

Prevention and treatment of malignant hyperthermia in certified training hospitals in Japan: a questionnaire

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Abstract

Purpose. To assess the preparedness of hospitals in Japan for cases of malignant hyperthermia (MH).

Method. A survey was sent to 884 training hospitals certified by the Japan Society of Anesthesiologists (JSA) in June and July 2000. Useful answers were received from 431 (48.8%) institutions.

Results. For general anesthesia, inhalation anesthetics were widely used in 283 (65.7%) hospitals, and succinylcholine was the most commonly used muscle relaxant, which was used in 270 hospitals (62.5%). For patient monitoring, 422 (97.9%) hospitals used a pulse oximeter for all general anesthesia cases. A capnogram was used in 152 (35.3%) hospitals, and continuous body temperature was measured in 128 (29.7%). Two hundred and eighty-eight (66.8%) hospitals had more than six vials of dantrolene prepared for use, whereas 13 (3.0%) had none.

Conclusion. The results of the survey revealed that some hospitals had inadequate monitoring methods and a lack of prepared dantrolene for cases of MH under general anesthesia. We recommend that essential monitors be deployed and adequate preparations of dantrolene be maintained for effective early diagnosis and treatment of MH.

Key words Malignant hyperthermia · Dantrolene · Patient monitor · Inhalational anesthesia · Succinylcholine

Introduction

A recent report showed that the mortality rate of malignant hyperthermia (MH) is apparently higher in Japan than in European countries or North America [1]. One of the reasons was considered to be inadequate preparation for patient monitoring and the use of dantrolene in every hospital, even though the Japan Society of Anesthesiologists (JSA) has revised their monitoring

guidelines for safe anesthesia [2]. The nature of MH has recently been elucidated, but it remains difficult to predict and prevent. Thus, the only means currently available to lower mortality rates are early detection and suitable treatment. For this purpose, properly equipped patient monitors and an adequate supply of dantrolene are essential in training hospitals certified by the JSA. This study details the results of a questionnaire sent to certified hospitals to assess their preparations for MH events.

Methods

The survey was conducted in June and July 2000 using the questionnaire described in Table 1, which was sent to 884 JSA-certified training hospitals in Japan. Useful answers were obtained from 431 (48.8%) institutions.

Results

Hospitals with fewer than 500, 1000, 1500, and 2000 beds numbered 231, 171, 26, and 1, respectively. Those with fewer than 1000, 2000, 3000, 4000, 5000, and 7500 anesthesia cases numbered 142, 166, 83, 23, 11, and 5, respectively.

Inhalation anesthetics were the type most widely used for general anesthesia in 283 (65.7%) hospitals, while intravenous anesthetics and combined inhalation and intravenous anesthetics were used in 57 (13.2%) and 47 (10.9%) institutions, respectively. The most common muscle relaxant was succinylcholine, which was used in 270 (62.5%) hospitals. It was used in 19 (4.4%) hospitals which had more than 1000 cases annually, and in 299 (69.3%) with fewer than 100 cases annually.

Regarding patient monitoring, in 422 (97.9%) hospitals a pulse oximeter was used for all general anesthesia

Table 1. Main issues surveyed

1. Current anesthetics used for general anesthesia
2. Current use of muscle relaxants
3. Current quality of patient monitoring methods, i.e., pulse oximeter, capnogram, and continuous body temperature measurements
4. Current stock of dantrolene
5. Current plan for transportation to another hospital in the event of malignant hyperthermia

Table 2. Are a pulse oximeter, capnogram, and continuous body temperature measurements always used for general anesthesia?

Answer	(%)
1. Yes	79.8
2. No	20.2
Reason for a "No" answer	
1. Randomly used but not always	25.3
2. Used only for inhalational general anesthesia	2.3
3. Used only for emergency cases	1.1
4. Other	71.3

Table 3. Monitor use in hospitals

Cases (%)	Facilities (%)
Pulse oximeter	
100	97.9
99–80	2.1
<80	0.0
Capnogram	
100	35.3
99–80	33.9
79–60	21.1
<60	9.7
Continuous body temperature measurement	
100	29.7
99–80	38.7
79–60	13.7
<60	17.9

cases, while end-tidal carbon dioxide was measured in 152 (35.3%) hospitals, and continuous body temperature was measured in 128 (29.7%). For general anesthesia, there were 344 (79.8%) institutions in which all three monitors were used for every case (Table 2). Table 3 shows the percentage use of monitors. In most hospitals a pulse oximeter was used, whereas CO₂ and body temperature were monitored only infrequently.

More than six vials of stored dantrolene were available in 288 (66.8%) hospitals, while 13 (3.0%) had none (Table 4). In hospitals with fewer than six vials of available dantrolene, 23 (13.3%) reported that the time required to replenish dantrolene was less than 30 min

Table 4. How many vials of dantrolene are in stock?

Answer	(%)
In the hospital	
6 vials or more	66.8
Between 3 and 6 vials	28.8
Between 1 and 3 vials	1.4
None	3.0
In the operating room	
6 vials or more	33.0
Between 3 and 6 vials	37.8
Between 1 and 3 vials	6.7
None	22.5

Table 5. How much time is required to have dantrolene prepared and available in case of an emergency?

Answer	(%)
Those with more than 6 vials in the hospital	
Less than 30 min	13.3
Between 30 and 60 min	37.8
More than 60 min	16.1
No answer	32.9
Those with more than 6 vials in the operating room	
Less than 30 min	9.7
Between 30 and 60 min	34.1
More than 60 min	14.8
No answer	41.4

Table 6. How is dantrolene obtained in an emergency? (Multiple answers possible)

Answer	(%)
A predetermined supplier will deliver	27.8
No predetermined supplier	24.1
Agreement between hospitals to provide dantrolene	18.6
Able to prepare 120 mg dantrolene within 30 min	14.4
Agreement between hospitals regarding medical care in the district	8.6
Other	5.8

(Table 5). The most frequent source of dantrolene replenishment in an emergency was from a predetermined supplier (Table 6). Hospitals without dantrolene had an agreement with another institution in their district to get dantrolene (Table 6).

Cases of MH had been experienced in 126 (29.2%) hospitals, whereas 305 (70.8%) had never seen one. Of those who had MH experience, nearly 83% had treated it successfully, and 13.7% said that they had not. Of those not prepared to handle an MH emergency, 72.9% reported their lack of an intensive care unit, and 62.7% reported a lack of trained personnel. However, 13 (3%) had an agreement with another hospital in case of such an event, whereas 46 (10%) had no established arrangement.

Discussion

The signs of MH include increased body metabolism and skeletal muscle rigidity, resulting in hyperthermia, and the mortality rate is high when appropriate treatment is not applied. The nature of MH is gradually being revealed, although at present the best prevention is risk-detection prior to surgery. The prediction of an increased rate of Ca-induced Ca release is one of the methods used for this purpose [3], although it is not generally applicable in all patients. When the risk of MH is apparent or suspected, the likelihood can be calculated [4], but currently there is no way to ensure complete prevention. The mortality rate for MH is approximately 10% at present, while it was nearly 80% in the 1960s; dantrolene has contributed greatly to the decline in mortality since 1979 [5]. In the present survey, we aimed to evaluate current preparations for an MH event in training hospitals certified by the JSA.

Volatile inhalation anesthetics as well as the depolarizing muscle relaxant succinylcholine may trigger MH [5], and therefore the best way to avoid this potentially fatal condition is to use noninhalation anesthetics in combination with nondepolarizing muscle relaxants, although it is often difficult to apply this strategy clinically in all cases. The results of the survey show that volatile inhalation anesthetics are widely used and succinylcholine remains an important muscle relaxant, even though the annual number of cases of MH was less than 100 in institutions that used them most often.

The incidence of MH is approximately 1:60000 in Japan [5], and the mortality rate is 12%. These figures are slightly higher than the rates in Europe and North America [1]. To improve these results, anesthesiologists should prepare patient monitors thoroughly and have dantrolene readily available, as time is critical in the event of an MH emergency. Patient monitoring methods, including use of a pulse oximeter, a capnogram, and continuous body temperature measurement, are essential for early diagnosis and detection [6], and dantrolene is the most important part of appropriate treatment. According to *Monitor Guidelines for Safe Anesthesia* [2], a pulse oximeter, a capnogram, and body temperature measurement are essential components of general anesthesia, and a capnogram is especially helpful for early detection of MH.

These results showed that most of the responding hospitals used appropriate patient monitoring methods and had adequate preparations of dantrolene in stock. In those without enough dantrolene, a means to obtain the drug rapidly was in place, for example through arrangements with other hospitals in the district. However, we also found that there were hospitals with inadequate monitoring methods and/or supplies of dantrolene. The reasons given for these unsatisfactory

findings were that stocking dantrolene was financially prohibitive and/or not applicable for ordinary cases. We consider that each hospital manager has a responsibility to store at least the amount of dantrolene needed for an emergency and, to ensure patient safety, each chief anesthesiologist should also be accountable.

Once MH is suspected, the administration of triggering agents must be stopped immediately, respiratory minute volume should be increased using oxygen, and dantrolene should be administered. The recommended dosage of dantrolene is approximately $2\text{--}3\text{ mg}\cdot\text{kg}^{-1}$ initially, and it should be available for further doses up to $5\text{ mg}\cdot\text{kg}^{-1}$ within 24 h [7] (Malignant Hyperthermia Association, <http://www.mhaus.org/>). Therefore, the stock of dantrolene available for an initial rescue should be more than six vials. It is easily conceivable that mortality rates will increase if dantrolene is not administered. Therefore, every effort should be made to shorten the time until the initial administration, and to procure the necessary amounts for storage to start the administration of dantrolene early. If there are insufficient trained personnel or facilities, MH is not easily treatable. A small number of the responding hospitals noted their agreement to offer dantrolene and medical care, including interhospital transportation, although some of the remaining hospitals lack the necessary facilities and arrangements.

In summary, the results of the present survey revealed that there are JSA-certified hospitals that have inadequate patient monitoring methods and dantrolene preparations for emergency cases of MH. We strongly recommend that sufficient monitors and minimum amounts of stored dantrolene be deployed for early diagnosis and adequate treatment.

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