessary catheterization due to suspected urinary retention.
E - 2021[27] Brazil	Cross-sectional study Level 6	44 patients	To describe the frequency of urinary complaints, bladder balloon and need for urinary catheterization relief from ultrasonography; to verify the relationship between the urinary volume estimated by ultrasonography and that drained during catheterization; and to describe the relationship between the patients' complaints and detection of bladder balloon with the urinary retention diagnosis.	205 evaluations were performed in 44 patients. Urinary retention was detected through ultrasonography in 33.2% of the evaluations. There was a strong correlation between ultrasonography and bladder catheterization. Greater frequency of bladder balloon identification was verified in urinary volumes ≥ 300 mL.	The incidence of urinary retention was higher when ultrasonography was employed for the diagnosis, when compared to the patient's complaint and to the physical examination. Ultrasonography proved to be precise in determining urinary volume.

FIGURE 2: Distribution of the studies according to year, country, type of research, level of evidence, sample, objectives, results and conclusions. Uberaba, MG, Brazil, 2021 (Continuation).
Source: Prepared by the authors, 2021.

DISCUSSION

In the category of advantages of using US to measure urinary volume in critically-ill adult and aged patients in the hospital environment, efficiency in measuring urinary volume and reduction of unnecessary use of IUCs stood out.

In relation to the effectiveness of resorting to US to measure urinary volume, a scoping review was carried out in 2018 with the objective of identifying diverse scientific evidence about the practices for UR diagnosis; through the study, it was possible to confirm that US is effective because it is fast, safe and painless, requires little cooperation from the patient and, above all, it is appropriate to quantify urinary volume[14].

A research carried out with Nursing students attending the fourth and last year of the undergraduate course at a public university in Portugal highlighted that the use of US is necessary for safe and accurate measurement of the volume of urine in the bladder, as well as for the indication of IUC use. Thus, bladder US becomes an extension of the physical examination performed by nurses, facilitating its diagnosis and cooperating to minimize errors and promote patient safety[28].

A systematized review detected that UR is the most common complication in high-complexity patients, and that contributing to solve this problem is fundamental to prevent pain, infection and trauma[3].

In a study conducted in a hospital unit with 1,928 neurological patients who had impaired level of consciousness and neurological sequelae, the subjects were divided into two groups: group 1 with bladder US not available and group 2 with bladder US bladder made available by nurses after bladder emptying. The result was that the association of using imaging technology reduced UTI incidence, hospitalization time and complications[29].

Urinary volume measurement by means of US allows reducing unnecessary and undue use of the IUC. A study[24] included in the current sample, carried out in two neurosurgery units in Taiwan, highlighted that US is an effective tool that assists in the assessment of urinary volume and substantially reduces the use of IUCs, as well as it provides clarity to determine which patients have the correct indication to receive an IUC and also when the correct time is to apply urinary relief catheterization[9,24].

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In relation to the "Profile of the critically-ill patients with predisposition to present UR in the hospital environment" category, age greater than or equal to 60 years old stood out. A research study[26] carried out with 134 patients admitted to a medical clinic at the *Fundación Alcorcón* University Hospital evidenced that aged individuals have a predisposition to present UR and, consequently, need an IUC or relief catheterization. Another considerable factor that concerns aged individuals is the hypocontractility of the bladder's detrusor muscle and, as a consequence, there is difficulty in bladder emptying that can evolve to urinary retention in this age group[30].

It is noteworthy that, in addition to age, the UR diagnosis stood out due to prolonged IUC use, which is evidenced as an important and worrying causal factor by the study listed in this sample, which can trigger UTI, urethral lesions and bleeding[24].

Prolonged IUC use is harmful to the patients; a survey conducted with 85 hospitalized patients asserts that prolonged IUC use causes lack of stimulation of the bladder stretch receptors that are activated when the bladder volume reaches 150-300 ml, which consequently causes UR due to absence of the urination reflex, generating immediate and late problems that are difficult to measure regarding aspects of these patients' quality of life[1].

Recognizing the profile of the patients who are subjected to the manifestation of UR allows professionals to systematize their care, with the objective of preventing UR, as well as mitigating damage and harms to their health[13].

It is essential to recognize that the US diagnosis performed by nurses involves several aspects such as professional experience, ability to perform the physical examination and, mainly, proper use of additional resources such as US[27]. Associating the use of technology during the physical examination to apply the Nursing diagnosis adds value to the nurses' assistance during conduction of the Nursing process[13,14,27].

The study provides diverse evidence to the health sciences and mainly to Nursing, for compiling the knowledge produced about the use of US in the measurement of urinary volume in critically-ill adult and aged patients, presenting the main advantages of resorting to US and highlighting the profile of the patients with UR.

However, despite these results, the studies are not yet grounded on manuscripts with levels of evidence 4 (cohort studies) and 6 (observational studies).

Given the above, it is suggested that there is a need to carry out methodologically well-designed studies that address and appropriate knowledge about the use of US in patients with UR, in order to enable better decision-making in the clinical practice, based on reliable and reliable evidence[31].

Study limitations

The reduced number of scientific publications about the research topic and the low level of evidence found in the literature up to the present day stand out as limitations.

CONCLUSION

The advantages of using ultrasonography to measure urinary volume and the profile of critically-ill patients with predisposition to present UR in the hospital environment were listed. Among the advantages, efficiency in urinary volume measurement and reduction in unnecessary use of IUCs stood out due to their frequent occurrence. Regarding the profile, it was observed that age greater than or equal to 60 years old and prolonged use of IUCs contribute to the occurrence of UR in this population.

This study contributes to research, teaching and health care and mainly in Nursing by promoting the application of bladder ultrasonography to measure urinary volume and improve the techniques for the Nursing diagnosis for the benefit of the patients who are at risk of developing urinary retention.

Technology contributes autonomy to professionals and more safety to patients, providing better care planning, saving time and improving the quality of Nursing care.

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