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## Use of technologies in intravenous therapy: contributions to a safer practice

*Uso de tecnologias na terapia intravenosa: contribuições para uma prática mais segura*  
*La utilización de tecnologías en la terapia intravenosa: aportes para el manejo más fiable*

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### ABSTRACT

**Objectives:** To identify what are the difficulties of the nursing staff in the management of technologies during intravenous therapy (IVT) and discuss the difficulties identified under the perspective of patient's safety. **Method:** Descriptive study of qualitative approach with data collected by semi-structured interview and analyzed by the Alceste software. **Results:** The greatest difficulty of cognitive and technical emphasis was the lack of training; and regarding administrative emphasis, the greatest difficulty was the lack of material and human resources. Infusion pumps and their proper use were highlighted as the technological resource that most contributed to patient safety. **Final considerations:** The lack of training is presented as the greatest difficulty of nursing professionals and permeates safety issues of both patient and professional when using the hard technologies in IVT. Training is essential to the development of techniques, considered nursing tools.

**Descriptors:** Infusion Pumps; Patient Safety; Critical Care; Nursing; Intravenous Infusions.

### RESUMO

**Objetivos:** Identificar quais são as dificuldades da equipe de Enfermagem no manejo das tecnologias durante a terapia intravenosa (TIV) e discutir as dificuldades identificadas sob a perspectiva da segurança do paciente. **Método:** abordagem qualitativa, do tipo descritivo com dados coletados por entrevista semiestruturada e analisados pelo programa Alceste. **Resultados:** A maior dificuldade de ênfase cognitiva e técnica foi a falta de treinamento; e de ênfase administrativa, foi a falta de recursos materiais e humanos. As bombas de infusão e sua utilização adequada foram destacadas como o recurso tecnológico que mais contribuiu para a segurança do paciente. **Considerações finais:** A falta de treinamento é apresentada como a maior dificuldade dos profissionais de Enfermagem e permeia as questões de segurança do paciente e do profissional ao utilizar as tecnologias duras na TIV. O treinamento é imprescindível para o desenvolvimento das técnicas, consideradas como ferramentas do fazer da Enfermagem.

**Descritores:** Bombas de Infusão; Segurança do Paciente; Cuidados Críticos; Enfermagem; Infusões Intravenosas.

### RESUMEN

**Objetivos:** Identificar las dificultades del personal de enfermería en utilizar tecnologías durante la terapia intravenosa (TIV) y discutir las dificultades encontradas bajo el punto de vista de la seguridad del paciente. **Método:** estudio cualitativo, de tipo descriptivo, en el cual se empleó entrevista semiestructurada para la recolección de los datos y los analizó por el programa Alceste. **Resultados:** La dificultad de énfasis cognitiva y técnica más frecuente fue la ausencia de capacitación para utilizar la tecnología; y la de énfasis administrativa fue la ausencia de recursos materiales y humanos. El recurso tecnológico que más contribuye para garantizar la seguridad del paciente fue las bombas de infusión y su correcto empleo. **Consideraciones finales:** El personal de enfermería relató que la ausencia de capacitación es la dificultad que más enfrentan, y que les va a influir en

la seguridad del paciente y del profesional al emplear las tecnologías en la TIV. Las capacitaciones son esenciales para el desarrollo de las técnicas, consideradas las herramientas de hacer enfermería.

**Descriptores:** Bombas de Infusión; Seguridad del Paciente; Cuidados Críticos; Enfermería; Infusiones Intravenosas.

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## INTRODUCTION

Significant changes have been occurring in nursing care from the incorporation of new technologies, especially regarding intensive care, as health technology is a complex phenomenon that generates daily reflections and discussions among the health professionals involved in the care of the patient in the Intensive Care Unit (ICU)<sup>(1)</sup>.

Currently, we have a series of technological resources that can contribute to a safer practice and quality in intravenous therapy (IVT), from intravenous catheters (peripheral and central), accessories with safety devices, to cutting-edge infusion pumps.

Therefore, the nursing staff is closely related to and responsible for the practice of IVT, especially the nurse; the knowledge about the technologies used in this therapy needs to be expanded, meaning not only the incorporation of equipment, but also implying the need for professionals able to use technologies, taking advantage of all the benefits offered to promote a safer care. For this, usability-related issues should be considered.

In the quest for obtaining best results despite the increasing complexity, associated to the professional improvement is the increased participation of the pharmaceutical industry and of inputs in the area, which, by the association of knowledge from various aspects, contributes to the improvement of the professional interface with the technologies and the innovations that transform and make the specialty of the IVT evolve under the aspects of quality and safety for the patient<sup>(2)</sup>.

In this sense, it is necessary to identify the difficulties encountered by professionals when handling technologies, to establish strategies to improve usability in the context mentioned.

The objectives of this study were:

1. To identify what are the difficulties of the nursing staff in the management of technologies during the IVT; and
2. To discuss the difficulties identified under the perspective of patient safety.

By identifying the difficulties faced by the nursing staff in the handling of technologies that underlie the practice of IVT, we will have subsidies to understand how these professionals act before a critically ill patient dependent on this therapy, enabling more control of management tools and instruments necessary to enhance their practice and providing positive developments regarding the safety of the patient.

Under this perspective, when managing the care, the nurse develops actions directed to the planning and organization of the environment, from the material resources, equipment and human resources, to the provision of the care itself, promoting a good systematic nursing care<sup>(3)</sup>.

The study will contribute to the concept of safe care assistance in the culture of health professionals who work in this environment, strengthening the assistance quality as a premise and not as a consequence of the work. In addition, it will serve as a stimulus for the development of future studies on the topic.

## METHOD

### Ethical aspects

The ethical principles were respected, with approval of the Research Ethics Committee.

### Type of study

Descriptive study of qualitative approach.

### Methodological procedures

The scenario was the ICU of a large University Hospital in Rio de Janeiro. The study subjects were 32 nursing professionals who made up the staff that worked in that ICU. Inclusion criteria for the subjects were: to act directly with the patient using the central continuous IVT in the period of research and who agreed to participate. Professionals taking a leave of absence during the period of data collection were excluded.

Data were collected from the individual semi-structured interview, used when the researcher uses a guide to orientate and ensure that all items desired are included. In this type of interview, the interviewer's role is to encourage interviewees to speak freely about the issues at hand<sup>(4)</sup>.

Data analysis was performed using the software *Analyse Lexicale par Context d'un Ensemble of Segments of Texte (ALCESTE)*, which performs the lexical analysis of the content of the texts automatically, through quantitative techniques of processing of texts, among which stands out the Chi-square test ( $\chi^2$ ). The software works through the domain of Hierarchical Classification, which consists of estimates conducted on the co-occurrence of words in text segments, seeking to distinguish classes of words that represent distinct forms of discourse on the research topic of interest<sup>(5)</sup>.

On content analysis, the thematic plurality present in the discourse of the subjects was identified, considering the frequency of these themes in the whole material and allowing the comparison between the elements of the corpus (words or sentences); this way, the elements of meaning were grouped, building the classes of representative discourses<sup>(5-6)</sup>. The content has originated two classes, namely: (1) Difficulties in the Management of Intravenous Therapies; and, (2) Use of Technologies and Patient Safety.

## RESULTS

The class (1) was formed from the reduced forms that showed higher frequency of appearance in this class (training, difficulty, hospital, and work). Of the difficulties most cited by the subjects, three distinct emphases were identified: cognitive, administrative (related to institutional issues), and technical.

### Cognitive emphasis

This emphasis has shown us that the difficulty is closely related to the lack of knowledge for the management of technology and that this is due to the deficiency in training.

*[...] difficulty indeed, if I don't have adequate training, if I have to use something and I didn't have any training and no one explained how to use it. (ECU: 112 Class: 1 x2: 11)*

*I think the risk of infection is very high, is a type of therapy that, indeed, if we don't have a certain training, we have a lot of difficulty. (ECU: 147 Class: 1 x2: 9)*

*Well, when it's a material I don't know, I find it difficult to use all the mechanisms that it offers, but when there's training, I don't normally have a lot of difficulty. (ECU: 121 Class: 1 x2: 7)*

*The difficulty is when you come on duty and have a new equipment and nobody had training. That's the greatest difficulty. (ECU: 58 Class: 1 x2: 5)*

Under this perspective, the professionals contradict themselves when they relate their difficulties to the lack of training, because they confirm the completion of training on hard technologies in the institution in question.

*I've had training at Antonio Pedro [...]. Recently, I was at Antonio Pedro, not long ago, less than six months. (ECU: 189 Class: 1 x2: 23)*

*Well, specifically related to intravenous therapy, what I can remember, is basically, training with infusion pumps, which are pumps that are renewed periodically in the hospital, so there's always this training. (ECU: 72 Class: 1 x2: 10)*

*[...] The training was at the Antonio Pedro university hospital. About the handling of infusion pumps. (ECU: 183 Class: 1 x2: 6)*

Nursing professionals stressed the importance of conducting the training in the universe they operate.

*They are essential because with training you have the possibility of staying updated on their use, these conducts, this material, this equipment, anyway, these technologies. (ECU: 102 Class: 1 x2: 10)*

*[...] so I think sometimes it can be a risk too, if you don't have good training, the staff can represent a risk. (ECU: 95 Class: 1 x2: 5)*

### Technical emphasis

In technical emphasis, once again, training appears as the trigger for some technical difficulties, which brought with them significant weight in the practice itself and, in their majority, were correlated with the subject of knowledge acquired through continuous training on the handling of health technologies in IVT.

*Well, the difficulties are the manipulation by multiple people, and sometimes this manipulation is poorly made. Here we have the manipulation also by the blood bank, which would not be correct because the blood bank should have an exclusive access to pass blood. (ECU: 4 Class: 1 x2: 3)*

*Regarding intravenous therapy, I don't see much difficulty. The difficulties sometimes occur regarding some specific medications and then those difficulties we try to solve, in relation to stability, drug interaction. (ECU: 76 Class: 1 x2: 3)*

*[...] the staff itself doesn't pay attention, there's a lot of loss of access also during the manipulation made by the nursing staff. (ECU: 6 Class: 1 x2: 2)*

Professionals highlight that, when they are facing difficulties in the management of technologies, they seek to minimize them in different ways according to the context in which they are inserted.

*Basically, these are the problems that occur on a daily basis and we try to solve with a specific literature, with the pharmacist, if he's in the hospital, but it's basically it. (ECU: 77 Class: 1 x2: 2)*

*[...]I usually ask for help to any professional who has more experience. (ECU: 221 Class: 1 x2: 2)*

Another issue highlighted in the nurse's interview was care management, pointing out her responsibility for the supervision of the technical staff, in the management of human resources and training at work.

*Hard technology is not always used correctly due to the lack of human material. I, as a nurse, trying to do a training at work or demanding what sometimes there's no way of happening, unfortunately, in a university hospital. (ECU: 19 Class: 1 x2: 9)*

### Administrative emphasis

In this group we find discourses that emphasized the issues related to the structural part of the institution. The difficulties encountered by professionals were highlighted as a result of the lack of materials to instrumentalize health care.

*Then, we don't have the continuity of the product, which ends up causing difficulties. There are restrictive difficulties of working in a public hospital where you don't always have that product and knowing that the product is important to the patient. (ECU: 80 Class: 1 x2: 1)*

*Sometimes there's a lack of material, staff, sometimes there's lack of infusion pump, which becomes a difficulty regarding therapies. (ECU: 129 Class: 1 x2: 1)*

In the class (2), the reduced forms that showed higher frequency were: infusion, time, medications, infusion pumps, and volume.

In this class, the professionals were aware of the importance of safe care to them and their patients. On the other hand, in front of numerous technologies that could provide more safety in their practices, the professionals mentioned the infusion pumps because they can offer, under their conceptions, a safe infusion, offering dripping, volume and time controlled with precision.

*Regarding the drippings of some medications, such as: when the patient is in use of swan ganz, with norepinephrine and then you have analyze the condition of medical infusion, volume correction. (ECU: 139 Class: 2 x2: 18)*

*[...] for obvious reasons, the infusion, the dripping is super-controlled millimetrically, not infusing medication all at once, or too slowly. (ECU: 199 Class: 2 x2: 18)*

*[...] in this case, to administer medication, to have greater control. The technologies, in this case, I will give example of infusion pumps, play this role, of having greater control of the medication, which is better for the patient, in this case, in the treatment. (ECU: 218 Class: 2 x2: 18)*

*Well, first, the parenteral drug administration, appropriate dosage, at the appropriate time and in a synchronized way, is what prevents the patient from getting higher or lower volumes than he should get. (ECU: 123 Class: 2 x2: 10)*

Regarding the safety provided by the hard technologies, only one professional pointed out in his discourse, safety in both perspectives: patient and professional.

*It is completely safe for the patient, because the technology benefits both him and the professional. Mainly the patient, because the use of technology, such as an infusion pump, can calculate the dose, volume, all set up to benefit the patient in therapy. (ECU: 185 Class: 2 x2: 4)*

## DISCUSSION

When analyzing the results, we found that in the cognitive and technical emphasis, nursing professionals mentioned the lack of training as the main factor in the direct impact of the knowledge deficit and in the proper performance of the techniques that use technologies as tool and, as a consequence, do not enjoy the benefits of technology. They reported being able to optimize the time and improve their work with effective training.

This result is alarming and worrisome because the growing complexity adopted in hospitals — particularly in intensive care units, considered as a major source of financial and material resources consumption, and as the place where new advances in care and their associated risks are most commonly presented — demands from the professionals working in these places to stay updated to incorporate new knowledge and technological innovations related to care assistance<sup>(7)</sup>.

We need to understand that the technological apparatus in the intensive therapy consist of, countless times, means of communication between the patient critically ill and the staff. Hence the need for professionals to be able to manage these resources envisioning a harmonization among safe care, hard technology, and the patient critically ill<sup>(8)</sup>.

The not always effective communication between staff members and patients, in addition to the lack of guidance to professionals, are aspects that trigger the difficulties on a daily basis. In this sense, the nurse plays a key role in this context, because he links the members of the multidisciplinary staff and leads the largest group of professionals who works directly with the patient critically ill in constant use of hospital technology. Such a group requires training and supervision to ensure the proper and optimized use of the technological potential that this innovation, under his responsibility, has to offer<sup>(9)</sup>.

As to supervisory activities, we can highlight the role of the nurse in preventing errors and ensuring the safe medical drug administration, which requires more attention due to the volume of drugs administered to patients, mostly intravenously. This stresses the need for stricter rules of preparation and administration due to the chance of complications originated from bad practice.

Results of the Harvard Medical Practice Study<sup>(10)</sup> show that the complications related to the use of medications are the most common type of adverse event on hospitalization (19% of patients experience the occurrence), and 2% – 3% of hospitalized patients experience reactions caused specifically by pharmacological interactions<sup>(11)</sup>. The simultaneous use of several medications is common in intensive therapy, being intrinsically related to the risk of drug interactions, and this concern is highlighted by the subjects of this study.

The occurrence of medication errors increases twice as much the risk of death in hospitalized patients<sup>(11)</sup>. Allied to this, the use of a hard technology — the infusion pump — which is referred to in the study, in general, as “hard to handle” and therefore characterized as a safety risk, particularly for the risk of harm to the patient.

About 98 thousand Americans die each year due to medical errors; however, the underreport of the errors suggests that perhaps the rates shown in previous studies are even larger, increasing the magnitude of the problem<sup>(12-13)</sup>. Corroborating, American data show that the annual cost of damage resulting from medication errors revolves around U\$ 76.6 billion, requiring greater attention from professionals and institutions regarding prevention<sup>(14-16)</sup>.

Still in risk characterization, it is understandable that the misuse of infusion pump in this context can promote the error in the administration of medications, causing harm to the patient and increasing the costs to the institutions.

Thus, the concern of the subjects is justified when they understand that the usability related to ineffective handling of the infusion pump represents considerable risk by engaging both pharmacovigilance and technovigilance issues, requiring greater domain and supervision of the actions of health professionals.

Professionals highlighted the infusion pumps as the technology of greater representativeness in terms of safety and as a



big ally for actions on patient care, giving them peace of mind, safety and good services. However, the handling of this technological resource does not guarantee that an error with adverse events may not occur because of the human intervention in the programming of these bombs. Thus, training is essential to keep professionals up to date and able to receive patients better and safer, preventing risks and adverse outcomes<sup>(8,17)</sup>.

Data from ANVISA<sup>(18)</sup> in the period from 2006 to 2011 show that 12.7% (251 of 1,971 reports analyzed) of adverse events involving equipment relate to the use of infusion pump, being the free-flow event the most common complication, which leads to overdose on medical drug administration<sup>(19)</sup>. Most of these problems are attributed to misuse by health professionals, and the infusion pump is the health technology with higher risk for the patient. This reinforces the need to intensify training on the equipment with all the nursing staff on a continuous basis, regardless of notifications and/or faults detected.

Although the professionals feel safer when using infusion pumps to provide care to the patient in use of IVT, flow-based programming is not recommended because it is considered an unsafe practice<sup>(17)</sup>. Whereas it should be analyzed carefully the human intervention in the infusion pump design, the programming, and the interface to handle it, the technological market has innovating in this technology, aiming to minimize risks to the patient, as a result of misuse of equipment.

This way, the new infusion pumps of the smart type are already a reality. They are respected as those that have a software in which a drug library can be installed, consisting of a combination of drugs, which receives a series of parameters, such as dose units, standard concentrations, maximum and minimum doses, and infusion flow rates. For each drug of the library, the so-called relative and absolute limits are defined<sup>(19)</sup>.

This resource allows alerts to be triggered when specific medications are not inserted in the drug library or when the rates of doses do not reflect what was predetermined in the protocol<sup>(17)</sup>. However, in a systematic review developed in the United States, an analysis of 22 publications was performed about the risks and benefits of smart pumps, and the authors concluded that this technology can reduce, but not eliminate, programming errors<sup>(20)</sup>.

The technological resources are inexhaustible sources of information, which should be translated to the professionals that handle them. In this perspective, in addition to the health staff, the clinical engineering must also be engaged in terms of training, contributing significantly to patient safety. The professional — clinical engineer — contributes not only to the area of technical assistance, but also to training, identifying the complicating factors inserted with the technologies, aiming to mitigate them with detailed study and training for technological innovation, being, currently, an almost mandatory activity developed in hospitals<sup>(21)</sup>.

Contrary to every concern of professionals as to the relevance of the training for the proper handling of technologies, we observe that when training is offered and made available, it is common for professionals not to be available, whether due to difficulty in leaving the work environment, in the case of training conducted during the shifts; whether for lack of

interest or difficulty in going to the hospital outside of the working day, since most do not have exclusive dedication and acts in other institutions.

That makes us reflect on the limits and constraints of human performance. Fatigue and excessive working hours are examples of how the individual capacity is limited and influenced by the work environment and by the organizational context; the latter, however, should consider issues related to the individual, since this interaction (individual–organization) will influence both on the availability of professionals for training and patient safety<sup>(22)</sup>.

The discourses that gave voice to the difficulties of administrative emphasis are in accordance with some authors who consider the quality and quantity of the material as one of the guarantors of the efficiency of the care provided. In addition, the reality is that it is not possible to offer good assistance if there is no integration between management and care actions, and the nurse needs to be up to date with the quantitative and qualitative aspects of essential medical supplies in a unit<sup>(23-24)</sup>.

Maybe one of the points that most afflict the professionals involved in the management process is the scarcity of some material within a hospital, which implies, often, in the interruption of service, leading to harmful situations and stressful experience for the client, family and professionals<sup>(25)</sup>.

In the scenario studied, we observed that the implementation of the Standardization Committee with the nurse as a member of this staff increased, in qualitative terms, the availability of materials.

However, about the quantitative question, the healthcare staff mentioned the lack of material in the sectors, which is the responsibility of the nurse coordinator and the central property, whose function is the management of stocks. Sometimes, this professional does not develop the activities efficiently and effectively, which can be attributed to the diversity of materials and lack of computerization in this sector, in addition to issues such as the need to deprecate the dispensation of certain materials to supply a sector instead of another due to the lack of ideal quantitative material<sup>(25)</sup>.

The management process of materials in the institutions influence significantly the work of the professionals who act directly in care assistance. Issues such as quantity and quality of materials and lack of preventive maintenance of equipment shall be valued by the professionals involved<sup>(24)</sup>.

Although the nursing staff of the institution studied has identified the lack of training and the lack of resources as the greater difficulties in handling IVT technologies, the staff was also searching for solutions to solve the problems of daily routine during care management, using tools and management instruments for the correct accomplishment of activities.

This way, the technological innovation market expands every day at the disposal of human life, and the care in the context of technology refers to the reflection on the work routine of the nursing staff before the innovations, the conditions and organization of work in health care, especially in hospitals, focusing on a nursing care that considers the use of these technologies as a strategy of patient safety and on the professional during nursing care in IV therapies.

## FINAL CONSIDERATIONS

This study allowed reflections on the usability of hard technologies in the development of techniques that are tools of the nursing practice. For the development of techniques, we observed that training is essential. The lack of training is presented as the greatest difficulty of nursing professionals and permeates the issues of patient and professional safety when using the hard technologies

in IVT. There is the need to encourage notification of faults and accidents without punitive character, as well as to encourage the institutional culture of safety. However, for safety practices to be discussed and implemented, it is necessary for the leaders of the organizations to be engaged in developing this safety culture focused on the patient and organize a multidisciplinary staff to lead these discussions, seeking to analyze and evaluate each existing process in search of improvements.

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