FACILITIES AND DIFFICULTIES OF THE ONLINE TEACHING-LEARNING PROCESS OF PERIOPERATIVE NURSING IN THE COVID-19 PANDEMIC CONTEXT

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The global scenario established by the Coronavirus Disease (COVID-19) required society to change habits, needs, and perceptions due to the pandemic. In this context, these demands also occurred in the adapted teaching-learning process in nursing education.

Managers of higher education institutions (HEIs) and nursing professors adopted challenging strategies in the process of teaching nursing through information and communication technologies (ICT), tools rarely used prior to the pandemic, considering that students must learn in relational processes of "people taking care of people."

Faced with so many uncertainties, emergency remote / online teaching was introduced as an alternative, aiming to reduce the damage to learning and ensure the continuity of the training process of the sought-after professionals in the pandemic care scenario.

A study pointed out that the imposition of online education sets limitations to older students, those who live in rural areas, those with professional and family responsibilities, and students with limited electronic resources, as online education goes beyond the continuation of in-person classes[1].

Another research showed that students, as well as professors, had to adapt to a routine at home, even with the maintenance of days and shifts already planned prior to the pandemic period. This is because family members, overall, have also been developing remote activities, whether concerning work (home office) or related to kindergarten, elementary, secondary, and higher education. In addition, there are household chores and the need to deal with the full-time presence of children in the home space, which is also a distractive factor for learning[2].

Long-standing challenges have emerged with the pandemic. For many professors and students, the use of new technologies was another barrier to be overcome, in addition to other adversities caused by the pandemic.

Although these difficulties have been faced with courage and commitment, it is worth reflecting on how our university classes were before the pandemic. Were practice scenarios actually used? Did the professors provide updates in their field of knowledge? Did the in-person teaching really bring students and professors closer? How can the use of technology in education be an ally? Even though technologies in teaching have been absorbed, it is necessary to reflect on the pedagogical approach provided by the teacher, and not only technology itself. It must be understood that technology is not a self-sufficient tool; its pure and simple application will not solve all the problems inherent in teaching[3].

Currently, the teaching provided in 2020 has been under evaluation, retrieving possible damage to students regarding content, restructuring, replacement of practical activities, and continuing education of teachers to improve the use of ICT.

To date, a scenario of great transformations persists, with the permanence of contemporary technologies in the education of perioperative nursing in different levels: undergraduate and graduate programs, continuing education in health institutions, associations, and class councils.

Increasingly, the world of work pressures the nursing services, seeking competent professionals to take over the several fields of activity in the perioperative period. Thus, the responsibility for training and preparing these professionals cannot be disregarded, even in a challenging moment like this. What is envisioned for nursing education is the emergence of interface technologies that articulate the physical and the digital environments and also expand the debate, the exchange of experiences, interaction, reflection, and critical thinking[4].

The educational adaptations due to the pandemic were relevant to the continuity of academic education; however, in courses such as nursing, resources that ensure interaction between people should not be disregarded. This is because the profession is imbued with a practical character, as it deals with the health-disease process and requires

the development and/or improvement of specific skills for providing care[4,5].

In post-pandemic times, one must remember that nursing care is essential and carried out in-person. Thus, the education of professionals to take care of human lives must be developed and based on this precept.

Everyone has a role to play in advocating for the health of our communities and supporting nurses everywhere. Amidst all the uncertainties about the virus and how long it may take for life to return to a "new normal," the training of nursing professionals will gain new educational technologies, and these professionals will become stronger and better prepared to face new challenges.

Simone Garcia Lopes

Doctoral student at the Graduate Program in Adult Health Nursing (PROESA) of the School of Nursing, Universidade de São Paulo (EEUSP). Professor of the Undergraduate Program in Nursing at Centro Universitário Faculdade de Medicina ABC (FMABC) and Director of Assistance at SOBECC Nacional (2019-2021 administration).

Soraya Palazzo

Master in Adult Health from EEUSP. Coordinator of Graduate Nursing Programs in Sterile Processing Department, Surgical Center, and Anesthetic Recovery and Multiprofessional Graduate Program in Oncology at Centro Universitário São Camilo and Director of Regional Events at SOBECC Nacional (2019-2021 administration).

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PREVALENCE OF SUSPENSION OF ELECTIVE SURGERIES IN A PUBLIC HOSPITAL IN SOUTH BRAZIL

Prevalência de suspensões cirúrgicas eletivas em um hospital público do sul do Brasil

Prevalencia de suspensiones quirúrgicas electivas en un hospital público del sur de Brasil

Luana Maria dos Santos Machado[1], Keyla Cristiane do Nascimento[2*], Ana Graziela Alvarez[3], Neide da Silva Knihs[4], Luciara Fabiane Sebold[5], Daiana Cesconetto[6]

ABSTRACT: Objective: To characterize the prevalence and causes of suspension of elective surgeries considering clinical and non-clinical factors. **Method:** Exploratory, retrospective, quantitative study. Data were collected in the electronic database of a public hospital in southern Brazil between January 2018 and December 2019. The variables gender, age group, number of surgeries, medical specialty and reasons for suspending surgeries were assessed, and a descriptive statistical analysis was performed. **Results:** Of the 11,792 (100.0%) scheduled surgeries, 2,170 (18.4%) were suspended. The surgical specialties that most suspended surgeries were orthopedics (32.6%) and general surgery (19.0%), the main non-clinical factors being: priority for urgency (21.5%), lack of vacancy in the intensive care unit (15.6%) and no attendance of the patient (13.6%). The main clinical reason for surgical suspension was clinical unfavorable condition (8.7%). **Conclusion:** This study contributed to the assessment of quality indicators related to the scheduling and suspension of surgical procedures in the Surgical Center, in addition to providing opportunities for the creation of clinic continuous improvement.

Keywords: Elective surgical procedures. Surgery department, hospital. Hospitals, public. Health evaluation. Surgicenters.

RESUMO: Objetivo: Caracterizar a prevalência e as causas de suspensão das cirurgias eletivas considerando determinantes clínicos e não clínicos. **Método:** Estudo exploratório, retrospectivo, quantitativo. A coleta de dados foi realizada no banco eletrônico de um hospital público do Sul do Brasil, no período entre janeiro de 2018 e dezembro de 2019. Consideraram-se as variáveis sexo, faixa etária, quantitativo de cirurgias, especialidade médica e motivos da suspensão das cirurgias e realizou-se análise estatística descritiva. **Resultados:** Das 11.792 (100,0%) cirurgias programadas, 2.170 (18,4%) foram suspensas. As especialidades cirúrgicas com maior taxa de suspensão foram ortopedia (32,6%) e cirurgia geral (19,0%), tendo como principais motivos não clínicos: prioridade para urgência (21,5%), falta de vaga em unidade terapia intensiva (15,6%) e não comparecimento do paciente (13,6%). O principal motivo clínico de suspensão cirúrgica foi condição clínica desfavorável (8,7%). **Conclusão:** O estudo contribuiu para a avaliação dos indicadores de qualidade relacionados aos agendamentos e às suspensões cirúrgicas no Centro Cirúrgico, além de oportunizar a criação de estratégias de melhoria contínua.

Palavras-chave: Procedimentos cirúrgicos eletivos. Centro cirúrgico hospitalar. Hospitais públicos. Avaliação em saúde. Centros cirúrgicos.

RESUMEN: Objetivo: Caracterizar la prevalencia y causas de suspensión de cirugías electivas considerando determinantes clínicos y no clínicos. **Método:** Estudio exploratorio, retrospectivo, cuantitativo. La recolección de datos se realizó en la base de datos electrónica de un hospital público del sur de Brasil, de enero de 2018 a diciembre de 2019. Se realizaron las variables sexo, edad, número de cirugías, especialidad médica y motivos de suspensión de cirugías y análisis estadístico descriptivo. **Resultados:** De las 11.792 (100,0%) cirugías programadas, 2.170 (18,4%) fueron suspendidas.

[1]Nurse from Universidade Federal de Santa Catarina (UFSC) – Florianópolis (SC), Brazil.
[2]PhD in Nursing from UFSC. Professor of the Department of Nursing at UFSC – Florianópolis (SC), Brazil.
[3]PhD in Nursing from UFSC. Professor of the Department of Nursing at UFSC – Florianópolis (SC), Brazil.
[4]PhD in Nursing from Universidade Federal de São Paulo. Professor of the Department of Nursing at UFSC – Florianópolis (SC), Brazil.
[5]PhD in Nursing from UFSC. Professor of the Department of Nursing of the Postgraduate Program in Nursing Care Management at UFSC – Florianópolis (SC), Brazil.
[6]Master of nursing from UFSC. Nurse at the State Health Department of Santa Catarina. Surgical Center Coordinator at Hospital Governador Celso Ramos – Florianópolis (SC), Brazil.
*Corresponding author: keyla.n@ufsc.br
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Las especialidades quirúrgicas con mayor tasa de suspensión fueron Ortopedia (32,6%) y Cirugía general (19,0%), con las principales razones no clínicas: prioridad por urgencia (21,5%), falta de espacio en la unidad de cuidados intensivos (15,6%) y no asistencia de pacientes (13,6%). El principal motivo clínico de la interrupción quirúrgica fue una situación clínica desfavorable (8,7%). **Conclusión:** El estudio contribuyó a la evaluación de indicadores de calidad relacionados con la programación y suspensiones quirúrgicas en el Centro Quirúrgico, además de brindar oportunidades para la creación de estrategias de mejora continua.

Palabras clave: Procedimientos quirúrgicos electivos. Servicio de cirugía en hospital. Hospitales públicos. Evaluación en salud. Centros quirúrgicos.

INTRODUCTION

Organization and planning are essential steps to ensure the proper functioning of a surgical center (SC), since it involves a large number of professionals, materials and equipment. In general, the number of scheduled and suspended surgeries is related to productivity and patient safety, and constitutes an important quality indicator[1]. Surgical suspension refers to any surgical procedure scheduled in the SC's elective surgery list on the day before, but not performed according to the schedule[2].

The costs of surgical procedures correspond to 40% of the total expenses of a hospital[3], and surgical suspension reduces the efficiency of the SC, incurring in significant financial losses with an impact on the patient and on team management[2,4]. Due to the high costs of the SC when performing surgical procedures, hospital managers have been paying greater attention to surgery suspension rates with the objective to reduce them, considering that 60 to 80% of suspensions have avoidable causes[3,5-7].

In order for the rate of suspension of elective surgeries to be reliable, one must correctly notify the cause with view to the involvement and awareness of the teams in reducing rates and assisting managers in planning strategies to improve the indicator to achieve ever lower rates, with a focus on improving quality of patient care[6,8].

Among the recommendations proposed to reduce surgical suspensions, we highlight the tracking and investigation of reasons for suspension, improvements in the planning of future surgeries and communication between the institution and patients, in addition to monitoring indicators[8,9]. The detailed record by professionals involved in the suspension is essential, as well as constant awareness and continuing education activities[1,4,8,9].

In this scenario, the nurse, a protagonist in the SC, has been instrumentalized in structural organizations to organize and plan such work environments, committed to keeping the team always aware of the importance of reducing suspension rates[8]. It is up to the nurse to use the information about indicators and the relation of direct costs to manage the SC and develop strategies to solve the problem[3,5].

OBJECTIVE

To characterize the prevalence and causes of suspension of elective surgeries, considering clinical and non-clinical determinants.

METHOD

Retrospective, descriptive study with a quantitative approach, carried out in a public hospital in Florianópolis, state of Santa Catarina, southern Brazil.

The hospital provides tertiary care to users of the Brazilian Unified Health System, directed to surgeries. The hospital has 224 beds, the SC has seven operating rooms (OR) and eight post-anesthetic recovery rooms (PAR), in which an average of 400 surgeries/month are performed.

Data collection took place from February to April 2020, using secondary data obtained from the Micromed® database, a system used by the State Health Department to keep the record of elective surgeries and suspensions in the studied period: January 1, 2018 to December 31, 2019.

The criteria for inclusion of records were elective surgeries scheduled and/or canceled in the Micromed® database in the period studied. Urgency and emergency surgery records were excluded.

Data was collected by the researchers from February to April 2020, with their own instruments addressing the variables: quantity of scheduled, performed and suspended surgeries, date of suspension, patient age and gender, medical specialty, determinants of cancellation for clinical and non-clinical reasons, and professional responsible for cancellation.

Among the clinical reasons, we had: upper airway infection, hyperthermia, pneumonia, productive cough, drop in oxygen saturation, urinary tract infection, fasting, lack of preoperative examination (laboratory, imaging), among others. Non-clinical reasons included: refusal by the patient or guardian, lack of equipment or material, instruments, medication, orthosis and prosthesis, error in surgical programming, medical criteria, delay in releasing the operating room and change of medical conduct[8].

To organize data, a spreadsheet was created in the Excel® software for tabulation and simple descriptive analysis of variables (frequencies, percentages) and the results were presented in tables.

The study complied with Resolution nº 466/2012 and was approved by the Ethics Committee for Research on Human Beings of Universidade Federal de Santa Catarina, under opinion 3.701.031 and Certificate of Presentation for Ethical Appreciation (CAAE) 96646018.0.0000.0121.

RESULTS

Of the total 11,792 elective surgeries scheduled in the study period, 9,622 (81.6%) were performed and 2,170 (18.4%) were suspended. Of suspensions, 189 (8.7%) occurred for patient's clinical reasons and 1,981 (91.3%) for non-clinical reasons. Regarding gender, the distribution of suspensions was 1,313 (60.5%) for male patients and 857 (39.5%) for females.

The summary of data related to surgical suspension is presented by medical specialty and patient gender in Table 1. It is noteworthy that the medical specialties of orthopedics, general surgery, urology and neurology account for more than half the proportion of suspensions.

There was a predominance of surgical suspensions in the age group between 19 and 59 years (1,452/ 66.9%), followed by 60 years or more (695/ 32.0%) and 15 to 18 years (23/ 1.1%). Table 2 shows the distribution of age groups in the four medical specialties that prevailed in surgical suspensions.

Findings relating to the causes of surgical suspension, according to clinical (representing unfavorable clinical conditions) and non-clinical reasons, are presented in Table 3.

Regarding the frequency distribution of surgical suspensions per month and year, a higher incidence was identified in planned surgeries in April (194/ 17.0%), May (182/ 16.0%) and June (115/ 10.1%) of 2018, and in September (122/ 11.8%), May (116/ 11.3%) and October (107/ 10.4%) of 2019.

The professionals responsible for the suspensions, keeping record of justification, were surgeons (939/ 43.3%), nurses (192/ 8.9%) and anesthesiologists (140/ 6.5%). In 487 (22.4%) suspensions, the professional responsible for it was not specified.

Table 1. Suspension of elective surgeries according to medical specialty and patient gender.

Medical specialty	Female n	%	Male n	%	Total n	%
Orthopedics	241	11.1	467	21.5	708	32.6
General surgery	238	10.9	175	8.1	413	19.0
Urology	72	3.3	264	12.2	336	15.5
Neurology	169	7.8	148	6.9	317	14.6
Spine	21	01	78	3.6	99	4.6
Otolaryngology	40	1.8	45	2.1	85	3.9
Plastic surgery	13	0.6	47	2.1	60	2.8
Bucco maxillary	16	0.7	28	1.3	44	2.0
Vascular	17	0.8	26	1.2	43	2.0
Head and neck	19	0.9	19	0.9	38	1.7
Thoracic surgery	09	0.4	14	0.6	23	1.0
Anesthesiology	01	0.05	01	0.05	02	0.1
Ophthalmology	-	-	01	0.05	01	0.05
Proctology	01	0.05	-	-	01	0.05
Total	**857**	**39.5**	**1,313**	**60.5**	**2,170**	**100**

DISCUSSION

According to national studies[5,8], surgical suspension rates range from 6.8 to 33.8%, while international rates[4,10,11] range from 3.5 to 31.6%, being higher in developing countries. The study found a rate of suspension of elective surgeries of 18.4%. This data alone has great value for the institution's managers, enabling an analysis of surgical cancellation indicators followed by strategic planning for improvements.

Suspensions occurring on the date of the surgical intervention generate hospital expenses, a problem reflected by the waste of human and instrumental resources and specific surgical materials, among others, causing a deficiency in the process and affecting the management of the SC. They also result in the need for overtime and expansion of teams, delays in other surgeries, increased patient stay rate, increased risk of infection, among others[5,12].

In the present study, the specialties that most contributed to the increase in surgical suspension were orthopedics, general surgery and urology, similar to the findings of a study also carried out in the South of the country[6]. These data refer to the profile of the institution being studied, a reference in trauma care where patients are often referred for orthopedic surgical interventions.

A study carried out in a teaching hospital in northeastern Brazil, in Aracaju (Sergipe)[3], had a suspension rate of 19.5%, with pediatrics (26.8%) and oncology (14.4%) and general surgery (13.1%) as the specialties that most suspended procedures. The reasons for suspensions were related to institutional conditions (50.8%), the patient (22.4%) and clinical conditions (20.8%). In Beirut, Lebanon, the surgical suspension rate in a university hospital was 4.4%, and, of these suspensions, 71.6% would be preventable[13], the causes being related to lack of medical examinations (32.6%), resource/facility (19.9%), admission (19.2%), reasons related to the patient (17.6%), availability of bed (8%) and decision of the team/surgeon (2.7%)[13].

Table 3. Reasons for suspension of elective surgeries.

Reasons for suspension of elective surgeries	n	%
Clinical reasons		
Unfavorable clinical condition	139	6.4
Lack of preoperative exams	34	1.6
Incomplete fasting	16	0.7
Non-clinical reasons		
Priority for urgency	467	21.5
No vacancy in the intensive care unit	339	15.6
Others or unspecified	304	14.0
Patient did not attend	296	13.6
Delay in previous surgery	114	5.2
Surgery dependent of time or room	91	4.2
Surgery performed previously	85	3.9
Lack of materials	51	2.3
No hospital bed	35	1.6
Problem or defect in hospital infrastructure	31	1.4
No operating room available	29	1.3
Transfer to another hospital	28	1.3
Problem or defect in surgical material	25	1.1
Patient not found	24	1.1
Problem or defect in equipment	14	0.6
Surgeon could not be at the SC	13	0.6
Transfer of date upon medical request	11	0.5
Lack of other professionals	8	0.4
Duplicate patient record	4	0.2
Obit	4	0.2
Inadequate or incomplete surgical preparation	3	0.1
Lack of blood products	2	0.1
Patient does not accept blood reserve	2	0.1
Refusal by the patient or family member	1	0.05
Total	**2,170**	**100**

Table 2. Surgery suspensions by patient age* in the four predominant medical specialties.

Medical specialty	Age group					
	15-18 years		19-59 years		60 or more	
	n	%	n	%	n	%
Orthopedics	8	0.4	550	25.3	150	6.9
General surgery	1	0.05	262	12.1	150	6.9
Urology	4	0.2	172	7.9	160	7.4
Neurology	3	0.1	212	9.8	102	4.7

*Categorization of age group according to the Child and Adolescent Statute and the Elderly Statute.

Suspension rates and their causes are usually different between hospitals both nationally and internationally, and are considered undesirable effects of underlying reasons, generating limitation in the surgical service, planning failures in administration and ineffective SC management[9,14]. As for hospital management, especially the SC units, corrective actions dedicated to reducing surgical suspension rates, in addition to serving as a theoretical support for the construction of more solid parameters for the interpretation of indicators in question, can most often avoid the suspensions[6,9,14].

With regard to gender, there was a predominance of surgical suspensions among male patients. This finding is similar to that of two international studies, in which surgical cancellations had a higher incidence among men, with percentages of 56.8[10] and 75.1%[14]. Adults aged 19 to 59 years were the most affected by surgical suspensions, followed by the elderly. These results are in agreement with the study carried out in Bogotá, Colombia[15], in which the most affected age group was 21 to 45 years old (46%). However, other studies[8,16] indicate different results, with patients of all age groups (children and the elderly) identified as the most affected by surgical suspensions, depending on the stratification of the study or the profile of the operating room.

The main determinants of surgical suspensions do not differ from those found in other hospital services in emerging countries. Most suspensions occurred for reasons unrelated to the patient, that is, linked to the organization and surgical planning, which contributes to a negative assessment of this quality indicator[13].

Of suspended surgeries, in the surgical unit locus of the study, cancellations for non-clinical reasons prevailed, justified by the priority given to urgencies and the lack of vacancies in intensive care. This hospital performs a significant number of surgeries involving multisystem trauma, as it is one of the largest units in the public health network in Santa Catarina and because it offers a complex urgent/emergency service considered reference in the care of multiple trauma patients and in neurosurgery. For this reason, there is a strong justification for surgical suspension to prioritize urgency surgeries.

Regarding suspensions due to no vacancy in the intensive care unit, this unit receives patients with continuous monitoring needs for early identification of complications and adoption of necessary support measures to preserve their lives[17]. For this reason, unavailability in intensive care is an important factor for patient safety and justifies surgical cancellation. However, this must be previously evaluated to avoid routine suspensions. That is, the absence of beds for critically ill patients requires an investigation of demand, better sizing and turnover in bed management.

Corroborating the findings of our study, a survey carried out in Recife, capital of Pernambuco[18], pointed out among the main causes of surgical suspensions for non-clinical reasons the lack of human resources (63.5%), specifically anesthesiologists and surgeons, and the organization of the unit (11.3%), highlighting errors in surgical programming (31%) and lack of beds available in intensive care (26.7%). Problems related to the patient (16.5%) also led to a significant portion of cancellations, including unfavorable clinical conditions (57.1%) and non-attendance (26.3%). A cohort study performed in the United Kingdom with 245 hospitals analyzed data from 14,936 patients undergoing elective surgery and reported 33.3% of suspensions due to patient-related factors such as change in clinical condition and unavailability of beds[19].

In national studies[5,6,8], there is a predominance of non-clinical reasons for the suspension of surgeries related to the institution, administration and/or professionals, while international studies indicate reasons related to the patient and their unfavorable clinic condition as the main cause of suspensions[11-13].

Regarding seasonality, the frequency of suspension was higher between April, May and June 2018 and in May, September and October 2019. The year 2018 had higher suspension rates. This scenario may be associated with the recent deployment of the system used: Micromed. Other points that influence the increase in surgical suspensions are employee strikes, lack of human resources and changes in the SC[5] management. However, seasonality did not interfere with surgical suspensions, as there was no trend of decreasing suspensions related to variations at regular and specific intervals.

The professionals who most suspended surgeries were surgeons, followed by nurses and anesthesiologists. This result is similar to that of a study carried out in a public university hospital located in the countryside of São Paulo[16], which had surgeons (39.7%) as responsible for suspensions, followed by anesthesiologists (22.0%) and nurses (4.6%). Professionals responsible for surgical suspension may be surgeons (change of conduct and a more severe patient in need of a surgery), anesthesiologists (lack of exams and clinical change), nurses (lack of materials or personnel, or a situation exceeding pre-established time), or the patient, when they give up on the surgery[16,20].

The suspension of elective surgeries in a hospital institution acts as an indicator of the quality and productivity of the actions developed by the SC, reinforcing the need for planning and reducing avoidable costs[6,9]. Although the causes of surgical cancellation are varied, this is frequently experienced in hospitals, especially in public institutions, due to deficiencies in their physical structure[16,21]. Nevertheless, it is important to

state that the causes related to lack of time, no vacancy in the intensive care unit, inversion of order of surgeries, error in surgical schedule, lack of exams and/or documents and lack of equipment are very likely products of the troubled dynamics commonly experienced in public hospitals[6].

The absence of justification for canceling the surgery due to incomplete registration, as well as the use of secondary data, makes it difficult to analyze the context, as unavailability of information is one of the limitations of this study and suggest the need for training and awareness of professionals about a comprehensive filling in the system. It is important that prospective studies addressing this issue are carried out, as well as research and interventions that assess measures adopted and their impact on the percentages of suspensions.

The main contribution of this study was to show that most determinants of surgical suspensions are considered avoidable, so reducing them for a better use of public resources is possible. This includes improvements to the SC infrastructure, protocols for preoperative assessment and preparation, communication with the patient, professionals and across health care sectors. Given the scenario presented, the role of the nurse, as a unit manager, is to develop strategies with their work team to improve this picture, given that the suspension of surgeries, in addition to burdening the health system, causes stress, anxiety and discomfort especially for the patient and their family members, who are awaiting the procedure.

Thus, it is recommended that nurse managers of the SC outline improvement strategies based on quality standards, such as conducting a preoperative visit by the nurse, improving communication between patients and professionals (fasting guidelines, preparation and preoperative exams), in addition to establishing measures to reduce the causes of surgical suspension related to the organization of the unit, human resources, materials and equipment, outlining goals to be achieved.

Considering that many of surgical suspensions are related to structural problems and situations that involve the team, the nurse as a manager of the surgical environment should carefully assess each situation and identify opportunities for improvement in each situation presented.

Based on these data, a possible strategy would be to include measures to strengthen the patient safety culture among the hospital's management team to encourage changes in group and individual values, attitudes, perceptions and competencies, involving the whole team and hospital management while providing opportunities for behavioral changes and adjustments in work processes with focus on quality of care.

CONCLUSION

The research allowed for a situation analysis of the main factors leading to suspension of surgeries in a public hospital, most of them being related to administrative problems. In this way, it was possible to evaluate the assistance provided and adapt the work process to the needs of patients and the SC.

The overall suspension rate found in the study (18.4%) had, among the main determinants, the priority of other more urgent surgeries, lack of intensive care beds and patient absence, being more frequently determined by orthopedics and general surgery surgeons.

Identifying the prevalence and determinants of surgery suspensions in a state public hospital contributed to assessing the quality indicators of appointments and suspension of elective surgeries and to the establishment of continuous improvement actions.

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MEDICAL WASTE IN THE SURGICAL CENTER: ADJUSTMENTS WITH COST MEASUREMENT

Resíduos de serviços de saúde em centro cirúrgico: adequações com mensuração do custo

Residuos de servicios de salud en centros quirúrgicos: adaptaciones con medición de costos

Giovana Alves Santos[1]*, Magda Lúcia Félix de Oliveira[2], Danielly Negrão Guassu Nogueira[3]

ABSTRACT: Objective: To identify the cost of the necessary adjustments to a surgical center so that it meets the current Brazilian legislation, which provides for medical waste. **Method:** Exploratory, descriptive research with a quantitative approach in the modality of case study of the surgical center of a public university hospital. In the protocol, a documental research was applied, through a check-list comparing the current Brazilian legislation with the reality found, mapping the process with the technique of the flowchart map. The average direct cost was used as a costing method. **Results:** There was an average direct cost of R$ 7,891.25 for the hospital to fully comply with the Brazilian legislation on healthcare waste, with infrastructure adjustments and long-term acquisitions and an additional monthly cost of R$ 542.38. **Conclusion:** For all groups of waste from health services in the surgical center under study, adjustments are needed in order to comply with the legislation, as well as the articulation of the various managers involved in the management and measurement of costs related to waste to optimize economic results in health.

Keywords: Costs and cost analysis. Surgicenters. Legislation. Medical waste.

RESUMO: Objetivo: Identificar o custo das adequações necessárias a um centro cirúrgico para que este atenda à legislação brasileira vigente, que dispõe sobre resíduos de serviços de saúde. **Método:** Pesquisa exploratória, descritiva, de abordagem quantitativa na modalidade de estudo de caso do centro cirúrgico de um hospital universitário público. No protocolo, foi aplicada uma pesquisa documental, por meio de um *check-list* comparando a legislação brasileira vigente com a realidade encontrada, mapeou-se o processo com a técnica do mapa-fluxograma. Utilizou-se como método de custeio o custo direto médio. **Resultados:** Verificou-se o custo direto médio de R$ 7.891,25 para o hospital atender integralmente à legislação brasileira de resíduos de serviços de saúde, com adequações de infraestrutura e aquisições de longa permanência e um adicional no custo mensal de R$ 542,38. **Conclusão:** Para todos os grupos de resíduos de serviços de saúde do centro cirúrgico em estudo, são necessárias adequações a fim de atender à legislação, bem como articulação dos diversos gestores envolvidos no manejo e na mensuração dos custos relacionados aos resíduos para otimização de resultados econômicos em saúde.

Palavras-chave: Custos e análise de custo. Centros cirúrgicos. Legislação. Resíduos de serviços de saúde.

RESUMEN: Objetivo: Identificar el costo de los ajustes necesarios a un Centro Quirúrgico (CQ), para que cumpla con la legislación brasileña vigente que prevé Residuos de Servicios de Salud (RSS). **Método:** Investigación exploratoria descriptiva con abordaje cuantitativo en la modalidad de estudio de caso de un CQ en un Hospital Universitario Público. En el protocolo se aplicó investigación documental, a través de un *checklist* de la legislación brasileña vigente con la realidad encontrada, se mapeó el proceso mediante la técnica de diagrama de flujo-mapa. Se utilizó el costo directo promedio como método de cálculo de costos. **Resultados:** Hubo un costo directo promedio de R$ 7.891,25 para que el hospital cumpliera plenamente con la legislación brasileña sobre RSS, con ajustes de infraestructura y adquisiciones de largo plazo y un costo mensual adicional de R$ 542,38. **Conclusión:** Para todos los grupos RSS del CQ en estudio, se necesitan ajustes para cumplir con la legislación. Existe la necesidad de articulación entre los distintos gestores involucrados en la gestión, medición de costos relacionados con los residuos para optimizar los resultados económicos en salud.

Palabras clave: Costos y análisis de costo. Centros quirúrgicos. Legislación. Residuos sanitarios.

[1]Master's Student of the Postgraduate Program in Nursing at Universidade Estadual de Maringá (UEM) – Maringá (PR), Brazil.
[2]PhD in Public Health by Universidade Estadual de Campinas. Professor at the Nursing Department at UEM – Maringá (PR), Brazil.
[3]PhD in Nursing Management from the School of Nursing at Universidade de São Paulo. Professor at the Nursing Department at Universidade Estadual de Londrina – Londrina (PR), Brazil.
*Corresponding author: giovanaalvessantos@yahoo.com
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INTRODUCTION

Medical waste (MW) has generated wide discussion in recent decades among health service managers, especially with regard to hospitals, their largest generators. There are legal responsibilities related to environmental, social, and health aspects, which implies the need for safe management at all stages of the handling of MW, starting with the classification of these residues in hospitals. The conscientious use of materials should be encouraged, avoiding waste and excessive expenses, thus contributing to sustainable and economic development.

Due to the need to regulate and improve the disposal of these materials, Resolution of the Collegiate Board of Directors (*Resolução da Diretoria Colegiada* – RDC) No. 222/2018 was approved, replacing RDC No. 306/2004, which was in force for 14 years. RDC No. 222/2018 has new guidelines to be implemented, with new procedures and criteria. Thus, health services need to readjust their Waste Management Plan (WMP)[1,2], also taking into account the Brazilian Standard (*Norma Brasileira* – NBR) 7500 and Ordinance No. 344/98[3,4].

RDC No. 222, of March 28th, 2018, provides for good practices for managing MW and the importance of occupational safety. It contains the classification of MW into: Group A (infective, which is divided into five subgroups: A1, A2, A3, A4, and A5), Group B (chemical), Group C (radioactive waste), Group D (common recyclable and non-recyclable), and Group E (sharps)[1].

MW management comprises planned and implemented actions based on current Brazilian legislation. This management includes the following steps: segregation, identification, packaging, collection, internal and external transport, temporary and external storage, treatment, and final disposal[5].

In the hospital context, the surgical center (SC) is classified as a sector with restricted access, which has its specificities both in material and human resources. Due to the diversity of surgeries performed, this sector has a multidisciplinary team[6], is a great consumer of material resources[7] and, consequently, a great generator of hospital waste.

In view of the classification of MW generated in the SC, a study showed that, of the total waste, 50.62% belonged to the infective and sharp waste group (Group A + Group E), 28.50% to non-recyclable waste (Group D), 19.26% to recyclables (Group D), and 1.64% to Group B[8].

WMP should estimate the amount of waste that will be generated and, if possible, consider local reverse logistics methods to dispose of it, thus encouraging local social initiatives[1,9].

Therefore, an adequate approach to MW is necessary, in order to minimize environmental impact. Even with current legislation, there is still no compliance with these in its entirety by some health services. With this, the promotion of continuing education measures regarding waste is paramount[10].

This study was justified by the change in legislation on waste that took place in 2018. Therefore, it is necessary to identify the changes in legislation so that health services can adapt to the one concerning hospital waste in Brazil.

OBJECTIVE

To identify the cost of the necessary adjustments to a surgical center so that it meets the current Brazilian legislation on medical waste.

METHOD

This is an exploratory, descriptive research with a quantitative approach, in the form of a case study. The study was carried out at the SC of the University Hospital of Universidade Estadual de Londrina (HU/UEL), a supplementary body of the institution[11].

The SC observed has seven operating rooms, a post-anesthesia care unit (PACU), support areas such as a locker room, satellite pharmacy, pantry, equipment storage room, administrative area, and medical rest area.

The case study becomes relevant when research questions require a broad and deep description of some phenomenon, problem or real situation, that is, it seeks to explain some present circumstance, the how or why of this phenomenon. It is a contemporary investigation within a real context, which is not clearly defined, and adopts multiple sources of evidence without the use of manipulation or control[12].

In turn, the case study aims to answer practical questions, bringing solutions to problems. The collection and analysis of data aims to study aspects in a varied and in-depth way, and to examine the event within its context[13].

Chart 1 is presented next, with the protocol model[12] used in the steps of the case study.

After the documentary research, based on RDC No. 222/2018, NBR 7500[3] and Ordinance No. 344/1984, the

current legislation in Brazil was compared, through a checklist, with the reality found in the sector. This comparison was carried out in February 2020. The flow of MW management in the SC was represented using the map-flowchart technique, which consists of a flowchart placed on the physical plant of the site for process mapping[14]. The generation points by location and the classification of MW by groups of RDC No. 222/2018 were considered[1].

The average direct cost was used as the costing method for cost information from the HU/UEL management information system.

The study is part of the research project entitled Sustainability and Hospital Cost Management (*Sustentabilidade e Gestão de Custos Hospitalares*), which is approved by the Research Ethics Committee (CEP), with Opinion No. 3.814.132 and Certificate of Presentation of Ethical Appreciation (CAAE) No. 21617119.9.0000.5231.

RESULTS

The distribution of MW collectors by group and the flow of MW management, observed in the SC under study during the period of data collection, were presented in Figure 1.

It was observed that all operating rooms had a collector with a milky white bag for infectious waste (Group A), and a rigid puncture-resistant collector for sharp waste (Group E); the other groups had no specific segregation. In the sector's routine, after the surgery, the nursing technician tied and identified the bags with the room number

Chart 1. Research protocol of the case study on MW in SC.

Steps	Objectives	Activities
To analyze the national legislation on MW and know the sector being studied.	To know the management processes of the WMP.	– Documentary research on legislation (RDC No. 222/2018 of the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária* – Anvisa)). – Visit to HU/UEL for observation. – To identify the initial links in the chain of reference that guided the key informants responsible for managing MW. – Participant observation of the management steps in the SC.
To identify MW management criteria.	To map the current management process.	– To represent the flowchart map of the SC studied.
To compare RDC No. 222/2018 with the reality found in the SC.	To comparison of reality with RDC No. 222/2018.	– Documentary research to compare current legislation with the reality found. – To compare the reality found with the checklist based on RDC No. 222/2018.
To propose an adequacy plan.	To contribute to the adequacy of HU/UEL to national legislation.	– To articulate with the CC team and the technical manager possible proposals to be carried out in the reality of the hospital.
To measure the cost of adjustments to comply with the current legislation.	To contribute to more efficient MW management choices.	– To identify inputs, materials, and equipment involved in MW management. – To check physical structure adjustments. – To measure the cost of each item based on the micro-costing of the hospital's financial information. – Items not included in the hospital's financial information system were: three prices were consulted for the products and their average price was calculated.
Data analysis.	Analysis related to sustainability actions and costs.	– Triangulation of sources, aiming to contrast the data collected through documentary research, participant observation, checklist, and cost calculation based on the Real currency (R$).
Conclusion.	To present a conclusion to managers in the form of management reports, with proposals for adequacy and publication in scientific journals.	– To synthesize data, considerations, and contributions in management decision making.

and work shift, and left them in the external corridor for the hospital hygiene employee to transport them to the temporary shelter.

The PACU had a collector for MW from groups A, D (recyclable), and E. The satellite pharmacy had collectors for waste from groups A, B, D (recyclable), and E. In the pantry, there were waste collectors from Group D (recyclable and non-recyclable), while in the administrative areas there were collectors for Group D waste (non-recyclable). In these areas, the waste was sent directly by the hygiene worker to the temporary MW shelter.

For recyclable Group D waste, a green bag was used and for non-recyclable ones, a black bag. Professionals from the general services division were responsible for transporting the MW from the SC's internal to the external shelter, located near the hospital parking lot, where they were accommodated in separate cells, according to the groups established by the legislation.

Subsequently, recyclable waste was collected by a recycling cooperative three times a week. The Group D MW (non-recyclable) was collected by a university truck, which sent them to a landfill.

Infectious, chemical, and sharp waste, classified as Class I hazardous waste, were weighed before being collected by the outsourced company. Infectious and sharps were sent for autoclaving and chemicals for incineration; later, the final disposition of these MW was carried out.

The hospital pays for the disposal of these wastes according to their weight and after presentation of the destination certification, which guarantees that the MW were disposed of in a safe and legal manner.

It can be seen in Figure 1 that the current Brazilian legislation was not fully complied with in the hospital under study. The need for new criteria for MW classification, acquisition of equipment and inputs in groups A, B, D, and E was evaluated, as shown below:

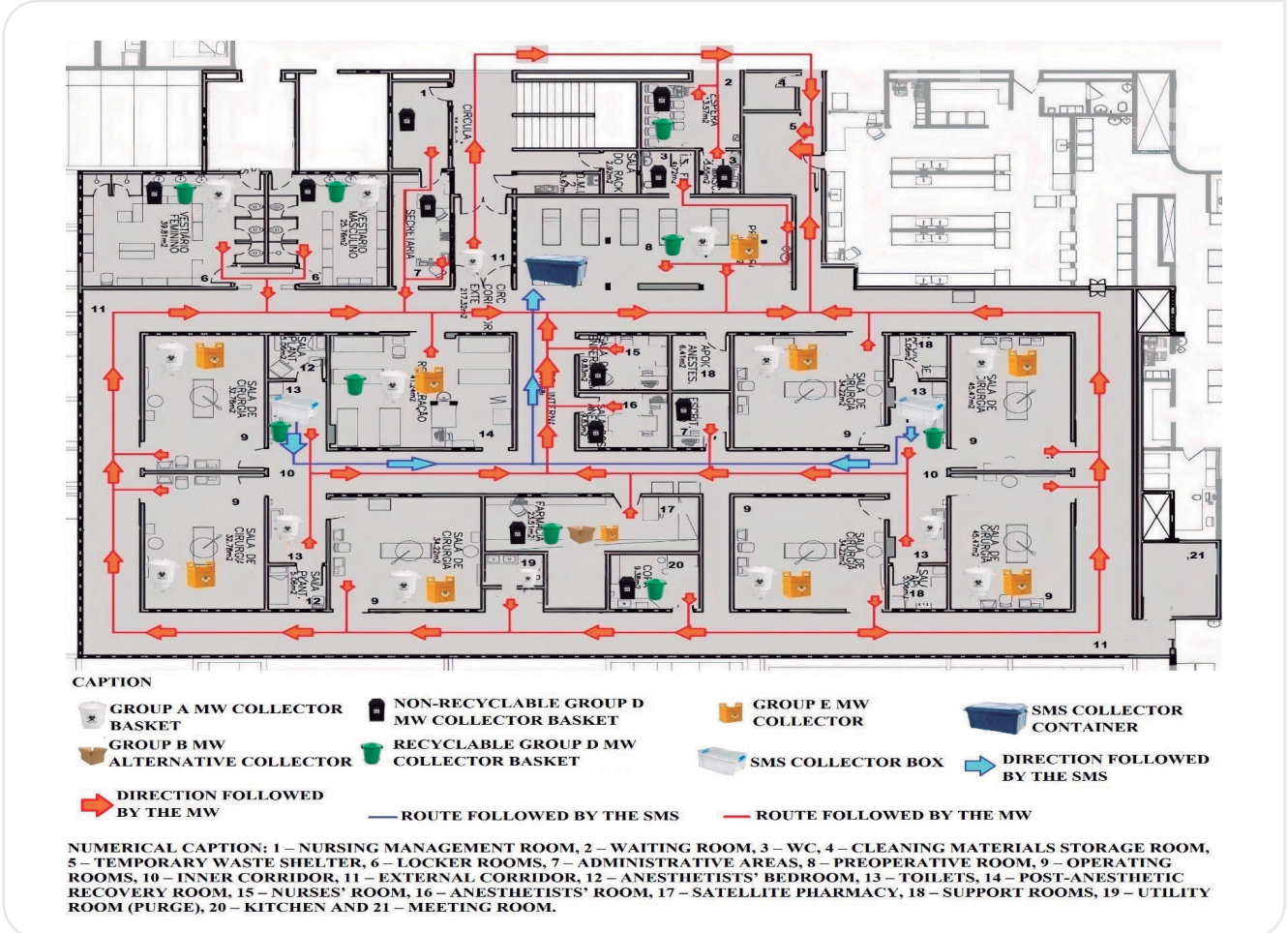

Figure 1. Distribution of collectors by MW group in the SC observed during data collection.

- Group A: implementation of 30 L and 50 L red collection bags (subgroup A1);
- Group B: implementation of a chemical waste collector centralized in the satellite pharmacy for disposal of leftover medication, a 50 L collection canister, which is suggested to be allocated in the internal waste shelter to collect chemical waste, such as formaldehyde, bottles of fixatives of anatomical parts, reagents, and liquid and sanitizing products;
- Group D: implementation of collectors for recyclable waste for serum near surgical center washrooms, operating rooms, and administrative areas;
- Group E: replacement of nine 20 L sharp waste collectors, at a unit cost of R$ 5.45, found in the SC under study, by 3 L collectors, at a unit cost of R$ 2.15 (values extracted from the management information system of HU/UEL) and implementation of a 90 L collector for large-format materials, such as disposable materials used in videosurgeries.

As for the adequacy of the intermediate shelter on the SC premises, it is necessary to purchase a platform, so that the sharps boxes are not placed directly on the floor, in addition to rigid containers with lids (to transport MW) and nameplates.

From the triangulation of the data, Figure 2 shows the flowchart map with proposals for adjustments to RDC No. 222/2018, so that the SC under study would fully comply with current legislation and include sustainable practices in MW management.

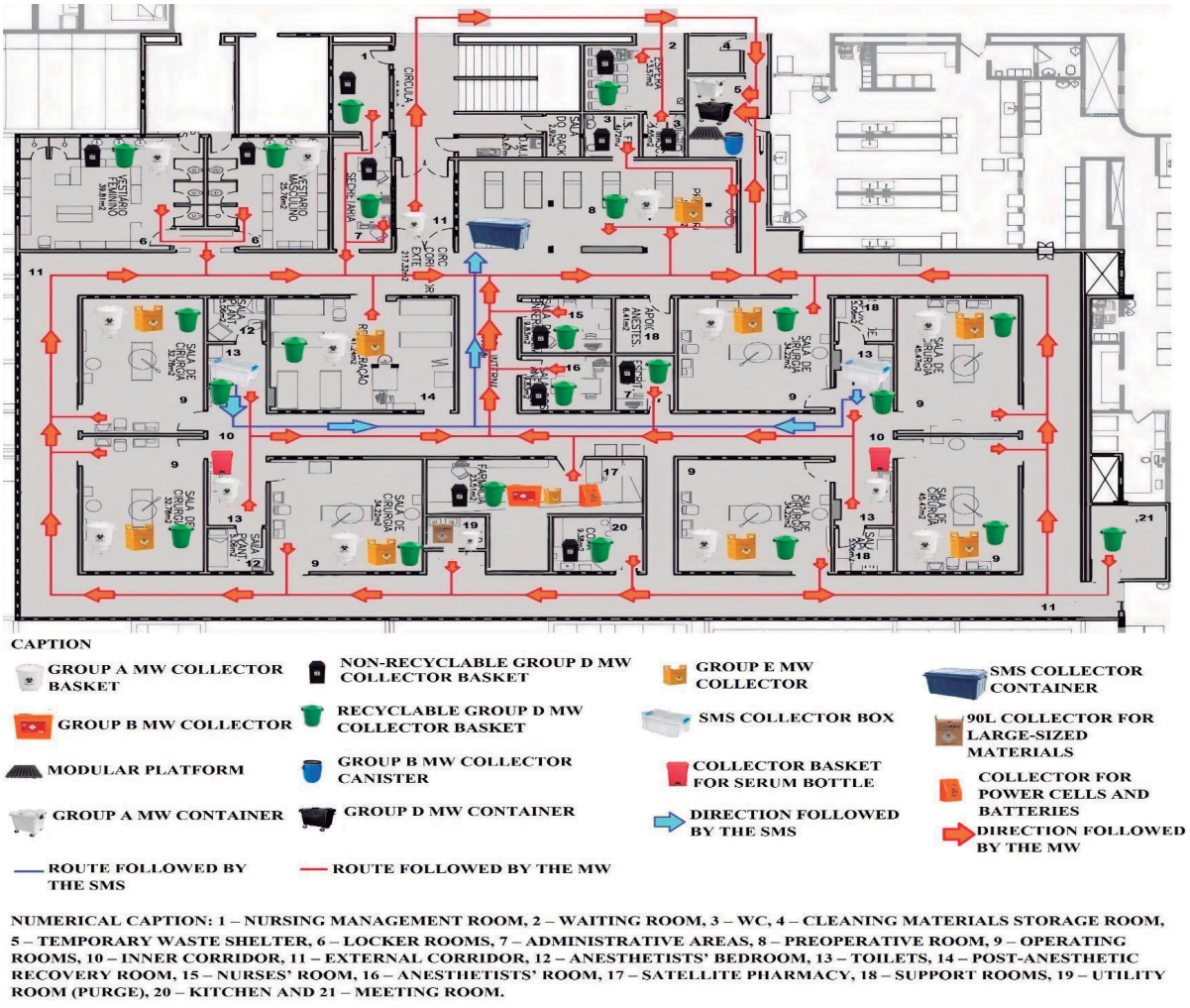

Figure 2. Proposal for adaptation to legislation RDC No. 222/2018 and improvements for the surgical center.

To enhance a possible implementation of the adjustments, the costs of the material resources involved were measured, from the perspective of the hospital manager.

The average direct cost of materials needed to purchase long-term items is shown in Table 1, and the items that must be purchased monthly in Table 2.

Together with the acquisition of new collectors, plates, identification stickers, among other proposed materials, it is essential that the service offers some type of continuing education activity, in order to raise awareness and guide professionals on the proper handling of MW.

As for the average direct cost of the necessary adjustments to the SC in this study, the initial total investment of R$ 7,891.25 was reached, with that, the SC would fully comply with the current Brazilian legislation. The main argument, from the manager's point of view, was the fact that no other reference studies were found that relate the cost of adapting the MW management processes.

DISCUSSION

The great challenge in managing MW is to articulate all the planned stages in a safe and sustainable manner, as this requires knowledge, investment, and multidisciplinary strategies on the part of the professionals involved in this process.

Nursing professionals are prominent actors in this scenario, as they are the ones who consume most of the materials that will give rise to the MW and who manage the processes related to this theme[15].

A study carried out with the objective of quantifying the types of MW generated in a hospital located in the southern

Table 1. Measurement of the cost of adequacy proposals for long-term items.

Items	Quantity	Unit Cost (R$)	Total Cost (R$)
60 L green collector basket	07	70.00	490.00
60 L red collector basket	01	70.00	70.00
10L trash can with pedal, with steel support	06	73.33	439.98
3 mm PVC plate, size 80x15 cm, in digital sticker, for identification*	01	16.80	16.80
3 mm PVC plate, size 40x10 cm, in digital sticker, for identification*	03	05.60	16.80
10x10 cm vinyl sticker for identification	42	03.83	160.86
15x25 cm vinyl sticker for identification	05	16.95	84.75
20x20 cm vinyl sticker for identification	05	17.00	85.00
Modular polypropylene platform*	01	64.68	64.68
Container (cart for manual transport – 500 L plastic model)*	04	1,480.00	5,920.00
Total cost			7,348.87

*Values extracted from the HU/UEL management information system, Londrina, 2020.

Table 2. Measurement of the cost of adequacy proposals with monthly purchase items.

Items	Quantity	Unit Cost (R$)	Total Cost (R$)
Group B MW Collector*	01	26.15	26.15
50 L collection canister for Group B MW	01	102.50	102.50
20 L collector for power cells and batteries	01	142.33	142.33
50 L green bag for common MW*	600	00.20	120.00
30 L red bag for infectious MW*	150	00.20	60.00
50 L red bag for infectious MW*	150	00.23	34.50
90 L collector for large-sized materials	01	56.90	56.90
Total cost			542.38

*Values extracted from the HU/UEL management information system, Londrina, 2020.

region of Brazil found that the operating room was the sector that occupied second place in terms of waste generation. The most generated were those in Group A (infective), due to the large number of invasive procedures performed in this sector[16].

Considering that the first step for proper MW management is the correct segregation of these wastes when they are generated, it is up to health professionals to dispose of them in the proper place to ensure the safety of the following steps of their management[5].

Therefore, it is extremely important that workers know the criteria for MW classification and, in the event of a change in the legislation on its management, that continuing education is promoted.

It is also essential that health services provide adequate collectors, transport, and storage structure for the management of these wastes.

It is worth noting a change in the legislation on the use of a red collection bag, which, in RDC No. 306/2004, was only for some subdivisions of Group A and, in current Brazilian legislation, the use of a red bag is mandatory for all Group A waste, which needs treatment[1,2].

The cost of disposing of hazardous waste was eight times higher than common waste, which is all the more reason for the proper handling of MW[8].

In this study, the placement of collectors for Group B-Chemical MW was suggested, two of them allocated in the satellite pharmacy, one for the collection of bottles with leftover medications and the other exclusive for batteries.

The collector of power cells and batteries was suggested to avoid negligence in their disposal, as presented in another study[17].

For the disposal of bottles of chemical products, such as formalin and sanitizing products (belonging to Group B), it was suggested to place a 50 L collection canister in the internal MW shelter of the SC under study.

The adaptations of collectors have the main objective of complying with legislation RDC No. 222/2018 and, consequently, reduce risks to the professional's occupational health and the environment.

It was observed that items such as disposable tweezers from videosurgery were being discarded in the sharps collector in an irregular manner. It was suggested to reduce the size of the piercing-cutting MW collection box in the operating room and to implement the 90 L collector for large-sized materials, which is a specific container for this type of material.

The operating room is a sector that poses a risk to the health of workers, so that professionals, at various times of care, are exposed to the generated MW. Nursing professionals are not the only generators of MW, but it is up to them to provide continuity of care. With this, they are often the professional designated to manage the MW[18].

Taking sustainability into account, it is essential to have articulated planning with the purchasing, material resource management, pharmacy and laboratories sectors, in order to implement measures for non-generation and/or reduction of MW, reuse policies, and recycling[19].

In this study, it was proposed to install collectors for recyclable waste in operating rooms. Another study showed the use of a specific collector for serum bottles, as this material can be recycled, transformed, and reused[20].

A reuse strategy already implemented in the SC under study is the separation of a non-woven fabric, the spunbonded metblown spunbonded (SMS), a product made 100% of polypropylene and used as surgical packaging, with no commercial market and technology for processing in the region. In the work routine, the room circulator personnel separate the clean SMS, fold it, and place it in boxes, which are sent to make bags for the patients of the hospital under study[21].

The correct identification of the type of MW is a requirement of current legislation in Brazil and an important facilitator of the health professional's work in the correct segregation of MW[17]. With that, there is a wide benefit for health services, workers, the community, and the environment.

Therefore, the acquisition of identification items is justified, as recommended by RDC No. 222/2018[1] and NBR 7500[3].

Taking into account Regulatory Standard (NR) No. 32, which discusses occupational safety and health in health services, it regulates that the service must promote measures that reduce and prevent occupational accidents[22].

It is noteworthy that, with the implementation of all proposals for adaptation and improvement for the sector, it is extremely necessary to carry out a broad and constant work of continuing education with the team members and health education with patients and caregivers[23].

The limitation of this study is related to the unavailability of indirect cost variables in the management of MW, as they involve several contracts with the university, so it is possible to include only the average direct cost in the scope of this research.

The advancement of knowledge lies in making known the necessary adjustments to the new legislation and to the

cost values (R$), which can be used as a model of comparison in studies involving other hospitals.

Carrying out a diagnosis of the profile of local waste generation, identifying the groups generated, sectors that generate them the most, estimating the generation and volume of collectors, mapping the existing transport, storage and final disposal flows and processes can enhance management practices sustainable in the operating room and increase the safety of workers and the environment[8].

CONCLUSION

It was evident that adjustments are needed in the surgical center under study regarding the current legislation in Brazil in all groups of MW so that their management is correct and safe. For the changes to be implemented, it is necessary to coordinate the various managers involved in the management and measurement of costs related to waste.

Measures focusing on occupational safety and continuing education related to MW are necessary for the implementation of sustainable practices and the maintenance of the adequacy plan proposed in this study.

This study is expected to help other health services to identify the necessary adjustments to Brazilian legislation and define cost methodologies so that it can be used as a reference in future investigations and arguments with managers, and that the cost values serve as a reference for other services that may need to be adapted to current Brazilian legislation.

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IODINE-IMPREGNATED INCISION DRAPES IN SPINE SURGERY: IMPACT ON SURGICAL SITE INFECTION

Campos impregnados com iodo em cirurgia da coluna: impacto na infecção de sítio cirúrgico

Paños quirúrgicos impregnados com yodo em cirugía de coluna: impacto en la infección del sitio quirúrgico

Eliane Carlosso Krummenauer[1]*, Jane Dagmar Pollo Renner[2], Rochele Mosmann Menezes[3], Telmo Tiburcio Fortes Lima[4], Marcelo Carneiro[5]

ABSTRACT: Objective: To evaluate the impact of iodine-impregnated incision drapes (IIIDs) to prevent surgical site infection (SSI) in the spine. Method: Retrospective cohort study comparing SSI outcome in patients in which IIIDs were and were not used, from 2015 to 2019. **Results:** The overall frequency of SSI was 16.7%, with SSI rate among patients using and not using IIIDs of 40% and 60%, respectively; p = 0.728; 95% confidence interval (95%CI) 0.19–3.11. Normothermia was the only independent protective factor for SSI (p = 0.043). The treatment of infectious complications resulted in hospital costs increase of 83.6% each day of care. Patients who were treated with IIIDs stayed 10 days less (± 4.9) in hospital. **Conclusions:** The results suggest that the use of IIIDs was not associated with a lower risk of SSI. These data can be useful for surgical planning and patient safety.

Keywords: Surgical drapes. Spine. Surgical wound infection. Infection control. Products with antimicrobial action.

RESUMO: Objetivo: Avaliar o impacto de campos adesivos impregnados com iodo (CAII) na prevenção de infecção de sítio cirúrgico (ISC) de coluna vertebral. **Método:** Coorte retrospectiva que comparou desfecho de ISC em pacientes que utilizaram CAII com os que não usaram, de 2015 a 2019. **Resultados:** A frequência geral de ISC foi de 16,7%, com a taxa de ISC para os que utilizaram CAII de 40% e, entre os que não usaram, de 60%; p = 0,728; intervalo de confiança de 95% (IC95%) 0,19–3,11. A normotermia foi o único fator protetor independente para ISC (p = 0,043). O tratamento de complicações infecciosas acarretou o incremento de custo hospitalar de 83,6% a cada dia de atendimento. Os pacientes que utilizaram CAII tiveram 10 (± 4,9) dias a menos de permanência hospitalar. **Conclusões:** Os resultados sugerem que o uso de CAII não foi associado a menor risco de ISC. Esses dados podem ser úteis para o planejamento cirúrgico e a segurança do paciente.

Palavras-chave: Campos cirúrgicos. Coluna vertebral. Infecção da ferida cirúrgica. Controle de infecções. Produtos com ação antimicrobiana.

RESUMEN: Objetivo: Evaluar el impacto de las paños quirúrgicos adhesivos impregnados de yodo (IIIDS) en la prevención de la infección del sitio quirúrgico (ISQ) de la columna. **Método:** Cohorte retrospectiva que comparó el resultado de ISQ en pacientes que usaron IIIDS con los que no lo hicieron, de 2015 a 2019. **Resultados:** La frecuencia general de ISQ fue del 16.7%, con una tasa de ISQ para los que usaron IIIDS del 40% y, entre los que no lo usaron, 60%; p = 0,728; Intervalo de confianza del 95% (IC 95%) 0,19–3,11. La normotermia fue el único factor protector independiente para la ISQ (p = 0,043). El tratamiento de las complicaciones infecciosas supuso un aumento de los costes hospitalarios del 83,6% por día de atención. Los pacientes que utilizaron IIIDS tuvieron 10 (± 4,9) días menos de estancia hospitalaria. **Conclusiones:** Los resultados sugieren que el uso de IIIDS no se asoció con un menor riesgo de ISQ. Estos datos pueden ser útiles para la planificación quirúrgica y la seguridad del paciente.

Palabras clave: Paños quirúrgicos. Columna vertebral. Infección de la herida quirúrgica. Control de infecciones. Productos con acción antimicrobiana.

[1]Master in Health Promotion from Universidade de Santa Cruz do Sul (Unisc). Nurse at Hospital Santa Cruz – Santa Cruz do Sul (RS), Brazil.
[2]PhD in Cellular and Molecular Biology from Pontifícia Universidade Católica do Rio Grande do Sul. Professor at the Stricto Sensu Program in Health Promotion and the Departments of Health Sciences and Life Sciences of Unisc – Santa Cruz do Sul (RS), Brazil.
[3]Master in Health Promotion from Unisc. Member of the Hospital Infection Control and Epidemiology Committee of Hospital Santa Cruz – Santa Cruz do Sul (RS), Brazil.
[4]Neurosurgeon at Hospital Santa Cruz – Santa Cruz do Sul (RS), Brazil.
[5]Postdoctoral Student in Education at Unisc. Professor at the *Stricto Sensu* Program in Health Promotion and the Departments of Health Sciences and Life Sciences of Unisc – Santa Cruz do Sul (RS), Brazil.
*Corresponding author: elianekrummenauer@gmail.com
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INTRODUCTION

Spine surgeries are procedures more and more performed due to the increase in average life expectancy[1]. When indicated, they aim to save an individual's or improve their quality of life, but the lack of safety regarding some uncontrolled factors can cause infections, disabilities and even death[2]. Despite using protocols for the prevention of surgical site infection (SSI), this remains a significant cause of postoperative morbidity, mortality and increased costs. Some procedures involving prostheses have a higher risk of complications, in addition to prolonged hospital stays and possible readmissions for new procedures and therapies[3].

Given this scenario, the need for efforts to create SSI prevention strategies is highlighted. It is important to identify risk conditions, which are clinical factors or conditions predisposing to SSI, in order to perform any adjustments and ensure surgical safety[2]. One relevant aspect is the surgical wound exposure to the environment during the procedure. Added to other predisposing conditions, this can be determinant for SSI[3]. SSI prevention is based on causes such as bacterial load, agent virulence, risk of infection and the patient's immune defense[2].

Among various elements identified for the prevention of SSI, one of the most important procedures is skin preparation, and there are few antiseptics available to meet this recommendation. The objectives of using these chemical agents are to remove microorganisms, provide chemical death and inhibit the growth of microorganisms through various techniques and combinations, thus reducing the skin (temporary and resident) microbiota for as long as the surgery can last[4].

Given this multifactorial context, multidisciplinary care and interdisciplinary actions are clearly needed, along with additional technologies to prevent this problem. The use of an iodine-impregnated incision drapes (IIIDs) is an option to reduce the resident skin microbiome that persists after the application of classic antiseptic preparations[4-6].

OBJECTIVES

Primary objective

- Assess the impact of IIID in preventing spinal SSI.

Secondary objectives

- To describe the clinical characteristics and risk factors of patients undergoing spinal surgery;
- To assess the cost-effectiveness of IIID in the incidence of spinal SSI;
- To check whether the use of IIID interfere with the length of hospital stay;
- To determine the frequency of cutaneous adverse reactions associated with IIIDs.

METHOD

This is a retrospective cohort study conducted with 60 patients undergoing spinal surgeries and assessing the use of IIIDs, from January 2015 to December 2019, in a teaching hospital in the countryside of Rio Grande do Sul (Brazil). The institution is philanthropic and has seven operating rooms, with an average of 622 anesthetic-surgical procedures per month and 2.6 spine surgeries per month during the study period.

The patients chosen for the research were identified in surgery reports extracted from the institutional care system, which made it possible to evaluate and classify the variables and the use or not of IIIDs. Inclusion criteria were all patients over 18 years old, undergoing spinal surgery in the study period, with a clean classification, by the only surgical team in the specialty. Patients undergoing spinal surgery classified as infected were excluded. All individuals were analyzed based on electronic and physical records, from which a form was filled in with the study variables and then sorted according to the use or not of IIID and the outcome of SSI (Figure 1).

Patients undergoing surgery for arthrodesis, spine fracture, spinal dislocation, spinal disc herniation and laminectomy were evaluated during hospitalization and in the long term (90 days after discharge) by the Infection Control Service. The criteria established by the National Health Surveillance Agency (ANVISA)7 and by the institutional SSI surveillance protocol after discharge were complied with. Superficial incisional SSI, deep incisional SSI, and organ-space SSI were considered. The records were made in a specific computerized infection control system and considered for SSI analysis.

Table 1 shows the variables predicting central nervous system SSI risk defined according to ANVISA[7,8], by the

American Society of Anesthesiologists (ASA)[9] classification and by the National Nosocomial Infections SSI risk index (IRIC), the National Nosocomial Infections Surveillance (NNIS) from the Centers for Disease Control and Prevention (CDC)[10]. The variables collected for analysis were: age, gender, care plan (private and non-private [Single Health System]), surgical emergency, pre-surgical admission and pre-surgical admission to an intensive care unit (ICU), ASA, body mass index (BMI), surgery site, surgery duration, skin preparation, use of IIID, antimicrobial prophylaxis (30 to 60 min before incision), extended prophylaxis (24 hours), surgical trauma, presence of infection before and after the procedure, normothermia (35.5 to 38.3 °C), use of drains up to 24 hours after the surgery, postoperative admission to the ICU, and death.

In the analysis of variables, location was categorized as "upper surgery" for procedures at the level of the cervical spine, regardless of levels or approach, and as "lower surgery" for all others.

IIID (Ioban® 2; 3M, St. Paul, MN) is a drape covered with a hypoallergenic acrylic adhesive and impregnated with iodine, very sensitive to pressure, which promotes a sterile surface and helps to prevent the migration of microorganisms to the surgical site4. Only one surgical team participated in the research and they did not have a criterion defined for IIID.

The costs of medicines, materials (including orthoses and prostheses), exams, hospital equipment and structure were measured. All hospitalization costs were considered, except the remuneration of the medical care team. These data were provided by the institution and reflect the aforementioned value for the period of care.

Data were analyzed in the Statistical Package for Social Sciences (SPSS IBM, Armonk, USA), version 23.0. Effect measures such as difference in means or difference in proportions, were used with their respective 95% confidence intervals (95%CI). A multiple linear regression model was applied to variables with $p < 0.20$ in the simple linear regression, to consider risk factors for the outcome. Values of $p < 0.05$ were considered significant.

The project was submitted, via Brasil platform, for consideration by the Research Ethics Committee and approved under opinion number 3,629,429, on October 8, 2019, in compliance with the Guidelines and Regulations for Research Involving Human Beings (Resolution 466/2012 by the National Health Council).

RESULTS

In total, 60 patients were paired according to use of IIIDs and diagnosis of SSI. Table 1 shows the study participants

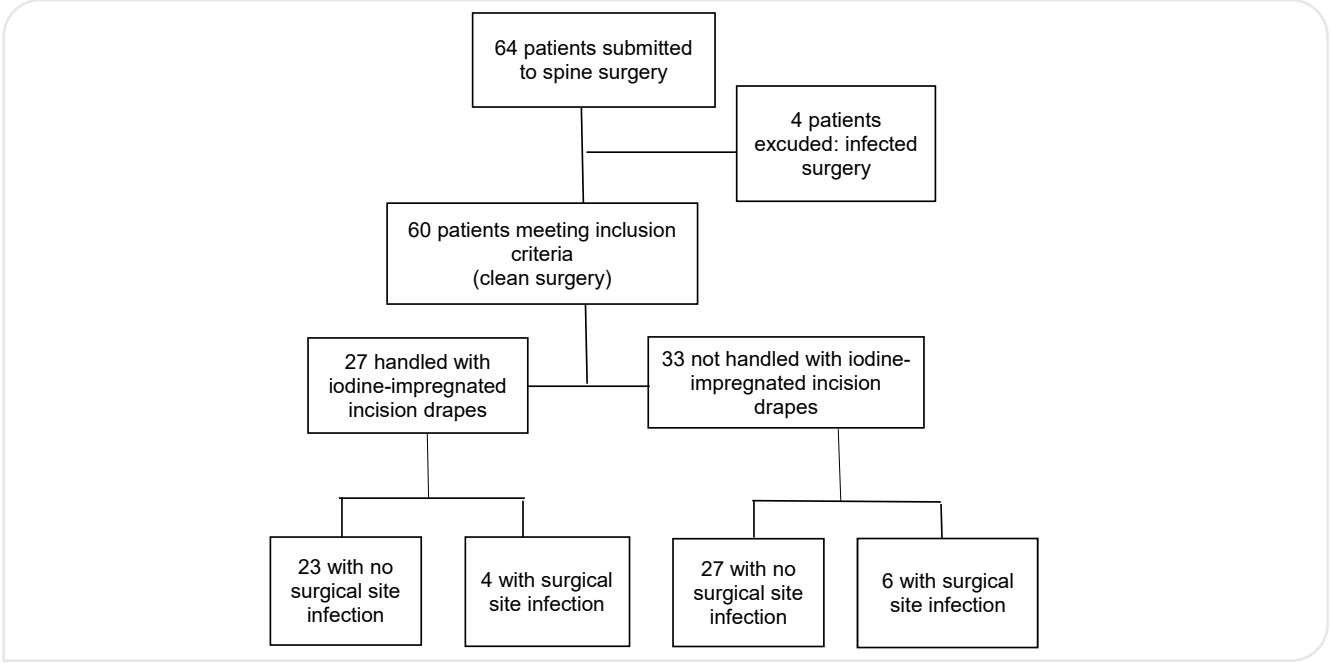

Figure 1. Flowchart of patients undergoing spine surgery in a teaching hospital in the countryside of Rio Grande do Sul (2015 to 2019).

and baseline variables. When comparing patients who had IIIDs applied to those who did not, a statistically significant difference was found with regard to ASA III score, length of stay with a drain > 24 hours, upper and lower surgery, surgical time (hours), surgical trauma and post-surgical ICU stay (days) in the immediate postoperative period, all with $p \leq 0.05$. The use of antimicrobial prophylaxis showed no difference between the group that used IIDs, and patients

Table 1. Characterization of patients undergoing spine surgery in relation to the use of iodine-impregnated incision drapes.

	IIIDs (n = 27)	No IIIDs (n = 33)	p
Mean age (years/SD)	59 (± 17.67)	55 (± 17.96)	0.346*
Age ≤ 60 years	14 (51.9)	18 (54.5)	0.835**
Male	14 (51.9)	23 (69.7)	0.157**
Surgical urgency	12 (44.4)	12 (36.4)	0.971**
Private care	22 (81.5)	14 (42.4)	0.002**
Non-private care	05 (20.8)	19 (79.2)	0.002**
Pre-surgical hospitalization ≥ 24 hours	14 (36.8)	24 (63.2)	0.216**
Pre-surgical hospitalization in ICU	08 (29.6)	09 (27.3)	0.840**
ASA I	05 (18.5)	01 (3.0)	0.257**
ASA II	16 (59.3)	26 (78.8)	0.212**
ASA III	06 (22.2)	06 (18.2)	0.050**
BMI < 25 kg/m²	07 (25.9)	12 (36.4)	0.387**
BMI 25 – 29,9 kg/m²	10 (37.0)	15 (45.5)	0.511**
BMI > 30 kg/m²	10 (37.0)	06 (18.2)	0.100**
Duration of surgery (hours/SD)	4.8 (± 1.35)	4.0 (± 1.38)	0.000*
Duration of surgery > 4 hours	19 (54.3)	16 (45.7)	0.087**
Skin degermination	27 (100.0)	33 (100.0)	0.529**
Skin antisepsis	27 (100.0)	33 (100.0)	0.051**
Use of extended prophylaxis	27 (100.0)	29 (87.9)	0.061**
1st generation antimicrobial prophylaxis	24 (88.9)	24 (72.7)	0.119**
Extended antimicrobial prophylaxis — glycopeptides	03 (11.1)	05 (15.2)	0.647**
Normothermia (T > 35.5 ºC)	13 (48.1)	16 (48.5)	0.979**
Use of drain	27 (100)	30 (90.9)	0.108**
Drain > 24 hours	06 (22.2)	17 (51.5)	0.008**
Upper surgery	05 (18.5)	14 (42.4)	0.048**
Lower surgery	22 (81.5)	19 (57.6)	0.048**
Surgical trauma	03 (11.1)	00 (0.0)	0.049**
Incidence of SSI	04 (14.8)	06 (18.2)	0.728**
Superficial SSI	00 (0.0)	02 (6.06)	0.163**
Deep SSI	02 (7.40)	04 (12.12)	0.545**
Organ-space SSI	02 (7.40)	00 (0.0)	0.112**
Postoperative ICU admission (days/SD)	3.3 (± 1.90)	2.7 (± 1.90)	0.001*
Postoperative ICU admission	10 (37)	11(33.3)	0.765**
Obit	01 (3.7)	00 (0.0)	0.529**

*Student's t-test; **χ^2 test; IIIDs: iodine-impregnated incision drapes; SD: standard deviation; ICU: intensive care unit; ASA: American Society of Anesthesiologists; BMI: body mass index (kg/m²); T: temperature (°C); SSI: surgical site infection.

who had it applied did not present any associated adverse skin reactions.

In Table 2, the predictive variables for SSI were: normothermia (relative risk — RR = 0.37; 95%CI 0.10–1.31; p = 0.050), duration of surgery (hours) (RR = 0.22; 95%CI % 0.09–6.11; p = 0.000), mean length of stay (days) after surgery in the ICU (RR = 0.32; 95%CI 0.12–5.85; p = 0.003). There were no differences between the incidence of infection in the groups that used or did not use IIIDs. The overall frequency of SSI was 16.7% (10/60), with rate 40% and 60% for patients who had IIIDs applied, respectively (p = 0.728; 95%CI 0.19–3.11).

Infections occurred in nine (90%) lower surgeries. Six (60%) patients required ICU admission after surgery, with an average of four (± 2) days. The mean hospital stay was 31 (± 2) days.

Tabela 2. Caracterização dos pacientes submetidos à cirurgia de coluna em relação à presença de infecção.

	no SSI (n = 50)	SSI (n = 10)	p
Mean age (years/SD)	54.94 (± 17.49)	56.80 (± 20.28)	0.766*
Age ≤ 60 years	27 (54.0)	05 (50.0)	0.817**
Male	32 (64.0)	05 (50.0)	0.406**
Surgical urgency	07 (14.0)	02 (20.0)	0.628**
Private care	28 (56.0)	08 (80.0)	0.157**
Non-private care	22 (44.0)	02 (20.0)	0.157**
Pre-surgical hospitalization ≥ 24 hours	33 (66.0)	05 (50.0)	0.338**
Pre-surgical hospitalization in ICU	15 (30.0)	02 (20.0)	0.522**
ASA I	06 (12.0)	00 (0.0)	0.248**
ASA II	35 (70.0)	07 (70.0)	1.000**
ASA III	09 (18.0)	03 (30.0)	0.386**
BMI < 25 kg/m²	16 (32.0)	03 (30.0)	0.901**
BMI 25 – 29,9 kg/m²	21 (42.0)	04 (40.0)	0.907**
BMI > 30 kg/m²	13 (26.0)	03 (30.0)	0.794**
Duration of surgery (hours/SD)	4.2 (± 1.36)	5.0 (± 1.48)	0.000*
Duration of surgery > 4 hours	29 (58.0)	6 (60.0)	0.907**
Skin degermination	50 (100.0)	10 (100.0)	0.019**
Skin antisepsis	50 (100.0)	10 (100.0)	0.047**
Use of extended prophylaxis	50 (100.0)	10 (100.0)	0.355**
1st generation antimicrobial prophylaxis	42 (84.0)	6 (60.0)	0.083**
Extended antimicrobial prophylaxis — glycopeptides	05 (10.0)	03 (30.0)	0.089**
Use of IIIDs	23 (46.0)	04 (40.0)	0.728**
Normothermia (T > 35.5 ºC)	27 (54.0)	02 (20.0)	0.050**
Use of drain	47 (94.0)	10 (100.0)	0.427**
Drain > 24 hours	26 (52.0)	08 (80.0)	0.149**
Upper surgery	18 (36.0)	01 (10.0)	0.107**
Lower surgery	32 (64.0)	09 (90.0)	0.107**
Postoperative ICU admission (days/SD)	2.6 (± 2.03)	04 (± 1.79)	0.003*
Postoperative ICU admission	15 (30.0)	06 (60.0)	0.069**
Obit	00 (0.0)	01 (10.0)	0.066**

*Student's t-test; **χ^2 test; IIIDs: iodine-impregnated incision drapes; SD: standard deviation; ICU: intensive care unit; ASA: American Society of Anesthesiologists; BMI: body mass index (kg/m²); T: temperature (°C); SSI: surgical site infection.

Two (6.1%) cases of superficial SSI were found, with incidence in patients who did not have IIIDs applied (p = 0.193; 95%CI 0.09–0.28) — one case of *Serratia* spp. confirmed and another case with negative culture. These infections happened in patients undergoing lower surgery. Infections occurred on average five (± 2) days after surgery, with mean of 15 (± 9) days of hospital stay.

Deep SSI occurred in two (7.4%) patients who had IIIDs applied during surgery and in four (12.2) who did not have it (p = 0.545; 95%CI 0.00–0.29). Of these, two had *Enterobacter* spp. and one had *Klebsiella* spp.; no microorganisms were found in the cultures of the other patients. Infections occurred on average within 33 (± 44) days, with five cases (83.3%) up to the sixteenth day. Of the six patients who had deep SSI, four (66.7%) were admitted to the ICU after surgery, with a mean stay of three (± 2) days and mean hospital stay of 36 (± 18) days. These infections (5/6) occurred in patients undergoing lower surgery.

In two (7.4%) patients in whom IIIDs were used, organ-space SSI was identified, although the difference was not significant (p = 0.112; 95%CI 0.13–0.34). In both surgeries, there was a rupture of the dura mater and no growth of microorganisms in the culture. Infections occurred within nine (± 1) days in postoperative patients admitted to the ICU, with a mean stay of five (± 1) days and a mean hospital stay of 28 (± 14) days.

Regarding the IRIC of the analyzed procedures, 47 (78.3%) surgeries had an IRIC equal to 1, including in this category seven (70.0%) cases of infection (p = 0.483; 95%CI 0.00–0.28). In the general analysis, pre- and postoperative glycemic control was achieved in 50% of these patients, and a later surgical approach occurred in 33 (55.0%) of them, with nine (27.3%) cases of SSI.

There was one (1.7) case of death on the 25th postoperative day after a deep SSI in a female patient, older than 60 years, with IRIC = 2, ASA III, obese and with comorbidities (diabetes and heart disease).

Variables with p < 0.20 were associated with variables with p < 0.05 for the multivariate analysis of risk factors for SSI: inpatient healthcare system (p = 0.157), extended antimicrobial prophylaxis with cephalosporin (p = 0.083), extended antimicrobial prophylaxis with glycopeptides (p = 0.089), surgical drain time > 24 hours (p = 0.149), upper and lower surgery (p = 0.107), postoperative stay in ICU (p = 0.069) and death (p = 0.069).

Table 3 shows the logistic regression, where normothermia had a p < 0.05 (RR = 0.27; 95%CI, 0.01–0.40) and maintained an association with SSI. Other tested variables maintained a p > 0.05, with no level of significance.

The cost of the procedures was R$ 3,031,388.7 (US$ 571,960.13), with R$ 1,135,125.7 (US$ 214,174.66) related to the ten patients who had SSI. The cost of the 50 patients who did not develop infection was R$ 1,896,263.0 (US$ 357,785.47).

On average, the costs were R$ 1,936.99/day (US$ 365.47/day) in patients who did not present infection and R$ 3,615.05/day (US$ 682.08/day) in patients who developed infection. The main difference was related to the costs of treatment for infectious complications, with an increase of 83.63%/day in hospitalization, as patients who had infections had a higher mean hospital stay, of 31.4 (± 17.4) days, compared to those who did not have it (19.6, ± 14.2 days), that is, 11.8 (± 3.2) days more.

The cost for healing of patients who were not handled with IIIDs was higher than those who were, although the difference was not significant (p = 0.728; 95%CI 0.00–0.33). Regardless of the outcome infection or absence of infection, this study shows that the mean hospital stay of patients not handled with IIIDs was 26 (± 17) days, and that of those who were handled with IIIDs was 16 (± 10) days.

DISCUSSION

The use of IIIDs to prevent infection in spine surgeries was not statistically significant in this study. When analyzing

Table 3. Multiple linear regression model with variables predicting surgical site infection in patients undergoing spine surgery.

	no SSI (n = 50)	SSI (n = 10)	p	RR 95%CI
Normothermia (T > 35.5 ºC)	27 (54.0)	02 (20.0)	0.043	0.269 (0.006–0.402)
Lower surgery	32 (64.0)	09 (90.0)	0.277	0.153 (0.104–0.353)
Postoperative ICU admission	15 (30.0)	06 (60.0)	0.242	0.166 (0.092–0.356)
Antimicrobial prophylaxis, 1st generation cephalosporin	42 (84.0)	06 (60.0)	0.229	0.196 (0.501–0.123)

SSI: surgical site infection; RR: relative risk; 95%CI: 95% confidence interval.

the clinical variables comparing patients who were handled with IIIDS with those who were not, this may have occurred due to the non-uniformity of groups and the fact that it was not controlled. Patients treated with IIIDs were considered more severe, that is, they had a higher ASA III score, longer surgical time, dura mater trauma (pre- and intraoperative) and were admitted to the ICU after surgery.

The protective factors against SSI were: normothermia, shorter surgical time and shorter postoperative stay in ICU. However, in the linear regression model, only normothermia remained as an independent variable, being even recommended by several national and international guidelines[11-14]. A meta-analysis suggests no association with SSI, but the authors propose further research[15]. A study showed that the incidence of hypothermia in surgical patients is high, increases during the procedure and is present in the post-anesthetic recovery room. The authors highlight the need for continuing education of the team regarding the application of preventive measures to avoid this problem[16].

In the analysis of the other variables, although not statistically significant, superficial SSI was not identified in patients who were handled with IIID. This probably stems from its property of reducing the transient microbiota, even in the deepest layers of the skin (1,000 micrometers), due to a technology of greater concentration and permanence of the antiseptic agent[5]. A study concluded that the use of IIIDs in orthopedic surgery significantly reduces the bacteria that colonize the skin where the incision is made, decreasing the theoretical probability of SSI[17]. Another research reported a decrease in superficial SSI in cardiac surgeries[4].

Deep SSI did not differ when using or not IIIDs. The cases of meningitis had trauma to the dura mater as a risk factor. As expected, IIIDs have no action in the face of deep traumatic complications[4], as its antiseptic technology does not encompass that. The frequencies of SSI categorized by IRIC in our study were higher than in other research[18].

Surgical procedures closer to the lumbosacral spine are known to encompass a larger tissue microbiome, especially with greater tissue recolonization in the peri- and postoperative periods. One of the goals of skin antisepsis is to mainly reduce bacteria of the *Staphylococcus* spp. Genus group, the main agent of spinal SSI[19].

Spinal SSI varies between 1 and 13%, and the posterior approach surgery has a higher incidence of infection than the anterior approach[19,20]. The surgical schedule is another related factor, with intervention at various intervertebral levels[2]. These findings raise questions about the confounding variables between superficial and deep SSI, which can generate conflicting results about the direct and indirect benefits of the IIIDs[6].

This analysis did not suggest that overweight added any level of risk of SSI, although it was present in 70% of the cases (superficial and deep SSI). On the other hand, this relation was also reported by another study[2]. There is evidence that for every 1 mm of subcutaneous fat thickness adds 6% to the risk of SSI, with an increase of up to four times in patients with fat thickness above 50 mm in the lumbar region[21].

Postoperative glycemic control was adequate in half of the patients and, as it is an easy-to-measure and low-cost variable, it should be a priority and encouraged by the surgical team.

Overall mortality was low, being comparable to that of another study. Age, female gender and comorbidities influence both the risk of postoperative complications and the mortality rate[22].

Patients who did not have SSI had a shorter hospital stay and, consequently, were associated with lower care costs. Determining the cost-effectiveness of IIIDs, although it is not significant in reducing SSI, brought up another great advantage, which was the reduction in the total costs of hospital care[4]. We emphasize that patients who were handled with IIIDs stayed in hospital ten (± 4.9) days less. Prescription of antimicrobials, surgical reinterventions, need for anesthesia and additional tests were very common. Reducing hospitalization costs is an important parameter to assess the effectiveness of a surgical procedure and adjuvant treatments.

STUDY LIMITATIONS

The fact that this was a retrospective investigation, with few subjects, without control of those who used or not IIIDs or its application to patients at higher risk, is a limitation. This may have resulted in no differences in SSI rates. The rate of positive microorganism cultures was low, which also makes it difficult to analyze the most common infectious agents. Variables that are known risk factors were not collected because they were not registered in the physical and computerized medical records.

CONCLUSIONS

Our results suggest that the use of IIIDs was not associated with a statistically significant reduction in SSI. Only normothermia was a protective factor for SSI in linear regression. The costs of complications related to the surgical site or other areas increased the cost of hospitalization, while in the group of patients using IIIDs we saw a reduction in the total cost of care. These data can be useful for surgical planning, patient counseling, and for tracing efforts to improve the safety and cost-effectiveness of spine surgeries. Further prospective, controlled and multicenter studies should be carried out to check for positive results.

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NURSING DIAGNOSES AND ROY'S ADAPTATION PROBLEMS IN PATIENTS UNDERGOING BARIATRIC SURGERY

Diagnósticos de enfermagem e problemas adaptativos de roy em pacientes submetidos à cirurgia bariátrica

Diagnóstico de enfermería y problemas de adaptación de roy en pacientes a través de cirugía bariátrica

Lívia Moreira Barros[1], Francisco Marcelo Leandro Cavalcante[2*], Jennara Cândido de Nascimento[3], Joselany Áfio Caetano[4]

ABSTRACT: Objective: To identify the nursing diagnoses of the North American Nursing Diagnosis Association (NANDA International) in patients who underwent bariatric surgery, during the postoperative period, and their relation to adaptation problems according to the Roy Adaptation Model. **Method:** This is an exploratory, multicase study carried out in a reference hospital for bariatric surgeries in the state of Ceará, Brazil, from November to December 2018. Data collection took place through interviews and physical examination using a structured instrument with the four modes of adaptation of the Roy Adaptation Model. **Results:** In this study, 21 nursing diagnoses were identified, which were related to the following adaptation problems: impaired breathing, difficulty dressing up, nutrition, sedentary lifestyle, sleep pattern, chewing, obesity control, low self-esteem, social interaction, healthy organism, anxiety, self-care, satisfaction with appearance, spirituality, healthy relationship, knowledge, and communication. **Conclusion:** Wellness nursing diagnoses predominated, which suggests that the performance of bariatric surgery and the obtained results, such as weight loss, increased disposition, and improved health status, positively influence the postoperative adaptation process.

Keywords: Bariatric surgery. Nursing diagnosis. Nursing theory. Perioperative nursing.

RESUMO: Objetivo: Identificar os diagnósticos de Enfermagem da *North American Nursing Diagnosis Association* (NANDA Internacional) nos pacientes no pós-operatório de cirurgia bariátrica e relacioná-los com problemas adaptativos propostos por Roy. **Método:** Estudo exploratório, a partir da técnica de multicasos, realizado em hospital de referência em cirurgias bariátricas no estado do Ceará, no período de novembro a dezembro de 2018. A coleta de dados ocorreu por meio de entrevistas e do exame físico em que se utilizou instrumento estruturado com os quatro modos adaptativos de Roy. **Resultados:** Neste estudo, foram identificados 21 diagnósticos de Enfermagem, que estiveram ligados aos problemas adaptativos respiração prejudicada, dificuldade para vestir-se, nutrição, sedentarismo, padrão de sono, mastigação, controle da obesidade, baixa autoestima, interação social, organismo saudável, ansiedade, autocuidado, satisfação com aparência, espiritualidade, relacionamento saudável, conhecimento e comunicação. **Conclusão:** Predominaram diagnósticos de Enfermagem de bem-estar, o que sugere que a realização da cirurgia bariátrica e os resultados obtidos, como perda de peso, aumento da disposição e melhora do estado de saúde, influenciam positivamente no processo de adaptação pós-cirurgia.

Palavras-chave: Cirurgia bariátrica. Diagnóstico de enfermagem. Teoria de enfermagem. Enfermagem perioperatória.

RESUMEN: Objetivo: Identificar los Diagnósticos de Enfermería Internacional NANDA en pacientes en el postoperatorio de cirugía bariátrica y relacionarlos con problemas adaptativos del Modelo de Adaptación de Roy. **Método:** Estudio exploratorio, mediante la técnica multicase, realizado en un hospital de referencia en cirugías bariátricas en el Estado de Ceará, de noviembre a diciembre de 2018. La recolección de datos se realizó a través de entrevistas y examen físico en el que utilizó instrumento adaptado estructurado con los cuatro modos adaptativos de Roy. **Resultados:** Se identificaron 21 Diagnósticos

[1]PhD in Nursing, Universidade Federal do Ceará. Professor at the Nursing Program of Universidade da Integração Internacional da Lusofonia Afro-Brasileira – Redenção (CE), Brazil.
[2]Undergraduate student in Nursing, Universidade Estadual Vale do Acaraú – Sobral (CE), Brazil.
[3]PhD in Nursing, Universidade Federal do Ceará. Professor at the Undergraduate Nursing Program of Centro Universitário Estácio do Ceará – Fortaleza (CE), Brazil.
[4]PhD in Nursing, Universidade Federal do Ceará. Professor at the Undergraduate Nursing Program, Universidade Federal do Ceará – Fortaleza (CE), Brazil.
*Corresponding author: marceloleandrocavalcante98@hotmail.com
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de Enfermería, los cuales se relacionaron con problemas adaptativos, dificultad para respirar, dificultad para vestirse, nutrición, sedentarismo, patrón de sueño, masticación, control de la obesidad, baja autoestima, interacción social, organismo sano, ansiedad, autocuidado, satisfacción con la apariencia, espiritualidad, relación sana, conocimiento y comunicación. **Conclusión:** Predominaron los diagnósticos de enfermería de bienestar, lo que sugiere que la realización de la cirugía bariátrica y los resultados obtenidos, como la pérdida de peso, mayor disposición y mejor estado de salud, influyen positivamente en el proceso de adaptación posquirúrgico.

Palabras clave: Cirugía bariátrica. Diagnóstico de enfermería. Teoría de enfermería. Enfermería perioperatoria.

INTRODUCTION

Bariatric surgery or gastroplasty is a therapeutic method increasingly sought by obese people to control and maintain severe obesity as well as comorbidities associated with this chronic health problem. In this context, for achieving beneficial and lasting results, it is imperative that individuals adequately understand which perioperative care practices should be implemented, in addition to being aware of the need for changing behaviors to achieve greater effectiveness of surgical treatment, better quality of life, and reduction of possible complications[1].

Patient's adherence to adequate health practices and lifestyle changes favors the improvement of obesity-related indicators after undergoing bariatric surgery[2]. However, many individuals experience several difficulties during the follow-up of the perioperative treatment, as this change process is complex and involves several aspects such as social, physical, and psychological ones[3].

Therefore, the nursing performance with patients undergoing bariatric surgeries is of fundamental importance, as these subjects face several changes and implications resulting from the treatment that require the provision of holistic, longitudinal, and scientifically-based care. Accordingly, nurses should use the nursing process (NP) and nursing theories to support and improve care practices[4].

In this study, the Roy Adaptation Model stands out, according to which the NP understands the human being as an adaptive system and encompasses the following steps: behavior assessment; stimulus assessment; nursing diagnosis (ND); setting goals; intervention; and evaluation. According to this theory, the adaptation process can constitute a guiding basis for nursing practice, consisting of five elements: person, nursing goal, nursing activities, health, and environment[5].

The person is the recipient of nursing care and is considered as a holistic adaptive system, whose behaviors can be classified as positive or inefficient adaptive reactions. These behaviors derive from mechanisms that can be identified based on four modes of adaptation: physiological, self-concept, role function, and interdependence[6].

Thus, the Roy Adaptation Model enables the understanding that people can demonstrate positive or negative responses to stimuli resulting from stressful situations, a context in which nurses act as mediators of strategies for implementing the actions of the care process, empowering the subjects to identify coping mechanisms that can mitigate negative responses and allow better results in their adaptation process[6,7].

Therefore, considering the scarcity of studies on this topic, the identification of ND and its comparison with the adaptation problems of the Roy Adaptation Model will enable the formulation and implementation of appropriate care plans for patients who experience the postoperative (PO) period of bariatric surgery. Taking this into consideration, the following questions arose: Which NDs are evidenced in patients in the PO period of bariatric surgery? Is there a relationship between the NDs identified and the adaptation problems of the Roy Adaptation Model?

OBJECTIVE

The present study aimed to identify the NDs of the North American Nursing Diagnosis Association (NANDA International) in patients who underwent bariatric surgery, during the PO period, and to relate them to the adaptation problems indicated in Sister Callista Roy's Theory.

METHOD

Study type and place

Exploratory study, with a qualitative approach, in which the multicase technique was employed. The survey was conducted in the state of Ceará, Brazil, from November to December 2018, in a reference hospital for bariatric surgeries of the Brazilian Unified Health System (SUS).

Population and sample

People who were followed up by the Obesity Program of the State of Ceará participated in the study. In order to recruit the subjects, the list of patients who were already in the PO period was requested from the bariatric surgery service of the institution under study. Then, patients were invited via telephone to participate in the study, and explanations regarding the purpose of the call and the relevance of the research were given. Twelve subjects were randomly recruited, of which six attended the focus group meeting.

The following inclusion criteria were defined: age over 18 years; PO period of bariatric surgery between 0 and 24 months; and receive follow-up care by the institution's multidisciplinary team. The authors chose to interview only individuals who had already undergone the surgery due to the possibility of investigating the adaptation process. Thus, at the time of data collection, questions about both the experience in the preoperative period and in the PO period were included.

Procedures for data collection

Data collection was carried out in a reserved air-conditioned room that was previously organized to facilitate the conduct of the focus group. A lead researcher assumed the role of moderator and three researchers were the observers at the time of data collection.

Upon starting the focus group, the moderator explained how the meeting would take place and the rules of coexistence in such a way that everyone had the opportunity to speak. In addition, it was also explained that the meeting would be recorded, with the aim of later analyzing the participants' speeches. A script with questions based on the four Roy's modes of adaptation was used, namely: physiological, self-concept, role function, and interdependence. In the physiological mode, aspects related to neurological function, oxygenation, senses, nutrition, protection, bladder and intestinal elimination, activity, and rest were investigated. As for the role function mode, data on identification and social role were investigated; in the self-concept mode, psychological, spiritual, and self-image aspects were emphasized; and in the interdependence mode, data on affective adequacy, loneliness, and interpersonal relationships were analyzed[8].

It is noteworthy that there were questions concerning the life before undergoing bariatric surgery, such as routine, eating habits, physical activity, and the effects of obesity on daily life, in addition to questions related to the PO period, such as changes in health practices, adaptation to the new reality, and expectations regarding the obtained results.

Data analysis

After transcribing the speeches, NDs were identified based on the NANDA-I Taxonomy II (2018–2020) and on the adaptation problems of the Roy Adaptation Model, comparing the diagnoses and difficulties in adaptation to establish similarities. The diagnostic process was carried out in two phases: analysis (data categorization and identification of gaps) and synthesis (grouping, comparison, identification, and relation of etiologic factors)[9].

Ethical aspects

Before data collection, the subjects received and signed the Informed Consent Form, and the objectives, benefits, and risks of the research were explained. In order to preserve the participants' anonymity, they were identified with names of butterflies. The study was carried out in line with the recommendations of Resolution No. 466/2012, and it was approved by the Research Ethics Committee of Universidade Federal do Ceará (UFC), under CAAE 56499116.2.3001.5041 and Opinion No. 1.658,436.

RESULTS

Six participants in the PO period comprised the final study sample, in which there was a predominance of women (five participants). With regard to age, most subjects aged between 30 and 51 years.

The NDs and their correlation with adaptation problems in each mode described in the Roy Adaptation Model are presented next: physiological, role function, self-concept, and interdependence modes.

Physiological mode

When evaluating the physiological mode of the individuals, changes were identified only in the aspects of nutrition and activity and rest, as demonstrated in Chart 1.

According to Chart 2, after surgery, wellness diagnoses related to nutrition and sleep pattern were identified. The diagnosis "impaired dentition" was also observed in two patients, as they reported difficulty chewing due to the use of dentures.

Role function mode

The participants, after surgery, reported that they felt good, in the adaptation phase, according to the following reports:

- *"I'm fine. I'm starting to eat properly again. I'm adapting* [to it]*..."* (Emerald Swallowtail Butterfly, PO period of two months);
- *"I'm feeling good today. I don't see myself as obese anymore."* (Ruby Tiger Butterfly, PO period of seven months);
- *"For some time, I didn't care, but then I realized I needed help. I recognize myself today as another person, with a different quality of life."* (Peacock Butterfly, PO period of 12 months);
- *"I look a lot better now."* (Queen Alexandra Birdwing Butterfly, PO period of nine months);
- *"I see myself as a fat woman undergoing treatment."* (Zebra Longwing Butterfly, PO period of 18 months).

When asked about what care they took to manage obesity in the past and currently, most individuals reported that they previously had treatments based on diet, physical exercise, and psychological support, but they could not maintain their weight for a long time. Conversely, currently, they try to follow the nutritionist's recommendations and to exercise.

- *"I used to try avoiding unhealthy foods as much as possible. Today I exercise and I have a balanced diet."* (Emerald Swallowtail Butterfly, PO period of two months);
- *"I used to see a psychologist and go on diets. Today I keep going into therapy and seeing a nutritionist. I also exercise nowadays."* (Queen Alexandra Birdwing Butterfly, PO period of nine months);
- *"It did nothing to control obesity. I couldn't. I suffered from deep anxiety and needed to eat. Today I ride a bike, take walks, try to follow the nutritionist's guidelines regularly and undergo treatment with a psychologist."* (Peacock Butterfly, PO period of 12 months);
- *"I tried walking, dieting, drinking Herbalife® shakes. Nowadays, I daily exercise and control my diet."* (Zebra Longwing Butterfly, PO period of 18 months).

All subjects also stated that social relationships were harmed, as they felt uncomfortable with criticism and prejudice. Currently, they feel comfortable with themselves and with other people.

- *"I didn't feel comfortable around people. I thought I was ugly. Even going to the gym was really bad. As I'm at the beginning* [of the treatment] *and my body hasn't changed yet, I see that my psychological well-being is changing."* (Emerald Swallowtail Butterfly, PO period of two months);

Chart 1. Domains, nursing diagnoses, and Roy's adaptation problems in the preoperative period of patients who had bariatric surgery.

Domains	Nursing Diagnoses	Roy's Adaptation Problems
Activity/rest	00032 – Ineffective breathing pattern related to obesity, evidenced by dyspnea.	Impaired breathing
	00094 – Risk for activity intolerance related to unfitness.	Sedentary lifestyle
	00204 – Ineffective peripheral tissue perfusion related to a sedentary lifestyle, evidenced by edema.	Sedentary lifestyle
Activity/rest	00109 – Dressing self-care deficit related to discomfort, evidenced by impaired ability to put on necessary clothing items and to put on shoes.	Difficulty getting dressed
Nutrition	00232 – Obesity classified by Body Mass Index (BMI) > 30 kg/m^2, related to disordered eating behaviors.	Nutrition
Health promotion	00168 – Sedentary lifestyle related to lack of interest, evidenced by choosing a daily routine without exercise.	Sedentary lifestyle

Chart 2. Domains, nursing diagnoses, and Roy's adaptation problems in patients who had bariatric surgery

Domains	Nursing Diagnoses	Roy's Adaptation Problems
Nutrition	00163 – Readiness for enhanced nutrition evidenced by consumption of adequate foods, regular intakes, and manifestation of knowledge about healthy food choices.	Nutrition
Activity/rest	00165 – Readiness for enhanced sleep evidenced by the manifestation of feeling rested after sleeping and amount of sleep consistent with developmental needs.	Sleep pattern
Safety/protection	00048 – Impaired dentition related to inadequate oral hygiene, evidenced by lack of teeth.	Chewing

- *"Since the surgery it's been better. I leave home now..."* (Ruby Tiger Butterfly, PO period of seven months);
- *"For sure it got in the way. I couldn't find an outfit and was embarrassed to go out. Obesity deforms you. Today I feel much better. I wear whatever clothes I want. It contributed not only to my health, but to my general well-being."* (Queen Alexandra Birdwing Butterfly, PO period of nine months);
- *"It brought me many hardships. I even lost my job. Today I can relate very well. I help people more."* (Peacock Butterfly, PO period of 12 months);
- *"It got in the way of my relationship with other people because of the criticism."* (Orange-tip Butterfly, PO period of 24 months).

The identified diagnoses and adaptation problems regarding the role function mode are presented in Chart 3.

Self-concept mode

All participants reported that there were changes in their lifestyle after undergoing surgery and that expectations for performing the bariatric procedure were related to improved health and quality of life and the search for a new body.

- *"It's a chance to have a new body."* (Emerald Swallowtail Butterfly, PO period of two months);
- *"It's about smiling again. To lose weight and be happier."* (Ruby Tiger Butterfly, PO period of seven months);
- *"I was hoping my life would change."* (Queen Alexandra Birdwing Butterfly, PO period of nine months);
- *"Having a good future without the disease and with quality of life."* (Peacock Butterfly, PO period of 12 months).
- *"To control diabetes, to have normal test results. A healthier life with quality of life."* (Zebra Longwing Butterfly, PO period of 18 months).
- *"My expectation was to eliminate all the excess weight that existed in me."* (Orange-tip Butterfly, PO period of 24 months).

When asked if they felt satisfied with their own appearance, all participants said yes and reported that they felt good for themselves in the process of transformation; however, they mentioned that they still needed to improve.

- *"I'm satisfied, but I still feel obese. I see myself in the process and I know that I will change even more."* (Emerald Swallowtail Butterfly, PO period of two months);
- *"I'm fine. I have to improve more."* (Ruby Tiger Butterfly, PO period of seven months);
- *"I'm great. I feel prettier."* (Queen Alexandra Birdwing Butterfly, PO period of nine months);
- *"I'm satisfied. I'm a different person."* (Peacock Butterfly, PO period of 12 months);
- *"I like what I see in myself, I'm a healthier person."* (Orange-tip Butterfly, PO period of 24 months).

All respondents were Catholics and believed it was important to seek God at all times in their lives, and stated that the concept of spirituality was meaningful and clear for them. Overall, the individuals positively characterized themselves in relation to their personality. The psychological characteristic present in almost all subjects was anxiety.

Chart 3. Domains, nursing diagnoses, and Roy's adaptation problems in patients in the pre- and postoperative period of bariatric surgery in the role function mode.

Perioperative period	Domains	Nursing Diagnoses	Roy's Adaptation Problems
Preoperative	Health promotion	00078 – Ineffective health management related to difficulty controlling the complexity of the therapeutic regimen, evidenced by the difficulty with the prescribed regimen.	Obesity control
	Self-perception	00153 – Risk for situational low self-esteem related to body-image disorder.	Low self esteem
	Roles and relationships	00052 – Impaired social interaction related to self-concept disorder, evidenced by dysfunctional interaction with other people.	Social interaction
Postoperative	Coping/stress tolerance	00187 – Readiness for enhanced power evidenced by the expression of willingness to increase participation in health choices.	Healthy organism
	Health promotion	00162 – Readiness for enhanced health management expressed by the desire to improve the management of prescribed regimens.	Obesity control

The identified diagnoses and adaptation problems regarding the self-concept mode are presented in Chart 4.

Interdependence mode

When asked about the most important person in their lives, the participants' responses varied between children, wives, and husbands. All subjects reported that they also lived or interacted with obese people, and that they instructed these people as for the need for managing weight to improve health and quality of life.

- *"Friends. I resolve their doubts and post them on social media so they can keep up with my postoperative period."* (Emerald Swallowtail Butterfly, PO period of two months);
- *"Siblings and friends. I try talking* [about it]*, but my brother doesn't want to have the surgery."* (Ruby Tiger Butterfly, PO period of seven months);
- *"My husband and friends. Some friends have even had the surgery."* (Queen Alexandra Birdwing Butterfly, PO period of nine months);
- *"My siblings, but they didn't seek treatment."* (Zebra Longwing Butterfly, PO period of 18 months).

Next, in Chart 5, the NDs and the adaptation problems for the interdependence mode are presented.

DISCUSSION

The present study evidenced NDs in the preoperative period of bariatric surgery, mainly related to the following adaptation problems: nutrition, activity, rest, self-esteem, and social participation. NDs in the PO period were related to nutrition, sleep pattern, and improvements in self-care, self-perception, communication, and family and social relationships.

In this context, in the physiological mode, the preoperative NDs "obesity," "sedentary lifestyle," and "risk for activity intolerance" represent frequent implications in the lifestyle of obese individuals linked to the adaptation problems of nutrition and sedentary lifestyle. These findings point to a growing increase in overweight and obesity rates in the world's population, which derives from inappropriate health behaviors such as sedentary lifestyle and unbalanced nutrition. These, in turn, corroborate the occurrence of psychosocial and physical impairments among obese individuals[10].

Another important ND was the "ineffective breathing pattern." Among changes resulting from obesity, there is the impairment of respiratory function, which is related to the dimension of oxygenation in the physiological mode of the Roy Adaptation Model, due to decrease in lung compliance and the efficiency of respiratory muscles, which decreases the inspiratory capacity and compromises gas exchange, in addition to favoring the occurrence of respiratory complications[11].

Chart 4. Domains, nursing diagnoses, and Roy's Adaptation Problems in patients who had bariatric surgery in the self-concept mode.

Domains	Nursing Diagnoses	Roy's Adaptation Problems
Coping/stress tolerance	00146 – Anxiety related to situational crises, evidenced by distress, apprehension, growing tension and concern.	Anxiety
Activity/rest	00182 – Readiness for enhanced self-care evidenced by the expression of increasing independence in maintaining well-being.	Self-care
Self-perception	00167 – Readiness for enhanced self-concept evidenced by the expression of satisfaction with their body image and personal identity.	Satisfaction with appearance
Life principles	00068 – Readiness for enhanced spiritual well-being related to prayer and participation in religious activities.	Spirituality

Chart 5. Domains, nursing diagnoses, and Roy's Adaptation Problems in patients who had bariatric surgery in the interdependence mode.

Domains	Nursing Diagnoses	Roy's Adaptation Problems
Roles and relationships	00159 – Readiness for enhanced family processes evidenced by proper communication and positive relationships.	Healthy relationship
Perception/cognition	00161 – Readiness for enhanced knowledge expressed by the desire to improve learning.	Knowledge
	00157 – Readiness for enhanced communication manifested by the desire to improve communication.	Communication

Still on the physiological mode, it was observed that NDs in the PO period were also related to adaptive responses in nutrition, sleep pattern, and chewing. Improvement in nutrition was identified after bariatric surgery, expressed by the ND "readiness for enhanced nutrition," which is shown as a relevant adaptation behavior, considering that change in dietary pattern represents one of the follow-up strategies for surgical treatment to ensure weight management[12].

The presence of insomnia and obstructive sleep apnea before bariatric surgery is common among obese patients, which compromises the basic need for activity and rest. An improvement in the sleep pattern was identified, which reflects a positive post-surgery adaptive response, as it provides greater physical comfort in the long term, with reduced fatigue, sleepiness, and increased physical disposition, favoring well-being and promoting improved quality of life[13].

Concerning the role function mode, three preoperative diagnoses were identified, which were related to ineffective obesity control, self-esteem, and social interaction. Obesity contributes to low self-acceptance, low self-esteem, changes in mood, and increased stress, thus boosting the search for the surgical procedure as a strategy for changing lifestyle and psychological relief[14]. A study identified that people with higher Body Mass Index (BMI) have high levels of anxiety and depression[15].

Conversely, in the PO period, two diagnoses were identified for the role function mode, concerning the willingness to manage obesity and having a healthy body, which shows that the subjects recognize the need for changes in inappropriate health behaviors as well as demonstrate resilience and willingness to make decisions and develop healthy habits to prevent weight regain.

Weight regain is related to the persistence of dysfunctional eating behaviors and can generate feelings of anxiety, frustration, fear, or failure due to frustration over the treatment process. Thus, adherence to care in the PO period becomes relevant to achieve good results after bariatric surgery, which requires holistic follow-up by health professionals, with an approach that permeates both the physical and emotional aspects, aiming to facilitate the patients' coping process and performance of effective adaptive responses[16].

In the self-concept mode, four diagnoses were identified, which were related to adaptation problems of anxiety, self-care, appearance, and spirituality. Anxiety is recurrent in the PO period, being a worrisome symptom because it increases the dependence of nursing care on the part of patients, negatively interfering with the clinical evolution. Hence, care aimed at the subjects' psychological aspects is relevant to promote anxiety relief, in addition to assisting patients to identify situations that favor the occurrence of this symptom and coping strategies[17].

Regarding self-care, the weight loss process after undergoing surgery brings, in addition to benefits to health and quality of life, the recognition of a new identity and the improvement of self-concept and care practices. In this sense, a study carried out in the south of England identified that patients undergoing bariatric surgery, in the PO period, experienced benefits such as improved mobility, performance of daily activities, relief of physical symptoms, and psychological well-being. However, they also dealt with negative changes, such as the development of excess skin and obstacles to eating in social events, which interfere with the subjects' self-perception and coping capacity regarding care and implications for the PO period[18].

Thus, it is worth highlighting that, after surgery, patients face a new process of adaptation in several particularities of their lives such as physical and psychological health, dietary pattern, body image, weight, and social participation. Such changes can be ambivalent when experienced in a positive or negative way, demanding health care that assists in recognizing the achieved benefits, reducing postoperative complications, and adapting to a new lifestyle[18,19].

From this perspective, the inclusion of the family in the entire perioperative period of bariatric surgery is emphasized, in such a way to empower and sensitize family members to provide the necessary support to the patient in complying with the treatment. In the interdependence mode, the ND "readiness for enhanced family processes" demonstrated that there were positive changes in relationships with family members in the PO period of the study participants, which indicates there may have been adequate adaptation of the relatives to the subjects' treatment process which in turn becomes important because it provides a support network that will contribute to the acquisition of good lifestyle habits by patients[20].

Therefore, the importance of comprehensive, individualized, and longitudinal follow-up on the part of health professionals is emphasized, as, throughout the treatment process, numerous doubts and concerns arise, as well as adaptation problems linked to the social determinants of health, whose resolution is pertinent in such a way that patients and families are more qualified to take and provide perioperative care[21].

Furthermore, the implementation of the Roy Adaptation Model with patients undergoing bariatric surgery can support

the provision of individual, holistic, and qualified care, making individuals active agents in their care process, enabling them to identify positive and negative stimuli that interfere with their adaptation to the PO period. In addition, this implementation allows for the development of a care plan consistent with the needs of individuals at each stage after surgery.

As contributions to the field of nursing, this study highlights the feasibility of the applicability of the Roy Adaptation Model in providing care to patients undergoing bariatric surgery, as well as making ND available to this population, based on the identification of phenomena specific to nursing. This can guide the practice of nurses who work in perioperative care in the development of more adequate care plans for this population.

Finally, a limitation of this study is the nonclinical validation of the NDs by expert judges as well as the impossibility of implementing a nursing care plan based on Roy's adaptation problems.

FINAL CONSIDERATIONS

The Roy Adaptation Model enabled to identify NDs and their correlation with modes of adaptation at different times during the perioperative period of bariatric surgery. The predominance of wellness diagnoses suggests that the stimuli present in the subjects' daily lives influence a positive response to the post-surgery adaptation process and that weight loss, increased well-being, and improved health status are the most evident stimuli for the occurrence of this positive response. Further studies should be conducted to compare the adaptation process between the preoperative period and the different phases of the PO period.

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| ERRATUM |

https://doi.org/10.5327/Z1414-4425202100030005erratum

In the manuscript "Nursing diagnoses and Roy's adaptation problems in patients undergoing bariatric surgery", DOI: 10.5327/Z1414-4425202100030005, published in the Rev SOBECC., v. 26, n. 3, p.156-164, on page 156:

Where it reads:

Jennara Câncido de Nascimento[3]

It should read:

Jennara Cândido de Nascimento[3]

PROBLEM SITUATION: AN ACTIVE METHODOLOGY WITH OPERATING ROOM NURSES FOR EDUCATIONAL PROCEDURE ABOUT ANESTHESIA

Situação problema: metodologia ativa para ação educativa sobre anestesia com enfermeiros de centro cirúrgico

Situación problema: metodología activa para la acción educativa sobre anestesia con enfermeros del centro quirúrgico

Cassiane Santana Lemos[1]*, Vanessa Brito Poveda[2]

ABSTRACT: Objective: To test an educational procedure among operating room nurses in order to discuss care limitations during anesthesia. **Method:** A descriptive study about a problem situation based on problem-based learning. A sample composed of 19 nurses that were divided into three groups which resulted in two meetings for a survey, problem resolution and concept synthesis. **Results:** In the first meeting, problem limitations were identified in relation to care organization, knowledge, professionals' training for care practice and problems in the work process, which influenced the nurses' actions. In the second meeting, the formulated questions were answered according to the literature review about anesthesia, care protocols and uniformity of actions. More than half of the nurses investigated considered that the activity contributed as a means to reflect on the nurses' actions in anesthesia, daily activities and professional attitudes as well as on the need for involvement with care and review of concepts. **Conclusion:** The use of problem situation as a methodology for education in nursing supported the conceptual discussions among nurses about anesthesia and the reflection on performance in the operating room.
Keywords: Education, continuing. Problem-based learning. Anesthesia. Operating room nursing. Professional practice.

RESUMO: Objetivo: Testar uma ação educativa entre enfermeiros de centro cirúrgico para discutir as limitações na assistência durante a anestesia. **Método:** Estudo descritivo de uma situação problema fundamentada na aprendizagem baseada em problemas. Amostra composta de 19 enfermeiros, divididos em três grupos, com a realização de dois encontros para levantamento, resolução de problemas e síntese de conceitos. **Resultados:** No primeiro encontro, identificaram-se problemas relacionados a operacionalização da assistência, conhecimento e treinamento dos profissionais para execução de cuidados e problemas no processo de trabalho, que impactam as ações dos enfermeiros. No segundo encontro, responderam-se às questões elaboradas com base na revisão de literatura sobre anestesia, diretrizes de cuidados e uniformidade de condutas. Mais da metade dos enfermeiros avaliou que a atividade contribuiu para refletir sobre as ações do enfermeiro na anestesia, as atividades diárias e a postura profissional, a necessidade de envolvimento com a assistência e a revisão de conceitos. **Conclusão:** O uso da situação problema como metodologia para educação em enfermagem favoreceu a discussão sobre conceitos de anestesia entre os enfermeiros e a reflexão sobre a atuação em sala cirúrgica.
Palavras-chave: Educação continuada. Aprendizagem baseada em problemas. Anestesia. Enfermagem de centro cirúrgico. Prática profissional.

RESUMEN: Objetivo: Probar una acción educativa entre enfermeras de un centro quirúrgico para discutir las limitaciones en la atención durante la anestesia. **Método:** Estudio descriptivo de una situación problemática, basado en el aprendizaje basado en problemas. Muestra compuesta por diecinueve enfermeros, divididos en tres grupos, con dos reuniones de encuesta, resolución de problemas y síntesis de conceptos. **Resultados:** En la primera reunión se identificaron problemas relacionados con dificultades en la operacionalización de la atención; conocimiento y formación de profesionales para realizar cuidados; y problemas en el proceso de trabajo, que impactan la acción de enfermeros. En el segundo encuentro se respondieron las preguntas

[1]Professor at the Nursing School, Universidade de São Paulo – São Paulo (SP), Brazil.
[2]Full Professor at the Nursing School, Universidade de São Paulo – São Paulo (SP), Brasil.
*Corresponding author: cassilemos@usp.br
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elaboradas a partir de la revisión de la literatura sobre anestesia, pautas de atención y estandarización de conducta. Más de la mitad de los enfermeros evaluaron que la actividad contribuyó a reflexionar sobre las acciones de los enfermeros en anestesia, acciones cotidianas y postura profesional, la necesidad de involucramiento con el cuidado y revisión de conceptos. **Conclusión:** El uso de la situación problema como metodología para la formación en enfermería favoreció la discusión sobre conceptos de anestesia entre enfermeros y la reflexión sobre el trabajo en quirófano.

Palabras clave: Educación continua. Aprendizaje basado en problemas. Anestesia. Enfermería de quirófano. Práctica profesional.

INTRODUCTION

In contrast with the traditional teaching method, based on classes and memorizing knowledge obtained passively and with individual reflection, the problem-based learning (PBL) emerged 50 years ago at the McMaster University Medical School and was founded on active learning with collective reflection in small groups to formulate knowledge and strategies that allow the shared resolution of tasks[1].

The PBL is based on the principles of engagement in learning, generating interest in solving real-life problems, reflection on prior knowledge and observations through self-inquiry, construction of knowledge through self-learning and self-assessment[2]. Learning is therefore self-directed by a teacher/advisor, and, by means of group discussions, reasoning strategies are used to combine and synthesize information about a problem or situation, allowing the elaboration of explanatory hypotheses.

In the nursing education process, PBL improves mainly critical thinking, knowledge, autonomy and student satisfaction with learning, in addition to developing an attitude of active search, ability to work as a team, motivation and ability to solve problems[3].

In the context of in-service education, the use of active methodologies in continuing education of nurses can facilitate the addition of updated concepts to prior knowledge, allowing for significant and critical learning[4].

Being an active learner and keeping oneself informed of current knowledge are necessary characteristics for nurses. PBL offers a holistic perspective of a problem, considering an approach focused on the individual, on the environment affecting the person's health and on specific issues that relate to nursing strategies for health management and promotion[5].

OBJECTIVE

To test an educational procedure with operating-room (OR) nurses to discuss the limitations in assistance during anesthesia.

METHOD

This is a descriptive study of the process of applying a problem situation as an educational strategy to discuss nursing care during anesthetic procedure among OR nurses in a private hospital in the city of São Paulo, Brazil.

A problem situation has a clear and neutral description of an event or sets of phenomena that represent a practical reality and need to be explained in terms of processes, principles or mechanisms. The problem must be written to achieve certain educational goals, encouraging participants to study content that is relevant to their educational goals, discuss in groups and then present results[6].

The problem situation task is applied in groups of eight to ten participants, mediated by a tutor/professor. Individuals are presented with a pre-elaborated problem, and the discussion takes place in two phases: first, the participants elaborate learning objectives based on the discussion of the problem; then, after an individual study, the subjects re-discuss the problem, taking into account new knowledge acquired[7]. Thus, the methodological steps of the problem situation are: reading the problem and clarifying terms or expressions; defining the problem to be evaluated; formulating explanations or hypotheses, elaborating learning questions to search for information in the scientific literature that test the formulated hypotheses; building new knowledge and meanings through a knowledge synthesis of the new information obtained, and review of initial hypotheses[6,7].

In the OR of the hospital, the team of clinical nurses had 20 professionals. After guidance on the study, 19 nurses agreed to participate in the educational action.

The educational activity took place in January 2018, with two two-hour meetings and a seven-day break between them. The nurses were divided into three groups: two with six nurses and one with seven nurses, according to their work shift. The meetings took place in a training room at the OR of the hospital.

The researcher was experienced with problem situations aimed to learning perioperative nursing, as she was a

member of the nursing school residency in OR of the institution where the research was conducted, whose teaching strategies are all based on active methodologies.

In the first meeting, the researcher presented the problem situation to the nurses; then, a group discussion was held to raise the problems highlighted and to elaborate learning questions to be searched in the scientific literature.

Seven days after the first activity, the researcher held a new meeting with the groups of nurses, in which the participants presented information obtained in the literature and answered the questions elaborated in the first meeting, aiming to update the concepts about anesthesia and standardize the care actions provided daily by the professionals.

Description of the problem situation

The problem situation was elaborated by the researcher, based on the care needs of patients undergoing general anesthesia and on a previous study that described the role of nurses during the three moments of anesthesia[8]. Thus, the case described was:

You are a nurse in the OR and will prepare it for patient AJS, 65 years old, who will undergo a unilateral total hip arthroplasty procedure. The patient has arterial hypertension and type I diabetes, being classified in the pre-anesthetic evaluation as having a difficult airway.

The anesthesiologist who will perform the procedure informed that he will apply combined general anesthesia, central catheter puncture and invasive blood pressure monitoring. While preparing the OR, you identified that the anesthesia equipment had partially violet soda lime, that there was no flowmeter in the gas sources, that the control of the operating table was not in the room and the alarms of the multiparameter monitor were turned off.

The patient was admitted to the OR, and the professional who performed the transport informed you that the blood type test prescribed by the doctor was not collected and that the patient did not bring a preoperative hip MRI.

The anesthesiologist starts the anesthetic induction and, at the time of intubation, asks you to perform the Sellick maneuver. Intubation occurred after four attempts, with a minimum saturation of 65% and confirmation of intubation through capnography, as there was no stethoscope in the room.

At the end of surgery, the anesthesiologist extubates the patient and requests the transport monitor. The patient has blood pressure 90 x 50 mmHg, saturation (Sat) O_2: 92%, with an O_2 catheter at 5 L/min, heart rate: 110 bpm, output of 50 mL in the lower limb drain and urinary catheter with output of 100 ml. You assist in transferring the patient to bed and inform the medical team that you will not be able to accompany until the intensive care unit, as you are being requested in another room.

In view of the situation presented, discuss the problems identified as a group and formulate learning questions to be searched in the scientific literature.

Data were analyzed according to the content provided by the participants. During the meetings, the researcher wrote down all the problems, hypotheses and learning questions raised by the professionals along with answers to them.

The content presented by the nurses was grouped according to the common themes identified in each group. The study met all ethical criteria for research involving human beings and was approved by the Research Ethics Committee of the Nursing School of Universidade de São Paulo, under CAAE 75167317.0.0000.5392 and opinion 2.340.000.

RESULTS

Nineteen nurses participated in the research, of which 17 (89.47%) were females, with mean age of 33.26 years. The educational action was carried out with three groups of professionals in two two-hours meeting taking place with an interval of seven days.

In the first meeting, the researcher presented the problem situation, encompassing actions performed in all moments of general anesthesia. After discussing the case, the nurses identified problems related to the difficulties in operationalizing the assistance, knowledge and training of professionals for the execution of care and problems in the work process that impact the nurses' activities. At the end of the first meeting, the professionals raised the learning questions to be researched in the scientific literature (Chart 1).

The nurses reported, in the first meeting, that a problem situation in continuing education was a new opportunity that reflected the practical experiences and daily challenges of nurses in anesthesia care, allowing for individual and team self-reflection on attitudes that impact the care for the surgical patient.

In the second meeting, the nurses presented the answers to the learning questions obtained from the literature search, and the concepts about nursing care in anesthesia and its limitations in daily practice were reviewed and updated.

The nurses participated in the discussions by establishing the learning questions in the first meeting and answering

them after searching scientific articles and, mainly, by consulting the care guidelines of medical and nursing specialist societies, as well as institutional protocols of the hospital.

When evaluating the activity in the second meeting, ten (52.6%) nurses reported that it contributed to a reflection on the role of nurses in anesthesia, as they could discuss their daily actions and professional posture, the need for involvement with care and uniformity of knowledge, in addition to the limitations of actions, due to inadequate staffing to supply the needs of patients.

Ten (52.6%) nurses stated that the task offered them an opportunity to review concepts with scientific foundation. However, eight (42.1%) of them reported difficulty in finding answer the questions prepared in the first meeting through scientific articles found in databases.

DISCUSSION

The discussion of concepts by nurses was the basis for obtaining new meanings about their role in anesthesia, considering that professionals had previous knowledge about the procedure and worked in the operating room daily.

During the educational procedure, nurses could identify the relevance of their role in the perioperative assessment of a patient, in the definition of intraoperative care and assistance during the anesthetic procedure, providing materials and care during periods of anesthesia.

The nurses' analysis of the problem situation raised questions about the difficulties to operationalize care, the need for knowledge and training of professionals aiming at quality, and the problems in the work process that influence nurses' activities during anesthesia. There was also a time for discussion between professionals about care needs during anesthesia and the importance of introducing a care protocol.

Nurses also recognized the importance of keeping themselves updated, but reported limitations in the search for information in the literature to support daily practice and encourage critical thinking for improvements in their workplace. Continuing education strategies not always favor the learning of professionals who are in practice, as they need to manage their workload and study time; education systems are not very flexible, with scheduled lectures that do not take into account working hours or the gap between theory and practice[9].

The lack of updating about the most recent evidence in their area of expertise and the follow-up of institutional care protocols, disconnected from a critical reflection on the scientific foundation of the developed actions, limit the transformation of clinical practice and lead to care that is little reflective, based only on institutional norms and routines.

In this context, active teaching-learning methodologies have been used for education and training in health[7], being included in undergraduate nursing courses and bringing greater motivation, interest and involvement of students, faster completion of studies with a lower dropout rate, greater retention of knowledge, development of professional skills and competences, and a stronger connection between theory and practice, integrating knowledge from different disciplines[10].

A study pointed out that changing educational practices with new methodologies such as PBL with nursing students contributed to developing skills for communication with patients and other professionals in the health team, aspects that can favor the effectiveness of care and a better patient-nurse relationship[11]. Added to this, the student takes an active role in decision-making regarding the cases and problems presented, which allows them to develop significant professional skills such as teamwork, planning, communication and critical thinking[12].

PBL promotes clinical reasoning by increasing self-efficacy in self-learning, using clinical reasoning and problem-solving pathways while transferring skills to clinical practice, building team knowledge, and developing leadership skills. It helps nursing students to become independent learners who are motivated to seek new information, relying more on problem-solving skills than on experience[13].

However, since the beginning of PBL, educational institutions and teachers also faced difficulties during the implementation of this methodology, involving a series of experiments, failures and lessons learned, with emphasis on the preparation of a tutor when developing activities and gathering groups during teaching activities[1].

In clinical practice, the continuing education of nurses in health organizations should be part of both the thinking and acting of professionals, with the objective of promoting personal and professional growth, contributing to organize care. It should favor the development of innovative agents that can transform their reality, allowing to produce changes, strengthen reflection in action, teamwork and the ability to manage work[14]. Thus, four factors can influence the impact of permanent education by health institutions: the organizational culture, to align between development plans for individual needs of professionals and organizational needs; the partnership, where

Chart 1. Problems identified in the problem situation, explanatory hypotheses, learning questions and answers elaborated by groups 1, 2 and 3.

Problems identified	Problem category	Explanatory hypotheses	Learning questions	Answers to learning questions
Pre-induction period				
- Inadequate preoperative preparation: lack of blood type test and examination (GROUPS 1, 2 and 3).	Operationalization of assistance	- Lack of communication within the preoperative team leads to inadequate care planning (GROUPS 1, 2); - Inadequate patient preparation can lead to intraoperative risk (GROUP 3).	- How is the communication between care teams made in face of the surgical patient? (GROUP 1); - What are the difficulties encountered in preparing the preoperative patient? (GROUPS 2, 3).	- Importance of patient assessment at all stages of the perioperative period, with the application of SPNC (GROUP 1); - Difficulty in communication between the inpatient unit and the surgical center nurse in exchanging information about the patient's preoperative assessment and continuity of care; reduction of failures with the recording of patient information and items sent to the operating room (GROUPS 2, 3).
- Patient's clinical conditions (age, hypertension, diabetes, DA and high-complexity surgery (GROUPS 1, 2 and 3).	Professional knowledge	- Unavailability of DA materials and equipment increases the risk of anesthetic complications (GROUP 1, 2); - Presence of risk factors increases the possibility of complications with the patient (GROUP 3).	- What defines DA and what materials are needed? (GROUPS 1, 2, 3); - What are the main risk factors that can cause complications in anesthetic induction? (GROUP 3).	- They described the criteria for classification of a patient with DA, considering the Mallampati, Comarch assessment and predictors (limited cervical mobility, dentition alteration, palate shape, thyromental distance, obesity). Among the materials, they mentioned the bougie guidewire, combitube, laryngeal mask, cricothyroidotomy needle, fast track mask, fiberscope, exchanger probe, flexible stylet and videolaryngoscope (GROUPS 1, 2 and 3); - They identified national guidelines on the importance of pre-anesthetic assessment to identify risk factors such as clinical and surgical history, use of medications, age (GROUP 3).
- Inadequate operating room preparation: violet soda lime, flowmeter, monitor alarms off, operating table control, material for difficult intubation, stethoscope (GROUPS 1, 2 and 3).	Problems in the work process	- Inadequate operating room preparation can compromise patient safety during anesthetic induction and the performance of professionals (GROUPS 1, 2 and 3).	- How can nurses contribute to anesthesia care? (GROUP 1); - What are the instruments needed to ensure proper preparation of the operating room? (GROUPS 2 and 3).	- Absence of guidelines for the work of nurses in Brazil in anesthesia, unlike the American practice (GROUP 1); - Importance of a checklist of materials needed in the operating room during the anesthetic-surgical procedure. The nurse must check the room setup, but there is difficulty in supervision due to the high number of rooms under their responsibility (GROUPS 2 and 3).

Continue...

Chart 1. Continuation.

Problems identified	Problem category	Explanatory hypotheses	Learning questions	Answers to learning questions
Induction period				
- Four intubation attempts (GROUP 1); - Four intubation attempts and O_2 saturation at 65%; - Hemodynamic instability of the patient in reversion of anesthesia (GROUP 3).	Professional knowledge and training	- Lack of knowledge and training of professionals about surgery and anesthesia impact care (GROUP 1); - Lack of evaluation and proper management by the multidisciplinary team in intra and postoperative periods can influence the patient's hemodynamic conditions (GROUP 3).	- What is the proper sizing of nursing team for the operating room? (GROUP 1); - What are the nurse's attributions in anesthetic induction? (GROUP 3).	- Nurses must manage up to four rooms, but they face limitations given their care and management role. The nurse must provide resources for the anesthetic procedure, assist in intubation, in the assessment of adequate ventilation and in the control of hemodynamic parameters with the anesthesiologist (GROUP 1); - Absence of a national guideline, but one care protocol initiative published (GROUP 3).
Reversion period				
- Nurse's absence during transport to the intensive care unit and patient instability (GROUPS 1, 2 and 3).	Operationalization of assistance	- The absence of a nurse during patient transport can compromise patient safety (GROUPS 1, 2 and 3).	- How to carry out safe transport of critical patients? (GROUPS 1 and 2); - What is the proper sizing of the nursing team in the operating room? (GROUP 3).	- The transport of patients must take place after the nurse's assessment, considering hemodynamic conditions; no guideline for mandatory nurse presence, but follow-up is suggested, in addition to monitoring and adequate ventilatory support (GROUPS 1 and 2); - The dimensioning in the operating room, in addition to the number of rooms, must also consider the severity of each patient (GROUP 3).

SPNC: systematization of perioperative nursing care; DA: difficult airway.

there is integration between service needs, team and availability of relevant courses to improve the practice, the manager having a fundamental role in supporting his team; the support to a learning environment; and the improvement of practice by developing knowledge and skills[9].

The literature points out that using active methodologies in continuing education of nursing professionals favors the development of technical skills for the establishment of safe practices and the promotion of professional knowledge, thus improving the quality of service provided[15]. Furthermore, when learning in small groups, professionals motivate each other to share knowledge in a collaborative way[16].

The study presented as limitation the carrying out of research in a single surgical center. However, it is an initial step to reflect on the processes of continuing education in health services and their importance to improve nursing care practices.

Therefore, the change in teaching methods towards a more participative role of nurses in their own training and updating process contributes to active search for improvements in practice and changes in traditional paradigms, developing autonomy and strengthening the profession.

CONCLUSION

An educational procedure for OR nurses, through the PBL, allowed the discussion of common themes in the anesthesia work routine, favoring the review of concepts about their daily practice. The problem situation, in turn, allowed a reflection on the difficulties faced by OR nurses during the anesthetic procedure and the importance of seeking improvements in daily actions.

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EDUCATION AT THE MATERIALS AND STERILIZATION CENTER: AN INTEGRATIVE REVIEW

Educação no centro de materiais e esterilização: revisão integrativa

Educación en el centro de materiales y esterilización: revisión integrativa

Carolina Gerhardt Primaz[1*], Rúbia Knobeloch dos Santos[2], Jessyca Zanetti Malgor Oliveira[3], Paôla Maros Heinen[3], Rita Catalina Aquino Caregnato[4]

ABSTRACT: Objective: To analyze the publications of the last five years about education at the Materials and Sterilization Center. **Method:** Integrative review with search in databases: Latin American and Caribbean Health Sciences Literature, Online Medical Literature Analysis and Retrieval System, Scopus Info Site, Web of Science, Cumulative Index to Nursing and Allied Health Literature via EBSCOhost, Cochrane, and Virtual Health Library. **Results:** Ten articles were selected, all of them considering it essential to constantly update and make available minimum resources to carry out professional activities with improvements in clinical practice. Four publications identified perceptions of education, knowledge gaps and development opportunities. The educational strategies used were: continuing education with teaching materials, application of theoretical and practical training, restructuring of processes with technical training, on-site educational mentoring programs and professional self-reflection on best practices. **Conclusion:** The publications reinforce the importance of educational interventions for professional training, with view to them mastering new technologies, providing quality services and having a favorable impact on the effectiveness of health products' processing.

Keywords: Sterilization. Education. Patient safety.

RESUMO: Objetivo: Analisar as publicações dos últimos cinco anos com temas sobre educação em Centro de Materiais e Esterilização. **Método:** Revisão integrativa com busca nas bases de dados: Literatura Latino-Americana e do Caribe em Ciências da Saúde, Medical Literature Analysis and Retrieval System Online, Scopus Info Site, Web of Science, Cumulative Index to Nursing and Allied Health Literature via EBSCOhost, Cochrane e Biblioteca Virtual em Saúde. **Resultados:** Selecionados dez artigos, todos consideraram indispensáveis a atualização constante e a disponibilização de recursos mínimos para realização das atividades profissionais com melhorias na prática clínica. Quatro publicações identificaram as percepções quanto à educação, lacunas de conhecimento e oportunidades de desenvolvimento. Estratégias educacionais utilizadas: educação permanente com materiais didáticos, aplicação de treinamento teórico e prático, reestruturação dos processos com treinamento técnico, programas de mentoria educativa *in loco* e autorreflexão profissional sobre melhores práticas aplicadas nos processos de trabalho. **Conclusão:** As publicações reforçam a importância de intervenções educativas para capacitação profissional, domínio de novas tecnologias, prestação de serviço de qualidade e impacto favorável na eficácia do processamento de produtos para a saúde.

Palavras-chave: Esterilização. Educação. Segurança do paciente.

RESUMEN: Objetivo: Analizar las publicaciones de los últimos cinco años con temas de educación en el Centro de Materiales y Esterilización. **Método:** Revisión integradora con búsqueda en bases de datos: Literatura de Ciencias de la Salud de América Latina y el Caribe, *Medical Literature Analysis and Retrieval System Online*, *Scopus Info Site*, *Web of Science*, *Cumulative Index to Nursing and Allied Health Literature via EBSCOhost*, COCHRANE y Biblioteca Virtual en Salud. **Resultados:** Se seleccionaron 10 artículos, todos considerados imprescindibles a la constante actualización y disponibilidad de recursos mínimos para realizar actividades profesionales con mejoras en la práctica clínica. Cuatro publicaciones identificaron percepciones de educación, brechas

[1]Master's Student of the Postgraduate Program in Health Education, Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA) – Porto Alegre (RS), Brazil.
[2]Nurse from UFCSPA. Resident Nurse of the Intensive Care Program at UFCSPA, Santa Casa de Misericórdia de Porto Alegre – Porto Alegre (RS), Brazil.
[3]Undergraduate in Nursing, UFCSPA – Porto Alegre (RS), Brazil.
[4]PhD in Education from Universidade Federal do Rio Grande do Sul. Adjunct Professor of the Department of Nursing at UFCSPA – Porto Alegre (RS), Brazil.
*Corresponding author: carolinagp@ufcspa.edu.br
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de conocimiento y oportunidades de desarrollo. Estrategias educativas utilizadas: formación continua con material didáctico, aplicación de formación teórica y práctica, reestructuración de procesos con formación técnica, programas de tutoría educativa presencial y autorreflexión profesional sobre las mejores prácticas aplicadas en los procesos de trabajo. **Conclusión:** Las publicaciones refuerzan la importancia de las intervenciones educativas para la formación profesional, el dominio de las nuevas tecnologías, la prestación de servicios de calidad y el impacto favorable en la efectividad del procesamiento de los productos sanitarios.

Palabras clave: Esterilización. Educación. Seguridad del paciente.

INTRODUCTION

The Materials and Sterilization Center (MSC) is a very specific and important area within a health service, being fundamental for its structure and functioning. In this sector, diversified practices that require specialized knowledge are carried out in order to properly process and provide health care products (HCP), ensuring safety in the care of patients[1,2].

The activities developed at the MSC include receiving dirty / contaminated materials, cleaning, inspection, preparation, disinfection and sterilization, storage and distribution[3]. All processes in this sector are intended to prevent health-care-related infections (HAIs), following scientific evidence for practice of quality in the preparation of HCP[4].

Professionals who work at the MSC do not only perform routine and repetitive activities, but also provide indispensable technical support by guaranteeing safe and contamination-free materials for patient care[5,6]. So they must understand the relevance and importance of these processes. Keeping up with technological advances and changes in other health sectors is essential, including the development of new instruments and surgical techniques[2,7,8].

From the understanding of work processes and recognition of the increasingly complex and sophisticated activities carried out at the MSC, the importance of qualified and motivated human resources is increased[1]. Therefore, education strategies that reinforce the improvement of MSC professionals are important to ensure the quality and safety of service, considering the lack of specificity during professional training[9,10].

Therefore, the implementation of continuing education (CE) and continuing education in health (CEH) activities is essential to promote changes in work processes and relationships between subjects and the environment, expanding learning spaces and contributing to the development of both the professionals and the service itself[4].

Given this scenario, the interest in researching the topic of education at the MSC emerged. The intention is to provide an updated overview on the production of knowledge in the area of education aimed at professionals who works on the front-line HCP processing.

OBJECTIVE

To analyze the publications of the last five years addressing education in MSC.

METHOD

This is an integrative review, which allows to synthesize and analyze the scientific knowledge available in the search for data that answer a research question[11,12].

To meet the methodological rigor, the article followed six steps:

- identification of the theme and selection of the research question;
- establishment of inclusion and exclusion criteria;
- identification of pre-selected and selected studies;
- categorization of selected studies;
- analysis and interpretation of results;
- presentation of review or knowledge synthesis[11,12].

The following research question was formulated: what has been published about the education of professionals working in the MSC?

To delimit the search, the inclusion criteria was scientific articles published in full, from January 2015 to October 2020, with free online access, that addressed the research question, regardless of their typology. Exclusion criteria were: publications classified as editorial, letter to editors, dissertations, theses, manuals, and protocols.

Data were collected from online scientific databases: Latin American and Caribbean Health Sciences Literature (Lilacs), Online Medical Literature Analysis and Retrieval System (Medline/PubMed), Scopus Info Site (Scopus), Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINaHL) via EBSCOhost, Cochrane and the Virtual Health Library (VHL).

The search for articles in the databases was performed from August 20th to October 7, 2020. The controlled descriptors obtained in the Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH) were: sterilization, education, continuing, professional and medical devices. Uncontrolled descriptors were also used: central sterile supply department, sterile processing department and sterilizing practices. The descriptors defined for the search were combined by the Boolean operators "AND" and/or "OR" and tested in different associations, resulting in the sequences of combinations presented in Chart 1.

To restrict the results that met the research question, the fourth combination was chosen and, after applying the filters, 13,346 articles were identified. After screening by title, 264 articles remained. Of these, 213 were eliminated after reading the abstracts for presenting one or more exclusion criteria and 30 for being repeated in different databases. After reading the articles in full, 11 were excluded for not meeting the research topic, and the ten articles that met the criteria previously defined and answered the guiding question were kept, thus constituting the final sample.

Chart 1. Descriptors combined with Boolean operators used in the article search steps.

Search steps	Combinations of descriptors with Boolean operators
1st	*Sterilization AND Education OR Continuing Education*
2nd	*Sterilization OR Medical devices OR Central sterile supply department AND Education OR Continuing Education OR Professional Education*
3rd	*Sterilization OR Medical devices OR Central sterile supply department OR Sterile processing department AND Education OR Continuing Education OR Professional Education*
4th	*Sterilization OR Medical devices OR Central sterile supply department OR Sterile processing department OR Sterilizing practices AND Education OR Continuing Education OR Professional Education*

The study followed the steps recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Prism)[13], as shown in Figure 1.

For data collection, a detailed instrument containing the following variables was used: title, journal, authors, year of publication, objectives, methods and results. In the following step, we carried out an analysis and synthesis of the articles obtained descriptively.

The articles were evaluated and classified according to their scientific rigor, according to the characteristics of each study, enabling a classification by level of evidence. At this stage, an instrument based on the Rating System for the Hierarchy of Evidence for Intervention/Treatment Question[14] was used to classify the level of evidence (LE) of the studies, shown in Chart 2.

RESULTS

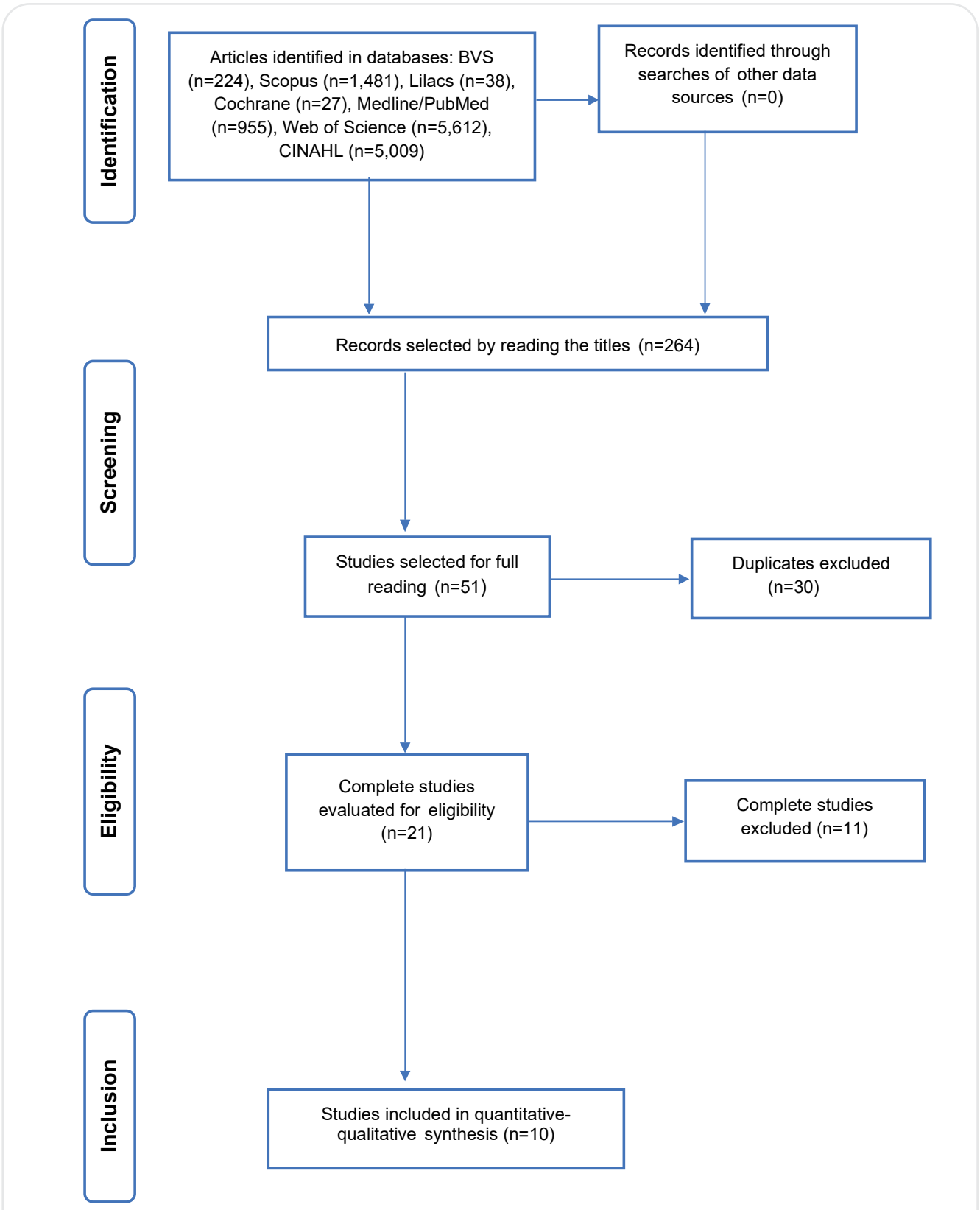
Among ten publications selected, 50% had been published in foreign journals. Of these, five were from Brazil, two from Africa, one from Australia, one from the United States and one from China. The periodicals in which the articles were published were: two in Revista SOBECC and two in Revista de Enfermagem of the Federal University of Pernambuco (UFPE) OnLine, and the others in the periodicals below: Revista Mineira de Enfermagem (Reme); Elsevier Journals — Infection, Disease & Health; Surgical Infections; BMC Health Services Research; Antimicrobial Resistance and Infection Control; PlosOne.

As for the study design, we had: six exploratory descriptive studies, one literature review, two experience reports and a cohort study. According to the Rating System for the Hierarchy of Evidence for Intervention/Treatment Question[14], they were classified as follows: one article with evidence level 4, one with evidence level 5, six with evidence level 6 and two with evidence level 7. Chart 3 presents the characteristics of the articles.

Chart 4 presents a summary of the objectives and results of the studies included in this integrative review.

DISCUSSION

The use of educational strategies to qualify professionals who work in the MSC has been of national and international interest. Interventions have intensified in the last decade, in



BVS: Biblioteca Virtual em Saúde. Scopus: Scopus Info Site; Lilacs: Literatura Latino-Americana e do Caribe em Ciências da Saúde; Medline/PubMed: Medical Literature Analysis and Retrieval System Online; CINAHL: Cumulative Index to Nursing and Allied Health Literature.

Figure 1. Flowchart of studies' selection based on methodologies used for education in the Material and Sterilization Center.

Chart 2. Classification of level of evidence.

Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions	
NE1	Evidence from systematic reviews or meta-analysis of randomized clinical trials
NE2	Evidence from randomized clinical trials
NE3	Evidence from clinical trials without randomization
NE4	Evidence from case-control and cohort studies
NE5	Evidence from systematic reviews of descriptive and qualitative studies
NE6	Evidence from descriptive or qualitative studies
NE7	Evidence from opinions from authorities/expert reports

Source: *Rating System for the Hierarchy of Evidence for Intervention/Treatment Question*[14].

line with the World Health Organization (WHO), which insistently recommends the implementation of continuing education programs as an essential initiative to develop professional skills and raise the standards of care procedures[2], ensuring reliability and safety in the prevention of HAIs.

The teaching and learning actions used to train professionals, in addition to demonstrating effective results in the qualification of teams working with HCP in several countries[16,18,22-24], are tools for professional motivation and enhancement[19,20,22,23]. However, the lack of robust guidelines and adequate infrastructure is a substantial obstacle that impacts the incidence of process gaps and directly affects patient safety[21,22].

Additionally, among the proper conditions for adequate performance of MSC professionals, constant updating and

Chart 3. Characterization of articles addressing education in a Material and Sterilization Center published in journals between 2015 and 2020.

Authors, year and country	Heading	Journal	Study design	Level of evidence
Athanázio e Cordeiro, 2015[15] Brazil	Continuing education for workers of a material and sterilization center	*Revista de Enfermagem UFPE On Line*	descriptive, exploratory, qualitative	NE6
Tolson e Friedewald, 2016[16] Australia	Beyond the patient zone: improving hand hygiene performance in a Sterilising Services Department	*Journals Elsevier – Infection, Disease & Health*	Case report	NE7
Farias et al., 2016[17] Brazil	Continuing education in a material and sterilization center: perception of the nursing team	*Revista de Enfermagem UFPE On Line*	Qualitative, quantitative, descriptive, cross-sectional	NE6
Paula et al., 2017[18] Brazil	Elaboration of didactic material for processing health products in primary health care units	*Revista SOBECC*	Case report	NE7
Bugs et al., 2017[19] Brazil	Profile of the nursing staff and perceptions of the work performed in a materials center	*REME*	Descriptive, qualitative	NE6
Lucon et al., 2017[20] Brazil	Training of nurses to work in the central sterile supply department nurse	*Revista SOBECC*	Qualitative, descriptive	NE6
Forrester et al., 2018[21] USA	Surgical instrument reprocessing in resource-constrained countries: a scoping review of existing methods, policies, and barriers	*Surgical Infections*	Scoping review	NE5

Continue...

Chart 3. Continuation.

Authors, year and country	Heading	Journal	Study design	Level of evidence
Wang et al., 2018[22] China	Application of a sub-specialties management model improves quality control in a central sterile supply department	*BMC Health Services Research*	Descriptive mixed	NE6
Fast et al., 2018[23] Benin	Mixed methods evaluation of the impact of a short term training program on sterile processing knowledge, practice, and attitude in three hospitals in Benin	*Antimicrobial Resistance and Infection Control*	Comparative, retrospective	NE4
Fast et al., 2019[24] Ethiopia	The impact of a short-term training program on workers' sterile processing knowledge and practices in 12 Ethiopian hospitals: a mixed methods study	*PLoS One*	Descriptive mixed	NE6

Chart 4. Synthesis of articles on MSC education published in journals from 2015 to 2020.

Authors, year and country	Objective	Methodological aspects	Results
Athanázio e Cordeiro, 2015[15] Brazil	To assess how continuing education functions on the qualification of nursing professionals at the MSC.	Application of semi-structured interviews with content analysis using the Bardin method.	Previous Note article presents results expected to contribute to a better understanding of the National CEH Policy by professionals working at the MSC; implementation and development of CEH in the unit; and future reflections, discussions and research on CEH.
Tolson e Friedewald 2016[16] Australia	To report the construction and application of the "5 steps" of hand hygiene at the MSC.	Description of the implementation of an audit program associated with training educational activities for effective hand hygiene technique.	The intervention promoted increased awareness of the need to improve personal hand hygiene practices. Global adherence to hand hygiene practice increased from 43% to 88%.
Farias et al., 2016[17] Brazil	To identify the perception of nursing professionals about continuing education at the MSC.	Application of a questionnaire with closed and objective questions, and semi-structured interview with collective subject discourse (CSD) analysis.	CSD showed that the concept of CE is understood as education aimed at improving the professional's performance. We identified absence of CE activities and the team's insecurity regarding new technologies.
Paula et al., 2017[18] Brazil	To report the experience of preparing a booklet on the processing of HCP in Primary Health Care Units.	Construction of educational material in booklet format involving three steps: preparation of content based on scientific literature; selection of illustrations on online search engines; elaboration and assembly.	The booklet was structured in four chapters: 1. MSC: infrastructure concepts and requirements; 2. Classification of articles and biosafety in MSC; 3. MSC areas and HCP processing steps; 4. Monitoring the sterilization process.
Bugs et al., 2017[19] Brazil	To draw the profile of the nursing team, identify the CE processes and the perceptions of the MSC team about their work process.	Application of a semi-structured questionnaire to collect personal data, professional profile information and valuing of the work by the nursing team.	Training on technical activities of the work process identified, but only 56.25% of respondents were trained over two years of work at the MSC.

Continue...

Chart 4. Continuation.

Authors, year and country	Objective	Methodological aspects	Results
Lucon et al., 2017[20] Brazil	To understand the training of nurses to work in the MSC.	Application of interviews with Bardin content analysis.	Content analysis showed difficulties in learning MSC practices, identifying knowledge gaps and deepening theoretical foundations. The construction of learning requires articulation between theory and practice through a comprehensive approach.
Forrester et al., 2018[21] USA	To explore the up-to-date status of HCP reprocessing in low- and middle-income countries and categorize barriers to implementing guidelines and safe practices.	Scoping review with description of current methods, guidelines and barriers for HCP reprocessing in low- and middle-income countries.	Deficits in the structure and workforce of the MSC due to insufficient training and education, in addition to outdated technology and lack of resources.
Wang et al., 2018[22] China	To investigate the effect of a routine management model by subspecialties in HCP processing on quality control and satisfaction of MSC professionals.	Use of a routine subspecialty model associated with ongoing staff training compared to the traditional model. Application of a questionnaire to assess professional skills.	The adaptation of routines for HCP processing by subspecialty showed better results in improving theoretical knowledge and practical skills, reflecting in the reduction of failures in processes and increasing the satisfaction of the areas served.
Fast et al., 2018[23] Benin	To evaluate the impact of training on knowledge, skills and professional practices, identifying institutional changes in HCP processing.	Application of a theoretical course followed by on-site practical mentoring. Intervention analysis through hospital assessments, knowledge tests and semi-structured interviews.	The thematic analysis of the interviews identified five key themes related to the change in the professionals' practices and attitudes after the intervention: 1. Changing things already done; 2. Changing the way things are seen; 3. Paying more attention; 4. Reducing surgical site infections; 5. Concerns about resources.
Fast et al., 2019[24] Ethiopia	To identify the impact of an education program focused on HCP reprocessing in 12 Ethiopian health facilities.	Application of a program of theoretical classes associated with training and on-site mentoring.	The knowledge test results showed significant improvements in knowledge acquisition. The practical improvement was statistically significant in several areas of the MSC after the program was implemented.

MSC: Material and Sterilization Center; CEH: Continuing Education in Health; PE: Permanent Education; CE: Continuing Education; CSD: Collective Subject Discourse; HCP: Healthcare Products.

the availability of minimum resources for the practices evaluated as essential for implementing improvements in clinical practice were mentioned in the ten studies[15-24]. In this sense, the development of technical skills to manage HCP can be monitored and improved through a variety of interventions such as permanent education with the implementation of teaching materials[15,18], application of theoretical and practical training programs[16,19,22-24], restructuring of work processes based on technical training[16,22,24], in loco educational mentoring programs[24] and self-reflection on best practices applied to work processes[15,17,20,21].

Continuing and permanent education, based on booklets and other teaching materials, are simple and viable proposals that facilitate management methods and benefit care practice[18], being in line with the National Policy on Continuing Education in Health[15], which can be starting point to stimulate actions to improve MSC professionals. However, data measuring the relationship with improvements in care indicators are not documented in the scenarios of these interventions.

Regarding the theoretical and practical training programs, the impacts on professional practice were monitored, including implementation of new attitudes during service, functional changes, implementation of best practices according to technical recommendations, and changes in the perception of the importance and result of the work for the quality of care provided, impacting the reduction of surgical infections[23,24].

Adhering to new practices is closely related to an understanding of tangible benefits and impacts. Measuring results and sharing data can contribute to improving organizational culture.

A study conducted in New South Wales[16], with an intervention to improve the quality of hand hygiene by the MSC team, achieved compliance with this practice as to the local benchmark through an audit program with team peers, with the association of theoretical-practical activities in the format of distance education. The result of hand hygiene rates over 18 months went from 43 to 88% compliance since the beginning of the program's implementation. In addition to this achievement, other benefits were reported by the team: optimism, self-responsibility, awareness, and cultural change.

An intervention carried out in a hospital in the city of Suzhou[22] added a routine subspecialty model for HCP processing coupled with ongoing staff training. The results showed that improving theoretical knowledge and practical skills, in addition to contributing to gains in efficiency and service quality, also impacts other dimensions of the practice and how other areas of the health service see the MSC.

Four[17,19-21] out of the ten publications included in the analysis were aimed at identifying the profile of professionals in this context when it comes to perceptions of education at the MSC, knowledge gaps and development opportunities. The results of the studies reinforced the importance of educational interventions as a professional training tool for mastering new technologies, providing quality services and having a favorable impact on the efficiency of HCP processing[17,19-21].

Considering the results of this study, there were few publications addressing education strategies in MSC. One limitation may be the standardization of descriptors for search in different databases. Considering the specifics of each platform, it can be assumed that using different descriptors for each database would be more effective.

However, in the search process, the relevance of the topic was evident, often mentioned as fundamental to promote improvements in the organizational culture and in the practices of health services at all levels of care, both in developed and developing countries[16,18,23].

FINAL REMARKS

This article aimed to analyze recent publications that addressed education in the MSC. The articles selected had a low level of evidence and 40% of the studies did not apply educational strategies, but were intended to identify the perceptions of professionals about training in the MSC.

The results show the importance of fostering new research to identify the training needs of professionals working at the MSC and to publicize existing education initiatives, in order to encourage the continuous improvement of this vital area of health services. The implementation of educational interventions enables the technical development and the mastering of new technologies, reducing flaws in HCP processing, improving the quality of the service provided, and stimulating the engagement, awareness and satisfaction of professionals.

More research on this theme is suggested, with the aim of promoting the qualification and appreciation of the teams that work on the front lines of HCP processing.

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AECIZATION OF MEDICAL DEVICES STERILIZED TO ETHYLENE OXIDE: CONSIDERATIONS ABOUT BRAZILIAN REGULATION

Aeração de dispositivos médicos esterilizados a óxido de etileno: considerações acerca da regulação brasileira

Aireación de dispositivos médicos esterilizados con óxido de etileno: consideraciones sobre la regulación brasileña

Eliana Auxiliadora Magalhães Costa[1]*

ABSTRACT: Objectives: To describe acceptable residual levels of ethylene oxide in medical devices, analyze recommended aesther processes and compare them with the Brazilian regulation. **Method:** Integrative literature review, with specific descriptors, without year of publication restriction. Data search between October and November 2019, which resulted in 34 studies included in the study. **Results:** Current Brazilian regulation is outdated in relation to product classification, the determination of waste values ethylene oxide toxic in medical devices and the recommended processes for the aecization of these products, and may contribute to risks of adverse events for patients users of inappropriately aenated devices, and consequently urge their update. **Conclusion:** The shortcomings of this regulatory framework indirectly benefit companies that outsource ethylene oxide sterilization by omitting essential controls for safety of the patient exposed to possible toxic residues of ethylene oxide, unsafe practices of sterilization of health products, in addition to hindering the control of health service by the country's health surveillance.
Keywords: Equipment and supplies. Sterilization. Ethylene oxide; Toxic waste.

RESUMO: Objetivos: Descrever níveis residuais aceitáveis de óxido de etileno em dispositivos médicos, analisar processos de aeração recomendados e compará-los com a regulação brasileira. **Método:** Revisão integrativa da literatura, com descritores específicos, sem restrição de ano de publicação. Busca dos dados entre outubro e novembro de 2019, que resultou em 34 estudos incluídos no estudo. **Resultados:** A regulação brasileira vigente está desatualizada em relação à classificação de produtos, à determinação de valores de resíduos tóxicos de óxido de etileno em dispositivos médicos e aos processos recomendados para a aeração desses produtos, podendo contribuir para riscos de eventos adversos para pacientes usuários de dispositivos inadequadamente aerados, e, consequentemente, urge sua atualização. **Conclusão:** As lacunas desse marco regulatório beneficiam indiretamente as empresas que terceirizam a esterilização a óxido de etileno ao omitir controles essenciais para a segurança do paciente exposto a possíveis resíduos tóxicos de óxido de etileno, favorecer práticas inseguras de esterilização de produtos para saúde, além de dificultar o controle de serviço de saúde pelas vigilâncias sanitárias do país.
Palavras-chave: Equipamentos e provisões. Esterilização. Óxido de etileno. Resíduos tóxicos.

RESUMEN: Objetivos: Describir los niveles residuales aceptables de óxido de etileno (OE) en dispositivos médicos, analizar los procesos de aireación recomendados y compararlos con la normativa brasileña. **Método:** revisión integrativa de la literatura, con descriptores específicos, sin restricción de año de publicación. Búsqueda de datos entre octubre y noviembre de 2019, que resultó en 34 estudios incluidos en el estudio. **Resultados:** La normativa brasileña actual está desactualizada en cuanto a la clasificación de productos, determinación y valores de residuos tóxicos de OE en dispositivos médicos y procesos recomendados para la aireación de estos productos, lo que puede contribuir al riesgo de eventos adversos para los pacientes que utilizan una aireación inadecuada de dispositivos y, en consecuencia, se necesita urgentemente una actualización. **Conclusión:** Las brechas en este marco regulatorio benefician indirectamente a las empresas que externalizan la esterilización a OE, al omitir controles esenciales para la seguridad de los pacientes expuestos a posibles residuos tóxicos de OE, favoreciendo prácticas inseguras de esterilización de productos sanitarios, además de dificultar el control de servicio de salud por la Vigilancia Sanitaria del país.
Palabras clave: Equipos y suministros. Esterilización. Óxido de etileno; Residuos tóxicos.

[1]Postdoctoral degree in Public Health; Full Professor at the Universidade do Estado da Bahia (UNEB) – Salvador (BA), Brazil.
*Corresponding author: costaeliana2003@hotmail.com
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INTRODUCTION

The reuse of medical devices classified as "reusable" or "multiple-use" requires reprocessing, a method that consists of converting a contaminated product into a ready-to-use instrument. It includes not only cleaning, disinfecting, or sterilizing the product but also ensuring its technical-functional safety through integrity and functionality testing[1-4].

The literature agrees that the reprocessing of health products (HP) is a complex issue, given the risks related to the potential transmission of pathogens and the integrity and performance problems of reused products[5-7].

The risk of pathogen transmission through the use of medical products depends on the presence of microorganisms, the type of procedure to be performed, and the body site where the product will be used[5]. Among the risks associated with HP reprocessing and reuse, the literature mentions: infection, presence of endotoxins, biofilms, loss of material integrity, bioincompatibility, and others[1-7].

Medical devices considered critical (inserted into sterile body parts) and thermosensitive (those that do not resist high-temperature sterilization methods) require low-temperature sterilization methods to be reused, including ethylene oxide (EO), hydrogen peroxide plasma, formaldehyde vapor, and ozone sterilization[8,9]. Among these methods, EO sterilization is the oldest and regarded as the gold standard due to the high diffusibility and power of the sterilizing gas; however, it is also the most toxic[8-19].

EO-sterilized products may present toxic residues (ethylene chlorohydrin [ECH] and ethylene glycol), which, if not removed, can harm patients users of these products, professionals who manipulate them, and the environment. Therefore, it is imperative that these HP be submitted to a process called "aeration" to remove toxic waste[8-20].

In Brazil, the standard regulating the EO sterilization of medical devices — Interministerial Decree No. 482[21] — dates back to the 1990s.

In this scenario, this study prioritizes the risk of toxic EO residues in products sterilized by this agent and seeks to answer the following central question: what are the acceptable levels of EO residues in sterile medical devices, and which parameters guide their aeration?

OBJECTIVES

The present study aims to describe acceptable residual levels of EO in medical devices, analyze aeration processes recommended in the literature, and compare them to the current Brazilian regulation in order to prevent risks for patients who use these devices.

METHOD

This is an integrative literature review, a method that allows analyzing studies with different methodologies on a particular theme, potentially producing new knowledge[22].

The present investigation followed these steps: identification of the study object and elaboration of the guiding question; data search and definition of inclusion and exclusion criteria for the sample; determination of the information to be extracted from the selected studies; assessment of the studies included in the review; presentation of the review; summary of the results.

The studies were obtained from searches in the Virtual Health Library portal, CAPES journals, and Web of Science. The set of health descriptors used in the search for publications was: *ethylene oxide gas sterilization* AND *time aeration of sterilized materials*; *ethylene oxide gas sterilization* AND *absorption sterilized materials*.

The inclusion criteria adopted in the study were: articles published in English, Spanish, and Portuguese, in any year, in the databases consulted, and with access to the full text. Articles on EO that did not address product aeration, published in other languages, and with paid access were excluded.

Data were searched online in October and November 2019, yielding 1,189 articles. After reading the titles and abstracts, 827 articles were excluded, 27 were selected, and 7 were incorporated from the references of the selected studies, totaling 34 articles in this review (references 8–21 and 23–42).

After selection, the full articles available and the abstracts of unavailable articles were read. Next, the studies were critically analyzed by exploring the material, treating the results obtained, interpreting the findings, and identifying explanations for different or conflicting results in order to make recommendations for the practice. The study was systematized using a data collection instrument that included: article title, objectives, method, results, and conclusion.

This review adopts the term "medical device" as a synonym for material, medical product, and HP, in accordance with the Brazilian Health Regulatory Agency (*Agência Nacional de Vigilância Sanitária* — ANVISA). The terms reprocessing and product processing are also used as synonyms, despite considerations about the differences between them.

RESULTS

Out of the 34 articles analyzed, 13 (38.2%) were literature reviews, 11 (32.3%) were experimental studies, 8 (23.5%) were recommendations from official agencies, and 2 (5.8%) were studies with varying methodologies. Regarding origin, 16 studies (47.0%) were carried out in the United States, 11 (32.3%) in Brazil, and 7 (20.5%) in other countries.

The articles from this integrative review are presented below.

Presentation of selected studies on ethylene oxide sterilization and aeration of medical devices

EO sterilization is the oldest low-temperature method, used since 1950. It is extremely effective for its high penetration power, high diffusibility, and permeability, favoring the sterilization of products within sealed packages and access to long and narrow lumens composed of any raw material[8-17,19,23-35].

This gas agent is explosive, colorless at atmospheric temperature and pressure, has an unpleasant smell, is soluble in water at 10°C, reacts in acid pH forming ethylene glycol, and reacts with chlorine forming ECH, both toxic. Its excellent bactericidal, virucidal, fungicidal, and sporicidal activity is attributed to the alkylation of proteins and nucleic acids of microorganisms; however, it does not inactivate prions[8-17,23-25,27-31,35].

It is considered a mutagenic, carcinogenic, teratogenic, and neurotoxic agent. Exposure to this gas may cause eye and respiratory tract irritation, headache, nausea, vomiting, contact dermatitis, burns through direct contact, and high exposures can lead to chromosomal aberrations in the short term. When inhaled, it has carcinogenic effects, resulting in several types of neoplasms, such as leukemia, brain cancer, and breast tumor[8-17,25,27-29,33,35-38].

The maximum level of EO vapors in the air in working environments is 1 ppm for an average of 8 hours of exposure and 5 ppm for maximum exposure of 15 minutes[8,9,14-17,20,23,24,27,28,33].

In 2010, the US Environmental Protection issued a regulation to reduce EO levels in workplaces and prevent the occupational carcinogenic potential related to this agent. It demanded that hospitals and health services use a single chamber, combining sterilization and aeration[34,39].

EO sterilization requires special inter-related controls that vary according to the type of sterilizer, but the general characteristics are: gas concentration from 450 to 1,200 mg/L; temperature between 37 and 63°C; relative humidity from 40 to 80%; exposure time from 4 to 6 hours. Surveillance should be performed by mechanical monitors (temperature, gas concentration, pressure, exposure time) at each sterilization load, chemical monitors (each package), and biological monitors (*Bacillus atrophaeus sp.*) at each cycle. The basic cycle consists of five stages: preconditioning or humidification, gas introduction, exposure, evacuation, and air washes and irrigation[8,9,14-17,19,20,29,33,35-37].

Excessive levels of residual EO or its by-products, such as ethylene glycol and ECH, in medical products are potentially toxic and should be removed from materials after the sterilization cycle to prevent harming patients who use these products[8,9,14-20,26,29-36,40].

Aeration é o método através do qual o óxido de etileno can be performed by the sterilizing chamber itself (mechanical aeration) or in exclusive rooms (ambient aeration). Mechanical aeration is considered the most efficient and safe method of EO waste removal[16,17,19,20,34,35,39-41].

Ambient aeration should be performed in exclusive and restricted rooms, under negative pressure, with control of air temperature and flow (minimum of 25 air changes/hour)[21,25,31,33], and exhaust to the outside environment. This aeration process is not only lengthy but exposes workers to toxic vapors during the transfer of sterile loads to the aeration room, may not be effective depending on air temperature and flow conditions, and is contraindicated by international regulatory bodies[20,27,34,35,39].

The aeration duration relies on some variables, such as: features of the medical device (composition, shape, density, weight, and packaging used), type of packaging, type of sterilizer, temperature of the aeration chamber, number of air filter changes per hour, and characteristics of the air flow, as well as the purpose of the product (external or internal use)[8-11,16,17,20,26,30,35,40].

Mechanical aeration parameters also influence the length of time required to remove EO from products. Temperature and the number of chamber air changes have a significant impact on the aeration process. The higher the temperature, the shorter the time required for product aeration[16,17,20,30,35,40].

Some authors report that aeration time can range from six hours to seven days depending on the composition, device size, aeration system, and type of sterilizer[26,29]. Another author[33] recommends a minimum aeration time of 12 hours when not specified by the product manufacturer.

A Cuban study reveals that total disposal or reduction of EO residues to permissible limits requires a detoxification process that can last from 48 hours to more than 10 days,

according to the number of sterilizations performed in the same device[36].

Before the regulation prohibiting ambient aeration in health services in the United States[39], the Centers for Disease Control and Prevention (CDC) recommended mechanical aeration from 8 to 12 hours at a temperature of 50 to 60°C or ambient aeration in exclusive rooms for 7 days at 20°C[8,9,27].

In Cuba, the aeration of EO-sterilized products follows a strict pattern: 24 hours of aeration inside the chamber after the end of sterilization, 8 hours of detoxification at 60°C, and ambient aeration from 7 to 10 days in a ventilated room[15].

A Brazilian study aimed to identify EO residues in polyethylene enteral feeding containers sterilized by this agent. After the standard sterilization cycle (430 mg/L EO for 6 hours, at 55°C, and relative humidity >35%), the samples were mechanically aerated with 14 pulses in air and vacuum and placed in an ambient aeration room at a temperature of 55°C with 27 air changes/hour. The samples were removed at 0, 4, 12, 24, and 48 hours, and their residual concentration for the limit of 10 µg/mL EO showed significant waste reduction ($p<0.05$) after 6 hours of aeration[31].

Another study that determined the aeration time of EO-sterilized products packaged in rigid containers revealed they needed 17 hours of aeration to be free from residues of this agent[32].

Research that evaluated the aeration time of EO-sterilized products in Southeastern Brazil identified that 100% of EO-sterilizing companies have aeration rooms, as recommended by the Brazilian standard, but present heterogeneous parameters regarding ambient aeration[14].

The American National Standards Institute/Association for the Advancement of Medical Instrumentation/International Organization for Standardization American National Standards Institute/Association for the Advancement of Medical Instrumentation/International Organization for Standardization American National Standards Institute/Association for the Advancement of Medical Instrumentation/International Organization for Standardi (American National Standards Institute/Association for the Advancement of Medical Instrumentation/International Organization for Standardization American National Standards Institute/Association for the Advancement of Medical Instrumentation/International Organization for Standardization American National Standards Institute/Association for the Advancement of Medical Instrumentation/International Organization for Standardization [20]ANSI/AAMI/ISO) international standard 10993-7 updated the acceptable residual EO and ECH levels for medical devices in 2012. This regulation adopts the criterion time of patient contact with the product, classifying it as "limited exposure" (time <24 hours), "prolonged exposure" (>24 hours and up to 30 days), and "permanent exposure" (>30 days). The residual EO and ECH daily dose should not exceed 20 mg and 12 mg, respectively, while for prolonged and permanent exposure products, it should not exceed the limit of 60 mg, as shown in Tables 1 and 2.

Recommendations of the Interministerial Decree No. 482/1999[21] differ from international standards and studies in various aspects, specifically concerning acceptable levels of EO residues, as well as procedures for HP aeration.

The Brazilian regulation classifies implantable products by weight (10 to 100 g) and contact of the device with the patient's mucosa, blood, and skin, recommending the control of EO residues in ready-to-use and single-use products, such as surgical sponges, intrauterine devices, and intraocular lenses.

In Decree No. 482/1999, residual EO and ECH levels range from 25 ppm (blood-contact products) to 250 ppm (mucosal-contact products); such limits were determined by the Food and Drug Administration (FDA) in 1978[42] and disagree with current levels for this toxic waste, as described in Table 3.

As for product aeration processes, the current Brazilian standard only recommends an aeration room for services that adopt this sterilization method, without mentioning mechanical aeration or defining the exposure time for ambient aeration.

Table 1. Maximum acceptable limits of ethylene oxide and ethylene chlorohydrin residues in health products, according to contact time.

Contact time	Ethylene oxide	Ethylene chlorohydrin
Medical product with prolonged contact	Maximum of 4 mg in the first 24 hours. Maximum of 60 mg in the first 30 days.	Maximum of 9 mg in the first 24 hours. Maximum of 60 mg in the first 30 days.
Medical product with permanent contact	Maximum of 4 mg in the first 24 hours. Maximum of 60 mg in the first 30 days.	Maximum of 9 mg in the first 24 hours. Maximum of 60 mg in the first 30 days.

Source: ANSI/AAMI/ISO 10993-7:2008 (R) 2012.

Summary of the results

The results of this review point to EO as an ideal sterilizing agent for critical and heat-sensitive devices, despite its toxicity and the need for controls related to sterilizers, workers, medical devices, and the environment.

As explained above, the Brazilian regulatory framework is outdated as to the determination of toxic EO residues in medical products, contributing to the health risk related to this sterilization method.

First, the classification of products based on "contact with the patient's mucosa, blood, and skin" adopted in this legislation differs from the current international standard[20], which specifies maximum limits according to the toxicological risk of these residues for the patient, considering the length of time the patient is exposed to the EO-sterilized device.

Residual levels defined in Decree No. 482 are higher than those recommended by the international standard, increasing the potential risk of adverse events for patients who use EO-reprocessed products.

The Brazilian standard recommends ambient aeration for the desorption of EO-sterilized products, which may not be effective, as it depends on many variables. Moreover, this process is contraindicated, as it has órgãos reguladores internacionais e been proscribed in the United States since 2010[20,27,34,35,39] In this scenario, mechanical aeration, not mentioned by this standard, is the gold standard for aeration of EO-sterilized products; nonetheless, this process also requires temperature and air flow control within the chamber[16,17,20,30,35,40].

Authors have reached a consensus that the duration of aeration relies on factors already described in this review. Among products made of polyvinyl chloride (PVC), polystyrene and rubbers are the ones that most absorb EO. Therefore, there is no recommended standard aeration time for all devices sterilized by this agent[8-11,16-18,20,23,26,30,35,40].

Os tempos de aeração descritos nesse estudo variam de seis horas a sete dias[26,29], 12 horas[33], 48 horas a dez dias[36], aeração mecânica a 50°C por 12 horas ou a 60°C por oito horas[27,35].

In order to overcome difficulties related to the duration of HP aeration, a study recommends that, if the medical device has an unknown composition, aeration should be performed with the most challenging parameters (as if the product was made of PVC), using mechanical aeration at 50°C for 12 hours or at 60°C for 8 hours. The American Hospital Association recommends these parameters as the minimum for any type of medical device[35].

Table 3. Maximum limits of ethylene oxide residues in related products (ppm).

Related Product	EO	ECH	EG
Implants			
Small (10 g)	250	250	5,000
Intermediate (>10 – <100 g)	100	100	2,000
Large (>100 g)	25	25	500
Intrauterine devices	5	10	10
Intraocular lenses	25	25	500
Mucosal-contact products	250	250	5,000
Blood-contact products	25	25	250
Skin-contact products	250	250	5,000
Surgical sponges	25	250	500

EO: ethylene oxide; ECH: ethylene chlorohydrin; EG: ethylene glycol.

Source: Brazil. Interministerial Decree No. 482/1999.

Table 2. Summary of permitted limits of ethylene oxide and ethylene chlorohydrin (per product).

Health product category	Ethylene oxide	Ethylene chlorohydrin
Product with limited contact (<24 hours)	4 mg	9 mg
Product with prolonged contact (>24 h <30 days)	60 mg/30 days	60 mg/30 days
Product with permanent contact (>30 days)	2.5 g/for life	10 g/for life
Tolerable contact limit	10 µg/cm²	5 mg/cm²
Intraocular lenses	0.5 µg/lens/day 1.25 µg/lens	4 x the suggested EO limit
Blood cell separators (apheresis)	10 mg	22 mg
Blood oxygenators	60 mg	45 mg
Cardiopulmonary bypass products	20 mg	9 mg
Blood purification products=-0987654321+ (hemodialyzers)	4.6 mg	4.6 mg
Dressings in contact with intact skin	10 µg/cm²	5 mg/cm²

Source: ANSI/AAMI/ISO 10993-7:2008 (R) 2012.

Since most products sent for EO-sterilization are thermosensitive and made of plastic polymers, particularly PVC, the possibility of absorption of high volumes of toxic residues increases as they undergo repeated sterilizations[35], a common situation in the routine of sterile processing departments (SPDs), requiring at least knowledge of residual EO and ECH levels of reprocessed products.

The issue is that the Brazilian standard does not regulate the periodicity of EO residue controls in sterile products by companies that outsource the EO sterilization process. Consequently, the implementation and delivery of these controls to contracting health services depend on the availability, initiative, and interest of these companies, with health services becoming prisoners in this context.

The basic cycle of EO sterilization including aeration may last from 14 to 30 hours. This interval restricts the availability of medical product rotation and can cause significant problems to health services[35]. In this regard, SPD nursing managers can contribute to unsafe practices regarding EO-sterilized products by receiving instruments returned from outsourced sterilization companies in times incompatible with the performance of aeration.

Given the considerations described above and the problems involving the aeration of EO-sterilized products, this study ratifies some questions raised by an author[35] back in the 1990s, while including other issues that also seem relevant and current: What are the criteria used by SPD nursing managers to indicate EO sterilization for certain products? Is the routine of sending and receiving EO-sterilized products compatible with their aeration process? What is the frequency of reports about residual EO levels in products sterilized by this agent? Taking into account that the volume of EO absorption also depends on the number of sterilizations, how often are these products used? Are health care leaders aware of the implications of EO sterilization?

CONCLUSION

This review has achieved its objectives by describing the residual EO levels in products sterilized by this agent and the methods of aeration for these products, as well as by comparing the current Brazilian standard with international studies on this theme.

Possible limitations of this study include using review articles and recommendations from official bodies as theoretical support, with a small number of experimental studies, which could report the risks related to EO toxicity and contextualize more concrete situations.

This review also showed that Decree No. 482 is outdated in crucial points related to the control and safety of EO sterilization of medical devices, such as the obsolescence of acceptable residual levels of this agent, product classification, and aeration methods, contributing to the risk of adverse events for patients, workers, and the environment. Thus, updating the current regulation is urgent.

Furthermore, the shortcomings of this regulatory framework indirectly benefit companies that outsource EO sterilization by omitting essential controls for the safety of patients who use products sterilized by this extremely toxic agent, favoring the unsafe sterilization of medical products, in addition to hindering the supervision of health services by the country's health surveillance.

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SIGNS AND SYMPTOMS RELATED TO SURGICAL SMOKE EXPOSURE: INTEGRATIVE REVIEW

Sinais e sintomas relacionados à exposição à fumaça cirúrgica: revisão integrativa

Signos y síntomas relacionados con la exposición al humo quirúrgico: revisión integrativa

Aryane Apolinario Bieniek[1]*, Patricia Aroni[2], Raquel Gvozd Costa[3], Renata Perfeito Ribeiro[4]

ABSTRACT: Objective: To analyze the scientific evidence available in the literature on signs and symptoms related to surgical smoke exposure among surgical block workers. **Method:** This integrative literature review searched the following databases: MEDLINE, Cumulative Index to Nursing and Allied Health Literature, Latin American and Caribbean Health Sciences Literature, Web of Science, and Scopus. **Results:** A total of 1,351 studies were pre-selected, 4 of which were found by manual search. In the end, five articles were analyzed. The signs and symptoms identified were: cough, burning sensation in the pharynx, sneezing, rhinitis, nasopharyngeal lesion, foreign body sensation in the throat, nasal congestion, airway inflammation, lacrimation, nausea, vomiting, abdominal pain, weakness, muscle cramp, headache, drowsiness, lightheadedness, irritability, discomfort (such as unpleasant smell in clothes). **Conclusion:** Great advances have been detected in the studies proposed. These investigations lay the foundation for the intensity of signs and symptoms and the orientation regarding harmful risks, providing managers with the knowledge and scientific basis for future interventions, both to protect the team and to prevent risks in the work environment.
Keywords: Signs and symptoms. Smoke. Electrosurgery. Electrocoagulation. Occupational health.

RESUMO: Objetivo: Analisar as evidências científicas disponíveis na literatura sobre os sinais e sintomas relacionados à exposição à fumaça cirúrgica em trabalhadores do bloco operatório. **Método:** Revisão integrativa da literatura, com busca nas seguintes bases de dados: Medline, Cumulative Index to Nursing and Allied Health Literature, Literatura Latino-Americana e do Caribe em Ciências da Saúde, Web Of Science e SCOPUS. **Resultados:** Foram 1.351 estudos pré-selecionados, sendo 4 por busca manual. Ao fim, obtiveram-se cinco artigos para análise. Os sinais e sintomas encontrados foram: tosse, ardência de faringe, espirros, rinite, lesão nasofaringe, sensação de corpo estranho na garganta, congestão nasal, inflamação das vias aéreas, lacrimejamento dos olhos, náuseas, vômitos, dor abdominal, fraqueza, cãibra, cefaleia, sonolência, tonturas, irritabilidade, desconforto (como mau cheiro na roupa). **Conclusão:** Observaram-se grandes avanços nas pesquisas propostas, estudos que embasam a intensidade dos sinais e sintomas e orientação dos riscos nocivos que proporcionem aos gestores conhecimento e fundamentação científica para futuras intervenções tanto contra a proteção ao trabalhador como para prevenção de risco no ambiente de trabalho.
Palavras-chave: Sinais e sintomas. Fumaça. Eletrocirurgia. Eletrocoagulação. Saúde do trabalhador.

RESUMEN: Objetivo: Analizar la evidencia científica disponible en la literatura sobre signos y síntomas relacionados con la exposición al humo quirúrgico en trabajadores de quirófano. **Método:** Revisión integrativa de la literatura, buscando en las siguientes bases de datos: *Medline*, *Cumulative Index to Nursing and Allied Health Literature*, *Latin American and Caribbean Literature in Health Sciences*, *Web Of Science* y SCOPUS. **Resultados:** Hubo 1.351 estudios preseleccionados, cuatro por búsqueda manual. Al final, se obtuvieron cinco artículos para su análisis. Los signos y síntomas encontrados fueron: tos, ardor faríngeo, estornudos, rinitis, lesión nasofaríngea, sensación de cuerpo extraño en la garganta, congestión nasal, inflamación de las vías respiratorias, lagrimeo de los ojos, náuseas, vómitos, dolor abdominal, debilidad, calambres, dolor de cabeza, somnolencia, mareos, irritabilidad, malestar como mal olor en la ropa. **Conclusión:** Hubo grandes avances en la investigación propuesta, estudios que apoyan la intensidad de los signos y síntomas y orientaciones sobre riesgos nocivos que brinden a los gestores conocimiento y fundamento científico para futuras intervenciones, tanto contra la protección del trabajador como para la prevención de riesgos en el entorno laboral.
Palabras clave: Signos y síntomas. Humo. Electrocirugia. Eletrocoagulación. Salud laboral.

[1]Ph.D. student in the Graduate Program in Fundamental Nursing from Universidade Estadual de Londrina (UEL). Nurse at the Sterile Processing Department of Hospital Regional do Norte do Paraná (HU) – Londrina (PR), Brazil.
[2]Ph.D in Nursing from Escola de Enfermagem de Ribeirão Preto at Universidade de São Paulo (EERP-USP). Professor at the UEL Nursing Department, in the area of nursing management – Londrina (PR), Brazil.
[3]Ph.D. in Nursing from Universidade Estadual de Maringá. Professor at the UEL Nursing Department, in the area of nursing management – Londrina (PR), Brazil.
[4]Postdoctoral degree in Nursing from EERP-USP. Professor at the UEL Nursing Department, in the area of nursing management. Coordinator of the Occupational Health Research Center at Universidade Estadual de Londrina – Londrina (PR), Brazil.
*Corresponding author: aryanebieniek@gmail.com
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INTRODUCTION

Electrocautery is a high-frequency electronic device capable of cutting, dissecting, and coagulating tissues and vessels. It is often used in different surgical procedures given its advantages, as, in addition to reducing the risk of bleeding, it also helps visualize the surgical site and decreases surgical time[1].

When the electrocautery burns the tissue, it produces surgical smoke, in which potentially carcinogenic toxic chemical compounds, such as formaldehyde, hydrogen cyanide, benzene, and carbon monoxide, as well as cell materials and viral particles, have been identified[2].

The presence of these compounds in surgical smoke represents risks to workers exposed during surgical procedures, with complications to their health, even when they use personal protective equipment (PPE), such as surgical masks and glasses[3], as is usually the case in surgical centers (SC).

A literature review on the use of an electric scalpel and the related nursing care identified the employees' and nurses' lack of knowledge regarding its handling and operation[4], impacting the risk to the worker's health.

A study carried out in a Mexican hospital with 115 resident physicians of all surgical specialties, where electrocautery is used in 70% of surgical procedures, the authors found the following signs and symptoms: foreign body sensation in the throat, burning sensation in the pharynx, nausea, vomiting, nasal congestion, headache, eye irritation, irritation in other mucous membranes, sneezing, weakness, and lightheadedness[1].

This study detected the need to define sign and symptom: a sign is an objective account, that is, a reported and identified complaint, while symptom indicates a subjective sensation of abnormality[5].

According to these researchers' experience, the workers have actually reported other signs and symptoms besides those described. The explanation for these signs and symptoms helps understand the risks involved in the exposure of health professionals to surgical smoke. In addition, these results can potentially contribute to the development of strategies to improve workers' health. Therefore, a systematic search for more scientific findings involving this theme is necessary.

OBJECTIVE

To analyze the scientific evidence available in the literature on signs and symptoms related to surgical smoke exposure among surgical block workers.

METHOD

Study design

The present study is an integrative literature review that gathered and summarized the knowledge produced by several articles, in addition to pointing out gaps in the knowledge of the theme that could be investigated in new research[6].

The following steps guided the study: choosing the theme and defining the objective, elaborating the guiding question of the research, searching databases to identify primary research according to the eligibility criteria for the studies, and, at the end of the process, performing the critical analysis of the studies included[6].

Theme identification and selection of the hypothesis or research question to elaborate the integrative review

The current study proposed the following research question to guide the review: what are the consequences of the signs and symptoms presented by health professionals exposed to surgical smoke?

We elaborated the research question based on the PICO strategy, an acronym for: Patients, which, in this study, corresponded to "health workers"; Interventions — "electrocautery"; Comparison, which does not apply to the objective of the study; Outcomes, represented by "consequences related to signs and symptoms" [7].

This study defined the terms sign and symptom as follows: sign is an objective account, that is, a reported and identified complaint; symptom indicates a subjective sensation of abnormality[5].

Data collection procedure

The databases selected for the search for primary studies were: Scopus, National Library of Medicine – National Institutes of Health (MEDLINE) via PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Latin American and Caribbean Health Sciences Literature (LILACS), and Web of Science (WOS). We also included studies retrieved by manual search in the analysis of this review. They are part of the database of the Occupational Health Research Center at Universidade Estadual de Londrina (NUESTUEL).

The strategy used to search for studies in the databases was based on controlled keywords of the Health Sciences Descriptors

(*Descritores em Ciências da Saúde* — DeCS): *eletrocirurgia*, *eletrocoagulação*, *saúde do trabalhador*; and of the Medical Subject Headings (MeSH): electrosurgery, electrocoagulation, surgical smoke, symptoms and signs, health occupation. The non-controlled keywords searched in DeCS were: *fumaça cirúrgica, fumaça, terapia a laser, cauterização, sinais e sintomas, exposição ocupacional, segurança do trabalho, segurança ocupacional, bisturi a laser, eletrocautério, manifestações clínicas, sinais clínicos, queixas e sintomas, exposição laboral a agentes químicos, físicos ou biológicos*; and in MeSH were: smoke, laser therapy, cautery, electrocautery, smoke evacuation, thermocoagulation, galvanocautery, surgical diathermy, endocavitary fulguration, personnel health, healthcare worker, health professions.

For the correlations between terms, we used the boolean operators "AND" and "OR" to obtain a refined search and a greater number of articles that could potentially answer the guiding question. The search was carried out from May to June 2018.

A broad literature search was performed, with no limitations as to language or year of publication. This research included only primary studies.

Selection criteria

The articles were selected first by reading the titles and abstracts and, later, the full texts. Two independent reviewers selected the articles, and, in case of issues, a third reviewer reassessed the studies.

Data analysis and treatment

We considered the following items to evaluate the level of evidence of the articles:

- level 1: evidence from a systematic review of all relevant randomized clinical trials or clinical practice guidelines based on evidence from systematic reviews;
- level 2: evidence obtained from at least one well-designed randomized clinical trial;
- level 3: evidence obtained from well-designed controlled clinical trials, without randomization, and quasi-experimental studies;
- level 4: evidence from well-designed case-control and cohort studies;
- level 5: evidence from systematic reviews of descriptive and qualitative studies;
- level 6: evidence from a single descriptive or qualitative study;
- level 7: evidence from authorities' opinions and/or expert committee reports[7].

This review did not include articles with levels of evidence 1, 5, and 7.

The current study followed the steps proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist[8].

Figure 1 represents the flow diagram of the path followed for identification, screening, and inclusion of primary studies, according to the databases listed.

RESULTS

To present the results, we chose to identify the studies by letter E, corresponding to the word *estudo* (study), with a numerical sequence from one to five. Among the 5 primary studies selected, all were published in the past 12 years, 3 studies were in Turkish (60%), 2 in English (40%), and 1 in Spanish (20%).

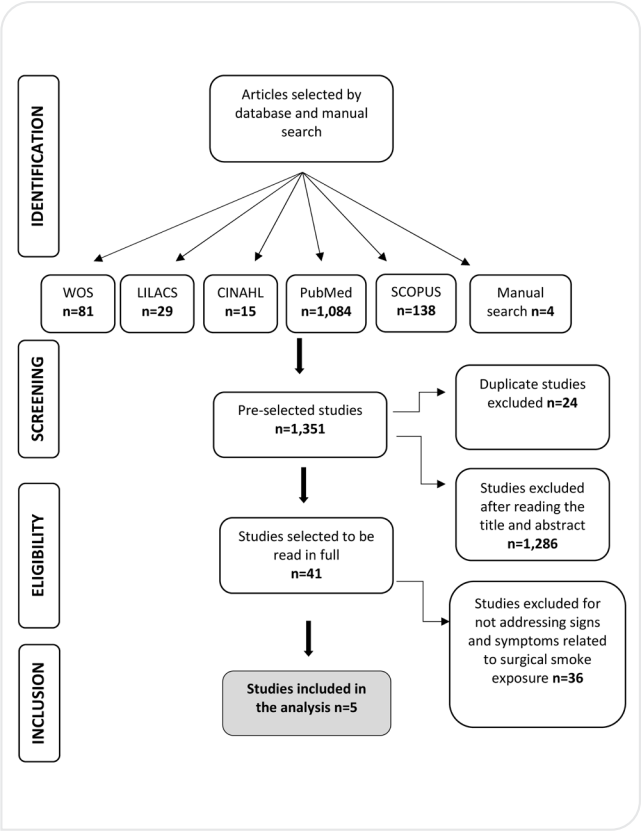

Figure 1. Flow diagram of studies in the integrative review.

As for design, they were all classified as descriptive observational studies, with a quantitative approach, thus falling into the scientific level of evidence 6.

Chart 1 summarizes the studies selected to comprise this review, according to authors, country, population, and signs and symptoms related to surgical smoke exposure.

In addition to the signs and symptoms presented in Chart 1, some studies described diseases related to surgical smoke exposure, such as anemia, rhinitis, asthma, conjunctivitis, dermatitis, cardiovascular diseases, hepatitis, and cancer.

Table 1 presents the signs and symptoms related to surgical smoke exposure.

Chart 1. Summary of the selected studies according to authors, country, population, and signs and symptoms related to surgical smoke exposure.

Study	Population/sample	Signs and symptoms
E1 – Navarro-Meza et al., 2013[1] (Mexico)	Resident physicians: 50	- Foreign body sensation in the throat: 58.0% - Burning sensation in the pharynx: 22.0% - Nausea: 4.0% - Nasal congestion: 2.0%
E2 – Ilce et al., 2017[9] (Turkey)	Nurses: 45 Physicians: 36	- Headache (nurses: 48.9%; physicians: 58.3%) - Lacrimation (nurses: 40.0%; physicians: 41.7%) - Cough (nurses: 48.9%; physicians: 27.8%) - Burning sensation in the pharynx (nurses: 40.0%; physicians: 38.9%) - Nausea (nurses: 44.4%; physicians: 30.6%) - Other*
E3 – Ünver et al., 2016[10] (Turkey)	Nurses: 54	- Headache 59.3% - Pharyngeal irritation: 56.6% - Nausea: 40.7% - Lacrimation: 38.9% - Weakness: 24.1% - Lightheadedness: 9.3%
E4 – Usta et al., 2019[11] (Turkey)	Nurses: 105	- Headache 61.9% - Nausea: 39% - Vomiting: 14.3% - Cough: 41.0% - Eye irritation: 54.3% - Burning sensation in the pharynx: 43.8% - Irritability: 29.5% - Lightheadedness: 32.4% - Respiratory problems: 27.6% - Nasopharyngeal lesion: 7.6% - Weakness: 25.7% - Muscle cramp: 22.9% - Abdominal pain: 15.2%
E5 – Okgün Alcan et al., 2017[12] (Turkey)	Nurses: 71	- Headache 71.8% - Nausea: 63.4% - Cough: 57.7% - Burning sensation in the pharynx: 49.3% - Lacrimation: 46.5% - Sneezing: 39.4% - Lightheadedness: 38.0% - Irritability: 31.0% - Airway inflammation: 29.6% - Weakness: 28.2% - Nasopharyngeal lesion: 7.0% - Vomiting: 5.6% - Abdominal pain: 8.5% - Muscle cramp: 9.9%

*Others: drowsiness, lightheadedness, sneezing, weakness, irritation, nasopharyngeal lesion, abdominal pain, vomiting.

In most of the five studies in the review, the respiratory system had the highest incidence of signs and symptoms when the professional was exposed to surgical smoke, followed by the visual system.

DISCUSSION

A descriptive study analyzing the gaseous by-products present in surgical smoke found that, due to their aerodynamic size, the particles generated — and inhaled by health workers and patients — traveled a distance of up to 100 cm from their site of production[13]. Also, 1 g of cauterized tissue causes a surgical smoke plume with mutagenic effects, equivalent to smoking from three to six unfiltered cigarettes[14,15].

In addition, the highest incidence of signs and symptoms found in this study was associated with the respiratory system. This result may be connected to the fact that inhalation of surgical smoke can penetrate the lung, leading to chronic and acute diseases, such as alveolar congestion, interstitial pneumonia, and bronchiolitis[13].

The same study reports that acrylonitrile and carbon monoxide (CO) are among the concerning chemicals most found in surgical smoke. They are responsible for signs and symptoms such as eye irritation, nausea, vomiting, headache, sneezing, weakness, and lightheadedness, and prolonged exposure to them can produce irritation and dermatitis. These signs and symptoms are related to the respiratory and integumentary systems[13].

Physiologically, the gas exchange process occurs during the ventilation and inhalation of air into the alveoli, which are surrounded by capillary vessels, with the exchange happening in the interface between the alveolar epithelium, interstice, and tissue capillary[16]. Therefore, the respiratory system becomes the main target when exposed to surgical smoke, probably due to the size of the oxidizing particles present in it.

Particles with less than 10 μm diameter dissipated in the environment can be inhaled and have the potential of impairing the respiratory tract; those below 2.5 μm reach the pulmonary alveoli when inhaled; particles with diameters even smaller than 0.01 μm, characterized as ultrafine particles (UFP), spread in surgical smoke can penetrate deeper into the respiratory system, leading to greater involvement of this system[1,17-20].

The acrylonitrile chemical compound, present in the surgical plume, has a toxic effect when inhaled due to the formation of cyanide, responsible for discomforts such as eye irritation, nausea, vomiting, headache, sneezing, weakness, and lightheadedness. Prolonged exposure to this compound can be potentially carcinogenic and causes irritation and dermatitis[13].

More commonly found in laparoscopic procedures, the CO chemical is absorbed by the cells and directed to the bloodstream. Combined with hemoglobin, it triggers a systemic hypoxic stress response, resulting in decreased oxygen transport capacity within the body. In individuals with cardiovascular diseases, it can be even more harmful[13,21].

The characteristic of the chemical is directly related to the type of tissue in which the electrocautery was used. Adipose tissues produce more aldehydes and less toluene, leading to greater development of signs and symptoms[22].

A proven case revealed that, after treating a patient with anogenital warts using laser, the surgeon developed laryngeal papillomatosis. Investigations were carried out and identified the presence of human papillomavirus (HPV) type 6 and 11 in the patient, the same ones found in the surgeon's larynx; with no other possible trigger for the disease, the occupational risk to this

Table 1. Signs and symptoms identified in the five studies selected for this review, grouped by systems.

Studies in the review	Signs and symptoms	Respiratory system	Visual system	Digestive system	Musculoskeletal system	Nervous system
	n	n (%)	n (%)	n (%)	n (%)	n (%)
E1	04	03 (75.0)	-	01 (25.0)	-	-
E2	13	04 (30.8)	01 (7.7)	03 (23.0)	01 (7.7)	04 (30.8)
E3	06	01 (16.6)	01 (16.6)	01 (16.6)	01 (16.6)	02 (33.2)
E4	13	04 (30.8)	01 (7.8)	03 (23.0)	02 (15.4)	03 (23.0)
E5	14	04 (28.6)	02 (14.3)	03 (21.4)	02 (14.3)	03 (21.4)

professional was characterized[23]. The exposure time for its development is unknown, but the literature reports that the HPV incubation period can range from 2 to 8 months, and clinical signs and symptoms may take up to 20 years to develop[24].

None of the articles analyzed in this review described the presence of a surgical smoke evacuation system in operating rooms, as recommended by world organizations. Some studies report the use of an aspiration catheter to aspirate surgical smoke, which has no evidence of protection against risks. In one of the studies, the authors stated that 92.5% of the professionals knew about the existence of surgical smoke, and 55.6% were aware of the harmful risk of exposure to these substances[12,25].

The diseases resulting from inhalation of surgical smoke are: emphysema, asthma, bronchitis, dermatitis, cardiovascular dysfunction, anemia, leukemia, nasal lesion, human immunodeficiency virus (HIV) infection, and hepatitis. Surgical smoke cumulates in the human body; therefore, the longer the exposure, the greater the risk[13,26].

The literature reports several harmful effects related to surgical smoke; however, it lacks evidence and consistent recommendations for protecting workers from exposure to surgical smoke[27].

The Occupational Safety and Health Administration (OSHA) recommends using surgical masks to capture particles larger than 5 mm. This type of mask does not protect against all compounds present in surgical smoke, as it has no seal or filter. Thus, the surgical mask is not adequate to protect against surgical smoke[13,27].

Regarding surgical smoke evacuation, OSHA has no specifications on filtration by equipment, but other organizations, such as the Association of PeriOperative Registered Nurses (AORN), support a surgical smoke filtration system and aerosols at high concentrations[25,28]. Other recommendations include engineering control, that is, the ventilation of operating rooms: 20 air changes/hour[29].

The smoke evacuation system and the devices should be used following the manufacturer's instructions. In high concentrations of surgical smoke with UFP smaller than 0.01 μm, filters should be used for smoke evacuation. Thus, for small smoke concentrations, the worker should use a surgical vacuum system with a 0.1 μm filter installed between the suction wall connection and the suction container. Therefore, the smoke capture device must be as close as possible to the surgical site so as to collect the surgical smoke, harmful to the professional's health[30].

The Guideline recommends the use of a set of protective measures to reduce the occupational risk to workers exposed to surgical smoke, including surgical smoke evacuation systems with air filtration and the use of a mask that protects against particles with 0.01 μm diameter, namely, masks with a 95% particle filtration, known as N95[25].

Proposals for the use of N95 may protect professionals exposed to surgical smoke. Nevertheless, compliance with this measure is poor since masks with 95% filtration are uncomfortable. Consequently, the workers do not recognize the risk of exposure to surgical smoke[31].

Furthermore, the lack of risk recognition, the workers' discomfort when using PPEs[31], and the lack of studies indicating the best ways of preventing this risk make it difficult to protect health professionals from falling ill.

Concerning study limitations, we underline the lack of standardization of data collection instruments in the studies selected for this review, as well as of signs and symptoms related to surgical smoke exposure, as, in most articles, they were confused with diseases. Thus, further studies with strong scientific evidence are necessary, as they might provide elements for future research to substantiate this theme. There is a knowledge gap regarding the surgical smoke exposure time for developing clinical signs and symptoms. New discoveries have been unveiled, but no consensus has been reached about exposure time.

We also highlight the scarcity of studies with scientific rigor so as to qualify the research as strong for a reasoned discussion.

CONCLUSION

Given the objective of the current study, the consequences of surgical smoke exposure for the worker is the development of signs and symptoms identified in this review, such as: cough, burning sensation in the pharynx, sneezing, rhinitis, nasopharyngeal lesion, foreign body sensation in the throat, nasal congestion, airway inflammation, lacrimation, nausea, vomiting, abdominal pain, weakness, muscle cramp, dermatitis, headache, drowsiness, lightheadedness, irritability, discomfort (e.g., unpleasant smell in clothes). Some diseases stand out, including anemia, rhinitis, conjunctivitis, cardiovascular diseases, hepatitis, and cancer.

Great advances are expected in the research about this theme with the development of this study. Research that

lays the foundations for the intensity of signs and symptoms triggered in professionals exposed to surgical smoke and the consequent orientation regarding harmful risks, providing managers with the knowledge and scientific basis for future interventions, both to protect the team and to prevent risks in the work environment.

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