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

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

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

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

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

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

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INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

OBJECTIVE

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

METHOD

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

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

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

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

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

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

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

RESULTS

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

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

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

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

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

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

Table 1. Continuation.

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

SC: surgical center; AR: anestheticrecovery.

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

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

MH: malignanthyperthermia.

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

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

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

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

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

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

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

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

DISCUSSION

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

IV: intravenous.

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

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

CONCLUSION

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

FINAL CONSIDERATIONS

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

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

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

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