THE CENTRAL STERILE SUPPLY DEPARTMENT AND ITS ESSENTIAL AND LARGE ROLE IN QUALITY OF CARE

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Every health service has, among other characteristics, the mission to ensure proper and safe health care. Moreover, avoiding health care associated infections is an important part of this mission. The Central Sterile Supply Department (CSSD), which exclusively focuses at avoiding the transmission of infections within health services, does it through the sterilization process.

When centralization of the sterilization process was recommended during the 1950–1960s, it aimed at ensuring the quality of processes that were performed there and to make them cheaper. During that period, the CSSD aimed at ensuring the quality of surgical procedures and the prevention of surgical-site infections. After the development of medical technology and increase in the complexity of care provided in health services, the use of clean and uninfected or sterilized equipment became a need. The use of invasive equipment has multiplied and it is already being used in different areas of the hospital. Moreover, the CSSD is responsible for supporting the prevention of infections like pneumonia or urinary tract infections.

By increasing its range, the importance of the CSSD in ensuring quality of the care provided to the patient/client, beyond the central axis of sterilization and operating room, has also increased. The impact of the services provided by the CSSD is visible, and it has ensured safe surgeries and care to many people. The lack of these good practices has been associated with outbreaks of infections and diseases to patients. Their implementation, based on evidence, is enough to avoid the occurrence of these situations, therefore ensuring quality and safety of the provided care.

The use of sterilized material for preventing infections in the surgical site is the first recommendation and possibly the one with the highest impact for preventing them. Cleansing and sterilization of surgical material are unquestioned and essential good practices. They are so essential that by ethical standards, paradoxically, their impact can only be measured through the lack or break of such procedures, when outbreaks and infections of the surgical site occur, but cannot be measured otherwise by the mere presence of these actions when the outcome is favorable for the patient.

Using sterilized or disinesininfected equipment or instrument is recommended in every manual and publication of international and national institutions for preventing infections that are transmitted in health services. A good example is the disinfection of respiratory and tracheal pieces, tubes, and equipment for ventilatory aid – which are essential for the prevention of pneumonia. Another example is the use of clean and uninfected bowls, which will avoid the colonization of the collecting bag, and reduce the chances of a urinary tract infection.

The technical break in the sterilization or disinfection process was described as the cause of many infection outbreaks from the surgical site or of infections that happened after endoscopic procedures. These infections could have been avoided, but since they were not, they resulted in heavy damages for patients as well as the health system.

Achieving the purpose of providing health services with safety and quality depends on the application of safe processes and procedures based on scientific evidence. The use of these two factors requires a critical and careful reading of the current scientific articles, chosen by excellence, by the professionals. The *Associação Brasileira de Enfermeiros de Centro Cirúrgico, Recuperação Anestésica e Centro de Material e Esterilização* (SOBECC) helps professionals to go through this path of knowledge, thus improving the quality and safety of the work performed in the CSSD by means of information and articles.

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OXYGENOTHERAPY RELATED TO PERIPHERAL OXYGEN SATURATION IN PATIENTS IN THE ANESTHETIC RECOVERY ROOM

Oxigenoterapia relacionada com a saturação periférica de oxigênio em pacientes na sala de recuperação anestésica

Oxigenoterapia relacionada con la saturación periférica de oxígeno en pacientes en la sala de recuperación anestésica

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ABSTRACT: Objective: Objective: To analyze the peripheral oxygen saturation in the use of oxygen therapy in the patient's first hour in a postanesthetic care unit. **Method:** Prospective, quantitative, and comparative study in a federal hospital located in Belo Horizonte, Minas Gerais. The sample consisted of 60 adults divided into two groups, with or without oxygen therapy, and one of the inclusion criteria was peripheral oxygen saturation, greater than or equal to 95% upon admittance to the postanesthetic care unit. **Results:** After 60 minutes, 5 patients without oxygen therapy (16.7%) and 2 patients with oxygen therapy (6.7%) showed mild hypoxemia. There was a marginally significant difference between the two groups for normal oxygen saturation (p=0.0563) and mild hypoxemia (p=0.0578). **Conclusion:** It is important to implement protocols for the admittance of patients to the postanesthetic care unit, including oxygen therapy, in order to maintain peripheral oxygen saturation, aiming to minimize the complications of hypoxemia.

Keywords: Perioperative nursing. Recovery room. Oxygen inhalation therapy.

RESUMO: Objetivo: Analisar a saturação periférica de oxigênio na utilização da oxigenoterapia na primeira hora de pacientes em sala de recuperação pós-anestésica. **Método:** Estudo comparativo, prospectivo e quantitativo, em um hospital federal localizado em Belo Horizonte, Minas Gerais. A amostra foi constituída por 60 adultos, distribuídos em dois grupos, sem ou com oxigenoterapia, e teve como um dos critérios de inclusão a saturação periférica de oxigênio maior ou igual a 95% na entrada da sala de recuperação pós-anestésica. **Resultados:** Completados 60 minutos, 5 pacientes sem oxigenoterapia (16,7%) e 2 pacientes com oxigenoterapia (6,7%) apresentavam hipoxemia leve. Houve diferença marginalmente significativa entre os dois grupos para a saturação periférica de oxigênio normal (p=0,0563) e hipoxemia leve (p=0,0578). **Conclusão:** É importante a implantação de protocolos de recepção de pacientes na sala de recuperação pós-anestésica, incluindo a oxigenoterapia, com o objetivo de manter a saturação periférica de oxigênio, minimizando as complicações da hipoxemia.

Palavras-chave: Enfermagem perioperatória. Sala de recuperação. Oxigenoterapia (vide documento suplementar).

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RESUMEN: Objetivo: Analizar la saturación periférica de oxígeno en la utilización de la oxigenoterapia en la primera hora de pacientes en sala de recuperación pos-anestésica. **Método:** Estudio comparativo, prospectivo y cuantitativo, en un hospital federal localizado en Belo Horizonte, Minas Gerais. La muestra fue constituida por 60 adultos, distribuidos en dos grupos, sin o con oxigenoterapia, y tuvo como uno dos criterios de inclusión la saturación periférica de oxígeno mayor o igual al 95% en la entrada de la sala de recuperación pos-anestésica. **Resultados:** Completados 60 minutos, 5 pacientes sin oxigenoterapia (16,7%) y 2 pacientes con oxigenoterapia (6,7%) presentaban hipoxemia leve. Hubo diferencia marginalmente significativa entre los dos grupos para la saturación periférica de oxígeno normal (p=0,0563) e hipoxemia leve (p=0,0578). **Conclusión:** Es importante la implantación de protocolos de recepción de pacientes en la sala de recuperación pos-anestésica, incluyendo la oxigenoterapia, con el objetivo de mantener la saturación periférica de oxígeno, minimizando las complicaciones de la hipoxemia.
Palabras clave: Enfermería perioperatoria. Sala de recuperación. Terapia por inhalación de oxígeno.

INTRODUCTION

The postanesthetic care unit (PACU) is a site suitable for the recovery of patients after a surgical procedure, as well as for planned and implemented nursing care to prevent and treat complications resulting from the anesthetic-surgical procedure. In this sense, it is assumed that parameters of evaluation and control of this assistance should be established, and one of the possible evaluation tools is the Aldrete Kroulik Index (AKI)[1,2].

The parameters evaluated by the AKI are muscle activity, breathing, circulation, consciousness, and peripheral oxygen saturation (SpO_2). The AKI is used according to the variation of values from zero to two for each parameter, where zero indicates conditions of greater severity; value one corresponds to an intermediate level; and two represents reestablished functions[2,3].

The application of the AKI in the PACU is indicated upon the patient's arrival, considering minute zero as the patient's arrival in the PACU; afterwards, every 15 minutes in the first hour, every 30 minutes in the second hour, and every hour from the third hour[3].

The period of anesthetic recovery (AR) is the moment when the patient is most vulnerable and unstable, due to anesthetic drugs and the surgical procedure itself. Therefore, the stay in the PACU requires constant evaluation and assistance[3].

Peripheral oxygen saturation (SpO_2) is an important aspect to be analyzed in the PACU, because it suffers significant decreases due to anesthetic-surgical procedures. SpO_2 is one of the components of the AKI that jointly analyzes muscle activity, breathing, circulation, and consciousness – important parameters used for evaluation and evolution of the patient during AR [2].

Out of the respiratory complications, hypoxemia is one of the most frequent in PACU. Every patient needs continuous surveillance due to the development of varied degrees of hypoxemia when SpO_2 is lower than 90%. In order to diagnose hypoxemia, it is necessary to constantly monitor the respiratory level of the patient, mainly through the pulse oximeter[4].

Hypoxemia is defined as the reduction of arterial oxygen content, and is diagnosed by low blood pressure (below 60 mmHg), or by a decrease in SpO_2 (below 95% or a decrease greater than 5% of the initial value). Hypoxemia is considered intense when SpO_2 is below 85%[5].

The treatment of hypoxemia with oxygen through face mask or nasopharyngeal catheter is effective for the maintenance of adequate levels of alveolar oxygen pressure in most cases. This measure does not treat hypoxemia but alleviates symptoms while not being diagnosed and treated[4,5].

The prevention of hypoxemia is desirable and can be minimized with oxygen therapy in the immediate postoperative period, which may improve outcome by reducing the risk of surgical wound infection and the incidence of nausea and vomiting[5].

Not all institutions routinely transport patients from the operating room (OR) to the PACU with the use of oxygen therapy. In addition, in the PACU, SpO_2 is used routinely with 83.4% of patients, and oxygen therapy, with 57.2% of patients[5].

Regarding the patient's physical condition, the classification proposed by the American Society of Anesthesiologists (ASA) in 1963 is widely used throughout the world, being categorized into classes[3]:

1. healthy patient;
2. patient with mild systemic disease;
3. patient with severe systemic disease;
4. patient with impacting systemic disease, with risk of death;
5. patient dying, with little probability of survival;
6. patient with brain death;
7. patient requiring emergency surgery.

The hypoxemia that manifests in PACU, especially in patients with a physical ASA rating of one, is most often related to anesthesia. Usually the patient presents respiratory

depression due to the residual action of opioids and neuromuscular blockers, due to loss of vaso-constricting reflexes, increased oxygen consumption and muscle tremors[6].

In the present study, the importance of anesthesia-related hypoxemia control in the prevention and control of complications during the AR period was considered.

Considering that the patient in the AR period is vulnerable to several complications, with hypoxemia being one of the most frequent, this study poses the following question: do the SpO_2 values improve with the use of oxygen therapy upon the patient's admittance to the PACU?

OBJECTIVE

To analyze the values of SpO_2, with and without the use of oxygen therapy, in the first hour of patient's stay in the PACU.

METHOD

This is a quantitative, comparative, field study with a methodological, prospective approach.

The study site was the PACU of a large general public hospital located in Belo Horizonte, Minas Gerais. The PACU has 7 beds and keeps room temperature between 22 and 24°C and relative air humidity between 45 and 60%, according to the recommendations of the Ministry of Health.

The research project was approved by the Research Ethics Committee of Universidade Federal de Minas Gerais (CEP/UFMG), registered under protocol no. 274.655 and Certificate of Presentation for Ethical Appraisal (CAAE) no. 14887213.4.0000.5149, pursuant to Resolution no. 466/2012 of the National Health Council.

Because the subjects were AR patients, they were located in the unit of origin through the daily surgery scale, and the Informed Consent Term was offered in the patient unit by the researchers before the administration of the pre-anesthetic medication, when indicated.

Inclusion criteria were having signed the ICF; being an adult between the ages of 18 and 64 years; having undergone elective surgical procedure; having received general anesthesia, with at least one hour of anesthesia; and having had an ASA rating of I or II and $SpO_2 \geq 95\%$ upon admittance to the PACU.

Patients with previous respiratory disorders, smokers, age and weight extremes, ASA classification III to VI, urgency and emergency surgeries, local anesthesia and $SpO_2 < 95\%$ upon admittance to the PACU.

The sample consisted of 60 subjects, divided into two groups: 30 subjects for the group without oxygen therapy (GSO) and 30 subjects for the group with oxygen therapy (GCO).

The sample size was defined according to the number of predictive variables initially proposed, using five subjects for each group, in relation to each of the variables[7].

Upon arrival, the GSO subjects did not receive oxygen therapy and GCO subjects received nasal catheter oxygen therapy. Whether or not oxygen therapy was administered upon admittance to the PACU was indicated by the health team at the study site. Therefore, the researchers did not participate in the choice of subjects to the groups to which they belonged, whether GSO or GCO.

Both GSO and GCO subjects were transported from the OR to PACU without oxygen therapy, according to the field study procedure.

For data collection, a structured instrument (Appendix 1) was elaborated containing data on sociodemographic and clinical aspects of the patient, such as sex, age, comorbidities, and ASA classification, and data on the surgical anesthetic procedure, which were the specialty of the surgery and the duration of anesthesia.

The data on the PACU were the patient's time of arrival and the group to which they belong, whether GSO or GCO (for the latter, also the time of administration of oxygen therapy). Data were collected during the first hour of stay in the PACU. The first analysis of the SpO_2 was carried out immediately, upon the patient's entry into the PACU, followed by four other collections: after 15, 30, 45 and 60 minutes, as recommended by the AIK[3].

SpO_2 was analyzed as normal (≥95%), mild (91–94%), moderate (90–86%), and intense (<85%) hypoxemia[5].

The software used in the data analysis was R, version 2.13.1. To verify the homogeneity between the GSO and the GCO, the Mann–Whitney test was used for the comparison of the quantitative variables and for presenting the absolute and relative values with a significance level of 5%.

RESULTS

The results were organized according to sociodemographic and clinical data, anesthetic-surgical procedure and SpO_2 analysis in the first hour of stay in PACU.

Sociodemographic and clinical data

Table 1 shows that, in relation to sex, there was a similarity between the groups, which consisted mostly of women, with 23 (76.7%) and 20 (66.7%), compared to 7 (23.3%) and 10 (33.3%) men in the GSO and GCO, respectively.

The mean age of patients in the GSO was 46.3 years, with a range of 18–64 years. In GCO, the mean was 48.6 years, with an amplitude of 20–64 years.

The comorbidities more frequently identified were systemic arterial hypertension (SAH) and diabetes mellitus (DM). The highest frequency was SAH, in 30% of GCO patients.

In the ASA assessment, there was a predominance of ASA II in 18 patients (60.0%) in GCO, followed by ASA I in 17 patients (56.7%) in GSO.

Anesthetic-surgical procedure data

In this study, all patients underwent general anesthesia, which was one of the inclusion criteria in the sample. Regarding the time of anesthesia, it can be observed in Table 2 that there was similarity between the groups, lasting more than 180 minutes, 20 (66.6%) in the GSO and 22 (73.4%) in the GCO.

As for the surgical specialty, there was a diversity for the two groups; for the GSO, the most frequent was breast surgery, with 7 patients (23.3%), and for the GCO, it was the digestive tract and associated organs, in 11 patients (36.7%).

Analysis of SpO_2 in the first hour of stay in the PACU

Table 3 shows the variation in SpO_2 of the patients during the first 60 minutes, period of stay in the PACU. SpO_2 was checked every 15 minutes and classified into normal, mild, moderate, and intense hypoxemia, according to previously defined criteria.

In this study, the inclusion criterion was normal SpO_2 (≥95%) upon the patient's admittance to the PACU; therefore, at minute zero, all patients, of both GSO and GCO, presented a normal SpO_2.

In the first 15 minutes of stay in the PACU, 4 patients (13.4%) from the GSO presented a decrease in SpO_2, and 3

Table 1. Distribution of the patients of the groups without oxygen therapy and with oxygen therapy, according to sociodemographic and clinical data. Belo Horizonte, MG, Brazil, 2014.

Variables	GSO		GCO	
	n	%	n	%
Sex				
Male	7	23.3	10	33.3
Female	23	76.7	20	66.7
Age				
18|– 28	7	23.3	3	10.0
29 – 38	5	16.6	4	13.3
39 – 48	7	23.3	5	16.6
49 – 58	9	30.0	11	36.7
59 |–65	2	6.7	7	23.3
Comorbidities				
Hypertension	3	10.0	9	30.0
DM	0	0.0	1	3.3
Hypertension + DM	3	10.0	3	10.0
ASA				
I	17	56.7	12	40.0
II	13	43.3	18	60.0

GSO: group without oxygen therapy; GCO: group with oxygen therapy; DM: diabetes *mellitus*; ASA: classification proposed by the American Society of Anesthesiologists.

Table 2. Distribution of patients in the groups without oxygen therapy and with oxygen therapy, according to the duration of anesthesia and surgical specialty. Belo Horizonte, MG, Brazil, 2014.

Variables	GSO		GCO	
	n	%	n	%
Duration of anesthesia (minutes)				
60 to 120	5	16.7	4	13.3
121 to 180	5	16.7	4	13.3
Over 180	20	66.6	22	73.4
Surgical specialty				
Digestive system and accessory organs	5	16.7	11	36.7
Bucomaxillofacial	5	16.7	2	6.7
Head and neck	2	6.7	1	3.3
Cardiovascular	0	0.0	2	6.7
Breast surgery	7	23.3	1	3.3
Neurosurgery	0	0.0	1	3.3
Orthopedics and traumatology	2	6.7	4	13.3
Otolaryngology	3	10.0	4	13.3
Plastic	3	10.0	4	13.3
Urology	3	10.0	0	0.0

GSO: group without oxygen therapy; GCO: group with oxygen therapy.

(10.0%) shifted from the normal classification to mild hypoxemia, and 1 (3.3%), for moderate hypoxemia.

It was identified that the GCO remained with a normal SpO2 within the first 15 minutes in the PACU.

Within 30 minutes of stay in the PACU 1 patient (3.3%) from the GSO presented moderate hypoxemia.

Mild hypoxemia, within 45 minutes, was more frequent in the GSO – 6 patients (20.0%) – than in the GCO – 4 patients (13.3%).

No patient had severe hypoxemia in the course of 60 minutes of PACU stay. However, it was observed that, in this period, 5 patients (16.7%) from the GSO and 2 patients (6.7%) from the GCO had mild hypoxemia.

Table 4 shows the behavior of the groups over the course of 60 minutes in relation to the SpO_2 values.

Normal SpO_2 (p=0.0563) and mild hypoxemia (p=0.0578) values were observed to have a marginally significant difference between GSO and GCO, analyzed during the 60 minutes of patient stay in the PACU.

It is also observed that there was no statistical significance for moderate hypoxemia between groups, because only one subject was present in each group, and p=1.00. No subject presented severe hypoxemia, that is, $SpO_2 \leq 85\%$.

DISCUSSION

The results showed that there was a marginally significant difference between GSO and GCO regarding normal SpO_2

Table 3. Distribution of patients in the groups without oxygen therapy and with oxygen therapy, according to the classification of peripheral oxygen saturation, within 60 minutes of stay in the postanesthetic care unit. Belo Horizonte, MG, Brazil, 2014.

SpO_2 (%)	0		15		30		45		60	
	n	%	n	%	n	%	n	%	n	%
Normal (≥95)										
GSO	30	100.0	26	86.7	28	93.3	24	80.0	25	83.3
GCO	30	100.0	30	100.0	28	93.3	26	86.7	28	93.3
Mild hypoxemia (94–91)										
GSO	0	0.0	3	10.0	2	6.7	6	20.0	5	16.7
GCO	0	0.0	0	0.0	1	3.3	4	13.3	2	6.7
Moderate hypoxemia (90–86)										
GSO	0	0.0	1	3.3	0	0.0	0	0.0	0	0.0
GCO	0	0.0	0	0.0	1	3.3	0	0.0	0	0.0
Intense hypoxemia (≤85)										
GSO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
GCO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

GSO: group without oxygen therapy; GCO: group with oxygen therapy; SpO_2: peripheral oxygen saturation.

Table 4. Distribution of patients in the groups without oxygen therapy and with oxygen therapy, according to the association of the occurrence of hypoxemia, within 60 minutes of stay in the postanesthetic care unit. Belo Horizonte, MG, Brazil, 2014.

SpO_2 (%)	Groups	Mean	SE	Median	Minimum	Maximum	p value
Normal	GSO	98.1	0.19	97.6	96	100	0.0563
	GCO	98.3	0.38	97.9	96	100	
Mild hypoxemia	GSO	97.2	0.51	96.5	91	97	0.0578
	GCO	97.3	1.05	96.9	91	97	
Moderate hypoxemia	GSO	97.1	0.11	95.5	86	96	1.00
	GCO	97.3	0.25	95.6	86	96	

GSO: group without oxygen therapy; GCO: group with oxygen therapy; SpO_2: peripheral oxygen saturation; PACU: postanesthetic care unit; SE: standard error.

and mild hypoxemia within 60 minutes of patient stay in the PACU.

Factors related to a decrease in arterial oxygen content include all those that modify the amount of hemoglobin, the fraction of inspired oxygen, and the fractional saturation of oxyhemoglobin[5].

The origin of the changes that trigger hypoxemia during the immediate postoperative period is multifactorial and encompasses the synergy between the patient's illness, the effects of anesthesia, and the changes caused by the surgical procedure performed[5,8].

The main components involved in the development of hypoxemia are related to the patient's age, preoperative pulmonary function, residual action of the anesthetics used, the surgical area involved in the procedure, duration of anesthesia, and the type of postoperative analgesia employed[5,6,8-10]. Please refer to the supplementary document.

The hypoxemia that manifests in patients in the PACU, especially patients with an ASA I classification, is mostly related to anesthesia. The patient may present respiratory depression due to the residual action of opioids and neuromuscular blockers, loss of vaso-constricting reflexes, increased oxygen consumption and muscle tremors, which may, among other things, cause drowsiness and increase recovery time and delay discharge from the PACU[8-10].

In this study, ASA I and II classifications were more frequent in GSO and GCO, consecutively, demonstrating the need for supplemental oxygen in all cases.

A literature review of research conducted on the subject from 1998 to 2008 demonstrated that hypothermia is the most frequent complication in the PACU, followed by nausea, pain, vomiting, sweating, and hypoxemia, among other signs, symptoms, and complications[9].

Studies report hypoxia and bronchospasm as adverse effects of respiratory origin in patients during the period of AR, as well as those of cardiovascular origin such as dysrhythmias, hypertension, and hypotension[2,9].

A meta-analysis confirmed the need for pulse oximetry to detect hypoxemia in the immediate postoperative period and its consequences. In addition to being non-invasive and cost-effective, its use contributes to an increase in the early identification of cardiac events due to hypoxemic episodes, with a reduction in the incidence of myocardial ischemia and bradycardia. It also identifies the possible need for oxygen therapy after discharge from the PACU and thus decreases the rate of complications and postoperative mortality[5].

The American Society of peri-Anesthesia Nurses (ASPAN) recommends patient admission to the PACU in three stages. The first stage is called ABC assessment, being Airway, Breathing, and Circulation. In the evaluation of the airways, the recommended interventions are the observation of patency, administration of humidified oxygen, and placement of pulse oximetry, in order to prevent hypoxemia[11].

In the AR period, the postoperative assessment includes the verification of respiratory rate and heart rate, level of consciousness, oxygen saturation, and blood pressure, as well as observation of wound and dressing conditions, permeability of access, and drainage routes and assessment of pain levels[2,3,11,12].

Oxygen monitors for perioperative use need to be in continuous operation to detect early adverse events, and ideally reduce anesthetic-surgical morbidity. Currently, the decrease in SpO_2 measured by the pulse oximeter is the earliest and most important sign of hypoxemia[5,6,8].

The impact of the anesthetic-surgical act on the patient's pulmonary function is responsible for the development of hypoxemia in the immediate postoperative period. In times of cost reduction, as well as the adoption of evidence-based conducts, the use of supplemental oxygen therapy should be rationally oriented. However, the risk of potentially serious complications associated with its non-use cannot be underestimated[5].

Since the PACU is destined to the care of patients in the immediate postoperative period submitted to general and/or loco-regional anesthesia, specialized technical and human resources are needed to support the prevention, detection, and early implementation of specific care[8].

In a study carried out in Porto Alegre, Rio Grande do Sul, regarding the nursing needs of patients in a post-anesthetic recovery unit, the authors highlighted the assistance specificities of these patients, who "present a high degree of dependence and require rigorous clinical observation for skilled management and quick and accurate decision-making skills"[13].

Patient SpO_2 monitoring during the AR period is an important aspect to be considered in planning and implementing patient care in the PACU, since the occurrence of a decrease in oxygen saturation can trigger a number of preventable postoperative complications.

CONCLUSION

The results of this research allowed us to conclude that the use of oxygen therapy upon the patient's admittance to the PACU can prevent hypoxemia.

The data analyzed showed that there was a marginally significant difference in peripheral oxygen saturation for patients of the two groups throughout the PACU stay, for normal SpO_2 ($p=0.0563$), and mild hypoxemia ($p=0.0578$).

This marginally significant difference between the group that did not receive and the group that received oxygen therapy was demonstrated by the difference in oxygen saturation at minute zero, equal in all subjects of both groups, and at 60 minutes, with five GSO subjects presenting mild hypoxemia.

In this sense, measures to control oxygen saturation should be part of the systematization of nursing care. It is necessary to construct and implement assistance protocols for the perioperative period, increasing the patient's stay in the PACU and including oxygen therapy in the intervention processes, aiming to maintain the peripheral oxygen saturation, in order to minimize the consequences of hypoxemia, such as drowsiness and nausea.

It can be concluded that the use of oxygen therapy upon the patient's admittance to the PACU prevents hypoxemia, and this should be associated with measures of patient care in the PACU period.

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Appendix 1. Data Collection Instrument.

Initials: Bed:					
Sex: ( ) M ( ) F			Date:		Registration:
Age:			Surgery performed:		
ASA:	( ) I	( ) II	IA:	TA:	T:
( ) Hypertension	( ) DM	( ) Other	( ) IV total		( ) IV + Inhalation

Anesthetic recovery					
Admittance:		Discharge:		Total:	
Oxygen therapy upon admittance: ( ) Yes ( ) No Mask ( ) Catheter( )					
If yes, removes in: 0 15 30 45 60					
Decrease in SpO_2: ( ) Yes ( ) No					
If yes, after how many minutes of PACU stay: 0 15 30 45 60					
Start:		End:		Total:	
Oxygen therapy during decrease in SpO_2: ( ) Yes ( ) No					
Start:	End:	Total:	Mask ( )		Catheter ( )
	0	15	30	45	60
Activity					
Consciousness					
Breath					
Circulation					
SpO_2					
TOTAL					
BP					
HR					
RR					
Temperature					

IMPLEMENTATION OF A NURSING ORIENTATION FOR PRE-OPERATIVE CARDIAC SURGERY PATIENTS USING A DIGITAL MEDIUM

Implementação de orientações de enfermagem aos pacientes pré-operatórios de cirurgia cardíaca em meio digital

Implementación de orientaciones de enfermería a los pacientes en preoperatorio de cirugía cardiaca en los medios digitales

Patrícia Silveira Almeida[1], Lucia Campos Pellanda[2], Rita Catalina Aquino Caregnato[3], Emiliane Nogueira de Souza[4]

ABSTRACT: Objective: Analyze the implementation of nursing orientation for preoperative patients of myocardial revascularization surgery using a digital medium. **Method:** An intervention study performed in a hospital in Porto Alegre, Rio Grande do Sul, using a management process method, which has characteristics that include planning, doing, checking, and acting. From August to September of 2015, the patients received presurgical guidance by means of a tablet. **Results:** After guidance was offered, patients and nurses evaluated the use of the strategy, and the data were analyzed by descriptive statistics. Twenty-seven patients were included, and they had an average age of 63.14±10.87 years. All the persons who attended the orientation, reported that they had learned more with regard to the surgery and the required preparation. Four nurses were also included in the study, and all of them affirmed that the use of the audiovisual resource standardized the information transmitted to the patients. **Conclusion:** The use of the tablet facilitated the understanding of preoperative patients of myocardial revascularization surgery and standardized the preoperative orientation given by the nurses.

Keywords: Nursing care. Video-Audio media. Perioperative care. Myocardial revascularization.

RESUMO: Objetivo: Analisar a implementação das orientações de enfermagem aos pacientes pré-operatórios de cirurgia de revascularização do miocárdio em meio digital. **Método:** Estudo de intervenção realizado em hospital de Porto Alegre, Rio Grande do Sul, utilizando método gerencial de processos, que tem como características: planejar, executar, verificar e avaliar. De agosto a setembro de 2015, os pacientes receberam orientações pré-cirúrgicas por meio de um *tablet*. **Resultados:** Após orientações fornecidas, pacientes e enfermeiros avaliaram o uso da estratégia. Os dados foram analisados por estatística descritiva. Foram incluídos 27 pacientes, com idade média de 63,14±10,87 anos. Todos afirmaram ter aprendido mais a respeito da cirurgia e sobre o seu preparo. Também foram inseridas quatro enfermeiras, e todas afirmaram que a utilização do recurso audiovisual padronizou as informações transmitidas aos pacientes. **Conclusão:** A utilização do *tablet* favoreceu o entendimento dos pacientes pré-cirúrgicos de cirurgia de revascularização do miocárdio e padronizou as orientações pré-operatórias de enfermagem.

Palavras-chave: Cuidados de enfermagem. Mídia audiovisual. Assistência perioperatória. Revascularização miocárdica.

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RESUMEN: **Objetivo:** Analizar la implementación de las orientaciones de enfermería a los pacientes pre-operatorios de cirugía de revascularización del miocardio en medio digital. **Método:** Estudio de intervención realizado en hospital de Porto Alegre, Rio Grande do Sul, utilizando método gerencial de procesos, que tiene como características: planificar, ejecutar, verificar y evaluar. De agosto a septiembre de 2015, los pacientes recibieron orientaciones pre-quirúrgicas por medio de un *tablet*. **Resultados:** Tras orientaciones suministradas, pacientes y enfermeros evaluaron el uso de la estrategia. Los datos fueron analizados por estadística descriptiva. Fueron incluidos 27 pacientes, con edad promedio de 63,14±10,87 años. Todos afirmaron haber aprendido más al respecto de la cirugía y sobre su preparación. También fueron insertadas cuatro enfermeras, y todas afirmaron que la utilización del recurso audiovisual estandarizó las informaciones transmitidas a los pacientes. **Conclusión:** La utilización del *tablet* favoreció el entendimiento de los pacientes pre-quirúrgicos de cirugía de revascularización del miocardio y estandarizó las orientaciones pre-operatorias de enfermería.

Palabras clave: Atención de enfermeira. Medios audiovisuales. Atención perioperativa. Revascularización miocárdica.

INTRODUCTION

The technological and therapeutic advances in cardiology have been allowing the survival of individuals who are victims of the ischemic heart disease. Myocardial revascularization surgery (MRS) is an intervention that helps to alleviate symptoms, allows for the reestablishment of a patient's physical condition, increasing their survival and promoting a better quality of life for the individual. Considering that it is a complex procedure, it requires appropriate treatment in all of its operative phases. This type of surgery has repercussions in the life of the patient, because it demands that the patient adapts to a new way of life as a result of which they have to face physical restrictions and make changes in their lifestyle.[1,2]

Under these circumstances, the higher the level of understanding of the patient about the procedure which he or she will undergo, the lower the level of his or her anxiety will be for the surgical intervention and, thus, the better his or her recovery will be. In addition, the manner in which the patient handles the surgical experience may lead to complications that can negatively interfere in their recovery. This may intensify morbidity in the postoperative period.[3] Additionally, since 2004, the National Sanitary Surveillance Agency (ANVISA) incorporated into its scope of action, the planned actions in the World Alliance for Patient Safety of the World Health Organization (WHO), of which Brazil is a member. The National Program of Patient Safety (PNSP), established in Brazil by MS Ordinance No. 529, of April 2013, advocates for the implantation of a culture of safety in health institutions, stimulating the participation of patients for their own safety.[4]

Thus, it is the responsibility of nurses to transmit the information to the surgical patient with respect to their health problem, their surgical intervention, and about the manner in which they can actively contribute to their postoperative recovery.[5] The orientation from nurses provided systematically enhances the knowledge of the patient with respect to their disease and concerning the essential procedures necessary for their recovery, in addition to qualifying and contributing toward the actions in all levels of health assistance, which collaborates with the work of the team.[6]

Diverse resources used in preoperative orientation, such as the use of images, audio and video, and visits to the surgical center or to the area where the patient will stay during the immediate postoperative period were observed.[7]

A study performed with the objective of verifying the effect of audiovisual resources in the preoperative orientation and about the knowledge of the patients undergoing cardiac surgery compared with the usual orientation from the nursing team, showed that patients who received audiovisual orientation by means of an explanatory video and a PowerPoint presentation were more prepared for the procedure that was going to be performed on them. In addition, the patients demonstrated more knowledge about the perioperative period, when compared with patients who received routine verbal guidance from the unit.[8]

With regard to the effectiveness of the audiovisual resources used in the preoperative orientation, evidenced in the cited study[8], through which the patients had a better understanding of the process which they would be undergoing and, consequently through which they would be able to deal better with their anxieties and doubts, justifies the implementation of an intervention in service which includes the use of such resources. In this context, this study aimed at analyzing the implementation of the nursing orientation for the preoperative patients of MRS with a digital medium, using a management process method which has the following characteristics: plan, do, check, and act.[9]

METHODS

This is an intervention study in a hospital, performed in two inpatient medical-surgical units that assist patients through the Brazilian public health system (SUS) and through health supplement insurance, considered cardiology reference center in south of Brazil. The period of intervention was from August to September 2015.

The mentioned hospital develops teaching and research in cardiology and cardiovascular diseases of various levels, and as a teaching hospital, it offers curricular internships to other teaching institutions in the most diverse areas of health. This same institution was the location of the previous study[8] that proved, by a randomized clinical trial, the effectiveness of the use of audiovisual resources in the preoperative orientation for patients who would be undergoing MRS.

The population of the study was composed of nurses and patients of two medical-surgical units of this hospital. The sample was chosen for convenience according to the period of the intervention.

Those who were included were preoperative hospitalized MRS patients in the two units during the period of the intervention, with an age over 18 years and presenting favorable cognitive and physical conditions for receiving orientation by audiovisual resource and this was followed by an evaluation.

Four nurses who work in these units were included. They give orientation to the patients in the MRS preoperative period and they accepted participating in the study.

The orientation about the perioperative MRS provided by the nurses from the institution are verbal and occur on the day before the surgery, prior to the beginning of the preoperative preparation. There is no checklist of information to be provided, only the preoperative preparation items that should contain due dates and should be verified and checked off by the nurse on duty when the patient is ready to be transferred to the surgical wing.

On the basis of the management method plan, do, check, act (PDCA), this study was developed. The stages are presented as follows:

1st stage: Plan

A first meeting with some of the nurses from the sectors involved was conducted with the support of the head of nursing services, to present the problem as well as the proposal for intervention. The information was presented in a PowerPoint, and elaborated by the researcher. It contained some items such as a brief explanation about the surgery, the preparation of the patient for the surgery, and intraoperative and postoperative periods. A video containing images and animations with narration in Portuguese, in accessible language, explaining the surgical procedure, was presented. This video has a duration about 4 minutes, and belongs to the American company Nucleus Medical Media. It was acquired with a financial support from the Institutional Research Support Fund for prior study.[8] The material was finalized to be presented in a second meeting of the nurses of the medical-surgical units, where the intervention was performed, so that they could familiarize themselves with the tablet and its content.

2nd Stage: Do

The patients were identified from a list of surgeries provided daily to the inpatient medical-surgical units, where the researcher showed up from Monday to Friday during the morning and performed the approach for the preoperative MRS patients at their bedside. Patients who were familiar with this type of device were able to handle it themselves. The participating nurses only accompanied the researcher in the implementation of the orientation.

3rd Stage: Check

After each orientation provided to the patients using the tablet, a questionnaire evaluating the use of this tool for the preoperative guidance of MRS was administered. To verify the applicability of this tool in guidance for surgical patients as a routine, a questionnaire was administered to the nurses who accompanied the researcher. The data obtained through this stage are described in the Results section.

4th Stage: Act

From the opinion of the patients and the nurses and some adjustments made to optimize the use of this strategy, considering the time and technique used by the nurses, the results were presented to the nursing service, which will then evaluate, with their team, the best moment to implement this tool as part of a routine assistance.

A descriptive study was performed and the data were transcribed into a table in Excel. The categorical variables were classified in absolute numbers (n) and percentages (%). The continuous variables were described as means and

standard deviation, in accordance with the characteristics of the data collected.

This study was approved by the Research Ethics Committee (REC) of the hospital with a CAAE 38680114.5.0000.5333 and under number 893.946, having followed the ethical recommendations set forth in the present resolution.

RESULTS

Of the researched sample of 27 patients, the majority of whom were of the masculine sex, the average age was 63.14±10.87 years. Other data are demonstrated in Table 1. The sample totaled 27 patients.

Among the patients of the sample, 17 (62.96%) were hospitalized by SUS. The orientation by means of the tablet had an average duration of 25 minutes. Eighteen (66.67%) patients who were being guided were accompanied by relatives and of these relatives, 14 (77.78%) also wanted to watch the orientation instructions by means of the presentation and explanatory video. Fourteen (51.85%) patients did not need help from the researcher or nurse to maneuver the tablet or read the instructions; and 13 (48.15%) needed some type of help. Nevertheless, an important fact to be mentioned is that the patients were primarily elderly, so in the majority of cases, the researcher had to maneuver the audiovisual device in order to pass through the slides on the screen. As was observed, many patients avoided holding onto the tablet, affirming that they did not know how to use it correctly or that it could fall, and then asked the researcher to hold. In one of the cases, a relative of the patient said that it was better to explain the orientation in words, because the patient would understand it better because of his/her low-level of education.

Table 1. Socio-demographic characteristics of patients undergoing myocardial revascularization surgery (n=27). Porto Alegre, RS, Brazil, 2015.

Variable	n (%)
Sex	
Male	22 (81.48)
Female	5 (18.52)
Age range (years)	
30–39	1 (3.70)
40–49	3 (11.11)
50–59	5 (18.52)
60–69	9 (33.33)
70–79	9 (33.33)
Schooling	
Illiterate	1 (3.70)
Elementary school	15 (55.56)
High school	6 (22.22)
Higher education	5 (18.52)

Figure 1 shows the opinions of the patients about the use of the tablet for the orientation on the surgery and the perioperative.

When asked about their opinion with respect to the presentation on PowerPoint, with the orientation of the MRS perioperative, 26 patients who responded, affirmed that they liked it.

The third question on the questionnaire sought to know the opinion of the patients about the explanatory video on MRS, and obtained a unanimous response from the 27 patients (100%) of having liked it.

The 25 patients who responded to the fourth question, affirmed that they learned more about the surgery and about its preparation, with the presentation and with the explanatory video.

Figure 2 presents the feelings checked off by the patients after receiving the instructions for the MRS by means of the tablet. In this question, the patients could check off any number of feelings that they wanted.

With regard to the doubts raised, a large part of the patients wanted to know if they would return to perform

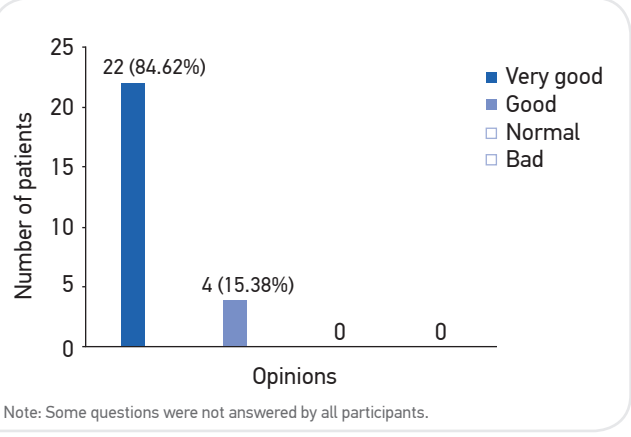

Figure 1. Patients' opinions (n = 26) about receiving the orientation through a tablet. Porto Alegre. RS. 2015.

the activities that they did before the surgical procedure. Other patients reported that they were able to clarify their doubts and understand some processes with the orientation provided – for example, one patient, upon seeing a slide of the presentation that illustrated the intubation, mentioned that they had a very different idea in their mind than what was being presented.

Despite the limitations and difficulties encountered, the bedside instructions were beneficial to the patients, optimism was evident in most of them, many said that everything would go well in surgery and they were confident. Most of the patients seemed to be calm during the use and handling of the tablet. They showed no visible reactions of anxiety or nervousness. They showed curiosity to see the orientation. They got up quickly or arranged themselves to better see what was contained in the device, and most of their companions had an interest in seeing the orientation as well.

Only two female patients demonstrated apparent nervousness, they stayed quiet upon seeing the orientation and showed a semblance of sadness. On the other hand, one patient commented that he was nervous before the orientation, thinking that he would be shown photos of the act of the surgery itself, but by they end of the presentation, he was quite calm.

The four nurses who participated in this study, all of them of the feminine sex, were of an average age of 28.75±3.34 years, and had a minimum time since graduation of 3 years, and a maximum of 10 years. The shorter employee tenure at the institution was eight months and the highest was three years.

Table 2 shows the questions given to the nurses and their respective responses about the use of the tablet for transmitting the orientation to the surgical patients.

With respect to the opinion of the nurses about the use of the tablet in the orientation of the patients undergoing MRS, two of them (50%) responded that the instructions contained in this device were fundamental for giving orientation to the patients and the other 2 (50%) affirmed that the information existing in the tablet helped to transmit the orientation to the patients. None of them responded that the material provided little or no support to transmit the orientation to the MRS patients.

When asked about the implementation of the resources in the routine of the unit in order to give orientation to the surgical patients, two nurses (50%) affirmed that the use of the tablet, in addition to standardizing the information transmitted to the patients, also reduced the time of the orientation; and two (50%) considered that the use of this device standardizes the information passed on and increases the time spent on giving the orientation to the patients.

In the question that sought to know whether the nurses would use the tablet while giving the orientation to the patients routinely, for those who responded that they would use it sometimes or never, they were asked to justify their responses. As such, two nurses who responded "sometimes" justified as follows:

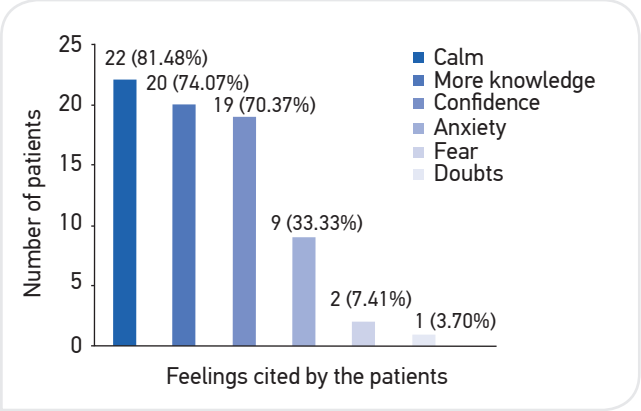

Figure 2. Feelings presented by the patients after receiving the orientation about the myocardial revascularization surgery through the tablet. Porto Alegre. RS. 2015.

Table 2. Questions about the use of a tablet in the orientation. Porto Alegre. RS. Brazil. 2015.

Questions	Answers n (%)
What is your opinion about handling the tablet?	
Very easy	3 (75)
Easy	1 (25)
What is your opinion about the content in the orientation?	
Very good	3 (75)
Good	1 (25)
What is your opinion about inserting the tool in your everyday routine?	
I would always use it	2 (50)
I would use it sometimes	2 (50)
Did the content contribute to improve the surgical patients comprehension?	
Yes	4 (100)

> I would use it sometimes, because I do not have time. (E2)

> Because of time, in some moments it is difficult because of the number of surgical patients there are. (E3)

At the end of the questionnaire destined for the nurses, there was an open space for suggestions, where all of the participating nurses left comments or suggestions, and are presented as follows:

> The resource is adequate and provides clarity in the information. (E1)

> Slides with an automatic presentation, so that the patient does not have to touch the screen. (E2)

> Increase the size of the font as a way of highlighting the information and the reading of the patients. (E3)

> Depending on the patient, ideally only the video would be used. (E4)

In general, the utilization of the audiovisual resource to give orientation to the MRS patients was well accepted by the nurses who participated in this study. Their approval for the proposal of this implementation was observed; however, they clearly had little time available for it.

DISCUSSION

On the basis of the data of the previous study performed in the institution, which demonstrated significant results for the perioperative orientation given by nurses with the use of a digital medium, when compared with the normal orientation, this study aimed at analyzing the implementation of this orientation for the preoperative MRS patients by means of a tablet and evaluate the feasibility of this intervention. Even though some limitations were found with respect to the incorporation of this new tool as a routine, the evaluation on behalf of the nurses was positive.

In relation to the profile of surgical patients, the results found in this study were found to be similar to those demonstrated in the literature, [10,11] which characterize the patients in preoperative cardiac surgery to be mostly male, aged 60 years or older and having a low level of education.

More and more, patients undergoing MRS are elderly and have diverse associated comorbidities such as, for example, systemic arterial hypertension and diabetes. When they are hospitalized for a large surgical procedure, the presence of close relatives is necessary. The majority of patients included in this study were with their companions or relatives, and a large part demonstrated interest in receiving the orientation together with the patient. As it was presented in the study, a majority of the families lived through the sickness with the patient, and gave their opinions many times about the treatment. Thus, both the patient and their relatives should receive clear and concise instructions. The relatives should act as part of the team, giving guidance and supporting the hospitalized person. [12]

With regard to the sentiments manifested by the patients after receiving the instructions, tranquility, anxiety, and fear were mentioned, which agrees with what was stated in a study concerning the ambiguity of feelings that the patients experience in the preoperative cardiac surgery. The subjects of this study verbalized contradictorily, tranquility and anguish, fear, and anxiety in their testimonies. [13] In this context, it is highlighted that the nursing professional should give instructions to the identified patients about their necessities, with the intention of avoiding increasing their anxiety with a large quantity of information.

The nursing diagnostics of Anxiety and Fear are common in the preoperative period in patients undergoing cardiac surgery.[14] In a low or high scale, anxiety is present in most patients in immediate preoperative, which is expected with regard to the magnitude of the procedure.[15] Therefore, the use of the audiovisual resources during the approach of the patient in perioperative can enhance their knowledge on the procedure and the recovery, in addition to clarifying doubts, which calms the patients down.

The reduced number of nurses who participated in the intervention is a limiting aspect of the study. One of the factors that were attributed for a low participation in the intervention, was a lack of time due to the assistance and managerial demands in the units of hospitalization. Nevertheless, the activities of giving orientation and education to the patient are considered essential for the nurse. Those who participated, characterize themselves as young women. Similar data referencing the profile of nurses of

inpatients units are found in Brazilian literature studies.[16,17] These studies showed that among the principal characteristics, the nurses were in the age group of 32–37 years, and the large majority of them were of female.

When asked about the use of the tablet in the daily routine as a tool to strengthen the orientation, half of the nurses said that the resource would not be used every time the orientation was given, because there would not be enough time in relation to the number of surgical patients. As stated in the literature, many times the nurses do not give an orientation to preoperative patients, due to the difficulty that the nurses face in communicating to them, such as, for example, because of their administrative and care assistance work. This leads to the orientation not being given at all due to lack of time, shortage of human resources, excess of routines in the units, lack of planning, and lack of prioritizing the visit among other situations[13].

In general, the nurses' routine assistance requires many tasks that must be completed in a short amount of time and with reduced human resources. Under these circumstances, strategies that bring quality to the care, and at the same time allow for the agility of the processes are necessary. One study, with the use of an audiovisual resource for transplant patients, showed a good cost–benefit relationship and a decrease in the time needed to inform the patients about the surgical procedure that they would undergo.[18]

Nevertheless, the nurses mentioned that the use of the tablet aided in the transmission of the orientation to the patients by standardizing the information. The use of audiovisual resources is a means of complementing their work and seeks to facilitate the comprehension of information in addition to standardizing and aiding the work of the team.[18]

The nurses agreed that the orientation with audiovisual resources was important for improving the comprehension of the surgical patients with respect to the procedure that they would undergo. A study that used an explanatory video about the cardiac catheterization examination directed toward the patients who were to undergo the examination, showed a better understanding among the patients after watching the video. [6] It is believed that the more the patient has knowledge about their future possibilities, the better he or she will adapt to the hospitalization, and consequently, will have a better recovery. [12,13]

The nurses who mentioned lack of time and many tasks to perform demonstrated some resistance to participate in the study. Change processes are known to cause uncertainties and to affect individuals psychologically, provoking fear and, as a result, generating resistance, because everything that is outside their comfort zone and unknown, causes a natural tendency for resistance.[19]

There are numerous strategies indicated to handle this type of situation, and one among them is communication, because it involves meetings, discussions, presentations to groups and essays that help the person understand the logic and the necessity of the change.[20]

Among the limitations of the study, there was no meeting with a larger number of nurses to discuss the proposal of the intervention. Regarding the economic situation of the government, who is responsible for transferring SUS resources to public health institutions, many procedures and hospitalizations were suspended because of the shortage of financial resources, which also reflected the availability of human resources. Additionally, the fact that researcher herself applied the evaluation questionnaire to the patient, directly after the orientation, can be characterized as a bias.

With the intent of making this audiovisual resource available in these inpatient units, on the basis of what was mentioned by the patients and the nurses, adjustments were made to improve the use of this strategy, considering the time and technique used by the nurse. In order to complete the fourth stage of the PDCA cycle, the head of nursing service will decide with their team, the most appropriate moment for the implementation of this tool in routine assistance. Additionally, financial planning is necessary to pay for the purchase of the tablets.

FINAL CONSIDERATIONS

The importance of the orientation provided to patients who would undergo surgical interventions, is noteworthy. New techniques are used in patient care, which aim at improving the quality of information provided to them. In the face of the diverse evidence, which notes the effectiveness of the use of audiovisual resources in increasing knowledge and reducing anxiety in preoperative patients, it becomes important for new instruction strategies to be implemented in hospital institutions.

The use of these technologies is intended to complement the work of the professionals, who would provide the orientation, but also to insure that there is quality in giving the orientation. Institutions also need to have sufficient staff to

work, as the workload is ever more present in Brazilian hospitals, affecting the physical and mental well-being of nurses, which directly influences the care provided to the patient.

Thus, the strategy of audiovisual instructions using a tablet showed to be feasible in the scenario studied. However, to adjust the size of the nursing staff is necessary (in this case, the nurses), as well as their involvement in the implementation of a new routine in the care given to the patient, and it is recommended (among the care actions) the clear orientations for patients and their families.

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AN EVALUATION OF THE USE OF SURGICAL INSTRUMENTS IN AN OUTPATIENT SURGERY CENTER

Avaliação da utilização de instrumentais cirúrgicos em um Centro Cirúrgico Ambulatorial

Evaluación de la utilización de instrumentales quirúrgicos en un Centro Quirúrgico Ambulatorio

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ABSTRACT: Objective: To evaluate the number of surgical instruments that are used and go unused during surgeries performed at an outpatient surgery center of a university hospital. **Method:** This is a cross-sectional, quantitative, and descriptive study, carried out using a survey of data of observations related to the use or non-use of surgical instruments present in surgical boxes. **Results:** A total of 176 surgeries were observed among the specialties: ophthalmology 132 (75%), otorhinolaryngology 16 (9.09%), plastic surgery 12 (6.81%), and other specialties 16 (9.09%). It was confirmed that 49.10% of the instruments were wasted, as they were not used in the outpatient surgeries. **Conclusion:** This study brings a new perspective about the role of nursing in Outpatient Surgery Centers and responsibility of nurses with regard to the management and control of costs at health institutions.

Keywords: Surgical Instruments, Outpatient Surgical Procedures, Cost control.

RESUMO: Objetivo: Avaliar o número de instrumentais cirúrgicos utilizados e não utilizados durante cirurgias realizadas em um centro cirúrgico ambulatorial de um hospital universitário. **Método:** Trata-se de um estudo transversal, quantitativo e descritivo, realizado a partir do levantamento de dados com a observação da utilização ou não dos instrumentais cirúrgicos presentes nas caixas cirúrgicas. **Resultados:** Foram observadas 176 cirurgias, dentre as especialidades: oftalmologia 132 (75%), otorrinolaringologia 16 (9,09%), plástica 12 (6,81%) e outras especialidades 16 (9,09%). Verificou-se 49,10% de desperdício dos instrumentais, por estes não terem sido utilizados nas cirurgias ambulatoriais. **Conclusão:** Este estudo traz uma nova perspectiva sobre a atuação da enfermagem no Centro Cirúrgico Ambulatorial e sua responsabilidade perante o gerenciamento e controle de custos de uma instituição de saúde.

Palavras-chave: Instrumentos cirúrgicos. Procedimentos cirúrgicos ambulatórios. Controle de custos.

RESUMEN: Objetivo: Evaluar el número de instrumentales quirúrgicos utilizados y no utilizados durante cirugías realizadas en un centro quirúrgico ambulatorio de un hospital universitario. **Método:** Se trata de un estudio transversal, cuantitativo y descriptivo, realizado a partir del levantamiento de datos con la observación de la utilización o no de los instrumentales quirúrgicos presentes en las cajas quirúrgicas. **Resultados:** Fueron observadas 176 cirugías, entre las especialidades: oftalmología 132 (75%), otorrinolaringología 16 (9,09%), plástica 12 (6,81%) y otras especialidades 16 (9,09%). Se verificó un 49,10% de desperdicio de los instrumentales, por estos no haber sido utilizados en las cirugías ambulatorias. **Conclusión:** Este estudio trae una nueva perspectiva sobre la actuación de la enfermería en el Centro Quirúrgico Ambulatorio y su responsabilidad ante la gestión y control de costos de una institución de salud.

Palabras clave: Instrumentos Quirúrgicos, Procedimientos Quirúrgicos Ambulatorios, Control de Costos.

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INTRODUCTION

Outpatient surgery around the world is linked to the history of nursing and has become possible with the progressive advances of minimally invasive surgical techniques and anesthetic drugs that enable a patient's rapid recovery with minimal complications[1,2].

The main goal of an outpatient surgery center is to ensure safety at low cost and allow the patient to stay in the hospital for only a short period of time[2].

An Outpatient Surgery Center (OSC) is very similar to a traditional Surgery Center (SC), differing only from the fact that the patient's discharge occurs on the same day of the procedure, allowing for a number of advantages, such as the reduction of anxiety, less risk in contracting hospital infections, reduced recovery time, and economic savings for the hospital[1-2.]

Surgeries that can be performed in the OSC are not very complex, and they use local, regional, block (spinal and/or epidural), or general (inhalational and/or intravenous) anesthetic techniques. Patients should have no systemic impairments due to other diseases or to surgery, will undergo surgical procedures that do not require specific postoperative care, and must have a companion in order to be discharged[1-3].

An important factor to ensure trans-operative nursing care in a SC is the necessary interaction with the Central Sterile Supply Department (CSSD), which provides all the sterilized materials and instruments used in each surgical procedure.

The primary function of the nursing team is to control the use of surgical instruments used within the operating room in order to guarantee the safety of the patient and the medical team, and also ensure that the proposed surgical technique is adequately performed. The nurse receives the material from the CSSD, does an initial check of the instruments present in the room, and, at the end of the surgery, verifies the integrity of the instruments, and returns them for further processing to the CSSD[4-6].

Surgical instruments and other materials used in the hospital environment are considered material resources and represent 75% of the capital of organizations. Therefore, the way in which they are administered directly reflects on the costs of the company[7,8].

The number of material resources, specifically surgical instruments, should be counted by the nurse, allowing for the surgery to happen while avoiding unforeseen consequences, waste, and high costs[7,8].

This study involves important progress in trans-operative nursing care. The patient is rigorously assessed and monitored within the operating room, and the control of all processes and procedures that will be performed in the operating room throughout the surgery, especially the control and evaluation of the instruments and materials that will be used at that time, are the responsibility of the SC nurse[1].

OBJECTIVE

To evaluate the number of surgical instruments that are used and go unused during surgeries performed in the OSC of a university hospital.

METHODS

A quantitative and descriptive study was carried out based on the data collection from the systematic observation of the use or nonuse of surgical instruments present in the surgical boxes.

The study site was the OSC of a university hospital, located in the interior of the state of São Paulo. It has 411 beds at the tertiary and quaternary level, where all services are performed and paid in full by the Public Health System (SUS). The OSC performs on average 600 surgeries per month in eight operating rooms in the areas of ophthalmology, otorhinolaryngology, dermatology, plastic surgery, otolaryngology, neurology, and urology.

The data were collected after analysis and approval from the Ethics Committee of the State University of Campinas under the substantiated report number 1,384,178 dated 06/01/2016. The data collection was authorized by the nursing director of the OSC, and by the nurses responsible for the site, after they explained the research objectives. It was authorized after the reading and signing of the Term of Free and Informed Consent, thus ensuring the ethical and legal principles involved in research with human beings and thus respecting the ethical and legal aspects of Resolution No. 466/2012 of the National Committee for Research on Human Beings.

The data collection instrument consisted of the lists of surgical instruments contained in the surgical boxes of the surgeries performed in the OSC. Some surgeons in specialties such as ophthalmology, used the surgeons' own surgical boxes, which do not have a list. For the collection of data

with regard to surgeries that used unlisted surgical boxes, the number of total instruments in the surgical box and the number of instruments used during the surgery were observed. Surgeries during the second quarter of 2016 were monitored from the beginning to the end for the reliable evaluation of the surgical instruments that were used and went unused.

The data were collected by the researcher, stored in a spreadsheet, put into tables with the aid of the Microsoft Excel® program, and analyzed under statistical guidance.

The sample calculation was performed considering the objective of estimating the proportion of surgical instruments not used in OSC surgeries over a period of three months. The sample calculation considered a proportion *p* equal to 0.50, whose value represents the maximum variability of the binomial distribution, thus generating an estimate with the largest possible sample size.

The population (N) considered for the calculation of the sample size was composed of 1,629 outpatient surgeries, carried out from February to April 2015. In addition, a sampling error of 5% and a significance level of 5% were assumed. Under these conditions, the calculated sample size was 176 surgeries. This sample was divided proportionally according to the number of surgeries performed and the specialties of the surgeries.

RESULTS

The OSC of this hospital performed 7,196 outpatient surgeries in 2016 and 1,659 surgeries in the second quarter of that year, during which the data from this study were collected.

During the data collection period, 176 surgeries were observed, corresponding to 10.6% of the surgeries performed in the second quarter among the specialties: ophthalmology 132 (75%), otorhinolaryngology 16 (9.09%), 12 (6.81%), and other specialties 16 (9.09%), such as otolaryngology (6), dermatology (8), neurology clinic (1), and urology (1).

The number of surgical boxes opened during surgery ranged from 1 to 4, with only one box being used in 145 of the surgeries (82.38%).

In 176 surgeries collected at the OSC, 132 (75%) were ophthalmologic surgeries and an average of 18.17 instruments were used in each surgery. For the otorhinolaryngology surgeries 16 (9.09%), there were on average 40.19 instruments in the operating room.

It is also found (Table 1) that, among these small outpatient surgeries, there are some procedures that require only one instrument and others that require up to 86 instruments.

It was found in Table 2 that otorhinolaryngological surgeries have an average of 27.06 unused instruments, while in the ophthalmology specialty the average of unused instruments is 9.55.

Among the 176 surgeries analyzed, it was found that, on average, 11.67 instruments are not used in outpatient surgeries.

It was also found (Table 3), in this study, that there was an overall average of 49.10% instruments not used in outpatient surgeries.

DISCUSSION

Daily, an OSC performs simple and complex surgical procedures in several different specialties. Perioperative nursing care includes an assessment of the patient's safety costs, and the care given. In addition, it is the responsibility of the nurses, who have ethical and technical skills training, to manage human and material resources [9].

Among the 176 surgeries, it was found that, on an average, there were 21.13 instruments in the operating rooms. There were surgeries that had up to 86 instruments. Considering that there was on average 11.67 unused instruments in general, and up to 27.06 in otorhinolaryngology, we question the high number of these unused instruments present in the operating rooms.

Table 1. Distribution of instruments in the surgical boxes that were used in the Outpatient Surgical Center. Campinas, 2016 (n=176).

Variable	Total Surgeries by Specialty	n	Average	Standard Deviation	Minimum	Maximum
Total Instruments	Ophthalmology	132	18.17	8.46	1	56
	Otolaryngology	16	40.19	21.98	13	86
	Plastic surgery	12	23.83	10.22	8	56
	Others	16	24.44	5.82	12	41
	Total	176	21.13	12.07	1	86

As soon as the surgical box is opened inside the operating rooms – thus exposing the instruments – they must be sent to the CSSD, where they undergo a sterilizing process[6]. Such a process carried out unnecessarily can lead to the wearing off of the material, and also increased costs for the health institution.

This present study demonstrated that, on an average, 49% of surgical instruments are not used during OSC surgeries. This number is considered high because these instruments have to go through the sterilization process again, which accumulates higher costs for the institution. There are expenses on supplies, labor for cleaning, packing, and storing the instruments, in addition to expenses due to water consumption, electricity, and maintenance of the sterilizer[10].

As they are a major investment for the institution, surgical instruments must be used properly in order to maintain their quality and prolong their life. It should be emphasized that health organizations, because of their limited resources and high health care costs, need to find alternative ways to reduce expenditures and increase productivity so as to reduce waste [10-12].

The reasons why these instruments are not used are: in the surgery boxes, which have been previously established by the surgery team, there is an excess number of instruments that are not necessary for the proposed surgical procedure; the simplicity of the outpatient procedures combined with the fast evolution of surgical techniques, has caused many instruments to no longer be used; and lastly, sometimes there is a preference for specific instruments that are not included in the proposed surgery box, and that are extremely specific instruments from a box of another specialty or another member of the surgical team. Thus, it is evident that instruments are not used as often as they could be, entailing unnecessary costs on the institution, especially considering that these costs can be predicted and corrected[13,14].

The nurse is responsible for controlling materials, as well as communicating between units so that there are lower costs when processing the materials. Oftentimes the practice of replacing instruments is time consuming and bureaucratic, resulting in higher costs[14,15].

The CSSD is responsible for ensuring the safe reuse of the instruments, processing them, and also verifying their performance in the specific testing environment in order to ensure greater patient and professional safety[16,17].

It is up to the nurse to research new alternatives and solutions to the problem concerning unused surgical instruments,

Table 2. Distribution of the instruments that were used and went unused in the Outpatient Surgical Center. Campinas, 2016 (n=176).

Variable	Specialty	n	Average	Standard Deviation	Minimum	Maximum
Instruments Used	Ophthalmology	132	8.61	3.74	1	21
	Otolaryngology	16	13.13	8.2	1	32
	Plastic surgery	12	9.5	5.47	3	21
	Others	16	12.69	4.56	5	19
	Total	176	9.45	4.75	1	32
Instruments not used	Ophthalmology	132	9.55	7.51	0	47
	Otolaryngology	16	27.06	16.62	5	64
	Plastic surgery	12	14.33	7.94	4	23
	Others	16	11.75	6.28	2	27
	Total	176	11.67	9.94	0	64

Table 3. Percentage of instruments that were not used in surgeries performed at the Outpatient Surgical Center. Campinas, 2016 (n=176).

Variable	Specialty	n	Average	Standard Deviation	Minimum	Maximum
Percentage of Waste	Ophthalmology	132	46.4	23.28	0	86.67
	Otolaryngology	16	66.49	14.9	38.46	93.75
	Plastic surgery	12	58.35	16.99	33.33	87.5
	Others	16	46.97	19.39	10	78.26
	Total	176	49.1	22.68	0	93.75

with the reduction of unnecessary costs as their primary objective. To this end, it is essential to identify what is being wasted in addition to raise awareness and create behavioral changes among the team that works in the outpatient surgical center. This will be done through continuous education with a focus on the work processes in order to improve and develop professionals with the aim of reducing waste, and creating strategies to minimize it[16,17].

With this goal in mind, we propose a revision of work processes that integrate the OSC and CSSD, as well as involve both the nursing and medical teams, and reformulate the composition of the specific surgical boxes, so that they keep up with the evolution of modern surgical techniques[16,17].

CONCLUSION

The overall average of instruments not used in outpatient surgeries at the surgical center was 49%, and especially in ophthalmology surgeries, most of which used one surgical box per procedure with an average of 21.13 instruments per box. It was found that it is the responsibility of the nurse to manage the material resources in the OSC. He or she impacts cost controls at the institution and also searches for better strategies that aim to improve the work process.

It is important to emphasize the integration of the OSC and CSSD, which would allow for the revision of the instruments contained in the surgical boxes, as well as the design of specific instrument kits for certain procedures or specific individually wrapped instruments.

A limitation of this study was the few publications on this subject in both the national and foreign literature, thus making it difficult to compare results. Therefore, the results found do not apply to all institutions. Even so, the study achieved its objective and stands out because it identified the percentage of wasted surgical instruments, contributed to the revision planning of technical and administrative work processes, and encouraged greater use of surgical instruments, which would reduce costs for health institutions. It also raises new perspectives for future studies on nursing performance in the OSC and its responsibility toward the management and control of material resources in health institutions.

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MALIGNANT HYPERTHERMIA IN THE OPERATING ROOM: CAN THE NURSING TEAM RECOGNIZE IT AND INTERVENE?

Hipertermia maligna no centro cirúrgico: a equipe de enfermagem sabe reconhecer e intervir?

Hipertermia maligna en el centro quirúrgico: ¿el equipo de enfermería sabe reconocer e intervenir?

Mariana Mystica Silva Titato[1], Rachel de Carvalho[2]

ABSTRACT: Objective: To assess the knowledge of the nursing team of the operating room (OR), on the diagnosis and treatment of malignant hyperthermia. **Method:** Field research, correlational, with quantitative analysis. Data collection from the 50 nursing team professionals (34 technicians and 16 nurses) working in the OR of a private hospital in São Paulo, Brazil, who answered 10 questions (six on diagnostics, and four on treatment). Descriptive analysis and comparison of means, using the Student t test. **Results:** Average of correct answers in 62.5% of the diagnostic questions, and in 71.2% of the treatment questions; percentage of correct answers in diagnosis was significantly lower than in treatment (p=0.007); average of 6.52 correct answers (6.4 for technical and 6.8 for nurses); there was no significance for the total of hits between the two groups (p>0.05). **Conclusion:** The nursing staff had reasonable knowledge of malignant hyperthermia, showing more than 50.0% accuracy.

Keywords: Malignant hyperthermia. Operating room nursing. Postanesthesia nursing.

RESUMO: Objetivo: Verificar o conhecimento da equipe de enfermagem do bloco cirúrgico (BC) sobre diagnóstico e tratamento da hipertermia maligna. **Método:** Pesquisa de campo, correlacional, análise quantitativa. Coleta de dados junto a 50 profissionais da equipe de enfermagem (34 técnicos e 16 enfermeiros) que atuam nos dois BC de um hospital particular de extraporte de São Paulo, que responderam dez questões de múltipla escolha (seis de diagnóstico e quatro de tratamento). Análise descritiva e comparação de médias por teste *t* de Student. **Resultados:** Obteve-se médias de acertos de 62,5% nas questões de diagnóstico e de 71,2% nas de tratamento; a porcentagem de acertos em diagnóstico foi significativamente menor do que em tratamento (p=0,007); média de acertos de 6,52 (6,4 para técnicos e 6,8 para enfermeiros); não houve significância quanto ao total de acertos entre os dois grupos (p>0,05). **Conclusão:** Os profissionais demonstraram conhecimento razoável sobre hipertermia maligna, evidenciando mais de 50,0% de acertos.

Palavras-chave: Hipertermia maligna. Enfermagem de centro cirúrgico. Enfermagem em pós-anestésico.

RESUMEN: Objetivo: Verificar el conocimiento del equipo de enfermería del bloque quirúrgico (BC) sobre diagnóstico y tratamiento de la hipertermia maligna. **Método:** Estudio de campo, correlacional, análisis cuantitativo. Colecta de datos junto a 50 profesionales del equipo de enfermería (34 técnicos y 16 enfermeros) que actúan en los dos BC de un hospital particular de extraporte de São Paulo, que respondieron diez cuestiones de múltiple elección (seis de diagnóstico y cuatro de tratamiento). Análisis descriptivo y comparación de promedios por test t de Student. **Resultados:** Se obtuvieron promedios de aciertos del 62,5% en las preguntas de diagnóstico y del 71,2% en las de tratamiento; el porcentaje de aciertos en diagnóstico fue significativamente menor de que en tratamiento (p=0,007); promedio de aciertos de 6,52 (6,4 para técnicos y 6,8 para enfermeros); no hubo significancia cuanto al total de aciertos entre los dos grupos (p>0,05). **Conclusión:** Los profesionales demostraron conocimiento razonable sobre hipertermia maligna, evidenciando más del 50,0% de aciertos.

Palabras clave: Hipertermia maligna. Enfermería de quirófano. Enfermeríaposanestésica.

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INTRODUCTION

Malignant hyperthemia (MH) is a pharmacogenetic disorder, with autosomal dominant inheritance, characterized by an abnormal hypermetabolic reaction to inhaled anesthetic agents in the group of halogens, such as halothane, isoflurane, sevoflurane, and desflurane, and to depolarizing muscle relaxants, such as succinylcholine[1,2].

The normal skeletal muscle contraction is mediated by the liberation of calcium (Ca^{2+}). It occurs when an electrical impulse stimulates the skeletal muscle, which triggers the release of acetylcholine, which connects to the receptors located in the skeletal muscle, generates depolarization and stimulates the release of Ca^{2+}, leading to muscle contraction[3].

For the process to happen, the action of adenosine triphosphate (ATP) is required. When muscle work is increased, there is consequently higher ATP consumption, generating a hypermetabolic state and producing carbon dioxide (CO_2), besides systemic hypoxemia, lactic acidosis, destruction of skeletal muscle cells and potassium release[3].

The primary MH deficiency affects the skeletal muscle, in the level of Ca^{2+} transfer of the muscle cell. Patients who are prone to MH have genetic disorders in muscle receptors, allowing the excessive accumulation of Ca^{2+}in the presence of certain triggering anesthetic agents. The intracellular result of hypercalcemia leads to hypermetabolism, which causes the increasing production of CO_2 e O_2 consumption, besides the rupture of cell membranes[2].

Because the muscle tissue is unable to return to a residual state in susceptible patients, the primary signs begin to appear: high intracellular concentration of ionized calcium, tachycardia, dysrhythmia, tachypnea, hypercarbia, respiratory acidosis, masseter muscle rigidity, generalized muscular rigidity, cyanosis, and fast temperature rise[4]. Even though high temperature is a sign of MH, it is a posterior symptom affecting 30% of the patients.

The incidence of MH is reported in 1:15 thousand anesthesias administered in children, and 1:50 thousand anesthesias administered in adults, with mortality rates around 10%, affecting both genders equally, even if crises are more common among men. The highest occurrence is found in white and Asian individuals; it is more common among children and young adults, and rare among the elderly[3,5]. In almost all cases, the first manifestations take place in the operating room (OR), and also in the immediate postoperative period, in the post-anesthetic recovery room (PARR)[5].

There are two essential steps to control a MH crisis: to interrupt the exposure to triggering agents, replacing them with safe agents, and to correct the changes in Ca^{2+}cell metabolismo with dantrolene sodium[6].

Dantrolene is a skeletal muscle relaxant which also influences cardiac and vascular muscles[5]. It is a liposoluble derivative of the hydantoine, imidazolidinedione. Its action consists of releasing Ca^{2+} from the sarcoplasmic reticulum during the excitation–contraction coupling, reducing the concentrations of intracelular calcium[2]. The formula for its intravenous use contains 20 mg of dantrolene, 3.0 g of mannitol, and sodium hydroxide ($C_{14}H_{10}N_4O_5$); it is presented in a 70-ml ampoule bottle, and should be rediluted in 60 ml of sterile water[7].

The team working in the surgical center (SC) and in anesthetic recovery (AR) is the first one to notice the picture, by visualizing dark blood in the surgical field, cyanotic skin, sweating, and hyperthermia of the patient. It is possible to perform safe surgeries, preventing the use of triggering anesthetics, monitoring the central temperature and the results of capnography, besides having dantrolene in the OR, and making a good post-anesthetic observation[8].

Therefore, recognizing the fast evolution of the clinical picture, it is very important to perform an early diagnosis and provide specific treatment, allowing the reduction of mortality rates from 70% to less than 10%[8].

It is clear to understand how important it is that the health team, which provides care to the patient in the SC and the AR, have technical and scientific knowledge about the signs and symptoms of MH, as well as the immediate actions for its treatment.

Such need, added to the concern toward the safety of the patient undergoing surgery, encouraged this study, which aims at identifying the knowledge of the nursing team, to recognize the need for further interventions in training and update courses.

OBJECTIVE

To verify the knowledge/index of hits in the nursing team working in the SC and the AR regarding the diagnosis and treatment of MH.

METHOD

Field, descriptive-exploratory, comparative/correlational study, with quantitative data analysis.

Data collection was conducted in the surgical block (SB) of a private large hospital in São Paulo, which has two units: one composed of 18 OR, 30 AR beds, with 15 active beds and possibilities for more, according to the need, counting on the collaboration of 104 employees, with an average of 1,300 surgeries/month; and another one composed of 14 OR, 10 AR beds, 50 collaborators in the nursing team, and average of 1,500 surgeries/month.

The study population comprised the collaborators of the nursing team from both SBs, that is, about 150 nurses and nursing technicians. The sample had 50 collaborators, thus 34 nursing technicians and 16 nurses.

The instrument for data collection was elaborated by the authors and contains two parts: one regarding sample characterization (gender, age, working department, professional category, time of graduation, and time of work experience); and the other including 10 multiple choice questions, with five alternatives each.

Data were collected after the project was approved by the Research Ethics Committee (CEP) of the institution where the study was conducted, via PlataformaBrasil (CAAE 26153514.5.0000.0071), according to the recommendations from Resolution 466/2012[9], as well as the authorization of the manager of both SBs.

Each member of the nursing team (nurses and technicians) was approached individually, and after accepting to take part in the study, they signed the Informed Consent Form, and answered the questionnaire proposed, handing it to one of the researchers right after.

The results were analyzed statistically, presented in absolute numbers and percentage, demonstrated in tables and chart. The Student t test was used to compare the levels of hits between the professional categories (technicians and nurses), and between the types of questions (diagnosis and treatment), for dependent samples, considering a 5% significance level ($p<0.05$).

RESULTS

Fifty members of the nursing team in both SBs participated in the study, thus 34 technicians (68.0%) and 16 nurses (32.0%).

Table 1 describes the characterization of subjects who comprised the sample. The data obtained showed a majority of female participants (82.0%). Most of the team (64.0%) is aged between 31 and 40 years. Nursing technicians had been graduated for longer in relation to nurses, mostly between 7 and 11 years (44.1%); and more time of work, also between 7 and 11 years (47.1%). Regarding the field of work, the sample had 25 employees (50.0%) working in SC1: 22 (44.0%) in SC2; 2 (4.0%) in AR1; and 1 (2.0%) in AR2.

Concerning the knowledge of the nursing team, the questionnaire was divided into six questions about diagnosis and four about treatment, and the results are demonstrated in Tables 2 and 3.

The number of technicians and nurses who had hits each question about diagnosis and treatment.

Table 1. Samplecharacterizationaccordingto sex, age group, time ofgraduation, experienceand sector. São Paulo, 2015.

Variables	Nursing technicians (n=34)		Nurses (n=16)		Total (n=50)	
	n	%	n	%	n	%
Sex						
Female	29	853	12	75.0	41	82.0
Male	5	14.7	4	25.0	9	18.0
Total	34	100.0	16	100.0	50	100.0
Age group (years)						
21–30	9	26.5	1	6.2	10	20.0
31–40	19	55.9	13	81.3	32	64.0
41–50	4	11.8	1	6.2	5	10.0
51–60	2	5.9	1	6.2	3	6.0
Total	34	100.0	16	100.0	50	100.0

Continue...

Table 1. Continuation.

Variables	Nursing technicians (n=34)		Nurses (n=16)		Total (n=50)	
	n	%	n	%	n	%
Time of professional formation (years)						
1–6	5	14.7	9	56.3	14	28.0
7–11	15	44.1	6	37.5	21	42.0
12–16	9	26.5	–	–	9	18.0
17–21	3	8.8	01	6.2	4	8.0
22–26	2	5.9	–	–	2	4.0
Total	34	100.0	16	100.0	50	100.0
Time of work (years)						
1–6	7	20.6	9	56.3	16	32.0
7–11	16	47.1	6	37.5	22	44.0
12–16	6	17.6	–	–	6	12.0
17–21	3	8.8	1	6.2	4	8.0
22–26	2	5.9	–	–	2	4.0
Total	34	100.0	16	100.0	50	100.0
Sector of work						
SC 1	16	47.1	9	56.3	25	50.0
AR 1	1	2.9	1	6.2	2	4.0
SC 2	16	47.1	6	37.5	22	44.0
AR 2	1	2.9	–	–	1	2.0
Total	34	100.0	16	100.0	50	100.0

SC: surgical center; AR: anestheticrecovery.

Table 2. Numberof hits in thenursingteam, per question. São Paulo, 2015.

Questions	Nursing technicians		Nurses		Total	
	n	%	n	%	n	%
Diagnosis						
1. Definitionof MH	16	47.0	11	68.7	27	54.0
2. Triggeringfactorof MH	30	88.2	16	100.0	46	92.0
3. Clinicalsignsof MH	27	79.4	15	93.7	42	84.0
7. Incidenceof MH	3	8.8	3	18.7	6	12.0
8. MH physiology	23	67.6	10	62.5	33	66.0
9. Triggeringanesthetic agentes of MH	19	55.9	9	56.2	28	56.0
Treatment						
4. Medicine usedto reverse a MH crisis	31	91.2	15	93.7	46	92.0
5. Measuresassociatedwiththe medicine during a crisis	22	64.7	10	62.5	32	64.0
6. Pharmacologicalclassofthedantrolene	26	76.5	15	93.7	41	82.0
10. Presentationand formula ofthedantrolene	19	55.9	5	31.2	24	48.0

MH: malignanthyperthermia.

Table 3. Numberof hits in questionsabouttheinstrument, accordingto professional category. São Paulo, 2015.

Knowledgetest	Questions about diagnosis	Questions about treatment	Mean of hits
	%	%	n
Nursing technicians	58.3	72.1	6.4
Nurses	66.7	70.3	6.8
Mean	62.5	71.2	6.52

Regarding the definition of MH, 47.0% of the technicians had hits, and 68.7% of the nurses knew how to define it. Concerning the triggering factor and the clinical signs of MH, respectively, better results were observed: 88.2% of the technicians were right about the former, and 79.4% were right about the latter; among nurses, 100.0% were right about the former, and 93.7% were right about the latter. When considering the incidence of MH, the results were not satisfactory: 8.8% of hits among technicians and 18.7% of hits among the nurses. The fifth question of diagnosis, which requires knowledge about the physiology of the MH crisis, showed a satisfactory result, with 67.6% of hits among technicians and 62.5% of hits among nurses. Finally, the question considered which were the triggering anesthetic agents for a MH crisis, and, as a result, 55.9% of the technicians and 56.2% of the nurses gave the right answer.

By addressing the matter in terms of treatment questions, the results improved. In the first treatment question, about the medicine used to reverse the MH crisis, 92.1% of the technicians and 93.7% of the nurses knew how to answer. Regarding the measures associated with the medicine during the reversion of the crisis, the number of hits decreased. However, more than half of the employees gave the right answer (64.7%) of the technicians and 62.5% of the nurses. About the pharmacological class of dantrolene sodium, 76.5% of the technicians and 93.7% of the nurses knew how to identify the correct answer. Finally, in the last question about the treatment, the knowledge was verified in terms of presentation and formula of the dantrolene: 55.9% of the technicians and 31.2% of the nurses gave the correct answer.

The mean percentage rates of hits were compared in questions involving diagnosis (62.5%) and treatment (71.2%) for the entire nursing team. The result of the statistical test (Student's t test for dependent samples) showed that the percentage of hits in the questions about diagnosis was significantly lower than the hits in treatment questions (p=0,007).

When the same evaluation was conducted by separating the job positions, it was possible to observe that, among nurses, the difference between the percentage of hits in questions about diagnosis (66.7%) and treatment (70.3%) was not significant (p=0.313). For technicians, unlike nurses, the percentage of hits about diagnosis (58.3%) was significantly lower (p=0.004) than the percentage of hits in questions about treatment (72.1%).

By checking the level of hits in questions in both professional categories, 25.0% of the nursing technicians answered 1 out of 6 questions right, and the same percentage of nurses answered 4 out of 6 questions right; 50.0% of the technicians and the nurses got less than 7 answers right/ 25.0% of the technicians and nurses got between 8 and 9 questions right, and no one got all the questions right in the questionnaire.

The mean of hits among technicians was 6.4, and for nurses, 6.8, which resulted in a general mean of hits of 6.52. The statistical test showed there was no significance in the total of hits between technicians and nurses (p>0.05).

DISCUSSION

Described in the first half of the 1960s, MH began to be better understood in the two following decades. The base for its diagnosis and treatment was consolidated after 1980. In 1992, there was a concern to spread information about MH in Brazil[6].

In 1991, a telephone service was created for MH in Brazil, available for 24 hours a day, called Hotline (+55-11-55759873). The Brazilian service is in São Paulo, Hospital São Paulo, Escola Paulista de Medicina, from Universidade Federal de São Paulo (UNIFESP)[1]. Since 2009, the calls are forwarded to a group formed by two supervisors, who are also researchers specialized in HM, and eight doctors[1].

This study aimed at verifying the knowledge/index of hits of the nursing team working at the SC and the AR, regarding MH, since there is a major concern about the safety of the patient undergoing surgery. A patient having a MH crisis requires diagnosis, treatment, and immediate care, which allow reverse the clinical picture and prevent sudden death.

The results of this study showed that the nursing team had reasonable knowledge about MH. By analyzing the 2 groups (34 nursing technicians, and 16 nurses), it was possible to observe that both presented better results (>70.0%) in questions related to triggering factors of a MH crisis, clinical signals, medicine used to reverse the crisis, and the pharmacological class of dantrolene sodium.

The worse results referred to: definition, incidence, physiology, MH triggering anesthetic agents, measures associated with the medicine during the crisis control and presentation and formula of dantrolene sodium.

In a study conducted with 646 anesthetists, members of the Brazilian Anesthesiology Society (SBA), aiming at evaluating the preparation of these professionals to diagnose and handle an episode of MH, more than 90% of the answers were correct about the diagnosis and treatment of MH. On the other hand, approximately 50.0% of the answers about

the pharmacology of dantrolene were incorrect[6], and these results corroborate the findings in this study. Such discrepancy of hits also occurred both among nurses and technicians.

A study[10] that aimed at assessing the knowledge about MH of the nursing team in the SC of a hospital in São Paulo showed that 80.0% of the right answers were about: definition, triggering agents, and professionals involved in care. In the categories regarding diagnosis and treatment, the knowledge of professionals was of only 14.3 and 42.9%, respectively. Nursing technicians presented better rates in these categories, 31.5 and 47.2%[10]. The hits of the sample in our study (62.5 and 71.2%) were higher to those in the mentioned analysis[10].

In February 2006, Resolution SS-20, in the State of São Paulo, regulated MH as a condition that requires immediate compulsory notification. The nurse must fill out the Compulsory Notification of Adverse Events file and send it to the Pharmacosurveillance of the State[10,11].

Hospital institutions are recommended to have protocols to care for this crisis[12]. The American Association of Nurse Anesthetists (AANA) also recommends that certified anesthetist nurses develop their skills by continuous education in the treatment of MH[13].

There is still a long path ahead concerning the knowledge of the nursing team about the subject. Many actions have been implemented throughout the years in order to improve the quality of care addressed to the patient who will undergo surgery. One of these actions is the creation of protocols that can guide the team while handling a crisis.

The institution that hosted this study has a Protocol of Care for MH, which mentions the following recommendations:

- monitoring should be conducted with cardioscopy, blood pressure, pulse oximetry, capnography, and body temperature, which must be central (pulmonary, esophageal, nasopharyngeal arteries);
- considering mean blood pressure (MBP), central venous pressure (CVP), or other invasive monitoring, when necessary;
- suggestion of controlling the respiratory volume and frequency;
- placing the thermal mattress over the surgical table;
- available kit of dantrolene sodium;
- prophilaxis is not recommended;
- monitoring the vital signs every 15 minutes for 1 to 2 hours[14].

Chart 1 shows the steps that were followed at the occurrence of MH.

Besides the protocols, it is necessary that continuous education, trainings, and courses for the teams be more encouraged and implemented.

Chart 1. Steps to be followed during an episode of malignant hyperthermia[14]. São Paulo, 2015.

• Ask for help;
• Suspend the administration of halogenate or succinylcholine. Replace the material providing ventilation with another one that is not "contaminated" with halogenate (circuit, tracheas, bags, soda lime etc.);
• Hyperventilate with 2 to 3 times the minute volume with oxygen at 100%;
• Start on dantrolene 2.5 mg/kg IV, repeating it as many times as necessary to control the clinical signs; sometimes, more than 10 mg/kg can be required;
• Maintain dantrolene IV for at least 24 hours after the control of the episode (approximately 1 mg/kg every 6 hours);
• Maintain dantrolene for at least 36 hours after the event. After 24 hours being administered via IV, the dantrolene can be administered in a dose of 1 mg/kg every 6 hours, orally;
• Sodium bicarbonate can be used to treat acidosis, if it was not immediately reversed by dantrolene;
• Avoid calcium channel blockers;
• Monitor body temperature;
• Treat hypercalemia with insulin/glucose and calcium;
• If body temperature increases fast, cool the patient with cold solutions (IV infusion, gastric or rectal lavage, compresses on body surface); avoid exaggerated cooling;
• Maintain the patient under intensive care for at least 24 hours, controlling body temperature;
• Attention to serum levels of potassium, preventing, if possible, its parenteral use;
• Maintain adequate urinary output, with hydration and/or use of diuretics;
• Control gas and coagulation;
• Measure creatine kinase every 6 hours until its reduction. Conduct laboratory follow-up until its normalization, considering that some patients have high levels due to myopathy;
• Call the hotline for Malignant Hyperthermia–Information and Guidance During a Malignant Hyperthermia Crisis – available 24 hours a day. Number: (11)5575-9873 Hospital São Paulo;
• Notify the case: Brazilian Record of Malignant Hyperthermia – Information and Guidance; Number: (48)331-9169/234-3014; Fax: (48)234-3014; e-mail: registrohm@hu.usfc.br;
• Notify and advise family members.

IV: intravenous.

The results presented in this study are in accordance with results from other analyses, highlighting possible variations in the teams from different institutions; however, these differences are not too discrepant, within the data provided.

The reasonable knowledge of the nursing team about the subject reinforces the importance for further studies on the theme, showing the need for continuous training of professionals, therefore improving the care provided to the surgical patient.

CONCLUSION

This study allowed to conclude that the 34 nursing technicians (68.0%) and the 16 nurses (32.0%) who composed the sample demonstrated to have reasonable knowledge about MH, showing more than 50.0% of hits in questions about diagnosis and treatment. The mean of hits in questions about diagnosis was 62.5%, and in questions about treatment, 71.2%. The mean of hits among technicians was 6.4, and nurses, 6.8, with a general mean of hits of 6.52 questions. There was a statistical relation between the mean of hits in questions about diagnosis and treatment; comparatively, the team answered more questions about treatment correctly, than diagnosis of MH ($p=0.007$). There was no significance as to the total of hits between technicians and nurses ($p>0.05$).

FINAL CONSIDERATIONS

Even though there are a few papers addressed to nursing on this subject, making it difficult to compare our findings with the literature, the results in this study showed less assertiveness regarding physiology, triggering anesthetic agents for MH, measures associated with the medicine during a crisis control, and presentation and formula of dandrolene sodium, besides the recognition of the process of crisis development, the reason why the crisis takes place, that is, recognizing that the anesthetic medicine is the cause. Likewise, it may prevent the team from adopting the proper conduct to associate measures to reverse the crisis by using dandrolene sodium.

The unawareness about the presentation and formula of the medicine used allows mistakes from happening while preparing the drug, for example, or even possible problems in the manufacturing of the medicine. Changes in doses of the components of dandrolene, when not identified by the team, will possibly cause harm to the patients.

This result was satisfactory in comparison to other papers mentioned in the discussion of this study, which does not reduce the need for constant training of the teams. Therefore, the results of this research were presented to the management of the units where the data were collected, with a proposal for training, and, more specifically, the revision of the MH protocol that already exists in the institution.

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TRAINING OF NURSES TO WORK IN THE CENTRAL STERILE SUPPLY DEPARTMENT NURSE

Formação do enfermeiro para atuar na central de esterilização

Formación del enfermero para actuar en la central de esterilización

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ABSTRACT: Objective: To understand the training of nurses who will work in the Central Sterile Supply Department (CSSD). **Method:** Descriptive and qualitative study including a sample of 20 nurses enrolled in the professional and academic Master's Degree Programs of *Faculdade de Medicina de Marília* (Famema), in the period 2011 to 2014. The data were collected by interviews in 2014. **Results:** We found two thematic categories: nurse training based on the technicist model and the perspective of generalist training. The world of work and training are intertwined and the undergraduation course, therefore, contributes to the development of competent and ethical professionals, since it considers their realities in training processes. **Conclusion:** Regardless of teaching institutions' curriculum, nurses faced difficulties in studying the proposed theme further; however, they have collaborated with suggestions regarding changes in the teaching and learning practices for nurses that work in the CSSD; and they have also suggested it could be reconsidered in a better way.

Keywords: Education, nursing. Materials management, hospital. Sterilization.

RESUMO: Objetivo: Compreender a formação do enfermeiro para atuar na Central de Material Esterilizado (CME). **Método:** Estudo descritivo qualitativo, constituído por uma amostra de 20 enfermeiros matriculados nos programas de mestrado profissional e acadêmico da Faculdade de Medicina de Marília (Famema), no período de 2011 a 2014. A coleta de dados foi realizada por meio de entrevista em 2014. **Resultados:** Foram identificadas duas categorias temáticas: a formação do enfermeiro pautada no modelo tecnicista e a perspectiva da formação generalista. Constatou-se que o mundo do trabalho e a formação estão entrelaçados, sendo que a graduação contribui para o desenvolvimento de profissionais competentes e éticos, considerando as suas realidades nos processos de formação. **Conclusão:** Independente da proposta curricular das instituições de ensino, os enfermeiros tiveram dificuldades para o aprofundamento quanto ao tema proposto, mas colaboraram com sugestões de transformações das práticas de ensino e aprendizagem para atuação dos enfermeiros na CME e que essa formação possa ser repensada mais adequadamente.

Palavras-chave: Educação em enfermagem. Administração de materiais no hospital. Esterilização.

RESUMEN: Objetivo: Comprender la formación del enfermero para actuar en la Central de Material Esterilizado (CME). Método: Estudio descriptivo cualitativo, constituido por una muestra de 20 enfermeros matriculados en los programas de maestrando profesional y académico de la Facultad de Medicina de Marília (Famema), en el período de 2011 a 2014. La colecta de datos fue realizada por medio de entrevista en 2014. **Resultados:** Fueron identificadas dos categorías temáticas: la formación del enfermero pautada en el modelo tecnicista y la perspectiva de la formación generalista. Se constató que el mundo del trabajo y la formación están entrelazados, siendo que la graduación contribuye para el desarrollo de profesionales competentes y éticos, considerando sus realidades en los procesos de formación. **Conclusión:** Independiente de la propuesta curricular de las instituciones de enseñanza, los enfermeros tuvieron dificultades para la profundización cuanto al tema propuesto, pero colaboraron con sugerencias de transformaciones de las prácticas de enseñanza y aprendizaje para actuación de los enfermeros en la CME y que esa formación pueda ser repensada más adecuadamente.

Palavras clave: Educación en enfermería. Administración de materiales de hospital. Esterilización.

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INTRODUCTION

The Central Sterile Supply Department (CSSD) is an essential sector of hospitals that integrates its infrastructure and collaborates with client's service by means of a work that is comprised of internal production steps. It is also an important health service that can be classified as care[1]. Hence, trainers and students must pay attention to the importance of the CSSD.

The work of nurses in the CSSD requires specific knowledge about the diversity of equipment, pieces, and surgical instruments, as well as how to process them. This is a knowledge area of Nursing, whose main purpose is to ensure safe products for patient's support[1].

The Brazilian Nurse Council (COFEN) regulates the mandatorily presence of nurses in all units of services developing high-complexity Nursing actions, which are common in critical patient's treatment[2].

In the last few years, health training, especially training of nurses, suffered several changes. It seems there has been a distancing between training and professional practice in the sector of CSSD. Several changes involving procedures have happened, like in regulations, in the mandatory recommendations regarding safety and quality process of medical-hospital articles and biosafety aspects. These procedures may cause several consequences, even though they are routine ones, due to the lack of professional preparation.

With regard to training of health professionals, the Brazilian Department of Education proposed the National Curriculum Guidelines (DCNs) for health courses that aim at changing teaching practices, since this process was conducted apart from the reality lived in the services of this area.

As it is understood in the Nursing education area, there are many transformation proposals that include pedagogical and philosophical aspects, which are supported by the Resolution of the Brazilian Education Council that institutes the DCNs in Brazil. These guidelines aim at professional formation by training students to face the challenges lived by the society, the world, and the work changes. They approach the social needs, the Brazilian health system, and the teamwork. By seeking knowledge as something unfinished and processual, we should not comprehend Nursing education as a sequence of standardized actions, but as an exchange of scientific and popular knowledge[3].

Nevertheless, traditional education is still predominant in the nurses' graduation development by transmitting knowledge ministered in a fragmented manner and not contributing very much to the critical and transformative education that the new health attention context started to request[4].

However, we have also noticed an attempt of changing the paradigm and behavior by nurses, which results in reeducation through presuppositions, adding values and perceptions that may form a certain view of the reality, thus recognizing the human potential as a triumph for the institution. Therefore, these professionals should be respected as drivers and formers of a reality[5].

Based on the need of training professionals who are committed with technological and scientific advance of the area, with the aim of qualification, of learning, and care, we ask: Is the nurse prepared to work in the CSSD during the undergraduation course?

OBJECTIVE

To understand the training of nurses that will work in the CSSD.

METHOD

This descriptive research describes situations, occurrences, and how some phenomena are manifested[6]. It has a qualitative approach because it is a universe of reasons and meanings, aspirations and beliefs, values and attitudes; therefore, the expression of opinions and experienced feelings is a benefit to participants[7].

This study was developed including nurses that study in professional and academic Master Degree's programs of Famema – both are multiprofesional programs. The study population comprised a randomized self-selection sampling of 20 subjects in the period 2011 to 2014. Each course provided 15 positions and the total of nurses was the same.

The participants graduated in five different higher-level institutions (IES), which, with regard to adopted curriculum, could not be identified. Nurses enrolled in undergraduation courses as regular students were included in the study, whereas participants who were enabled or refused to take part in the study formed the exclusion criteria. The anonymity

of participants was maintained by using the letter P, and the sequential number of interviews.

Data were collected through interviews conducted from October to November 2014, and which were recorded with the participants' consent and then were completely transcribed.

The Research Ethics Committee of Famema received the project and approved it under the CAAE 25424013.4.0000.5413, as established in Resolution no. 466/12 from the Brazilian Health Council[8].

The data were analyzed by means of Bardin's content analysis technique[9]. We have chosen the thematic modality in the study because it is one of the most appropriate modalities to the investigation[7]. We found two thematic categories: nurse training based on the technicist model, and the perspective of generalist training. The data on the identification of the interviewed subjects were submitted to the descriptive analysis.

RESULTS

In the analyzed group of nurses, 85% of them were females and 15% were males. There was an age variation (between 25 and 49 years old), with a mean age of 34 years (70%). The sample comprises 18 (80%) nurses who work both in care and in education, and 2 (20%) nurses of them work only in management. With regard to graduation, 68% of them had graduated in the last 10 years and 55% of the participants got their diplomas between 1998 and 2008.

The arduous and careful reading of statements and records enabled identifying similarities, differences, and contradictions regarding both categories.

Nurse's training based on the technicist model

The participant declares feeling as if he were only an employee during his internship and had difficulties regarding learning and identifying his lack of knowledge and deepening his theoretical basis.

> [...] we were only employees, we helped washing materials; we rolled gazes and syringes the whole day. (P4)

The statements show that the development of learning needs an articulation between theory and practice:

> During my training following the traditional model, we used to give emphasis to the issue of the central sterile supply department. We had to make packages, to identify, to make those packages [...]. This helped my training. We, of course, were more focused on doing; we were more task makers. The teacher used to make we lead the department as if we were employees of the house. (P7)

> But we did not further our practice; we only went there to make packages and leave. We did not think of anything else. (P11)

The concern about how the student will experience the work process was also mentioned in the research; however, this future professional needs to be stimulated to seek knowledge, since he/she is still on training, because this will interfere directly in the quality of the care provided to patients.

> We should not provide theory; we should put them in the scenario and then raise questionings, the experience. Anyhow, the foundation. (P7)

Distancing between theory and practice was emphasized as well, i.e. what is approached in theory and what is experienced in professional practice.

> During the undergraduation course, we had a little approach to these cleaning, disinfection and sterilization processes. But, we only had them in theory, not in practice. We really need the practice to lay the foundation of theory and return to practice. (P3)

The feeling of "area inferiority" is verbalized, although it is considered a space of construction that is extremely relevant to care.

> We even affirm that the Central Sterile Supply Department is the heart of the hospital, even though it is known that "bad" professionals should work in it. However, we realize the CSSD is the opposite; it is the place where people with better qualification and more compromised

> should work, because in the event of a failure in such department, the entire hospital will face a health issue. (P15)

Nurses that will work in the CSSD should be able to teach other colleagues and demonstrate confidence to perform the activities, as well as to value the service.

> I believe support nurses should care more for it and should also pass it to their students, because it would be better and the service would be more valued. (P9)

In some curricula for training of nurses, the CSSD specific content was approached only in one subject; however, the interviewed subject still considers training as insufficient to his work capacity, and such subject should have been more widely approached throughout the undergraduation course.

> We do not learn about it in our college subjects. There are some comments in the surgical center subject, but they are very vague and short; it is not a specific formation. I suggest a larger training regarding this subject, because I believe it is still very lost. (P19)

The perspective of generalist nurse training

It would be important to such participants that the nurse had a generalist view during the training process, because this practice could be further developed in his/her professional life, thus providing knowledge in all specialties.

> I think [to approach] specificities are important during training, because they could even provide the nurse the opportunity of choosing. (P6)

The moments of discussions and experiences of the CSSD functioning during Nursing undergraduation course strengthens the formation of the critical and reflexive generalist to also satisfy the market demand.

> We have studied the RDC [collegiate board resolutions] on how the place should be, on how input and output materials should be organized through different doors; we could even make a critical analysis regarding the structure of what we had in the hospital (if they were appropriate or not). (P9)

A better identification of the nurse's role in the CSSD was extremely important to develop learning during the undergraduation course, as well as its presence in this location.

> I think we should have had a larger approximation to the practice scenario with the aim of changing, of showing what is the nurse's role inside the CSSD, of the evaluation of the entire complex within – which is very specific. We need to see how is the nurse's action inside there, regarding prevention, education, work on all of that, the team. (P11)

> I think the CSSD should be part of a practical experience. We are involved directly with body fluids and we should understand and learn the least about it. It was not very large, although we had a problematization methodology. (P16)

Specialization and contact in the undergraduation course may deepen knowledge in this area by supporting the nurse's training, especially to work in a health attention context. Additionally, the student remembers all his/her learning with the teacher's support.

> I believe internships in the material and surgical centers should be provided again, because we can no longer find them, it became a specialization. I really do believe it should be inserted in the curriculum; I had the opportunity of learning about it in my undergraduation course. (P17)

> It is surely important, because the Nursing department is the one in charge of materials. But I do believe it should not be something exclusively to the central sterile supply department. I think the processing area should be approached all the time, and not as a point. I believe this approach should be discussed throughout all contents. (P18)

DISCUSSION

Training of a technicist nurse, which is translated in the statements through procedures and tasks, (dis)articulation between theory and practice, (de)valuation and search for specialties, considers the knowledge of the CSSD as being of great importance to the performance of a nurse's current activities, in such a way as to ensure safety and quality of the articles to be used by professionals.

These professionals signalize the need of capacitation to those who follow this area of knowledge, as a way to ensure the quality of the provided service and to maintain decreased risk levels to users' health regarding the complexity of sterilization processes, the high costs for acquisition of surgical instruments and more sophisticated equipment, as well as investments in the CSSD professional qualification.

In order that nurses may perform their activities following current concepts of the laws, the technicist may represent a challenge for the emerging chains of larger care, especially because nurses who work in the CSSD have to know much more than only performing proper procedures. They need basic knowledge to provide the quality and safety of the pieces presented to their users, besides efficient coordination of their team.

Thus, focus integrality is essential in health actions to users, and it should not only use care fragmentation, but it should aim at the knowledge horizontal logic[10].

Hence, the DCNs establish that graduates become competent professionals with skills to present the desired profile, i.e. the profile of generalist, critical, and reflexive professionals, besides technical-scientific, ethic-politics and socio-educational skills to become secure in their future care actions. The health training issue based on the Brazilian Unified Health System (SUS) principles may be one of the current demands of professional training. Therefore, the capacity of fighting the challenges pointed out in the services is necessary, with duly critical comprehension and awareness of the experienced reality, including transformation of care practices focused on social integrality and justice[11].

Not all professionals understand the purpose of the CSSD; they verbalize their displeasure by manifesting unawareness and devaluation of professionals who work in such place. The professionals themselves undervalue the activities. They seek to being recognized and valued, so they are continuously trying to overcome their difficulties.

The majority of hospitals and health units with a CSSD incite nurses to perform their services. Therefore, with regard to management, the position in the CSSD needs to be occupied by a health professional with a specific qualification degree and experience in the area, and which legally responds to the action performed there. The nursing professional has the proper profile to perform it[12].

A technical opinion of the Brazilian Nursing Regional Council (Coren) from 2012 presented a questioning on the legal attributions that can be developed by the Nursing team in the CSSD and about the nurse's responsibility. Such roles are described in the RDC of the *Agência Nacional de Vigilância Sanitária* (RDC/ANVISA) from March 15, 2012 and in the Nursing Professional Exercise Law no. 7.498/1986 regarding the team and the nurse. Nurses must be prepared for such activities in the undergraduation course and historically they assume the entire process of the CSSD management in health services[13].

Another study signalizes the valuation of professionals working in the CSSD. Administrators of hospitals should pay more attention to the needs of the CSSD and should provide more attention to their professionals; despite their indirect attention to the patient, it is as important as those of direct performance[14].

Generalist nurses should learn about the CSSD during their training. Although it does not involve the patients directly, this hospital unit is a field of learning and professional work.

Since complexity involves processing activities, it implies that nurses seek formal educational processes that approach all actions developed systematically at short, medium, or long terms, to increase their professional capacitation. The increase of professional skills related to efficiency in the performance of the developed activities is a result of it[15].

With the aim of changing the paradigm in nurses' training, new teaching methodologies and alternative curriculums are sought to respond to the population's health issues. We recommend educational practices that value students' preparation and motivation to overcome such logic in order to graduate critical, motivated, creative, and flexible professionals who are committed with the purpose of their work.

Many health education institutions have adopted active learning methods, thus providing students with the independence and responsibility for their own study. They are supported by significant learning and discovery, they value learn-to-learn, stimulate participative management of the experience protagonists, and reorganization of the theory/practice relation. Hence, students started to be recognized as responsible for their own learning and to enjoy autonomy in knowledge (re)construction. They became able to interconnect knowledge and experiences before those available in the scientific field. They were also able to develop skills to reconnect knowledge, which were fragmented and disconnected before, for autonomy in the search of pertinent knowledge by stimulating continuous update, and awakening the critical view on scientific materials with which they have more contact[16].

Because CSSD work reflects directly on the quality of the care provided to the client, its good operation requires a combined work of technically and scientifically skilled personnel, in appropriate number to perform a set of large specificity tasks[14].

These skills express important ideas to analyze the nurse's training, because they provide developments to the professional practice by recommending the development of skills so that nurses can become proactive and integrated to the social context and overcome the specialty focus. After 16 years of operation, the DCNs have enabled us to apprehend how much these new professionals have translated these guidelines in practice.

Professionals that can follow all evolutions in the work market have been asked to ensure the quality of the provided service, and to keep decreased levels of damage risk to the users' health. The study has revealed that many nurses still need to learn more knowledge in this area – a question reported by them due to the low insertion in the training process. Therefore, we need to understand that nurses should graduate with basic knowledge of the CSSD.

Some statements mentioned the lack of comprehension about the work process carried out in the CSSD, which is the result of little involvement with training.

Almost all interviewed subjects expressed valuation of the work carried out in this department and highlighted its importance. Although some experiences regarding material processing have been reported, there was higher prevalence of total or partial unawareness of the activities that might be performed in these places, with emphasis on the mechanicism that was seen in the majority of statements.

Qualified care provision to users from health units, requires that CSSD employees, especially nurses in charge of work process management, be well qualified to respond to the demands of other hospital departments, including the most critical ones.

With regard to the content discussed throughout the undergraduation course, the professionals point out inadequacies in education methods, lack of content, and higher knowledge appropriation, especially in the CSSD practice scenarios. This has been happening both in IES that adopt traditional methodologies and in IES that chose active methodologies. The practice scenarios seem to be the main point so that future nurses may acquire more knowledge. Interviewed subjects believe it is necessary to make teaching closer to the reality of health services, because the practice field cannot be treated as something beyond the curriculum development.

Transformations in nursing curricula have been occurring slowly, but there is still, in the majority of them, the predominance of the medical-hospital model for the undergraduation course.

Literature shows a movement of change in the formation of the Brazilian nurse; however, decreasing the resistances to changes is necessary, as well as providing reflections about teaching in order to overcome challenges and implement the new training process. We have seen the support of curriculum matrices divided into disciplines; the existence of doubtful pedagogical reference as opposed to difficulties of insertion in the real world; and the predominance of the theoretical value on practice, seeking strategies that will result in decrease of health services distancing, by reinforcing the classical dichotomy between thinking and doing. In addition, especially in private IES, there is an excessive number of students, and the appearance of difficulties regarding the establishment of partnerships with health services, as well as hiring of teachers, which does not agree with the real needs[17].

Since the nursing formative processes approach the theme superficially, as seen in the statements, it can cause some distancing of the students, because they are afraid that the unknown may result in lack of deepening in this

area. Soon, graduated nurses, in turn, will need to search for graduation courses for their specializations and therefore decrease their lack of knowledge to work in a relatively unknown department.

CONCLUSION

The adopted methodology enables to accomplish the proposed objective, i.e. understanding nurse's training. It allow identifying the need of a greater involvement between theory and practice to optimize the nurse's professional exercise together with the approached and applied content throughout his/her training.

We also found that training models have been looking for innovative methods throughout the year, for improving the teaching-learning processes. However, ideal conditions are still needed to achieve such a purpose.

As a positive point, the CSSD presents, as a care area, its importance for health units regarding the processes being performed. In addition, the nurse should graduate with basic knowledge of this area. However, these professionals did not show much interest in studying this theme further during their undergraduation courses. There was no encouragement to seek this knowledge; some of them by free will, others because they did not have enough contact to it or because they did not identify themselves to this area. However, this issue will be the subject of a future investigation with the IES. There is a need of analyzing what is making the stimulation of graduates difficult or what is still needed to awaken the interest for specific areas like the CSSD.

The known weaknesses include traditional formation, which is still fragmented, and the existence of a hospital focus, which may damage the development of their skills.

There were some limitations throughout the study, such as insufficient theoretical foundation and long-lasting production. Still, the interaction with statements and possible adjustments was made throughout the inclusion of limitations.

This may also mean relevant aspects of this study, i.e. the lack regarding the theme and the importance of making public something that was not evident.

We expect this study to contribute for providing visibility to the professional training for the CSSD as a relevant health area and that provides new views regarding teaching methodologies, with the aim of improving Nursing conducts and perceptions of this professional work field.

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THE PERMANENT EDUCATION IN THE TRAINING OF NURSES IN THE SURGICAL CENTER: INTEGRATIVE REVIEW

A educação permanente no treinamento do enfermeiro de centro cirúrgico: revisão integrativa

La educación permanente en la formación de enfermeras en el centro quirúrgico: examen integrador

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ABSTRACT: Objectives: To Identify in the literature how the permanent education of the nurses of the operating room is held and to suggest a training roadmap. **Method:** Integrative review of articles indexed in the Virtual Health Library (VHL) and Google Scholar between 2002 and 2015. The descriptors used were the following: education in nursing, continuing education, training and surgical center. **Results:** The search led to 14 articles covering 4 main themes: continuing or permanent education as an important development for training on processes and technology; the nurse as educator and researcher; evaluation of the teaching-learning process; and distance education as an important tool for surgical center nurse training. **Conclusion:** Studies focused on the training of surgical center nurses are performed by means of distance education and the importance of on-the-job training using a script was reinforced.

Keywords: Education, nursing. Education, continuing. Inservice training. Surgicenters.

RESUMO: Objetivos: Identificar, na literatura, como é realizada a educação permanente do enfermeiro de Centro Cirúrgico (CC) e sugerir um roteiro de treinamento. **Método:** Revisão integrativa de artigos alojados na Biblioteca Virtual em Saúde (BVS) e no Google Acadêmico entre 2002 e 2015. Foram utilizados os descritores controlados: educação em enfermagem, educação continuada, capacitação em serviço e CC. **Resultados:** A busca permitiu a escolha de 14 artigos que abordaram 4 temas principais: a educação continuada ou permanente como importante desenvolvimento para a capacitação em relação aos processos e à tecnologia; o enfermeiro como educador e pesquisador; avaliação do ensino aprendizagem; e a educação a distância (EaD) como importante ferramenta para treinamento do enfermeiro de CC. **Conclusão:** Conclui-se que os estudos voltados para o treinamento do enfermeiro de CC são realizados na EAD; e foi apontada a importância do treinamento *in loco* seguindo um roteiro proposto.

Palavras-chave: Educação em enfermagem. Educação continuada. Capacitação em serviço. Centro Cirúrgico.

RESUMEN: Objetivos: Identificar, en la literatura, como se lleva a cabo la educación permanente de la enfermera del centro quirúrgico y sugerir un itinerario formativo. **Método:** Revisión Integrativa de los artículos alojados en la Biblioteca Virtual de Salud (BVS) y Google Scholar entre 2002 y 2015. Se utilizaron los descriptores controlados: educación en enfermería, educación continua, formación y quirófano. **Resultados:** La búsqueda ha permitido la selección de 14 artículos que abordaron 4 temas principales: la continua o permanente educación como un desarrollo importante para la creación de capacidad en relación con los procesos y la tecnología; la enfermera como educador e investigador; evaluación de centros quirúrgicos; la enseñanza y el aprendizaje; y la educación a distancia como una herramienta importante para la formación de enfermeras centros quirúrgicos. **Conclusión:** Se concluye que los estudios se centraron en el centro de formación enfermera quirúrgica se llevan a cabo en la educación a distancia; y fue nombrado la importancia de la formación in situ siguiendo una hoja de ruta propuesta.

Palabras clave: Educación en enfermería. Educación continua. Capacitación en servicio. Centros quirúrgicos.

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INTRODUCTION

To meet today's demands, it is necessary to rethink the work process in the operating room, aimed at an integrated assistance focused on patient safety with planning, education, and training[1].

Similarly, owing to the new demands of health organizations, nursing is also changing, and nurses need to expand their knowledge continuously[2].

Heath education leads to the transformation of the collective knowledge of those involved in the work process within the health care field, creating a dynamics in the process of making and remaking[3].

Individualized training is indicated as a proposal for health education, which enable the follow-up of the new employee before assuming his functions[4].

Nursing education involves training the team on the improvement of techniques and technologies.

Knowledge can be acquired using films, group dinamics, virtual environment, computer programs, and in person presentations[6].

The distance education became a training tool for the OR nurse and its advantages are the following: it is carried out in the workplace, professionals do not need to the leave their job activities for too long, and the content of the training are provided by means of videos and teleconferences[7].

The integrative review on how the permanent education of OR nurses is perfomed is necessary to contribute to the improvement of the care provided, as well as to the teaching, research, and administrative functions of OR nurses.

OBJECTIVES

To identify in literature how the permanent education of OR nurse is perfomed; and propose a training script for the operation room nurse.

METHOD

This is an integrative review on how the OR nurse is trained which used the six step methodological framework: problem formulation, establishment of inclusion and exclusion criteria, data collection from the texts, data evaluation collected, analysis and interpretation of data, and presentation of results[8]. The guiding question of this study was "How the permanent education of OR nurses is performed in institutions, with the new technologies and routines?".

Data were collected from January to June 2016. The *Biblioteca Virtual em Saúde* (BVS) was chosen for providing significant content from scientific materials of reference databases in health, such as *Literatura Latino-Americana de Ciências da Saúde da América Latina e do Caribe* (LILACS), *Literatura Internacional em Ciências da Saúde* (MEDLINE), *Biblioteca Cochrane*, *Scientific Electronic Library On-line* (SciELO) and *Base de Dados de Enfermagem* (BDENF). The descriptors in health sciences (acronym in Portuguese – DeCS) were used in combinations: education AND nurse AND operation room; continuing education AND nurse AND operation room; permanent education AND nurse AND operation room.

In order to expand the research because of the small numbers of articles found in literature involving training of OR nurses, Google Scholar was searched using the following combinations: continuing education AND permanent education; nurse AND operation room.

This extended period from 2002 to 2015 was justified by the scarce production related to articles focusing on OR nurse training.

Article titles that contained the words continuous or permanent education were analyzed, since many authors use these words as synonyms, in addition to nursing, operation room or perioperative, for the inicial selection of the articles.

Subsequently, the abstracts of the articles were reviewed. After this reading, some articles were not included because they had the education as subject, but with focus in a specific training that did not meet the objectives of the study. We selected articles in Portuguese and English that contained information about how the permanent or continuing education of OR nurse was carried out. These articles also need to have full versions online, whether of free access or not.

Articles on nursing education which could contribute to the training of OR nurses were included, owing to the lack of studies involving education for OR nurses.

Articles which did not address the study subject and which were written in other languages than English were excluded.

For classification of levels of evidence of the articles, the following scale from 1 to 6 was applied:

- level 1 (C1): evidence from the meta-analysis of multiple controlled and randomized clinical studies;
- level 2 (C2): evidence from individual studies in experimental design;
- level 3 (C3): evidence from nearly experimental studies;
- level 4 (C4): evidence from descriptive studies (non-experimental) or qualitative approach;
- level 5 (C5): evidence from case reports or experience;
- level 6 (C6): evidence based on expert opinions[9].

Article classification is a recommendation to any review study because it enriches and strengthens the conclusions regarding the topic searched.

After reading 14 articles and evaluating the data extracted from each text, data on authors, journal name or newspaper publication, country of origin, type of study, results, and level of evidence were included in a table.

The search provided a total of 357 items with the combinations shown in the flowchart (Figure 1).

RESULTS

Chart 1 shows the main characteristics of the studies included in the integrative review.

After reading 62 abstracts, 18 articles were selected, which were read in full; and studies have undergone an evaluation by the other inclusion criteria. Four articles were excluded: two did not respond to the research question and the other two had insufficient data regarding the research objectives. Finally, 14 articles were chosen.

With regard to the artices characteristics, 13 articles were published in Portuguese and one in English. The year of publication ranged from 2002 to 2015. For the presentation of the results, a chart was organized with the following information: authors, newspapers or magazines, origin, types of study, nine descriptive studies (C4 level of evidence), a reflection study (C5 evidence level), a case report (C5 evidence level), two review studies (C4 evidence level), and a case study (C5 evidence level)[9].

The year with highest number of publications (three) was 2008, followed by the years 2012 and 2007, with two publications each. The other articles were published between 2002 and 2015.

On the basis of the critical analysis of the articles, four thematic categories were identified concerning education for nursing or OR nursing, as follows: continuing or permanent education as an important development for training in

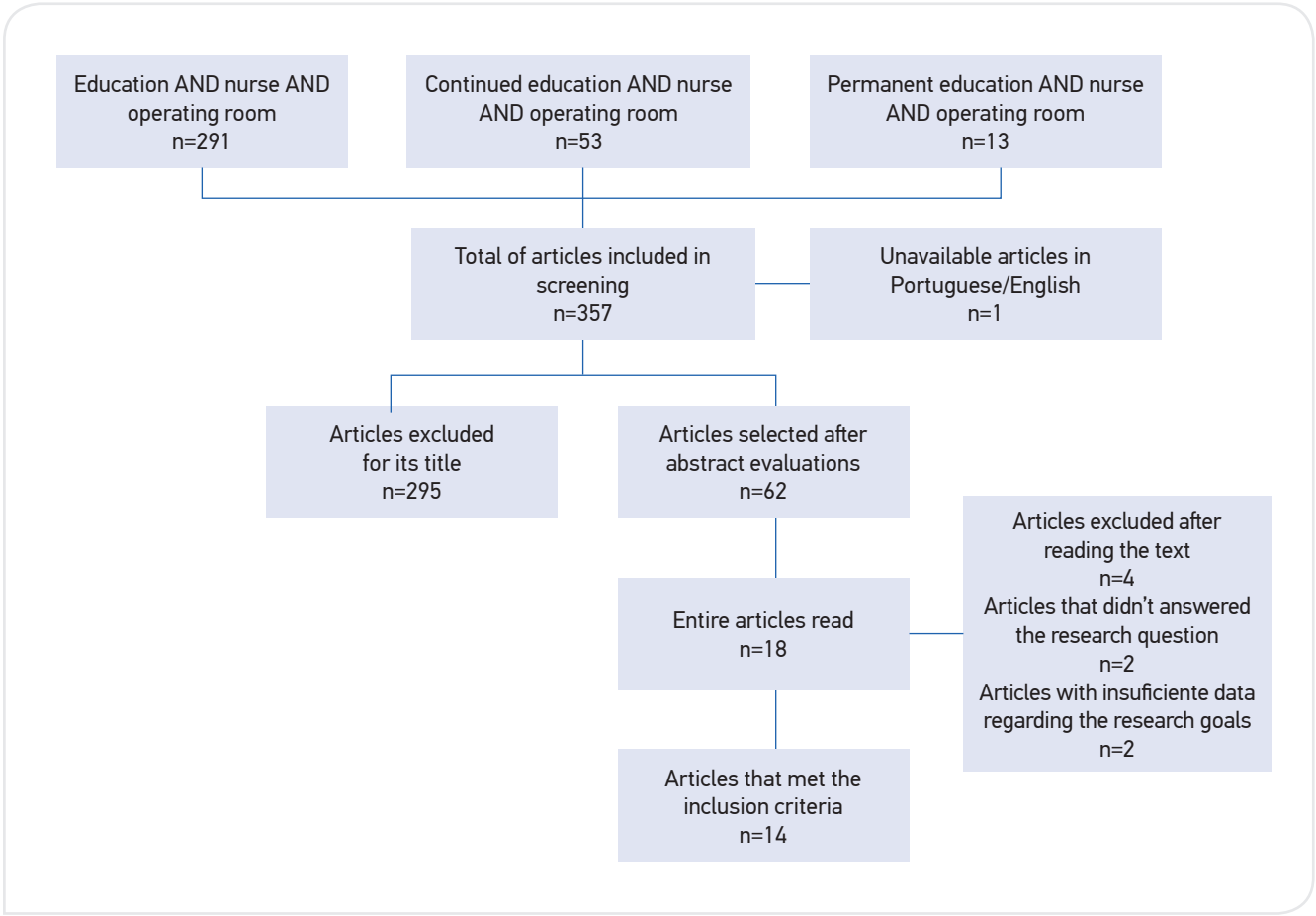

Figure 1. Flowchart of the cientific articles survey process.

Chart 1. Summary of studies found in relation to training for nursing and training of Operating Room Nurses.

Authors	Magazines/ newspaper	Origin	Tipe of study	Results	Level
Pereira et al.[1] (2013)	*Revista de Pesquisa Cuidado é fundamental Online*	Brazil	Qualitative, descriptive and exploratory	Were classified in five categories that indicates, in nursing work process: multiple comprehensions on management process; the implications of power relations; understanding of the same as the nursing process, continuing education and technology seen as a necessity for the development of that process.	C4
Bezerra[2] (2012)	*Revista Eletrônica de Enfermagem*	Brazil	Descriptive exploratory	Nurses believe in continuing education and most develop this activity annually; the predominant teaching and learning strategies are: exposure dialogue and questioning of cases; Programs include technical and behavioral skills and the evaluation is done through audit.	C4
Silva et al.[3] (2010)	*Revista Gaúcha de Enfermagem*	Brazil	Teorical reflection	Such articulation presents an educational design for the sake of worker's awareness of the contributions in different ways to receive and pursue continuing education in health and work Nursing.	C5
Siqueira e Kurcgant[4] (2005)	*Revista de Enfermagem da USP*	Brazil	Research report	The program has been showing good results regarding the individualization of training and participation of nurses from the institution.	C5
Puggina et al.[5] (2015)	*Revista Espaço para a Saúde*	Brazil	Descriptive exploratory with qualitative approach	Highlights the difficulty of professionals to participate in activities for lack of people to replace them, the lack of optimization of time and personal interest. As for the strategies is the planning of actions with the teams. It is emphasized that the permanent health education must be understood as a tool to promote the improvement of workers and constructive changes in working process.	C4
Oliveira[6] (2007)	*Revista Brasileira de Enfermagem*	Brazil	Descriptive	Indicates that the continuing health education is one of the strategies for professional training through collective work among teachers. Alternatively the distance allows to build a new approach to their development.	C4
Castro e Takahashi[14] (2008)	*Revista de Enfermagem da USP*	Brazil	Qualitative content analysis shed	Results showed the opinion of nurses in three distinct categories: (1) difficulties perceived in the process of assessment of learning in relation to the availability of time; negative feelings towards the evaluation; and lack of concern with the results of the training are the challenges to be worked on a daily basis; (2) methodology developed in the process of learning assessment should consider different learning agilities, their experience and life history, and previous knowledge; (3) evaluation of the teaching-learning process as an accurate indicator of past actions and control the quality of education adopted in training.	C4
Silva et al.[15] (2008)	*Mundo Saúde*	Brazil	Descriptive exploratory	It is hoped that can help improve their performance and professional development and to improve the self-esteem of nurses in educational activities, not only the unit itself but possibly other promoted by the continuing education.	C4
Silva e Sieffert[16] (2009)	*Revista Brasileira de Enfermagem*	Brazil	Case study Prospective quali-quantitative	Reflections emerged on the development of educational processes in nursing were sugested, identifying challenges overcome by the group. To make the education of nursing professionals an ongoing process, one must consider the daily work as axis of the educational process, source of knowledge and object of transformation that emphasizes collective and interdisciplinary participation.	C5
Galvão et al.[17] (2002)	*Revista Latino-Americana de Enfermagem*	Brazil	Review article	Evidence-based practice; general concepts, importance and barriers to their implementation in professional practice in order to encourage the surgical nurses to seek scientific knowledge through the development of research and use of its results.	C4

Continue...

Chart 1. Continuation.

Authors	Magazines/ newspaper	Origin	Tipe of study	Results	Level
Sena et al.[18] (2013)	*Revista Gaúcha de Enfermagem*	Brazil	Descriptive with qualitative approach	Most of the of care refers to the orientation of the patient in preoperative period. Care were directed to the physical aspects at expense of the psychological, in disagreement with the assistance methodology adopted in the hospital, supported by the Theory of Basic Human Needs.	C4
Oliveira e Servo[7] (2004)	*Revista Sitientibus*	Brazil	Review article	The distance education in the presentation of the limits and possibilities, as a lifelong learning strategy for OR nurse on new technologies, training of professionals in the workplace, reaching a large number of people and groups, continuing processes of access to knowledge.	C4
Ortiz et al.[10] (2008)	*Revista Cogitare de Enfermagem*	Brazil	Descriptive with quantitative approach	Results showed that the majority (59%) had a specialist degree and worked for over 10 years in perioperative care. It was observed that 88% had computer at home and 100% of them had access to the internet, however, only 35% used. As for experience with distance education, 53% said they have no experience. Most participants (88%) were interested in the availability of distance education courses.	C4
Vigeant et al.[19] (2008)	*Journal Nurses*	English	Review article	The use of video in training can be classified into three categories: the use of video to show content; the use of video for self analysis and the integration of video in multimedia teaching programs.	C4

processes and technology; the nurse as educator and researcher; evaluation of teaching learning; and distance education as an important tool for OR nurse training.

In a study with 17 nurses working in perioperative care, 88% of participants showed interest in participating in a course of distance education, making suggestions for topics and having the possibility of reconciling time and add new knowledge[10].

The research showed a lack of studies on how OR nurses are trained. On the basis of the nursing work according to Sanna model[11], a script for nursing training was developed in two stages: attend and participate in the pre-operative care, as well as to teach, research and administer to develop the nursing staff.

Attend and participate

- To be aware of the flowchart of the OR and the recovery room, as well as the location and operation of the support areas (pharmacy, clinical engineering, central sterile material, pathology lab and clinical analysis, computer system).
- To be aware of the standard operating procedures and how to get access.
- To receive the patient in the OR, checking full name and date of birth.
- To verify the terms: surgical, anesthetic and blood transfusion when needed.
- To verify the demarcation of the surgical site, where applicable, on the importance of the *checklist* of safe surgery[12].
- To be aware of the importance of pre-anesthetic evaluation according to the profile of the patients assisted by the institution.
- To prepare *kits* for anesthesia and monitoring.
- To assist anesthesia with notions regarding the types of anesthesia; actions of anesthetic drugs, adverse reactions, complications and pain control, which can be prepared in two parts: theoretical (with videos and lessons) and practical.
- To prepare different types of invasive monitoring.
- To attend the operating room (OR) in case of cardiac arrest.
- To be aware of the OR installation routine, as well as of the request flow of the surgical kit at the pharmacy and devices in the central sterile material, and the equipment in OR and how these should be tested.
- To be aware of the responsibility of the nursing technician and his or her activities as circulating nurse during the surgical procedure.
- To refer the patient to the recovery room or intensive care unit (ICU).

- To reinforce the importance of infection control in the operating room, use of barriers and antisepsis procedures. Surgeries do not occur in absolutely sterile conditions. There is always the possibility of penetration of microorganisms, both from exogenous (air, professionals, equipment etc.) and endogenous sources (from the patient itself)[13].
- To fill out the safe surgery *checklist* with the multidisciplinary team, focused on patient safety.
- To be aware of the surgical positions and the main types of surgical positioning and accessories used for protection (positioners).
- To perform nursing recording in OR of all operative period with details of anesthesia, positioning, surgery, and description of special and consigned materials to avoid claim denials by the insurance companies.
- In case of complications, must report the details of the care provided by the professional staff.
- To be aware of the functioning of the equipment and its use for each surgical procedure.
- To develop abilities on computer system used in the institution.
- To be aware of the admission routines of care in patient care in the recovery room.

Teaching, research and administration

- Training and retraining of the routines with the team and with new employees.
- Review and development of new Standard Operacional Procedures (SOPs).
- Team sizing, as well as elaboration of time off and vacations schedules and daily activities of employees.
- To be aware of the flow of the surgical schedule and the operation of the daily routine of surgical map, as well as distribution of procedures in operating theaters.
- To verify the request by the surgical map in order to predict and provide materials and equipment for each procedure.
- To ensure adherence of the multidisciplinary team to the safe surgery *checklist*[12.]
- To be aware of the indicators and participate, so that the goals are achieved.
- To acquire knowledge concerning health accreditations.
- To work on the reduction of costs in the OR, thus avoiding the waste with the opening of materials.
- To participate in the preparation of scientific papers for publication of research in nursing.

DISCUSSION

The literature review identified the most articles as descriptive studies and case reports. On the basis of the adopted methodological framework, study categories are classified in the levels of evidence C4 and C5.

This result showed that studies, such as cohort studies and systematic reviews with meta-analises[9] need to be developed to improve the number of scientific evidence on the subject of study.

Despite the fragility of the studies, these have important concepts and information that adresses the guiding question of the review.

The main issues identified in the critical analysis of the articles and their implications are presented and discussed next..

Development as researcher and educator

The importance of delivering teaching and learning in the workplace is emerging as an education tool in health organizations[14].

The development of the nursing staff is on the scope of the nurse responsible for continuing education, who should have the support of other nurses of the institution; however, this nurse should be developed as an educator and share this knowledge with the entire nursing team[15].

Continuing Education in Nursing, as methodological proposal, is considered important. Thus, the content developed should be focused on daily life, considering the daily work, the needs of the health field and institution, and technological evolution[16,17].

The implementation of evidence-based practice in perioperative nursing contributes to the improvement of care and to reduce costs[17].

In OR, the nurse has the responsibility to ensure the quality of care in order to reduce damage to the patient, as well as to act as opinion maker and train his or her team[18].

Education and technology

Distance education is a lifelong learning strategy for OR nurses, and an important tool to facilitate access to knowledge, in which learning occurs in the workplace, via teleconference or videoconference[7].

For OR nurses, distance education have some weaknesses that may compromise the training, such as intense surgical agenda, which may hinder the output of the operating room nurse for training in computer, as well as difficulties regarding the use of the media[7-10].

Training

With technology increasingly present in surgical procedures, preparing the nurse of the operating room for the use of this technology is a concern, but not cease to provide a humanized care to the patient[1].

The combination of teaching resources, such as movies, group dynamics, educational mannequins and simulated situations for discussions and evaluations of procedures, led to a greater involvement of the team in the training, with effective participation of the supervisor and newly hired nurse[4].

In a study conducted in the hospitalization unit, which had the supervisor nurse following the training and the development of the newly admitted nurse,using a script[4] was the basis for the construction of the OR nurse training script, as well as the use of video in training for OR nurses, in which knowledge is acquired through the simulation of practical experience and theoretical reference[19].

Nurse educator profile

The instructor, as planner and executor of the process, should establish concrete relations between theory, practice and reality; being the OR a highly complex sector, the nurse educator should have knowledge and mastery the routines, both administrative and care routines, to train new nurses and the nursing staff. [10,16].

The OR nurse, according to the *Associação Brasileira de Enfermeiros de Centro Cirúrgico, Recuperação Anestésica e Centro de Material e Esterilização (SOBECC),* is a qualified professional to manage the needs involving the anesthetic-surgical procedure in all its stages. It is recommended for the nurse to be an expert in the field of knowledge in which he operates[20].

Process evaluation and learning

The evaluation of the teaching-learning process shows real results through reliable instruments such as weak points, difficulties and how to overcome these failures, thus improving such articulation[14].

The technique of using video as self examination is an important tool for analysis and self knowledge[19].

Limitations

The study showed a reduced number of articles, and publications have didatic references based on studies with poor levels of evidence (C4 and C5).

CONCLUSION

The two studies related to the OR nurse education showed the distance education as a training tool, and an article indicated the use of video as a tool for education

This search revelead a study that indicates the importance of *on-site* training for nurses in the inpatient care unit. The model can be adapted to the OR, because of the high complexity and technology increasingly applied to the equipment. It is important for nurses to receive training in their workplace.

Based on this article, a script has been submitted to the OR nurse, taking into account the care, educational, research and administrative aspects.

The assessment is of great importance for the return of investment in learning and was mentioned in several articles of the study, facilitating interaction between educator and collaborator, providing opinions about the training content, which in turn leads to improvements in the teaching-learning process.

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INDICATIONS AND LIMITATIONS OF DIFFERENT DETERGENTS USED IN THE PROCESSING OF HEALTH PRODUCTS

Indicações e limitações dos diferentes detergentes utilizados no processamento de produtos para a saúde

Indicaciones y limitaciones de los detergentes diferentes utilizados en el procesamiento para la salud

Adriana Cristina de Oliveira[1], Maria Leticia Mati[2]

ABSTRACT: Objective: To identify studies that address indications and limitations of different detergents used in the processing of medical devices. **Method:** Integrative review that included publications in Scientific Electronic Library Online, Science Direct, Scopus, Web of Science and PubMed, from 2000 to 2016, in English and in Portuguese. **Results:** Nine studies were identified. Alkaline detergents remove dirt well, its use is indicated for automated equipment, and they are suitable in processes that use hard water, compatible with surgical stainless steel instruments. They may damage the medical device and react with aluminum, zinc, non-ferrous metals, rubber and latex. Enzymatic detergents are compatible with various materials and, due to the presence of enzymes, remove different types of dirt from the instrument. **Conclusion:** Although alkaline and enzymatic detergents present similarities, the choice of the product requires knowledge of its action, observing the characteristics of use, compatibility with the medical device and water quality.
Keywords: Housekeeping. Equipment and supplies. Detergents.

RESUMO: Objetivo: Identificar estudos que abordem indicações e limitações dos diferentes detergentes utilizados no processamento de produtos para a saúde. **Método:** Revisão integrativa que incluiu publicações presentes nas bases de dados *Scientific Eletronic Library Online, Science Direct, Scopus, Web of Science* e *PubMed,* no período de 2000 a 2016, nos idiomas inglês e português. **Resultados:** Foram identificados nove estudos. Os detergentes alcalinos apresentam boa remoção de sujidades, são indicados para uso em equipamento automatizado, adequados em processos que utilizem água dura e compatíveis com instrumentais cirúrgicos de aço inoxidável. Podem danificar o produto para a saúde e reagir com alumínio, zinco, metais não ferrosos, borracha e látex. Detergentes enzimáticos são compatíveis com diversos materiais e, devido à presença de enzimas, removem diferentes sujidades do instrumental. **Conclusão:** Embora os detergentes alcalino e enzimático possuam similaridades, a escolha do produto exige o conhecimento da sua ação, observando as características de uso, compatibilidade com o produto para a saúde e qualidade da água.
Palavras-chave: Serviço de limpeza. Equipamentos e provisões. Detergentes.

RESUMEN: Objetivo: Identificar los estudios que abordan indicaciones y limitaciones de diferentes detergentes utilizados en el procesamiento de productos de salud. **Método:** Revisión integrada que incluye publicaciones presentes en las bases de datos Scientific Electronic Library Online, Science Direct, Scopus, Web of Science y PubMed, de 2000 a 2016, en los idiomas Inglés y Portugués. **Resultados:** Se identificaron nueve estudios. Los detergentes alcalinos tienen buena eliminación de impurezas, están indicados para su uso en equipos automatizados, los procedimientos adecuados utilizando agua dura compatibles e instrumental acero inoxidable quirúrgico. Pueden dañar la salud del producto, y reaccionar con aluminio, zinc, metales no ferrosos, caucho y látex. Detergentes enzimáticos son compatible con diversos materiales y, debido a la presencia de enzimas, eliminan diferentes suciedades de los instrumentales. **Conclusión:** Aunque detergentes alcalinos y enzimáticos presenten similitudes, la elección del producto requiere el conocimiento de su acción, observando las características de uso, compatibilidad con el producto para la salud y la calidad del agua.
Palabras clave: Servicio de limpieza. Equipos y suministros. Detergentes.

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INTRODUCTION

Health-care products (HCP) that can be processed are medical devices designed and manufactured to allow repeated cycles of cleaning, preparation and disinfection or sterilization until they are no longer effective or functional[1]. The processing of these items is indicated to maximize the benefits of products that normally present high costs for the health system, and to minimize the environmental impacts caused by the HCP, as the reuse of these devices reduces the volume of waste released into the environment[2,3].

The proper cleaning of HCP is a determinant for the effectiveness of processing. It consists of the physical removal of clinical dirt (organic and inorganic materials), accompanied by the reduction of microbial load of the internal (lumen) and external surfaces of these devices using a water and detergent solution, enzymatic products and other accessories[1,4,5].

Detergents used in the processing of HCP must be biodegradable, non-abrasive, nontoxic at manufacturer-oriented dilution, effective in dirt removal, be low foaming and have good rinsability[6-8]. Through the action of surfactants, they reduce the surface tension of the water and provide greater contact with the dirt contained in the instrument, favoring the removal of the organic and inorganic residues present in the material[1,4,6].

Currently, it is widely recommended that the detergent used in HCP cleaning have enzymatic action[9]. In Brazil, this product is regulated by the Resolution from the Collegiate Board of Directors (RDC) No. 55, November 27, 2012, from the Brazilian Health Regulatory Agency (ANVISA). It defines enzymatic detergents as products whose formulation contains, in addition to the surfactant, at least one hydrolytic enzyme in the EC 3.4 protease subclass, the purpose of which is to remove clinical dirt and prevent the formation of insoluble compounds on the surface of the devices[10-12].

Unlike common detergents, enzymatic formulations can catalyze reactions by the action of enzymes. They act selectively on organic matter, degrade specific substrates, accelerate and optimize the HCP cleaning process[4,12,13]. Thus, multi-enzyme formulations are marketed in order to increase the action spectrum of the product on the dirt, thus making cleaning more effective[4,11].

Various formulations of detergents, which not only are composed of multiple enzymes, but also have different pH levels, are still available on the market. The pH value is an important characteristic of the product, since it can interfere with the stability of the solution and, consequently, with enzymatic activity. However, in Brazil, there is no specific pH determination for these products. RDC No. 55, from November 27, 2012, from ANVISA, only determines that the pH range of the pure solution and the dilution must be reported on the detergent label.[12].

It is noted that neutral enzymatic detergents with a pH of 7 and alkaline detergents whose pH value ranges from 7 to 14 are commercially available for the processing of HCP[14]. However, in clinical practice, the predominant neutral formulation is used in the cleaning of HCP, known for its ability to preserve the instruments. And, regarding the alkaline detergent, it is observed that questions about its use for cleaning HCP have been more and more frequent. However, the lack of information on indications and limitations, not to mention the potential damage that the different ranges of pH can cause to HCP, has raised doubts that are present in the clinical practice.

Therefore, given the existence of alkaline and neutral enzymatic formulations of detergents for HCP processing and the scarce number of publications that address this issue, the following questions are asked: What are the indications and limitations of the different types of detergents used in HCP processing?

OBJECTIVE

This analysis aims to identify studies that address the indications and limitations of alkaline and neutral enzymatic detergents in order to provide base for a critical analysis by health professionals.

METHOD

The method used in this study was an integrative review of the literature, since it allows to gather and synthesize research results on a delimited topic or issue, in a systematic and orderly manner, contributing to deepen the knowledge on the subject investigated[15].

Six different steps were taken for the construction of the integrative review: choice of research question; definition of inclusion criteria and sample selection; representation of selected studies in the form of synoptic tables; analysis of the findings; interpretation of the results and presentation[15].

The following guiding question was defined: What are the indications and limitations of the different types of detergents used in HCP processing? Next, the following inclusion criteria were outlined: original articles in English or in Portuguese that addressed the indications and limitations of the different types of detergents used to clean HCP, published from 2000 to 2016. The articles analyzing enzymatic and alkaline detergents that were not related to the cleaning of HCP were excluded.

The publications were selected from the following Health Sciences Descriptors (DeCS) in Portuguese and in English: *detergentes, infecção hospitalar, saneantes*, detergents, cross infection, sanitizing products. Also, the following uncontrolled descriptors were used: *alcalino, controle de infecção, limpeza, enzima, enzimático*, alkaline, infection control, cleaning, enzyme, enzymatic. All descriptors were used in isolation, as well as associated by the connector AND on all bases cited.

The selection of articles was carried out through the Coordination Portal for the Improvement of Higher Level Personnel (CAPES) using the Scientific Electronic Library Online (SciELO), Science Direct, Scopus, Web of Science and PubMed databases.

The initial selection of publications was conducted by the exploratory reading of the title and abstract of the papers, which led to the identification of 11 studies. Of these, one was found in the SciELO database, six in Science Direct, ten in Scopus, seven in the Web of Science and eight in PubMed. Some studies have been found in more than one database. From the analytical reading of the texts, three articles were selected, in accordance with the inclusion and exclusion criteria previously defined.

Faced with the scarcity of results found in the mentioned databases, research was also conducted in electronic content provided by associations, industries and manufacturers of medical and hospital materials, laboratories, and government agencies. Thus, six publications were found. The three articles from the databases were added to these publications, totaling nine papers for evaluation. Figure 1 summarizes the search process for publications.

What followed, therefore, was the categorization of studies by the creation of a thematic framework. This was intended to outline an overview of the articles. For the composition of the thematic framework, the following information was extracted from each article: title, authors, year, type of

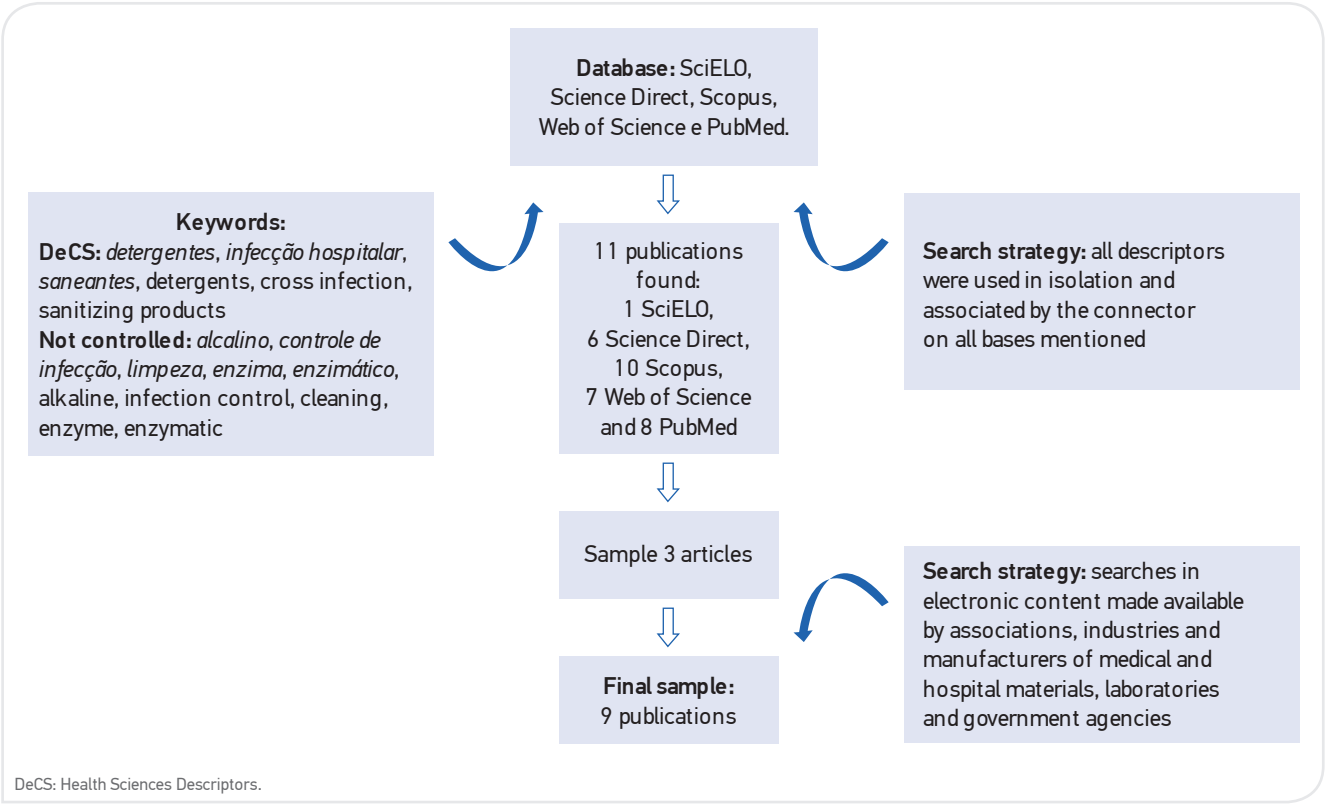


Figure 1. Search process for publications.

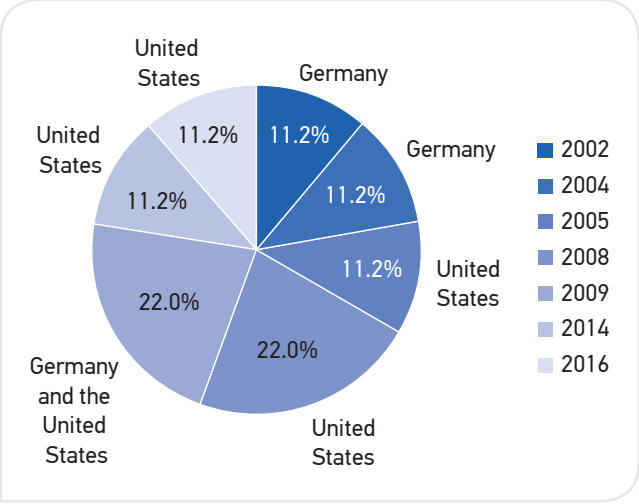
study / methodology and main results. This information was presented in Graphs 1 and 2 and Table 1.

RESULTS

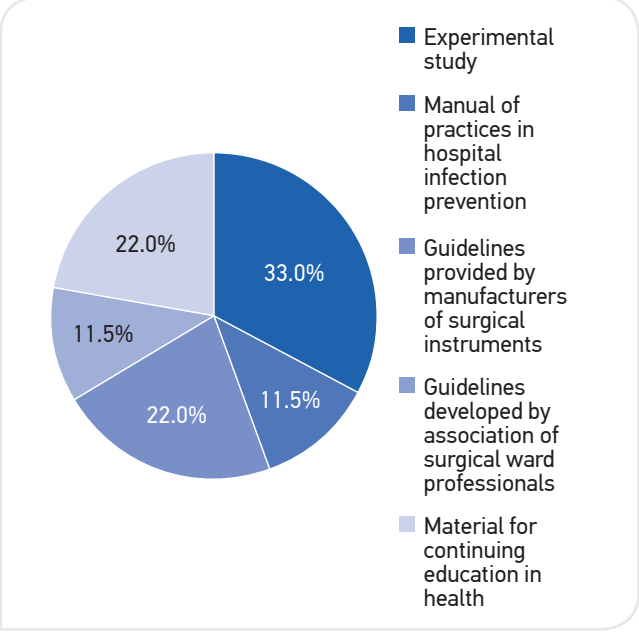
Nine publications have been identified that address the indications and limitations of alkaline and neutral enzymatic detergents. These studies were carried out in Germany (22%) and in the United States (77%). There were no studies performed in Brazil for the period analyzed. The publications were distributed as follows: 2002 (11.2%), 2004 (11.2%), 2005 (11.2%), 2008 (22%), 2009 (22%), 2014 (11.2%), 2016 (11.2%). This information is summarized in the Chart presented in Graph 1.

Regarding the studies' designs (Graph 2), three (33.0%) were experimental studies, one (11.5%) was a manual of practices on hospital infection prevention, two (22.0%) were guidelines elaborated by manufacturers of hospital medical products, one (11.5%) was elaborated by an association of professionals working in a surgical ward and two (22.0%) included materials for continuing education in health.

Indications for the application of alkaline[14,16-18] and neutral enzymatic detergents[5,10,14,17,19] used in HCP processing were pointed out in seven studies, and alkaline product



Graph 1. Percentage of publications according to year and country of origin, 2000 to 2016. Belo Horizonte, 2016.



Graph 2. Design of the selected studies during the bibliographical survey (2000-2016). Belo Horizonte, 2016.

Chart 1. Indications and limitations of the neutral and alkaline enzymatic detergents used to clean health products according to pH. Belo Horizonte, 2016.

Alkaline detergent	Indications	• Removal of organic waste[10,16-18]. • HCP cleaning in processes that use hard water[14]. • Cleaning of stainless steel surgical instruments[14]. • Cleaning in automated processes[14].
	Limitations	• Inactivation of enzymes, instrument damage and neutralizing rinse need when pH value is high[14, 20-21]. • Risk staining the instrument when not properly removed[14,20]. • Potential risk of corrosion and interference in the correct functioning of HCP[5,14,20,21]. • Risk of reacting with aluminum, zinc, non-ferrous metals, rubber and latex[14].
Neutral enzymatic detergent	Indications	• Compatible with metals and other materials used in HCP, such as aluminum, copper, plastic and rubber[5,10,14]. • Does not damage HCP[5,14,17,19].
	Limitations	• Not found.

HCP: health-care products.

limitations were cited in four publications[5,14,20,21]. No limitations were found regarding the use of neutral enzymatic detergent in the cleaning of HCP. The synopsis of these findings is shown in Chart 1.

Studies have indicated that alkaline detergents are suitable for cleaning surgical instruments made of stainless steel, and provide efficient removal of fats, proteins and other organic waste, disaggregating them from the HCP more easily when compared to the neutral detergent[14,16-18]. In cleaning processes in which hard water is used (when alkaline earth ions are present in the water), the alkaline product is the most suitable to be used[14].

Alkaline detergents can damage HCPs as they are able to stain and corrode them, interfering with their proper functioning[20,21]. These damages can occur if the detergent is not properly removed from the instruments during rinsing, if used in certain materials such as aluminum, zinc, non-ferrous metals, rubber and latex, and when the formulation has a high pH value (above 12), in which case the use of a neutralizing product is necessary to avoid more damage to the devices[14]. The neutralizing rinse takes place with the addition of an acidic solution to the water, in order to reduce the pH of the solution, leading it close to neutrality[14]. The pH higher than 12 may still impair the action of the enzymes as the functionality of these substances decreases[14].

Neutral enzyme detergents have a better profile of compatibility with different materials such as aluminum, non-ferrous metals and rubber, providing better enzyme performance, as well as not corroding surgical instruments and not damaging HCP. They are used to help the detachment of organic matter from the instrument's surface.[5,14,17,19].

DISCUSSION

The action potential of the enzymes present in the enzymatic detergent is influenced by a number of factors, including the pH of the formulation. PH value variation, higher or lower than what is necessary for the enzymatic activity to occur satisfactorily, can inactivate it and interfere with the action of these substances. This value is determined according to the nature of enzymes present in the detergent, since each of them presents with an optimal pH that allows the maximum performance of their activity[13,22]. Enzymatic detergents do not have bactericidal properties to destroy microorganisms, but to eliminate the organic matter that serves as substrate for the microorganisms to multiply[23].

According to RDC No. 55, from November 27, 2012, of ANVISA, enzymatic formulations cannot contain substances that compromise the activity of the enzymes or that damage the materials and equipment that get in contact with these products[1]. Thus, the neutral enzymatic detergent was indicated for being more compatible with the materials that compose the HCP. In the studied literature, the damage that this solution could cause to these devices was not reported[5,14,17,19].

In contrast, the alkaline product has been found to be compatible with devices made of stainless steel, but incompatible with various other materials that are present in the composition of different HCPs, including aluminum, zinc, non-ferrous metals, rubber and latex[14]. The compatibility of stainless steel with the alkaline detergent is owed to the presence of a chromium oxide (Cr2O2) layer on the surface of the material, passively formed by the reaction of oxygen with the chromium present on the surface of the material. This layer imparts extreme resistance to corrosion, protecting steel from the damage that the alkaline formulation could cause, from the action of many chemicals and physical parameters, such as temperature and pH variations[24,25].

HCPs that are not compatible with alkaline detergent may be stained, corroded, and may interfere with proper operation when in contact with the product[5,14,20,21]. These damages that occur on the devices imply higher costs for the health service, as these places will have, in addition to the budget, expenses with maintenance and replacement of instruments.

In relation to the action potential of detergents, some publications have indicated the alkaline formulation as the most effective one for the removal of organic matter[16-18]. A study developed by Smith et al.[26] corroborates this statement. The experiment consisted in evaluating the action of different chemical products, including alkaline and neutral detergents, in the removal of horse blood impregnated in stainless steel plates. The metal plates were inoculated together with the cleaning product to be tested and shaken on a shaking platform. Time of exposure and temperature were the same for all solutions tested. At the end of the procedure, the investigator found, through a bicinchoninic acid assay — protein quantification method compatible with detergents and denaturing agents[27] —, that the alkaline detergent is

more efficient for removing the proteins present on the surface of the metal plates[26].

In another study, developed by a manufacturer of products used in the processing of HCP, the performance of several detergents used for cleaning these devices was compared: alkaline detergent, alkaline with enzymes and multi -enzymatic with neutral pH. Metal plaques were prepared with different types of dirt that included: iodinated blood; clotted blood; protein-enriched lipid; polysaccharides; proteins and polysaccharide. Thereafter, they were soaked in cleaning solution and shaken in a shaker. At the end of the established contact time, the samples were removed from the solution, rinsed in cold water, dried and visually inspected. The conclusion was that neutral enzyme products presented the worst results for removing impregnated dirt from metal platelets; and alkaline formulations were the most effective ones[28].

However, a divergent result pointed out that, in terms of effectiveness, there is no significant difference between neutral and alkaline enzymatic detergents[17]. Such a finding was observed by Zuhlsdorf[17] in an experiment that consisted of inoculating blood containing *Enterococcus faecium* into teflon tubes, which were then subjected to automated cleaning with the use of different cleaning agents. The efficacy of the process was assessed visually and microbiologically by means of bacterial counting[17].

In clinical practice, professionals have noticed an apparent superiority in the performance of alkaline detergents, since the HCP, when processed with this product, acquire greater brightness and better appearance, as these formulations clean the instruments deeply, removing incrustations from their surface.

Thus, alkaline formulations have been become standard in the work routine of some health services, although the references on the subject are scarce and many professionals do not yet have the real knowledge about the product's action. The use of these formulations requires caution, since this type of detergent demands strict control of the rinse, the temperature of the solution, the pH of the water, besides not being compatible with all types of materials; otherwise, it could cause irreversible damages in HCP and impair the efficiency of device processing.

Although the marketed value of this product is generally higher than that of the enzymatic detergent, manufacturers promise better cost-effectiveness of the formulation, making it more economical. However, material wear and tear and repair, besides replacement costs, must be evaluated.

Alkaline formulations are generally indicated by manufacturers to be used in automated cleaning processes (thermodyne stricting and ultrasonic washing machines) because of low foaming. This is a necessary feature in this processing method, as it avoids damage to the equipment by decreasing the cleaning cycle time, due to the shorter rinsing time, and by causing less damage to the recirculation pump[29,30].

Although the foaming of the alkaline detergent is lower, this property should also be observed while choosing the detergent to be used for manual cleaning. Poor foaming leads to more professional safety, since it increases the visibility of sharp instruments within the solution and optimizes the cleaning process by facilitating rinsing and visualization of dirt on the instrument[14].

Being compatible with the equipment used in automated processing is an advantage of the product, since this has been considered the ideal method of cleaning. When compared to the manual method, the automated process has been shown to be more significant in terms of reducing the microbial load in HCP[31-33].

The reduction of occupational risks can also be listed as an advantage of this method, since it restricts the contact of the professional with the contaminated material; the standardization of the process, since it is expected that the equipment works equally for all different cleaning cycles; and the ability to measure and register the parameters involved in processing, such as the time and temperature of the solution.

However, other characteristics of the detergent, both neutral or alkaline, should be considered when used in the processing of HCP, regardless of the method adopted. One must be aware that bacterial contamination may be present in cleaning solutions contained in an ultrasonic washer or in manual cleaning containers, since enzymatic detergents usually have no bactericidal action[21].

The ideal action against such contamination is to dispose of the cleaning solution after each use, as recommended in the Guideline for Disinfection and Sterilization in Health Care Facilities, 2008, from the Centers for Disease Control and Prevention[5]. However, in clinical practice, enzymatic detergent solutions are reused several times, contrary to such information. In this scenario, the disposal of these products is usually determined by professionals, who use subjective methods to evaluate the quality of the solution, such as presence of visible dirt or turbidity. This practice of enzyme detergent reuse is carried out by the health services to reduce costs in the processing of the materials to

the detriment of the safety of the process, although studies indicate that the reuse of the enzymatic detergent solution can contribute with the elevation of microbial load in the HCP immersed[34].

Another important aspect to be analyzed, so that during the processing of the HCP the detergent is used correctly, refers to the characteristics of the water. In cleaning processes in which hard water is present, the alkaline detergent is the most suitable to be applied[14,35]. Hard water has a high level of alkaline earth metal salts (calcium, magnesium and strontium), which are released from the solution and settle on the surface of the HCP when the water is heated or evaporated; this impairs the action of most detergents and disinfectants. In this process, released ions interact with some chemicals and form insoluble precipitates on the surface of the instrument, causing corrosion and staining of the devices[36,37].

Water is the most widely used element throughout the HCP cleaning process and, therefore, requires attention[9]. In Brazil, the water used in the processing of HCP must meet the drinking standards defined in specific regulations, Ministerial Order No. 2914, from December 12, 2011, of the Ministry of Health[35]. When it does not meet the appropriate requirements, some processes can be used to treat it. Distillation or demineralization systems, for example, virtually remove all ionic material dissolved, turning it into soft water. It is known, therefore, that hard water is not indicated for use in health services, and its use is irregular.

CONCLUSION

Because this is a literature review, the limitations found in the results must be considered, since there is a comprehension of the strategies adopted, as well as the defined descriptors. This itself opens up a range of opportunities for investment in other studies that address the issue.

In addition to this fact, it was found that the indications and limitations of the detergents used in the HCP cleaning process were still a rather unexplored subject in the scientific literature, which contributed with the reduction of the number of articles.

The alkaline detergent is a relatively new product in the Brazilian market, and needs to have its characteristics explored and known before being implemented in health services. Although it presents prominent characteristics, such as the performance of deep cleaning in HCP, its use may cause irreversible damage to the devices. In this respect, the compatibility of the neutral enzyme detergent with different types of materials is an advantage of that formulation, as it reduces maintenance costs and acquisition of new HCP.

According to the characteristics presented, both the neutral and the alkaline enzymatic product present specific indications and limitations that must be observed by the professionals before standardizing them for cleaning the HCP.

Although literature shows records that alkaline detergents perform better in relation to the cleaning of HCP, divergent results were also verified, which highlights the need for more clinical studies on the subject.

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STEAM STERILIZATION: FUNDAMENTAL ASPECTS AND TECHNICAL RESOURCES TO REDUCE WATER CONSUMPTION

Esterilização pelo vapor: aspectos fundamentais e recursos técnicos para redução do consumo de água

Esterilización por vapor: fundamentos y recursos técnicos para reduccion del consumo de água

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ABSTRACT: Objective: To discuss the fundamentals of steam sterilization and the technical resources that can be used for a reduction of water consumption in the sterilization process. **Method:** Review of literature and technical and international standards related to the principles of construction, operation, and use of sterilization equipment by saturated steam under pressure. **Results:** The reduction in water consumption can be obtained by preferential acquisition of equipment with free water pumps, shutdown of the source of steam-generating power when the equipment is not in use, use of equipment with built-in degassers, assembly of the load in a way to facilitate vapor penetration and reduction of drying time, re-adjustment of the depth of the vacuum to the low time of use of the vacuum pump, and the preventive maintenance of the steam line traps. In addition, a pretreatment system can reduce the waste from reverse osmosis water treatment systems for steam generation. **Conclusion:** Knowledge of the fundamentals of sterilization by saturated steam under pressure allows an implementation of measures for a reduction of water consumption in the sterilization process.

Keywords: Steam. Water. Sterilization.

RESUMO: Objetivo: Discorrer sobre os aspectos fundamentais da esterilização pelo vapor e os recursos técnicos que podem ser utilizados para a redução do consumo de água no processo de esterilização. **Método:** Revisão da literatura e de normas técnicas nacionais e internacionais relacionadas aos aspectos construtivos, funcionais e de operação de equipamentos de esterilização pelo vapor saturado sob pressão. **Resultados:** A redução do consumo de água pode ser obtida pela aquisição preferencial de equipamentos com bombas *water free*, desligamento da fonte geradora de vapor quando o equipamento não estiver em uso, utilização de equipamentos com desgasificadores incorporados, montagem da carga de forma a facilitar a penetração do vapor e a diminuição do tempo de secagem, readequação da profundidade do vácuo para reduzir o tempo de uso da bomba de vácuo e manutenção preventiva dos purgadores da linha de vapor. Adicionalmente, a utilização de sistemas de pré-tratamento pode reduzir o rejeito de sistemas de tratamento de água por osmose reversa para geração de vapor. **Conclusão:** O conhecimento dos aspectos fundamentais da esterilização pelo vapor saturado sob pressão permite a implementação de medidas para a redução do consumo de água no processo de esterilização.

Palavras-chave: Vapor. Água. Esterilização.

RESUMEN: Objetivo: Discurrir sobre los aspectos fundamentales de la esterilización por el vapor y los recursos técnicos que pueden ser utilizados para la reducción del consumo de agua en el proceso de esterilización. **Método:** Revisión de la literatura y de normas técnicas nacionales e internacionales relacionadas a los aspectos constructivos, funcionales y de operación de equipos de esterilización por el vapor saturado bajo presión. **Resultados:** La reducción del consumo de agua puede ser obtenida por la adquisición preferencial de equipos con bombas *water free*, desconexión de la fuente generadora de vapor cuando el equipo no estuviera en uso, utilización de equipos con desgasificadores incorporados, montaje de la carga de forma de facilitar la penetración

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del vapor y la disminución del tiempo de secado, readecuación de la profundidad del vacío para reducir el tiempo de uso de la bomba de vacío y manutención preventiva de los purgadores de la línea de vapor. Adicionalmente, la utilización de sistemas de pre-tratamiento pode reducir el rechazo de sistemas de tratamiento de agua por osmosis reversa para generación de vapor. **Conclusión:** El conocimiento de los aspectos fundamentales de la esterilización por el vapor saturado bajo presión permite la implementación de medidas para la reducción del consumo de agua en el proceso de esterilización.
Palabras clave: Vapor. Agua. Esterilización.

INTRODUCTION

The basic principle of sterilization by saturated steam under pressure is to allow each product to be exposed to steam at a predetermined temperature, time, and pressure[1]. This method of sterilization is widely used by health services for its many advantages for thermoresistant products: it does not form toxic waste, it is easy to control and monitor, it has fast cycles and excellent penetration power in lumens, and sterile barrier systems[2].

As the process requires water for the generation of steam and for the operation of the vacuum pump or Venturi system, professionals of the Clinical Engineering Service (CES) and the Central Sterile Supply Department (CSSD) need subsidies for the application of technical resources that reduce water consumption – a global trend, in addition to the current water crisis in the state of São Paulo.

Therefore, this review article aims at discussing the fundamental aspects of steam sterilization and the technical resources that can be used to reduce water consumption, in order to support CES and CSSD professionals with the necessary information for the revision of its processes, aiming at the safety and rational use of water, a natural and finite resource.

METHOD

This is a review of literature and national and international technical standards related to the constructive, functional, and operational aspects of sterilization equipment by saturated steam under pressure.

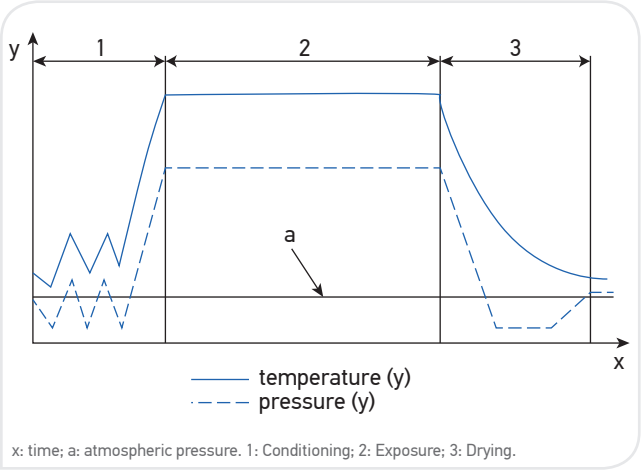
THE MECHANICS OF STEAM STERILIZATION

Saturated steam is considered as one of the best sterilization methods for thermoresistant products because of its ability to destroy bacterial spores in a short period of exposure by rapidly heating the products by heat transfer, which occurs by condensation of the vapor upon contact with the surfaces[3].

Nowadays, saturated steam sterilization equipment is found in various shapes and sizes and is used in hospitals, clinics, laboratories, and pharmaceutical industries. Basically, an autoclave consists of a steel chamber, covered by another chamber, with a sealing port at one or both ends (barrier autoclave), with pressure, temperature, and time of exposure as critical process parameters (Figure 1).

The operating cycles of this system vary according to the process; however, they can be summarized in three steps: conditioning, exposure, and drying (Figure 1).

The sterilization process can be performed in vented saturated steam systems (similar to gravitational steam systems, indicated for surface sterilization, not efficient in removing air in density loads and lumens), with forced air removal (a mechanical device forces removal, indicated for the sterilization of density loads and lumens), air–water vapor mixture (air is allowed inside the inner chamber to preserve the integrity of the product, which may be affected by the elevation of temperature, indicated for liquid cycles), water spraying (water is used as a thermal conductor, raising the temperature



x: time; a: atmospheric pressure. 1: Conditioning; 2: Exposure; 3: Drying.

Figure 1. Stages of a sterilization cycle of a saturated steam system with forced air removal.

of the product, and is indicated for a cycle in which the sterile barrier can be damaged by steam) and water immersion (similar to the previous one, but the whole load is immersed in water, and is indicated for a cycle in which the product and the sterile barrier may be damaged by the steam)[4].

In the conditioning phase, the air must be removed from the autoclave. The techniques used to remove air consist of gravitational displacement, mass flow dilution, pressure pulse dilution, high vacuum and gravitational displacement pressure pulses[3]. Regardless of the technique used, the air must be removed from the chamber for the vapor to be able to penetrate into the load, ensuring sterilization. Knowledge of the systems used to remove air from the chamber is essential, since its operation requires the use of water, both in the conditioning and in the drying phase. Thus, reducing the demand for these systems within the cycles is one of the main measures to reduce water consumption.

In order for the air to be removed from the chamber, a vacuum is required, which is obtained by means of a pump or Venturi system. There are several vacuum pump models and configurations, but they all use a mechanical means to create a centrifugal force to remove air, residual condensate, and steam from inside the inner chamber. The most common model is the water seal, in which the air enters the system composed of a rotor, whose movement of the vanes projects the water to the walls of the system, creating a vacuum zone and, consequently, a ring of water will be formed, which removes air and steam at the same time as it prevents reflux. In this process, the water used to form the ring is also disposed of with the air, condensate or steam, removed from the inner chamber[5].

Other means of sealing, besides water, can be used, such as oil, which is available in pumps with latest technology, which are deemed water-free.

The vacuum obtained by Venturi systems is not the most efficient and generates greater consumption of water or compressed air. The operation of this system is relatively simple: water enters through a pipe with pressure and velocity, where the diameter is reduced to one-third of the inlet and then is raised again to a diameter larger than that of the inlet. At the point where the diameter is reduced, a small diameter inlet tube connected to the inner chamber (Figure 2) is connected. The difference in pressure generated in this region by the differences in the diameters of the pipes forms a vacuum in this inlet, allowing the removal of air, condensate, and steam from the inner chamber[6].

For equipment with a vacuum pump, the water consumption per sterilization cycle is 150–600 L, according to the model, brand, and size of the autoclave. Autoclaves that use the Venturi system to generate vacuum, whose internal chamber size does not exceed 250 L, can consume up to 700 L of water per cycle.

In the sterilization phase, also known as threshold or exposure stage, air has already been removed from the chamber, which is filled by saturated vapor, and the temperature prescribed for the cycle, generally 121 or 134°C, has been reached. Thus, the product is exposed to this temperature for the time necessary to achieve sterility[3].

In the drying step, when the vapor of the inner chamber is exhausted through the vacuum system, drying begins. The residual condensate evaporates due to the reduction of the chamber's internal pressure and the high temperature at which the products and the walls of the chamber are at that moment. Upon reaching the maximum vacuum level, the evaporation rate is reduced due to the low thermal conductivity inside the inner chamber.

REDUCTION OF WATER CONSUMPTION IN STEAM STERILIZATION

During the steam sterilization process, water is used to generate steam and to operate the vacuum pump or Venturi system. Water consumption with the generator in the standby mode is of approximately 20% of the water consumption during the steam generation[7]. Therefore, there will be a reduction in water consumption with the shutdown of the steam-generating source when the equipment is not in use.

In the conditioning phase, one point to be observed is the quality of water for steam generation, which must be free of impurities and non-condensable gases, which will be drawn together with the vapor into the inner chamber, forming a barrier that will prevent the contact of the vapor with the load. This process increases the formation of condensate,

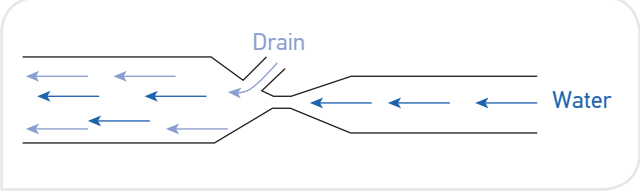


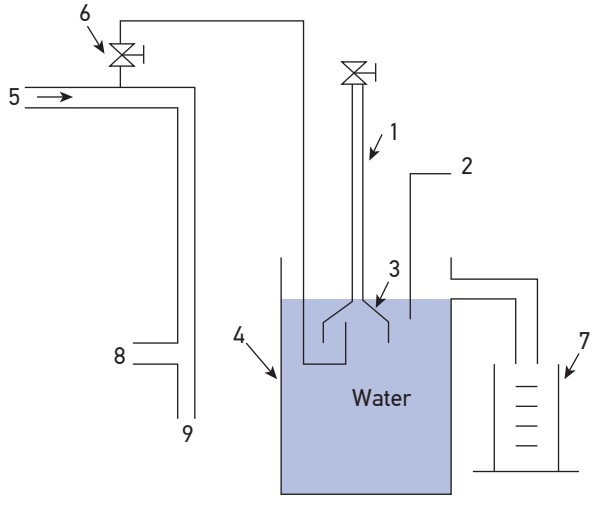
Figure 2. Venturi Vacuum System.

which will require a longer drying time, with a consequent increase in water consumption.

The detection of the presence of non-condensable gases requires the installation of an evaluation system, detailed in the European standard EN285:2009[7] (Figure 3).

Some autoclave models have already incorporated systems that remove non-condensable gases, known as degassers, which are installed in the water supply line before the steam generator inlet.

As shown above, a critical factor in sterilization by saturated steam under pressure is the level of water contaminants to generate steam. As all technical and legal references indicate this responsibility to the manufacturer, it has become common sense to recommend the use of a reverse osmosis-type water treatment system, which is capable of removing from 90 to 99% of particles, organic matter, and microorganisms in only one processing[8]. However, the adoption of this system is based only on the final quality of the water, and the actual levels of contaminants in the inlet water and the negative impact that such a system generates on water consumption are not observed, as for each liter of high-quality water generated, 60–90% of the same volume is discarded as waste from the system. Theoretically, the purer the inlet water in the reverse osmosis system, the greater the water savings, which justifies the pretreatment of the water.



1: 50 mL Burette; 2: Temperature measurement system; 3: Funnel with parallel sides; 4: 2000 mL vial; 5: Steam supply inlet; 6: Needle valve; 7: 250 mL graduated cylinder; 8: For the sterilizer; 9: For the purge system. Source: Adapted and translated from the EN285:2009[7] technical standard.

Figure 3. System for evaluating the concentration of non-condensable gases in the steam.

Before adopting a water treatment system, it is important to analyze the quality of the water supplied to the autoclave and compare it with the water quality table required for the steam generator feed, contained in the ABNT NBR ISO 17665-2:2013 standard[9]. Based on the result of this analysis, a water treatment system should be scaled.

It should be noted that the water used to generate the steam is different from the water used in the seal of the vacuum pump or the Venturi system. The quality of the water that will generate the steam is controlled, as it directly impacts the quality of the sterilization. Thus, the use of purified water is required. However, the quality of the water used in the vacuum pump seal does not interfere with sterilization, which may only be potable or according to the manufacturer's guidelines.

Another relevant aspect in the conditioning phase is the removal of air from the chamber. The first vacuum pulse is the most time consuming due to the large amount of air in the inner chamber. If the load is too thick or compressed, more time will be required to force the air out of the load, with increased demand for the vacuum system.

Immediately after the first vacuum pulse, steam enters the inner chamber, which will condense on contact with the products, thus heating them. If the medical device is too thick, the condensate volume will be larger, and the second vacuum pulse will be more time consuming due to vaporization of the excess condensate.

That said, measures aimed at reducing the formation of condensate should be implemented, since, by reducing the formation of condensate, there will be less use of the system, with consequent reduction of water consumption.

In the drying phase, all remaining condensates need to be vaporized. The vacuum pump plays a key role in this phase because by reducing the pressure in the inner chamber, a part of the condensate is vaporized as the pressure decreases to the minimum limit established by the manufacturer. Then the process is a bit more time consuming due to the need for other energy sources, such as the residual heat of the sterilized product, thermal radiation from the walls of the inner chamber or conduction of heat with other gases from the chamber. These processes are relatively slow due to the inefficiency of thermal transfer under vacuum[9]. The fraction of the mass of condensate remaining after the rapid vaporization afforded by the initial vacuum curve in the initial drying phase is given by the Equation 1[10]:

$$x = \frac{u_{ini} - h_g}{u_{final} - h_g} \quad (1)$$

In which
x = fraction of the mass of liquid remaining after reaching the vacuum level;
u_{ini} = internal energy of the saturated liquid at the end of the sterilization phase;
u_{final} = internal energy of the saturated liquid at the maximum vacuum level;
h_g = mean enthalpy of saturated steam during the drying phase (mean enthalpy at the end of the sterilization phase and at the maximum vacuum level).

Currently, in identifying wet packs, the solution commonly adopted by professionals is to increase the drying time. This solution is not the most suitable, as one must first observe whether the vacuum plateau is correctly configured per the minimum limit established by the manufacturer. Otherwise, the drying time should be longer to achieve the expected result, which implies higher water consumption. For every minute with the vacuum pump or Venturi system working, the water consumption will be between 10 and 20 L per minute, depending on the equipment and the model.

The adjustments in equipment for product drying need to be reviewed based on the operating mechanics, since the drying efficiency is not tied to the time, but to the depth of the vacuum, in which the technical argument must be to increase the depth of the vacuum instead of increasing the time. The efficiency of the vacuum system is also increased by reducing the temperature of the water passing through the vacuum pump. In countries that adopt EN285:2009[7], the maximum water temperature should be 15°C, because the viscosity of the water interferes with the performance of vacuum pumps.

Following the recommendations presented, users who work with a drying time of more than 15 minutes will have a significant reduction in water consumption. In addition to the depth of the vacuum, there are other measures to avoid wet packs and consequent increase in drying time, such as the placement of concave–convex conformation products in vertical or inclined position[11], which prevents condensation from forming in the concavity and facilitates drying, reducing the use of the vacuum pump; use of boxes that do not exceed 11.5 kg, since the excess weight makes drying difficult[12]; and use of sterile barrier systems, perforated boxes and vapor-permeable instrument holders[12], which will consequently facilitate drying. It should be noted that the drying process of products made from polymers will be longer because they do not have the same heat conduction properties as metallic ones such as stainless steel and anodized aluminum.

For the reduction of the use of the vacuum system, the equipment must be kept in optimum operating conditions. Thus, it is necessary to investigate the possible clogging of the drainage channel[12] and proper dimensioning of the steam trap[13].

CONCLUSION

The reduction of water consumption can be achieved by measures such as preferential acquisition of equipment with water-free pumps, shut-off of the steam generator when equipment is not in use, use of equipment with built-in degassers, assembly of the load in order to facilitate vapor penetration and reduce drying time, vacuum depth adjustment to reduce the use time of the vacuum pump, and preventive maintenance of steam traps. In addition, the use of pretreatment systems can reduce waste in reverse osmosis water treatment systems for steam generation.

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