

Incidence of incontinence-associated dermatitis among clinical inpatients

Incidência de dermatite associada à incontinência em pacientes de unidade de internação clínica

Incidencia de la dermatitis asociada a la incontinencia en pacientes de unidad de internación clínica

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ABSTRACT

Objective: to ascertain the incidence of Incontinence-Associated Dermatitis (IAD) and related risk factors among inpatients in a clinical unit. **Method:** in this prospective cohort study of 197 patients in an inpatient unit, descriptive and analytical statistics were used, and Relative Risk was calculated with a 95% confidence interval; these were considered significant at two-tailed $p < 0.05$. The research protocol was approved by the ethics commission. **Results:** incidence of IAD was 20.3% (40 patients). The relative risk IAD was significantly higher in the elderly, when using enteral feeding, diapers, oxygen therapy, antifungal, corticosteroids, cardiac glycoside, vasodilator or anti-dyspeptic. It was also higher in those with 15 or more days' hospitalization or with diseases classified as Mental and Behavioral Disorders or from External Traumatic Causes. **Conclusion:** the incidence of IAD was high in the study population, and associated with risk factors that involved, above all, dependence on care.

Descriptors: Nursing; Dermatitis; Urinary Incontinence; Fecal Incontinence.

RESUMO

Objetivo: identificar a incidência de Dermatite Associada à Incontinência (DAI) e os fatores de risco em pacientes de uma unidade de internação clínica. **Método:** estudo de coorte prospectivo com 197 pacientes de unidade de internação clínica. Utilizou-se estatística descritiva e analítica e calculou-se o Risco Relativo com intervalo de confiança de 95%, considerando-se significativos quando p bicaudal $< 0,05$. Estudo aprovado pelo Comitê de Ética em Pesquisa da Instituição. **Resultados:** a incidência de DAI foi de 20,3% (40 pacientes). O risco relativo para DAI foi significativamente maior em idosos, em uso de alimentação enteral, fraldas, oxigenoterapia, antifúngico, corticoide, glicosídeo cardíaco, vasodilatador ou antidispéptico. Também foi maior nos pacientes com 15 ou mais dias de internação ou naqueles com doenças classificadas como Transtornos Mentais e Comportamentais ou como Causas Externas Traumáticas. **Conclusão:** foi alta a incidência de DAI na população pesquisada, estando associada a fatores de risco que envolvem, sobretudo, dependência de cuidado.

Descritores: Enfermagem; Dermatite; Incontinência Urinária; Incontinência Fecal.

RESUMEN

Objetivo: determinar la incidencia de dermatitis asociada a incontinencia (DAI) y factores de riesgo relacionados entre pacientes hospitalizados en una unidad clínica. **Método:** en este estudio de cohorte prospectivo de 197 pacientes en una unidad de internación, se utilizó estadística descriptiva y analítica y se calculó el Riesgo Relativo con un intervalo de confianza del 95%; estos se consideraron significativos en $p < 0,05$ de dos colas. El protocolo de investigación fue aprobado por la comisión de ética. **Resultados:** la incidencia de DAI fue del 20,3% (40 pacientes). El riesgo relativo de DAI fue significativamente mayor en los ancianos, al utilizar alimentación enteral, pañales, oxigenoterapia, antifúngicos, corticosteroides, glucósidos cardíacos, vasodilatadores o antidispépticos. También fue mayor en aquellos con 15 o más días de hospitalización o con enfermedades clasificadas como trastornos mentales y del comportamiento o de causas traumáticas externas. **Conclusión:** la incidencia de DAI fue alta en la población de estudio, y se asoció a factores de riesgo que involucraron, sobre todo, dependencia del cuidado.

Descriptores: Enfermería; Dermatitis; Incontinencia Urinaria; Incontinencia Fecal.

INTRODUCTION

Incontinence-Associated Dermatitis (IAD) is a type of contact dermatitis that occurs due to prolonged skin exposure to urine and/or feces, affecting the perineum or adjacent areas¹. It comprises a set of changes that cause skin inflammation, being mainly characterized by bright erythema, macerated appearance, with or without epidermis erosion, followed by discomfort or pain similar to a burn. It can also cause edema, vesicles, scabs, or skin flaking, characterizing eczema^{2,3}.

The development of IAD occurs from a combination of irritating chemical substances (urea, ammonia, and digestive enzymes) that get in contact with the skin, associated with humidity, friction, colonization by microorganisms, duration and frequency of the exposure. The combination of these factors, originated from fecal and/or urinary incontinence, can change the pH of the skin and lead to IAD^{1,4}.

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In this regard, the provision of Nursing care to patients with incontinence is a challenge, as its large incidence implies skin problems, which interfere with care quality and patient safety indicators⁵.

Incontinence is a daily problem in hospitalized patients. A study carried out in 36 states of the United States of America (USA) identified some type of incontinence in 2,492 (46.6%) subjects of the sample, from a total of 5,342 patients in acute care. The overall prevalence rate of IAD was 21.3% (1,140/5,342), and the prevalence among those with incontinence was 45.7% (1,140/2,492)⁶.

In Brazil, data on IAD are still incipient, especially in the public health system and in non-acute care environments, such as clinical hospitalization units, with lack of national data⁷. Therefore, the study is justified by the need for national scientific data on the theme and by the high frequency of incontinent patients using diapers, especially due to population aging and to the increase of chronic diseases and repeated and prolonged hospitalizations^{5,8}.

According to these considerations, this study has the following objective: to identify the incidence and risk factors of IAD in patients of a clinical hospitalization unit.

METHOD

This is a prospective cohort study, developed in a clinical hospitalization unit of a hospital in the Metropolitan Region of Porto Alegre, Rio Grande do Sul, Brazil.

The field study unit has 62 hospital beds, six of which are psychiatric, seven pediatric, and 49 clinical. There are two nurses for each shift (morning/afternoon), one for each night (night A and night B), and 13 nursing technicians per shift in the Nursing team. All the patients of this unit are assisted through the public plan of the Unified Health System (*Sistema Único de Saúde*, SUS). In 2015, this unit assisted 2,002 adult/older adult patients in the clinical area, according to information obtained from the institution's human resources sector.

The study population included all the patients admitted in the clinical hospitalization unit of the field study during the data collection period, which started on October 1st, 2016. The inclusion criteria adopted were as follows: being 18 years old or older, being hospitalized in the unit since October 1st, 2016, and being hospitalized in one of the 49 clinical beds of the unit one of the data collection days (Mondays, Wednesdays, and Fridays). Patients using or not using diapers were included, as well as continent and incontinent ones, in order to avoid selection bias, as the intention was to identify the incidence of IAD in the hospitalization unit. The selection of new subjects to be part of the study considered those with less hospitalization time in the field study unit on that day, in addition to the initial inclusion criteria.

The exclusion criteria were as follows: having IAD at unit admission, having a new hospitalization in the unit after participating in data collection in the previous hospitalization or, also, being transferred to another institution.

For sample size calculation, the following were considered: total of 2,002 hospitalizations of clinical patients in the study field unit (2015), 15% prevalence of IAD⁹, 5% sampling error, and 95% confidence interval.

Based on the aforementioned parameters, the sample size calculated was 179 patients to be followed-up. However, due to possible losses and refusals, there was a 10% addition, so the study final sample included 197 patients.

Data collection was carried out by a nurse with a PhD and by Nursing students, who were subjected to training that included a theoretical-practical approach on the systematic assessment of IAD and of the skin in general. IAD was identified through physical examination and, when present or suspected, the lead researcher was contacted to validate the finding.

The researchers assessed all the 197 patients of the study (hospitalized in the unit according to the inclusion/exclusion criteria) on Mondays, Wednesdays, and Fridays (including holidays) from October to December 2016. Data collection was carried out only with the patients who agreed to participate in the study or upon authorization of those responsible for them, by signing of the Free and Informed Consent.

In order to better record the information, daily systematic follow-up of 25 subjects was recommended, that is, 25 patients (new ones and those already included in the study) were assessed every day. Therefore, collection started with a random draw of 25 of the 49 possible patients. As each subject was discharged, new patients were included to maintain the daily follow-up of 25 people. Each patient was followed-up from the beginning to the end of their hospitalization in the unit, regardless of their outcome (hospital discharge, transfer, or death), until reaching the total of 197 patients.

Initially, the patient's medical record was consulted for later conducting the physical examination and data registration in the collection instrument. The Data Usage Commitment Form was used to maintain the patients' anonymity and the use of data for scientific purposes only.

The data collection instrument covered sociodemographic, clinical, and specific data about IAD. The following variables were collected at the bedside through anamnesis and physical examination each day of data collection: presence of IAD, self-referred skin color, feeding route, oxygenation, type of incontinence, use of diapers, weight, height, and self-care with eliminations and liquid feces. The remaining variables (age, gender, use of medications during hospitalization, and medical diagnoses at admission) were collected from the patient's medical record.

The assessment of IAD signs and symptoms occurred through physical examination, once a day (on Mondays, Wednesdays, and Fridays), when the assistance team performed perineal hygiene, changed diapers, or bathed the patient.

The medical diagnoses were extracted from the patient's medical records (the day when each patient was included in the study) and grouped according to the International Classification of Diseases, version 10 (ICD-10)¹⁰. The use of medications during hospitalization was also extracted from the patient's medical records (each collection day) on the medical prescription of the day.

The information regarding weight and height was collected according to the patient's report or, as a second option, from their medical records, according to the records of the institution's nutrition service. Such information was not obtained from all patients in the sample. The BMI of the first data collection day was used for each patient, that is, that from the day when the patient was admitted in the unit.

The definition of the World Health Organization was used for the classification of the Body Mass Index (BMI)¹¹: underweight (below 18.5 kg/m²), normal (from 18.5 to 24.9 kg/m²), overweight (25 to 29.9 kg/m²), obesity (30 to 39.9 kg/m²), and severe obesity (from 40 kg/m²). The variable was later divided into normal and altered (other categories).

Data analysis was conducted in the *Statistical Package for Social Science for Windows* program, using descriptive statistics (frequency, percentage, mean, standard deviation, and incidence) and analytical statistics (Relative Risk with a 95% confidence interval), considering a two-tailed p-value < 0.05 as statistically significant.

The research was approved by the Research Ethics Committee of the proposing institution (Opinion No. 1,755,453/2016), in compliance with Resolution No. 466/2012 of the National Health Council. Participation in the study involved minimal risks to the patient as there were no interventions. There were only interviews and physical examinations, these being perceived as uncomfortable situations due to time and patient handling.

RESULTS

The characterization of the sample of 197 patients is presented in Table 1.

TABLE 1: Incidence and Relative Risk of IAD according to demographic and health variables. Metropolitan Region of Porto Alegre, RS, Brazil, 2016.

Variável		IAD		Total	RR (95% CI)	p- value
		No (157) n(%)	Yes (40) n(%)	n(%)		
Age	Up to 59 years old*	61(89.7)	7(10.3)	68(34.5)	2.48(1.1-5.3)	0.01
	60 years old or more	96(74.4)	33(25.6)	129(65.5)		
Gender	Female*	88(77.2)	26(22.8)	114(57.9)	1.35(0.7-2.4)	0.30
	Male	69(83.1)	14(16.9)	83(42.1)		
Skin**	White*	131(79.4)	34(20.6)	165(84.6)	1.23(0.7-1.1)	0.62
	Other	25(83.3)	5(16.7)	30(15.4)		
BMI	Normal*	47(85.5)	8(14.5)	55(42.3)	1.37(0.6-3.0)	0.42
	Altered	60(80)	15(20)	75(57.7)		
Feeding	Oral*	148(85.5)	25(14.5)	173(87.8)	4.35(2.6-6.9)	<0.01
	Enteral tube	9(37.5)	15(62.5)	24(12.2)		
Oxygenation**	In room air*	120(88.9)	15(11.1)	135(68.9)	3.54(2.0-6.2)	<0.01
	Oxygen therapy	37(60.7)	24(39.3)	61(31.1)		
Days followed-up**	Up to 14 days*	113(85.0)	20(15.0)	133(68.3)	2.03(1.1-3.5)	0.01
	15 days or more	43(69.4)	19(30.6)	62(31.7)		

*Reference category; **n<197; RR: Relative Risk.

The sample is characterized for being predominantly female, with a mean age of 64.2 ± 17.6 years old, white-skinned, with altered BMI, being fed orally, and ventilating in room air. The mean BMI was 25.6 ± 5.6 . The incidence of IAD was 20.3% (40 patients).

The risk of IAD was statistically higher in older adults (2.48 times), in patients using enteral feeding tubes (4.35 times), receiving oxygen therapy (3.54 times), and hospitalized for 15 or more days (2.03).

The results of the risk analysis for IAD are shown in Table 2.

TABLE 2: Incidence and Relative Risk of IAD according to variables related to urinary and fecal eliminations. Metropolitan Region of Porto Alegre, RS, Brazil, 2016.

Variable	IAD		TOTAL n(%)	RR (95% CI)	p-value
	NO (157) n(%)	YES (40) n(%)			
Urinary incontinence					
No*	132(98.5)	2(1.5)	134(68.1)	40.41(10.0-162.2)	0.01
Yes	25(39.7)	38(60.3)	63(31.9)		
Fecal incontinence					
No*	124(96.9)	4(3.1)	128(65.0)	16.69(6.2-44.9)	< 0.01
Yes	33(47.8)	36(52.2)	69(35.0)		
Double incontinence					
No*	134(95.7)	6(4.3)	140(71.1)	13.91(6.1-31.3)	< 0.01
Yes	23(40.4)	34(59.6)	57(28.9)		
Use of diapers					
No*	127(97.7)	3(2.3)	130(67.5)	23.9(7.6-74.5)	<0.01
Yes	30(44.8)	37(55.2)	67(32.5)		
Use of two diapers					
No*	21(50.0)	21(50.0)	42(62.7)	1.28(0.8-1.9)	0.26
Yes	9(36.0)	16(64.0)	25(37.3)		
Self-care with urine					
Independent*	112(99.1)	1(0.9)	113(57.4)	62.46(7.3-374.2)	<0.01
Dependent	45(53.6)	39(46.4)	84(42.6)		
Self-care with feces					
Independent*	122(97.6)	3(2.4)	125(63.5)	21.41(6.8-66.9)	<0.01
Dependent	35(48.6)	37(51.4)	72(36.5)		
Liquid feces					
No*	133(82.6)	28(17.4)	161(81.7)	1.91(1.1-3.3)	0.03
Yes	24(66.7)	12(33.3)	36(18.3)		

*Reference category; RR: Relative Risk.

The risk of IAD was statistically higher in patients with urinary incontinence (40.4 times), fecal incontinence (16.6 times), or double incontinence (13.9 times). It was also higher in those using diapers (23.9 times), depending on self-care with urine (62.4 times higher), self-care with feces (21.4 times), and those who presented liquid feces (1.91 times).

The results related to the incidence and Relative Risk of IAD according to diseases diagnosed and use of medications is shown in Table 3.

TABLE 3: Incidence and Relative Risk of IAD according to diseases diagnosed and use of medications. Metropolitan Region of Porto Alegre, RS, Brazil, 2016.

Variable	IAD		Total	RR (95% CI)	p-value
	NO (157) n(%)	YES (40) n(%)	n(%)		
Mental and Behavioral Disorders					
No*	156(80.4)	38(19.6)	194(98.4)	3.40(1.4-7.9)	0.04
Yes	1(33.3)	2(66.7)	3(1.6)		
Traumatic External Causes					
No*	156(80.8)	37(19.2)	193(97.9)	3.91(2.0-7.3)	<0.01
Yes	1(25.0)	3(75.0)	4(2.1)		
Corticosteroid					
No*	137(83.0)	28(17.0)	165(83.7)	2.21(1.2-3.8)	<0.01
Yes	20(62.5)	12(37.5)	32(16.3)		
Vasodilator					
No*	148(81.8)	33(18.2)	181(91.8)	2.40(1.2-4.5)	0.01
Yes	9(56.2)	7(43.8)	16(8.2)		
Cardiac glycoside					
No*	156(80.4)	38(19.6)	194(98.4)	3.40(1.4-7.9)	0.04
Yes	1(33.3)	2(66.7)	3(1.6)		
Antifungal					
No*	156(80.4)	38(19.6)	194(98.4)	3.40(1.4-7.9)	0.04
Yes	1(33.3)	2(66.7)	3(1.6)		
Antidyspeptic					
No*	154(81.1)	36(18.9)	190(96.4)	3.01(1.4-6.1)	0.01
Yes	3(42.9)	4(57.1)	7(3.6)		

*Reference category; RR: Relative Risk.

As for the diseases, according to ICD-10, the risk of IAD was higher in patients whose base diseases were diagnosed as Mental and Behavioral Disorders (3.4 times) or Traumatic External Causes (3.91 times). Regarding the medications, the Relative Risk was higher in those using corticosteroids (2.21 times), vasodilators (2.4 times), cardiac glycoside (3.4 times), antifungal (3.4 times), and antidyspeptic (3.01 times).

DISCUSSION

The incidence of IAD was of 20.3% among the 197 patients, and 63 (31.9%), 69 (35%), and 57 (28.9%) had urinary, fecal, or double incontinence, respectively, which evidences the following worrying problem: one out of five patients of the study developed IAD. Research studies on the incidence of IAD are scarce, as most of them have a cross-sectional design, limiting the comparison of the findings of this study. Consensus and reviews indicate IAD prevalence values ranging from 5.6% to 50% and incidence values from 3.4% to 25%, pointing out that these variations occur especially due to the difficulty in recognizing IAD as a condition and also differentiating it from other skin problems, such as Pressure Ulcers^{1,12}.

In China, a longitudinal study conducted with 109 patients receiving intensive care identified that the incidence of IAD was 23.9%. In the univariate analysis, incidence was higher in patients with nutritional risk, Pressure Ulcer, low albumin levels, some infection, fecal incontinence, higher frequency of fecal incontinence, type of feces (liquid), and double incontinence. In the multivariate analysis, the higher the serum albumin value (as long as it is within the normal values), the lower the risk of IAD; and the lower the risk of PU (according to the Braden scale), the lower the risk of IAD. In addition, double incontinence was an independent risk factor for IAD¹³. Other authors also reinforce the existence of a higher risk of IAD development in patients with fecal or double incontinence compared to those with only urinary incontinence^{6,14}.

On the other hand, this study identified a higher risk of IAD in patients with urinary incontinence (RR 40.41) compared to those with fecal incontinence (RR 16.69), or double incontinence (RR 13.91). A hypothesis to explain these data can be the fact that patients with fecal (or double) incontinence received more attention for changing their diapers in comparison to those with only urinary incontinence, i.e., patients with fecal incontinence may have more agility to change diapers, perform hygiene, and take care of their skin – as a result of the considerable discomfort and odor caused – and, consequently, less exposure. This situation is more likely to occur, especially, in hospitalization units than in intensive care units. Such a situation can characterize a confounding effect in the data, as it was not possible to control the hygiene frequency in the unit and the exposure time according to the type of eliminations, since it was not the study scope to perform any intervention in the assistance provided.

The possibility of a modifying effect, common in longitudinal studies, is also pointed out. As this study did not control the variables before and after the outcome, the results do not allow for a cause-effect relationship in the variables analyzed, only inferring an association between them¹⁵.

The time of exposure to urine and feces is a factor related to the incidence and prevalence of IAD due to higher humidity and time of contact of irritating chemical substances (urea, ammonia, and digestive enzymes) with the skin¹. The study points out a higher risk of IAD in people with liquid feces and higher dependence on care actions like support to change diapers, oxygen supplementation, or enteral nutrition, and in those with longer hospitalizations. These findings are in consonance with other studies that identified higher occurrence of IAD in older adults with liquid feces, low oxygen saturation, at nutritional risk, and immobility, among other characteristics^{6,13,16}. On the other hand, a Brazilian study identified that the need for nutritional support was a protection factor for IAD in critical patients⁵.

Regarding the higher risk of IAD in patients with urinary incontinence, it is highlighted that the use of devices such as urinary catheters or urinary codons (in men) can establish best practices for preventing and, above all, treating IAD, although the current guidelines restrict the use of invasive devices aiming to reduce urinary tract infections¹⁷.

In addition, a study carried out with 5,342 adult patients hospitalized in intensive care units of 36 states of all regions of the United States of America pointed out an IAD prevalence value of 21.3%, with 46.6% of the patients suffering from incontinence. Among those with incontinence, the prevalence of IAD was 45.7%, higher in patients with fecal (44.7%) or double (49.2%) incontinence than in those with only urinary incontinence (29.7%)⁶.

In Australia, 245 (65.1%) of 376 inpatients in intensive care had some incontinence, with IAD prevailing in 10% of all the patients and in 42% of those with incontinence. The incontinence prevalence rate was 24%. Liquid and pasty feces were associated with IAD ($p=0.027$), and clinical indication for fungal infection occurred in 32% of the patients with IAD¹⁸. In this study, incidence was higher in patients using antifungals (RR 3.40). In the American study with patients in intensive care, 14.8% (169/1,40) of those with IAD also had fungal eruption⁶.

The higher risk of infections, such as fungal, is complex and multi-factorial. A more alkaline pH (changed due to the use of soaps with pH values higher than that of the skin) increases the risk of colonization by microorganisms and, therefore, of cutaneous infections, which is also aggravated by the friction occurred with the use of compresses during perineal hygiene. In addition, the use of diapers with little absorption and/or little aeration favors the development of IAD due to the increase in humidity, a condition favorable for the development of fungi and bacteria, which worsen the characteristic of the lesion and hinders its treatment^{4,5,19}.

Therefore, it is urgent to maintain and improve skin integrity in dependent patients, especially those with some type of incontinence and using diapers. In addition to that, it is necessary to include the assessment of IAD in the nurses' praxis in view of the progressive increase of chronic and disabling diseases that lead to dependence, incontinence, and skin fragility^{1,13}.

In order to do so, it is necessary to elaborate and validate prevention protocols, especially in the stages of gentle cleaning, hydration, and protection with barrier products. The evolution of knowledge on the pathophysiology and epidemiology of IAD is widely known, as well as there is a simultaneous need for more substantial evidence on which products are more suitable for protection and treatment. Some show good effectiveness for treating and preventing IAD, such as 3-in-1 3% dimethicone-based wet wipes (cleaning, hydration, and protection), cutaneous protector in acrylic spray, barrier creams, and fecal containment devices^{4,20-23}.

In addition, the finding of a higher risk of IAD in patients with diagnosed diseases such as Mental and Behavioral Disorders (RR 3.40) or Traumatic External Causes (RR 3.91) is similar to the Brazilian cohort study with patients of two intensive care units, in which patients admitted due to trauma presented higher risk of IAD⁵. In this study, patients with a medical diagnosis of trauma presented a 16.11 times higher risk of developing IAD. It is believed that such association can be related to greater difficulty in perineal hygiene of patients with these disorders as a result of their low level of consciousness (they do not notice/control their eliminations) or trauma (hindering mobilization), which can influence exposure time and quality of hygiene in these cases.

Regarding the higher risk of IAD in patients who used corticosteroid, vasodilators, cardiac glycoside, and antidyspeptic (in addition to antifungals), specific studies on IAD and medications need to be conducted to understand if there is any relationship between the specific use of certain medications or if polypharmacy (and, consequently, the patient's health conditions) is what influences the occurrence of IAD.

Study limitations

The study limitations include the sample, which involves patients assisted by the Brazilian public health system in a clinical hospitalization unit at a medium-sized hospital that did not provide training specific to IAD approach to their collaborators; some research variables were collected only on the first assessment (BMI and diseases, for example) or considered in the overall context of the hospitalization, with no daily analysis of the incidence of IAD (use of medications, for example); the possibility of inaccuracies in the weight and height variables, as they were self-reported or collected from medical records; the fact that data collection took place three times a week, which can cause under-assessment of the incidence of IAD; the possibility of measurement bias (as the researchers could not be blinded), confounding bias, or modification bias, as certain variables could not be collected (number of diaper changes a day, quality of hygiene, type of diapers) for the unit not having standardization.

CONCLUSION

The incidence of IAD can be considered high (1/5 of the sample under study) when compared to the literature results, and for not being a sample with patients in critical care. The risk of IAD was higher in older adult patients with enteral feeding tubes, with more hospitalization days, using diapers, depending on support for their eliminations, with liquid feces, using some types of medications (corticosteroid, vasodilator, cardiac glycoside, antifungal, or antidyspeptic), or hospitalized due to diseases categorized as Mental and Behavioral Disorders or Traumatic External Causes. Among the types of incontinence, the risk was higher in people with urinary incontinence.

The results of this study identify IAD within the context of a Brazilian hospital, bringing some evidence that can be used in the assistance practice to recognize patients with a higher risk of IAD, improving quality of care. It is essential to implement effective and feasible Nursing interventions in skin care, as nurses have an essential role in hygiene care and comfort provision. Despite the considerable incidence, the subject matter is still little researched, requiring studies with other approaches and different populations.

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