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Original Article

Nursing professionals' knowledge of preparing and administering insulin to hospitalized children and adolescents

Conhecimento dos profissionais de Enfermagem sobre preparo e administração de insulina em crianças e adolescentes hospitalizados

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ABSTRACT

Objective: to describe nursing professionals' knowledge of preparing and administering insulin to hospitalized children and adolescents. **Methods:** a cross-sectional study with 64 nursing professionals from a highly complex public children's hospital, recruited by convenience sampling. A questionnaire was used to collect data, and the level of professional knowledge and the quality of care were analyzed using the positivity index. The ethical and legal principles of research were complied with. **Results:** there was a predominance of women (94.4%) with an average age of 37.16+8.09 years and an average time working in pediatrics of 13.90+8.91 years. Of the 19 items on insulin, those considered poor assistance (eight) prevailed, followed by borderline assistance (five), which may have an impact on the preparation and administration of insulin with glycemic and metabolic repercussions for pediatric inpatients. **Conclusion:** weaknesses were found concerning nursing professionals' knowledge of various aspects of insulin use in children and adolescents in the hospital environment. **Contributions to practice:** the study addresses gaps in the nursing team's knowledge of insulin injection, providing opportunities for improvement.

Descriptors: Nurse Practitioners; Insulin; Pediatrics; Knowledge; Patient Safety.

RESUMO

Objetivo: descrever o conhecimento dos profissionais de Enfermagem sobre o preparo e a administração de insulina em crianças e adolescentes hospitalizados. **Métodos: estudo transversal** com 64 profissionais de Enfermagem de um hospital público infantil de alta complexidade, recrutados por amostragem por conveniência. Utilizou-se um questionário para a coleta de dados; e o nível de conhecimento do profissional e a qualidade da assistência foram analisados pelo índice de positividade. Os princípios éticos e legais em pesquisa foram atendidos. **Resultados:** predominaram mulheres (94,4%) com média de idade de 37,16±8,09 anos, tempo médio de atuação em Pediatria de 13,90± 8,91 anos. Dos 19 itens sobre insulina, prevaleceram aqueles considerados assistência sofrível (oito), seguidos de assistência limítrofe (cinco) o que pode ter impacto no preparo e na administração da insulina com repercussão glicêmica e metabólica no paciente pediátrico internado. **Conclusão:** evidenciaram-se as fragilidades em relação ao conhecimento dos profissionais de Enfermagem em diversos aspectos sobre o uso de insulina em crianças e adolescentes no ambiente hospitalar. **Contribuições para a prática:** o estudo aborda lacunas do conhecimento da equipe de Enfermagem sobre a injeção de insulina, vislumbrando oportunidades de melhoria.

Descritores: Profissionais de Enfermagem; Insulina; Pediatria; Conhecimento; Segurança do Paciente.

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Introduction

Worldwide, Type 1 Diabetes Mellitus (DM1) is one of the most common chronic diseases of childhood. In 2021, there were an estimated 108,300 children and adolescents under the age of 15 newly diagnosed with DM1 and 651,700 children and adolescents living with the condition worldwide. Calculations for 2040 indicate an increase in prevalence from 8.4 million individuals worldwide to 13.5-17.4 million, with the greatest relative increase in underdeveloped countries[1].

Hospitalizations for DM1 in children and adolescents have been increasing in Brazil, following the growing trend of incidence rates and hospitalizations worldwide. Due to its chronic nature and the difficulties in managing it throughout life, DM1 in children and adolescents can trigger serious complications, such as ketoacidosis, which mainly affects adolescents, leading to hospitalizations and even death[2]. During hospitalization, insulin therapy requires rigorous care during the preparation and administration process, as it is considered a High Surveillance Drug with an increased risk of significant damage due to failures and errors in use[3].

The administration of excessive doses can result in hypoglycemia, which leads to encephalopathy, pulmonary edema, liver damage, coma, convulsions, and death, while the use of underdoses can aggravate hyperglycemia[4]. Therefore, proper technique in preparing and administering subcutaneous insulin injections is crucial to guaranteeing treatment efficacy in patients with DM. It is essential to follow a precise protocol since adopting the correct technique not only improves the effectiveness of the treatment but also minimizes discomfort for the patient during the administration of subcutaneous insulin[5-6].

There is a potential for harm to the patient due to the varying knowledge and experience about insulin of prescribers and nursing staff, as well as poor standardization[7]. Therefore, assessing knowledge about the correct handling of insulin is extremely important for safe practice.

Many of the problems related to insulin administration by nurses can be attributed to inadequate knowledge of insulin injection techniques[8]. Therefore, given the high-risk nature of insulin use in the hospital environment, patient safety is a priority in children's hospitals. Furthermore, the literature is limited on insulin-related adverse events in children's hospitals[7].

Given this context, it is imperative to identify the level of knowledge of nursing professionals about insulin, its preparation, and administration in hospitalized children and adolescents. Identifying challenges and weaknesses could contribute to a situational diagnosis. This will support planning data and evidence-based strategies and/or interventions that optimize the knowledge, skills and attitudes of nursing professionals with a view to pediatric patient safety.

The aim of this study was to describe nursing professionals' knowledge of preparing and administering insulin to hospitalized children and adolescents.

Methods

Type of research design

This is a cross-sectional study carried out in a high-complexity public hospital, a reference in children's care with 287 beds accredited to the Unified Health System (UHS), in Fortaleza, CE, Brazil. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) was used to report the study.

Population and sample

The population was made up of nursing professionals working in the clinical and surgical units, the Intensive Care Unit (ICU), and the emergency department. These locations were chosen because they cater to pediatric patients with more serious illnesses and because insulin is frequently used in these patients. A convenience sample of 64 professionals answered the questionnaire.

The inclusion criterion was working in the ser-

vice for at least three months. Those who filled in the instrument incompletely were excluded.

Data collection

Data collection took place from September to November 2023 by the researcher herself. The professionals were approached in person before, during, and after their shift in their work sector to invite them to take part in the research. Once they had agreed, they answered a questionnaire that could be printed out or accessed via a link sent by email or telephone, depending on the participant's preference. The nursing manager was also asked to make the invitation and the questionnaire link available in the nurses' group on the messaging app (WhatsApp®), which she promptly did.

This instrument consisted of two parts: 1) sociodemographic and professional data (gender, age, professional category, length of training, length of time working in pediatrics, sector of work, course and/or training on patient safety and insulin use) and; 2) data related to the use of insulin in professional practice, including 24 multiple-choice questions prepared by the researchers that addressed insulin preparation, administration and application techniques, as recommended by the guidelines of the Brazilian Diabetes Society (BDS)[6].

Data analysis

The data collected was extracted from the online form, typed up, and tabulated in a Microsoft Office Excel spreadsheet. The qualitative variables were presented using absolute and relative frequencies, while the quantitative variables were presented using means and standard deviations in tables.

To classify the level of knowledge of the professionals, their answers were analyzed based on the concepts of right or wrong, according to the Brazilian Diabetes Guidelines[6], with a total of 64 right answers being considered a high level of knowledge, equivalent to a percentage of 100%

Therefore, we adopted the classification that relates the level of knowledge of the professional and the quality of care through the positivity index. The higher the level of knowledge, the higher the positivity index and the better the quality of care, classified as desirable assistance (100% positivity); adequate care (90 to 99% positivity); safe assistance (80 to 89% positivity); borderline assistance (71 to 79% positivity); and poor assistance (70% to less positivity)[9].

Ethical aspects

The study complied with Resolution 466/2012 and Circular Letter 02/2021 of the National Research Ethics Committee. It was approved by the Research Ethics Committee of the Hospital Infantil Albert Sabin under opinion no. 6.128.334/2023 and Certificate of Presentation for Ethical Appraisal no. 69971323.8.0000.5042.

Results

The majority of this study's sample was made up of 63 women (94.4%), with an average age of 37.16 (standard deviation: 8.09) years, and nurses (43-67.2%). Twenty technicians and one nursing assistant were also interviewed. These professionals had been working in pediatric units for around 13.90 (standard deviation: 8.91) years and inpatient units 33 (51.6%), urgent/emergency 14 (21.9%), and ICU 11 (17.2%) were the most prevalent.

Most of the participants (58-90.6%) reported having previously attended a course on patient safety, but only 12 (18.8%) professionals had undergone any training on insulin therapy. Concerning difficulties related to the use of this medication, 41 participants (64.1%) reported some difficulty, among which the following stood out: dosage and insulin schedule 10 (15.6%); preparation and administration 8 (12.5%); types of insulin and duration of action, seven (10.9%); types of syringes and needles, five (7.8%); storage and preservation of insulin, three (4.7%); fasting for surgery and the relationship with the insulin regimen, two (3.1%) and lack of knowledge and training, two (3.1%).

Regarding the professionals' level of knowledge about the use of insulin, it was observed that all the participants chose the right answer when they mentioned that insulin is considered a highly monitored medication (100%) and 75.0% that hypoglycemia is an adverse event. However, only 35.9% of professionals reported hypoglycemia when it occurs in their clinical practice.

A considerable proportion of the participants (84.4%) knew that international units are used as the standard unit of measurement for insulin. Only 37.5% of participants correctly indicated the types of insulin used as basal insulin and 70.3% knew the types of rapid-acting insulin.

Concerning safe insulin administration devices, 59.4% and 84.4% were unable to indicate the ideal syringe and needle size, respectively. In addition, just over half (53.1%) said that it is not possible to use syringes with removable needles (Table 1).

Table 1 – Distribution of the number of nursing professionals, according to their knowledge of insulin and their respective positivity index, regarding the quality of care (n=64). Fortaleza, CE, Brazil, 2023

Variables	n (%)	Positivity Index
Insulin is a highly monitored drug		
Right	64 (100.0)	Desirable assistance
Hypoglycemia is an adverse event		
Right	48 (75.0)	Borderline assistance
Wrong	16 (25.0)	
Notification of hypoglycemia		
Right	23 (35.9)	Poor assistance
Wrong	37 (57.8)	
Not applicable	4 (6.3)	
Unit of measurement of insulin		
Right	54 (84.4)	Safe assistance
Wrong	10 (15.6)	
Type of basal insulin		
Right	24 (37.5)	Poor assistance
Wrong	35 (54.7)	
No knowledge	5 (7.8)	
Type of rapid-acting insulin		
Right	45 (70.3)	Borderline assistance
Wrong	17 (25.6)	
No knowledge	2 (3.2)	
Indicated syringe		
Right	26 (40.6)	Poor assistance
Wrong	38 (59.4)	
Use of removable needles		
Right	34 (53.1)	Poor assistance
Wrong	30 (46.9)	
Ideal needle size		
Right	10 (15.6)	Poor assistance
Wrong	54 (84.4)	

Table 2 shows the results of nursing professionals' knowledge of how to prepare and administer insulin to hospitalized children and adolescents.

Concerning preparation, 39.1% of the participants incorrectly answered that regular insulin should be homogenized, while 76.6% were correct in saying that when preparing a mixture of Neutral Protamine Hagedorn (NPH) and regular insulin, regular insulin should be aspirated first.

It should be noted that all professionals (100%) stated that insulin administration should be combined with a blood glucose test; 71.4% and 90.6% reported that the skin fold and the angle of the needle interfere, respectively, in the correct administration of insulin. However, there is a lack of knowledge about the correct age range for skin folds to be mandatory (50.0%), and insulin application sites in children and adolescents (70.3%).

With regard to the administration of intravenous insulin, 83.3% recognized regular insulin as the correct type of insulin administered by this route; 81.2% correctly indicated 0.9% saline as the appropriate diluent for preparing the intravenous insulin solution and 67.1% indicated the ideal time to change the solution during the infusion, which is every six hours.

Table 2 – Nursing professionals' knowledge of insulin preparation and administration in hospitalized children and adolescents (n=64). Fortaleza, CE, Brazil, 2023

Variables	n (%)	Positivity Index
Administration combined with blood glucose testing		
Right	64 (100.0)	Desirable assistance
Regular insulin needs to be homogenized		
Right	37 (57.8)	Poor assistance
Wrong	25 (39.1)	
Doesn't know	2 (3.1)	
Which insulin should be aspirated first		
Regular	49 (76.6)	Borderline assistance
Neutral Protamine Hegedorn	15 (23.4)	
Skin fold interferes with the application		
Right	46 (71.4)	Borderline assistance
Wrong	18 (28.6)	

(the Table 2 continue in the next page...)

Skin folds are mandatory		
Right	32 (50.0)	Poor assistance
Wrong	31 (48.4)	
Doesn't know or didn't answer	1 (1.6)	
Needle angle interferes with the application		
Right	58 (90.6)	Adequate assistance
Wrong	5 (7.8)	
Doesn't know or didn't answer	1 (1.6)	
Application spots		
Right	45 (70.3)	Borderline assistance
Wrong	18 (28.1)	
Doesn't know or didn't answer	1 (1.6)	
Type of insulin can be administered intravenously		
Right	50 (83.3)	Safe assistance
Wrong	8 (10.0)	
Doesn't know	6 (6.6)	
Which solution is used to dilute insulin for intravenous administration?		
Right	52 (81.2)	Safe assistance
Wrong	10 (15.6)	
Doesn't know or didn't answer	2 (3.2)	
When administering insulin intravenously by infusion pump, the solution should be changed within how long?		
Right	43 (67.1)	Poor assistance
Wrong	19 (29.7)	
Doesn't know or didn't answer	2 (3.2)	

It should be noted that of the 19 items evaluated, those considered to be poor assistance (eight) prevailed, followed by borderline assistance (five), safe assistance (three), desirable assistance (two), and adequate assistance (one).

It can thus be seen that most of the data on insulin were up to 79% positive (borderline or poor assistance), which can have an impact on the preparation and administration of insulin with glycemic and metabolic repercussions for the hospitalized patient.

Discussion

Given the findings of this study, it is worth highlighting the low level of participation in courses and/or training on insulin therapy and the many difficulties mentioned in the use of insulin. This fact is supported by other studies[7,10-11], which have shown the importance of continuing education and professional training as a positive factor in raising the level of knowledge, directly interfering in appropriate and desirable nursing care since science is dynamic and is renewed.

The most cited difficulty was getting the dose right, a fact that corroborates findings at a university hospital in which the difficulties described were due to calculating the dose to be administered with the pen and the occurrence of unexplained and repeated hypoglycemia in one patient[12].

From this perspective, dose errors were identified as the most frequent, which may be related to the lack of appropriate pharmaceutical formulations for pediatrics. In addition, 79% of incorrect dose reports were found to be for doses above the recommended value[13]. High doses of insulin can lead to hypoglycemia, convulsions, cardiac arrest, and even death.

It is noteworthy that the administration phase is primarily responsible for the majority of medication errors in pediatric patients, with incorrect doses being the most frequent type[14]. This reinforces the need for actions to mitigate errors and damage and improve pediatric patient safety.

Certain areas of deficiencies were found in nurses' knowledge of insulin, including which type of insulin is Aspart, when to inject short-acting insulin, management of the injection site after removing the needle from the insulin pen, mixing method for premixed insulin, proper disposal of the insulin needle after injection and the management of hypoglycemia (49.4%)[8]. In secondary and tertiary care hospitals in China, 73% of the nurses surveyed scored good or satisfactory in knowledge, and over 95% in attitude or behavior[15].

School nurses' knowledge of DM1 treatment is also insufficient[16]. There are gaps in the knowledge of newly qualified doctors about DM1. This can be adjusted by various strategies, such as changes to curricula, further training courses, more clinical exposure, and interprofessional education[17]. There is a lack of knowledge among health professionals about the procedures for filling high-concentration insulin prescriptions and the concept of an insulin unit[12]. In this study, 84.4% of professionals knew the unit of measurement for insulin, which was classified as safe care.

Inadequate knowledge negatively affects the care of people with DM1. And, DM1 can have negative consequences and impaired recovery. Nursing care management for people with DM1 should be extended to educational theory and clinical practice. Content on insulin therapy should be taught in detail at the undergraduate level[18].

These issues are important barriers to the effective and safe management of insulin injection and can have an impact on the preparation and administration of insulin with consequent glycemic and metabolic repercussions for the hospitalized patient.

It is important to note the various factors related to the administration, storage, and handling of insulin, such as: selecting suitable devices, rotating application sites, inserting the needle correctly into the skin, leaving the needle in the skin long enough to absorb the entire dose and inspecting the skin before and after injection, among others, which can contribute to efficient metabolic control. The correct administration technique is essential for the insulin administered to achieve the desired effects in people with DM1[19].

It is speculated that the knowledge gaps are due to a lack of training and updating on DM1 guidelines. Therefore, the need for periodic workplace training based on the latest evidence to further improve knowledge regarding insulin injection practices is highlighted.

Corroborating the knowledge deficiencies is the need for workplace learning and development programs, combined with guidelines and scientific evidence, which can improve nurses' insulin knowledge and practice in order to improve the quality of clinical nursing care[19]. In addition, there are gaps in higher education in Nursing[20], which indicates that information related to insulin therapy should be provided in more detail in the Nursing curriculum[18].

An intervention using the Lean 6σ methodology revealed a decrease in adverse drug events associated with insulin use in a tertiary children's hospital. There was a significant reduction in the length of time between glucose checks and insulin administration and improved rates of hyperglycemic and hypoglycemic events. These results were achieved through the implementation of a comprehensive insulin safety plan, including education of all staff, standardization, and automation of insulin ordering and administration, and training of frontline staff[7].

Strategies for preventing insulin-related errors in the hospital environment include computerized protocols, education, double-checking, the right five, legitimate medication reconciliation techniques, appropriate documentation, proper medication storage, separating "high alert" medications from other medications, having an accessible medication guide, knowing the institution's policies, regulations and guidelines[21-22].

All professionals who administer medicines, especially those of high vigilance, should have easy access to policies and information in their daily lives, such as organizational protocols, guidelines, and references directing the systematization and standardization of safe care. To this end, it is essential to know about the indications for the use of medicines, access to brand names and generics, the results expected during use, specific dosages, probable adverse effects and drug interactions, as well as the actions to be taken in the event of reactions and storage requirements[23].

Furthermore, it is recommended that a hospital DM1 management group should be established to promote standardized insulin injection procedures and ongoing training[8]. There has been a reduction in the length of stay and readmission rate of patients with DM1 since the introduction of DM1 specialist nurses[24].

This study on the general aspects, preparation, and administration of insulin among the nursing staff of a children's hospital reveals certain areas of deficiencies in knowledge that can be addressed to improve clinical nursing care.

Study limitations

The limitations considered in this study refer to the low response rate of the questionnaires; the

cross-sectional design and obtaining data by self-report, which can add to the biases of memory and information, since other professionals who know more about the subject did not have the opportunity to participate in the study; the descriptive analysis, making it impossible to establish cause and effect relationships; and the lack of previous research on the subject, which made it difficult to discuss the topic.

Contributions to practice

As contributions to practice, it is possible to identify gaps and weaknesses in the nursing team's knowledge of insulin when caring for hospitalized pediatric patients. Thus, there is an opportunity for improvement by planning training on insulin injection in order to optimize the knowledge of nursing professionals, which can improve the quality of care in health services.

Conclusion

This study highlighted the weaknesses in nursing professionals' knowledge of various aspects of insulin injection in children and adolescents in the hospital environment. This highlights the need to invest in permanent and continuing education for these professionals, in order to minimize the chances of errors and optimize good practices in the context of hospitalizing children and adolescents.

Authors' contribution

Conception and design or analysis and interpretation of data: Lavor SA, Oliveira SKP. Writing of the manuscript or relevant critical revision of the intellectual content, final approval of the version to be published, agreement to be responsible for all aspects of the manuscript related to the accuracy or integrity of any part of the manuscript being adequately investigated and resolved: Lavor SA, Magalhães FJ, Soares AF, Oliveira RM, Oliveira SKP.

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