






## Measures used in intensive care units to prevent infection: an integrative review

Medidas utilizadas em unidades de terapia intensiva para prevenção de infecção: revisão integrativa

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### ABSTRACT

**Objective:** to verify measures used in intensive care units to prevent infection related to health care. **Methods:** integrative review based on the data sources LILACS, SCOPUS, PubMed Central, Science Direct, Web of Science and CINAHL, whose descriptors used were: Infection Control and Intensive Care Units. Sample consisting of 146 studies. **Results:** thematic categories related to the relevant infection prevention measures were listed, developed in Intensive Care Units: bloodstream infection prevention measures, assistance-related pneumonia prevention measures, urinary tract infection prevention measure and preventive measures associated with general care. **Conclusion:** among the established thematic categories, care with skin preparation, oral hygiene, correct handling of the urinary catheter and daily bath with antiseptic were most frequently identified. **Descriptors:** Infection Control; Intensive Care Units; Nursing; Review; Universal Precautions.

### RESUMO

**Objetivo:** verificar medidas utilizadas em unidades de terapia intensiva para prevenção de infecção relacionada à assistência à saúde. **Métodos:** revisão integrativa, a partir das fontes de dados LILACS, SCOPUS, PubMed Central, Science Direct, Web of Science e CINAHL, cujos descritores utilizados foram *Infection Control* e *Intensive Care Units*. Amostra constituída por 146 estudos. **Resultados:** elencaram-se categorias temáticas relacionadas às medidas de prevenção de infecção pertinentes, desenvolvidas em Unidades de Terapia Intensiva: medidas de prevenção de infecção da corrente sanguínea, medidas de prevenção de pneumonia relacionada à assistência, medida de prevenção de infecção do trato urinário e medidas de prevenção associadas aos cuidados gerais. **Conclusão:** dentre as categorias temáticas estabelecidas, identificou-se com maior frequência o cuidado com a preparação da pele, a higiene oral, o manuseio correto do cateter urinário e o banho diário com antisséptico. **Descritores:** Controle de Infecções; Unidades de Terapia Intensiva; Enfermagem; Revisão; Precauções Universais.

## Introduction

Intensive Care Units are designed to care for critically ill and hemodynamically unstable patients. Due to the critical health conditions they present and the invasive procedures necessary for the recovery and maintenance of life, these individuals are highly susceptible to infections during hospitalization in this sector<sup>(1)</sup>.

Infections Related to Health Care are acquired in care procedures, in which patients are submitted or during hospitalization, and are associated with a significant increase in morbidity and mortality rates, directly reflecting on patient safety. In the occurrence of these infections, pneumonia, urinary tract infections, bloodstream infections and surgical site infections are considered as the main ones<sup>(2)</sup>.

In Brazil, data from 2017 showed that the highest rates of infection in Adult Intensive Care Units are ventilator-associated pneumonia, 11.5 per 1,000 devices-day, whereas in neonatal Intensive Care Units, there is a predominance of primary laboratory bloodstream infections, 8.6 per 1,000 devices-day, in neonates weighing less than 750 grams. In Pediatric Intensive Care Units, there were no major discrepancies between the incidence densities in primary laboratory bloodstream infections, urinary tract infection and ventilator-associated pneumonia<sup>(3)</sup>.

In the United States of America, there were 24,223 episodes of ventilator-associated pneumonia in 2018 in general acute care hospitals. As for urinary tract infections, 22,015 infections associated with the catheter were reported. Regarding bloodstream infections, there were 19,188 cases of infections associated with the central line<sup>(4)</sup>.

Multicenter study, based on active surveillance, carried out in Intensive Care Units, showed the incidence of Health Care-Related Infections in 22.6% of patients, in which the mortality rate associated with these infections was 10.8%<sup>(5)</sup>.

Research shows that the reduction of these

infections occurs by up to 70.0%, when health establishments and their professionals understand the severity of infections and assume the responsibility for putting infection control programs into practice<sup>(6)</sup>. Thus, the relevance of preventive measures that can be carried out through simple actions, such as hand hygiene, monitoring of asepsis measures, processing of articles and surfaces and use of personal protective equipment is perceived<sup>(2)</sup>.

Despite the considerable scientific advances related to infection control, there is difficulty in carrying out preventive actions by the professional team and other obstacles, such as inadequate physical space, lack of resources to implement aseptic techniques and high patient turnover<sup>(6)</sup>.

Thus, searching for scientific evidence on infection prevention measures and synthesizing the results, through an integrative literature review, allows the analysis of broad data in a clear way and, consequently, fosters the knowledge of health professionals about actions and measures preventive measures, in order to promote the control of infections related to health care, especially in Intensive Care Units. From the given context, the objective was to verify measures used in intensive care units to prevent infection related to health care.

## Methods

Integrative literature review study, characterized by a method that assesses, synthesizes results and provides resources for the broad knowledge of a given theme applied in clinical practice, organized based on a research protocol previously developed to obtain the sampling, analysis and presentation of results<sup>(7)</sup>.

This study was organized according to the stages: formulation of the research problem; bibliographic research, through the application of inclusion and exclusion criteria; data collection, through research instrument; critical analysis of studies; and presentation of results<sup>(7)</sup>.

When analyzing adverse events related to infections in the Intensive Care Unit associated with high mortality rates, the need to develop preventive measures is evident. In this regard, this research was carried out in order to obtain answers to the question: what measures are used in intensive care units to prevent infection related to health care?

Data collection took place between April and May 2019, by searching the data sources: Latin American and Caribbean Literature in Health Sciences (LILACS), SCOPUS, PubMed Central, Science Direct, Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINAHL). The search was carried out with the help of content accessed by the Federal University of Rio Grande do Norte, via the Federated Academic Community, through the Coordination for the Improvement of Higher Education Personnel.

As a search strategy for the studies, the descriptors ordered in the Medical Subject Headings were defined: Infection Control and Intensive Care Units. In the search process in the databases, the crossing was performed using the Boolean operator AND, combining the descriptors with each other. As for the inclusion and exclusion criteria, articles were included that addressed infection prevention measures in intensive care units; complete articles available in the databases; articles available in English, Portuguese and Spanish and published in the last 10 years. The time frame was performed in order to identify the most recent studies on the subject. Editorials, letters to the editor, expert opinion, theoretical studies, abstracts, reviews, reviews, books, book chapters, theses and dissertations were excluded from the research.

The pre-selection of the studies was carried out by two reviewers, through the reading of titles and abstracts, independently. After this stage, the articles repeated in the databases were counted only once and, subsequently, the studies that were selected to compose the final sample were read in full.

The extraction and categorization of data included in the integrative review was carried out through

the application of an instrument prepared with the following items: identification of the publication (article title, indexed databases, country, language and year of publication), methodological aspects of the study (objective of the study, type of approach, method employed and level of evidence), characterization of the Intensive Care Units, considerations on infection prevention measures and main results and conclusions.

As for the evaluation of the studies, according to the level of evidence, the classification was adopted based on the analysis of the Collaborating Center of the Joanna Briggs Institute. The studies were evaluated as follows: Level I - Evidence obtained through systematic review of randomized controlled clinical trials; Level II - Evidence obtained from a randomized controlled clinical trial; Level III.1 - Evidence obtained from well-designed controlled clinical trials, without randomization; Level III.2 - Evidence acquired from well-designed or case-control cohort studies; Level III.3 - Evidence reached from multiple time series, with or without intervention and dramatic results in uncontrolled experiments and Level IV - Opinions from respected authorities, based on clinical criteria and experience, descriptive studies or reports from expert committees<sup>(8:14)</sup>.

The study selection process was carried out according to the recommendations of the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol<sup>(9)</sup>. From the process of identifying studies in the databases, the search resulted in 4,514 articles. Of this result, 226 studies were pre-selected during the selection stage, of which 4,288 were excluded because they were not related to the research theme. After reading the full texts, in the eligibility period, 59 articles were excluded because they did not meet the criteria and 21 were duplicated in the databases. Thus, 146 studies were selected for inclusion in the final sample of the integrative review. The results are presented descriptively and in tables.

## Results

Regarding the studies, the distribution was prepared according to location, year of publication, language, method used, type of approach and level of evidence. The sample consisted of 146 studies, of which 35.6% were published in Asia, being the continent with the highest concentration of studies. Between 2015 and 2019, there was a percentage of 54.8% of published studies, followed by 45.2% between 2009 and 2014. As for the language of publication, 97.9% of the studies were made available in English, 1.3% in Portuguese and 0.6% in Spanish.

As for methodological aspects, the vast majority of studies (78.0%) were experimental, followed by cohort studies (13.7%), cross-sectional studies (5.4%) and case-control studies (2.7%). The studies identified in the sample were of a quantitative approach (100.0%). In 105 articles (71.9%), the classification regarding the level of evidence was II; in 34 (23.2%) it was III.2; followed by four (2.7%) level III.3 articles; and three (2.0%) level IV.

Regarding the characterization of Intensive Care Units, some studies have been carried out in more than one type of unit. Thus, it was observed that 91 (62.3%) studies were carried out in Adult Intensive Care Units, 39 (26.7%) in specialized Intensive Care Units, 17 (11.6%) in Intensive Care Units Pediatric, followed by 16 (10.9%) in Neonatal Intensive Care Units and only one (0.6%) in Pediatric Mixed Intensive Care Units (intended for the care of newborn and pediatric patients).

Concerning the categorization of prevention measures, Tables 1, 2 and 3 were organized to present the identified measures, which were summarized in categories established from the thematic analysis of the studies.

**Table 1** – Categorization of measures to prevent bloodstream infection in Intensive Care Units. Santa Cruz, RN, Brazil, 2020

Bloodstream infection prevention measures	n (%)
Skin preparation	33 (22.6)
Insertion	27 (18.4)
Sanitization of hands	25 (17.1)
Educational measures	24 (16.4)
Coverings	23 (15.7)
Use of insertion and disinfection bundles for hubs and connections	17 (11.6)
Catheter removal	16 (10.9)
Catheter selection and insertion site	11 (7.5)
Surveillance of processes and results	11 (7.5)
Rate and performance feedback	9 (6.1)
Sterile curtain to cover the patient from head to toe	3 (2.0)

**Table 2** – Categorization of pneumonia prevention measures related to health care, in Intensive Care Units. Santa Cruz, RN, Brazil, 2020

Health care-related pneumonia prevention measures	n (%)
Oral hygiene with antiseptics	29 (19.8)
Keep headboard elevated (30°-45°)	25 (17.1)
Daily adjust the level of sedation and the spontaneous breathing test	23 (15.7)
Sanitization of hands	14 (9.5)
Educational measures	14 (9.5)
Aspirate subglottic secretion routinely	12 (8.2)
Cuff pressure monitoring	12 (8.2)
Prophylaxis of stress ulcers and deep vein thrombosis	12 (8.2)
Indication and care for the suction system	10 (6.8)
Care of the fan circuit	9 (6.1)
Indication and care for humidifiers	9 (6.1)
Rate and performance feedback	9 (6.1)
Ventilator-associated pneumonia surveillance	8 (5.4)
Care of inhalers and nebulizers	6 (4.1)
Give preference to orotracheal intubation	4 (2.7)
Prefer to use non-invasive mechanical ventilation	4 (2.7)
Avoid gastric overdistension	3 (2.0)
Selective digestive decontamination	2 (1.3)
Information panels and protocols	2 (1.3)
Make careful use of neuromuscular blockers	1 (0.6)
Prophylactic antibiotic	1 (0.6)
N-acetylcysteine prophylaxis	1 (0.6)
Pulmonary thromboembolism prophylaxis	1 (0.6)
Probiotics ( <i>Lactobacillus rhamnosus</i> GG)	1 (0.6)

**Table 3** – Categorization of measures to prevent urinary tract infection and associated with general health care, in Intensive Care Units. Santa Cruz, RN, Brazil, 2020

Variables	n (%)
Measures to prevent urinary tract infection	
Correct catheter handling	8 (5.4)
Educational measures	7 (4.7)
Monitoring the process and results	5 (3.4)
Special infection prevention strategies	5 (3.4)
Sanitization of hands	5 (3.4)
Feedback on infection rates and performance	5 (3.4)
Maximum barrier precautions	4 (2.7)
Infrastructure for prevention	1 (0.6)
Prevention measures associated with general health care	
Daily bath with antiseptic	21 (14.3)
Sanitization of hands	19 (13.0)
Educational measures	18 (12.3)
Care for environment and structure	17 (11.6)
Screening and isolation of patients affected by bacteria	8 (5.4)
Feedback on infection rates and performance	8 (5.4)
Standard precautions	8 (5.4)
Information panels and protocols	7 (4.7)
Sample collection for culture	5 (3.4)
Surveillance of processes and results	4 (2.7)
Universal decolonization	4 (2.7)
Intranasal Mupirocin	3 (2.0)

## Discussion

This study had limitations with respect to publications of comparative interventional studies on measures to prevent infections related to health care, in the form of technical procedures, in addition to the difficulty related to the small number of studies on measures to prevent associated urinary tract infections to the catheter, requiring detailed studies, in order to expand discussions and support for professionals. The contribution of new studies to improve recent prevention measures is of paramount importance, in view of the need for constant updating in this sector.

The measures addressed in the publications and discussed in the present study consist of scientific

evidence that can be developed to prevent infections, according to the clinical conditions presented by the patients and the need for each Intensive Care Unit.

Regarding the category of measures to prevent bloodstream infection, care with skin preparation was the most frequent in the sample. Antiseptic solutions based on chlorhexidine, povidone-iodine and 70% alcohol were approached as methods for skin preparation. However, in research that compared the cost-effectiveness between chlorhexidine and povidone-iodine gluconate solutions, friction with chlorhexidine applied for 30 seconds, before insertion, proved to be significantly more effective than povidone-iodine solution for preventing catheter colonization intravascular<sup>(10)</sup>.

As for the measures related to the catheter insertion, maximum precautions of sterile barrier are urgent to be used in the insertion procedure<sup>(11)</sup>. Regarding the insertion site, preference is given to the subclavian vein, as this site presents a lower risk of infection. In addition, there is advice to avoid the femoral vein, since the frequency of infection is considerably higher in patients with femoral access than when compared to the subclavian and jugular access routes, exposing the importance of avoiding this location<sup>(12)</sup>.

Regarding hand hygiene for handling venous catheters, there is an emphasis on the importance of hand hygiene before insertion or manipulation of the catheter<sup>(11)</sup>. On the coverings, the use of dressings impregnated with chlorhexidine gluconate for central catheters is effective. Other dressings, such as sterile gauze and transparent semipermeable coverings, were addressed. It is recommended to perform the change every 48 hours for dressings with sterile gauze and every seven days for semi-permeable transparent covers, or when they are moist, loose or visibly soiled<sup>(13)</sup>.

According to the use of insertion and disinfection bundles from hubs and connections with 70% alcoholic chlorhexidine or alcohol, before accessing the catheters, the recommended duration was 15 seconds and, in addition, timely removal was addressed

and selection of the ideal catheter. For this purpose, the use of a sterile field to cover the patient from head to toe during the central catheter insertion procedure is also important for preventing bloodstream infection<sup>(11)</sup>.

Regarding general care, the studies in the sample mentioned educational measures, such as conducting lectures and training. Concerning this result, a randomized clinical trial, carried out in a Chinese Neonatal Intensive Care Unit, carried out mandatory training on the care of peripherally inserted central catheters, showing effectiveness in reducing the rate of bloodstream infection<sup>(14)</sup>. Other measures, such as surveillance of processes and results, feedback on infection rates and performance, were also cited in the sample as important for reducing bloodstream infections.

In the category of pneumonia prevention measures related to health care, oral hygiene with antiseptics was more frequent. Oral care with chlorhexidine antiseptic solution is often reported to prevent ventilation-associated pneumonia. Regarding this precaution, it is recommended to perform this practice every eight hours<sup>(15)</sup>.

Another randomized clinical trial survey evaluated the effectiveness of a Nanosil mouthwash for preventing ventilation-associated pneumonia. When compared to 2% chlorhexidine, Nanosil showed a broader and stronger antibacterial effect on oral bacteria<sup>(16)</sup>. However, when compared to potassium permanganate, chlorhexidine was more effective<sup>(17)</sup>.

As for the positioning of the patient, keeping the headboard elevated between 30° and 45° was also addressed in the sample as a preventive measure. However, only one study in the Neonatal Intensive Care Unit adopted this measure, which shows limitations regarding the elevation of the headboard in these units, since the handling of the newborn for this situation becomes less accessible<sup>(18)</sup>.

The variables adjusting the patient's level of sedation daily and performing a spontaneous breathing test were found in the sample and are associated with

reduced mechanical ventilation time, instituting early extubation and avoiding inappropriate intubation, in order to reduce pneumonia rates associated with ventilation<sup>(15)</sup>. General measures, such as hand hygiene, and educational measures, were also mentioned in the sample.

In addition, the presence of the orotracheal tube facilitates the aspiration of secretions colonized by the patient. Thus, the routine aspiration of subglottic secretions has been described as relevant for reducing the risk of infection, preventing the accumulation of secretions. Regarding the monitoring of cuff pressure, the recommendation is to keep it between 25 and 30 cmH<sub>2</sub>O or 18 to 22 mmHg, reducing the leakage of oropharyngeal secretions to the lower respiratory tract<sup>(19)</sup>.

Prophylaxis of stress ulcers and prophylaxis of deep vein thrombosis have been cited as preventing mucosal diseases induced by mechanical ventilation and gastrointestinal bleeding in order to reduce other serious complications<sup>(15)</sup>.

As for the devices, the indication and care for the suction system were also described in the sample. The care with the ventilator circuit and humidifiers was presented, which indicates the removal of condensate from the ventilation circuit, keeping it closed during the removal and replacement of the circuit, only when it is visibly dirty or with malfunction<sup>(18)</sup>. Care with inhalers and nebulizers was also reported in the sample as relevant measures to prevent pneumonia infection related to health care.

Other measures were mentioned less frequently, namely: giving preference to orotracheal intubation and using noninvasive mechanical ventilation, avoiding gastric overdistension, selective digestive decontamination and the presence of information panels and protocols, making careful use of neuromuscular blockers, use of prophylactic antibiotics for ventilation-associated pneumonia, prophylaxis with N-acetylcysteine, prophylaxis of pulmonary thromboembolism and use of probiotics.

With regard to the category of measures to

prevent urinary tract infection, few studies have been found in the literature on the implementation of preventive strategies. The correct handling of the catheter was the most frequent in the sample for this category. Measures such as aseptic insertion technique, proper catheter fixation, keeping the collector below the level of the bladder, preserving the closed and sterile drainage system, keeping the urine flow unobstructed and emptying the collection bag regularly are mentioned, as well as replacing the collection system, when there is disconnection or leakage, and cleaning the meatus as a routine practice<sup>(20)</sup>.

In relation to educational measures, training with the teams, in order to verify the criteria for indicating the urinary catheter, review the need to remove the delay catheter and document symptomatic urinary tract infections in a documentary manner, was described as relevant. In addition, the training of the nursing staff on the standards of care with the catheter, in addition to daily monitoring with a maintenance form against infections are also reported to be of paramount importance in reducing urinary tract infections associated with the catheter. Therefore, it is emphasized that training significantly improves the professionals' adherence to preventive measures<sup>(20)</sup>.

The monitoring of the process and the results were also present in the sample. These measures include the surveillance of professionals regarding adherence to hand hygiene and other basic measures to prevent infection, in addition to surveillance of infection rates before and after interventions. Thus, it is imperative to encourage professionals to adapt prevention measures<sup>(21)</sup>.

Feedback on infection rates and performance was included in the same proportion as the surveillance variable. Monthly reports, with performance results and data on the rates of catheter-associated urinary tract infections, are presented to professionals, with the purpose of improving infection prevention practices through awareness<sup>(21)</sup>.

In addition, in order to reduce the use of unnecessary catheters and decrease the chance of infec-

tion, a study reported the visit of doctors and nurses to the beds. From this, it addressed the assignment of meetings based on case discussions, in order to assess the need for using the catheter, according to the indication criteria<sup>(22)</sup>.

The maximum barrier precautions for catheter insertion were discussed to a lesser extent in the sample, as well as the infrastructure variable for prevention. A written protocol in the form of a checklist to confirm the indication, correct insertion and maintenance of the urinary catheter has been reported as a way to reduce errors that involve infections<sup>(22)</sup>.

As for preventive measures associated with general health care, this category has preventive measures that aim to reduce infections in general. The daily bath with chlorhexidine was discussed in greater number in the sample. As for this result, in research whose practice was implemented in an Intensive Care Unit with 16 beds, a significantly lower incidence of bacteremia was observed, when compared to the period in which patients received the standard bath protocol, decreasing by 22.2% to 12.7%<sup>(23)</sup>.

Hand hygiene was addressed and generally associated with other measures, such as educational measures, standard precautions, feedback on infection and performance rates, and process surveillance. They are practical, easy to perform and effective measures for preventing infections.

Regarding the care with the environment and structure, research reported the application of an ultraviolet disinfection complex in a way that complements standard cleaning methods, however, only infections with vancomycin-resistant enterococcus have been significantly reduced<sup>(24)</sup>. On the other hand, an ultraviolet germicidal irradiation system, addressed in a more recent study, was implemented to remove bacteria from the air and proved to be significantly effective in reducing general infections<sup>(25)</sup>.

Still referring to the environment and structure variable, a study mentions the use of antimicrobial coverage for surfaces, closing the Intensive Care Unit for environmental cleaning and strategies such as pro-

viding alcohol gel at the bedside and disinfecting the surfaces around the patient three times a day<sup>(26)</sup>.

Regarding the screening and isolation of patients affected by bacteria, the results show the relevance of considering the screening of patients for decision making regarding clinical therapy. Microbiological screening protocol, performed regularly since admission and every three days thereafter, has shown effectiveness, providing the chance for early intervention and, consequently, avoiding infections<sup>(27)</sup>.

However, other studies have shown that universal decolonization has a significantly greater reduction in infection rates when compared to targeted decolonization. A study with universal decolonization resulted in a 32.0% decrease in infection rates<sup>(23)</sup>. In addition, other measures were cited, such as panels and information protocols, sample collection for culture and intranasal mupirocin.

## Conclusion

This review contributed to the knowledge about the main infection prevention measures related to health care, in Intensive Care Units. Through this study, it was identified that among the established thematic categories, for measures to prevent bloodstream infection, care with skin preparation, insertion, hand hygiene, educational measures and the use of coverings were the most frequently mentioned. For measures to prevent pneumonia related to health care, oral hygiene with antiseptics, maintenance of the elevated headboard 30°-45°, daily adaptation of the level of sedation and spontaneous breathing test deserved special mention.

Therefore, the correct handling of the catheter and the educational measures were the main ones reported in the sample for measures to prevent urinary tract infection. Finally, regarding the preventive measures associated with general health care, the most frequent ones were the daily bath with antiseptic, hand hygiene, educational measures and care for the environment and structure.

## Collaborations

Dantas AC, Araújo JNM and Nascimento AAA contributed to the conception and design, analysis and interpretation of the data. Martins QCS and Araújo MG collaborated with writing the article, relevant critical review of the intellectual content and final approval of the version to be published.

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