Case Report

The expert novice – living and working with malignant hyperthermia

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Summary

Acute care common stem training involves developing competencies within anaesthesia. At this stage of their career, most doctors have little or no anaesthetic experience, and work under direct consultant supervision for the majority of the placement. An emergency medicine trainee with a known diagnosis of malignant hyperthermia undertook a 6-month anaesthetic rotation in a large teaching hospital, adding a unique set of considerations to his training. Having malignant hyperthermia posed a novel challenge to the department, and it was met with an understandable degree of uncertainty and caution. Providing the trainee with a useful and comparable introduction to anaesthesia was of concern, particularly on paediatric lists where there is increased potential for exposure to volatile anaesthetic agents. This report focuses on the trainee's personal reflection of the impact on his experience, as well as looking at how the department responded to this unfamiliar situation, and the learning points to share should a similar scenario be encountered in the future.

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Introduction

Malignant hyperthermia is a pharmacogenetic disorder of skeletal muscle calcium regulation; it is rare, but has the potential to be fatal [1]. The principal drugs known to trigger a crisis are the volatile anaesthetic agents and the depolarising neuromuscular blocking drug suxamethonium.

Doctors undertaking the acute care common stem training program have a 'parent specialty' of either emergency medicine, acute medicine or anaesthesia. All must complete a period of anaesthetic training, often 6 months, in order to gain the initial assessment of competence. Trainees begin this period by learning core skills such as bag-valve-mask ventilation, use of basic and more advanced airway adjuncts and induction of general anaesthesia.

It is reasonable to predict therefore, that the novice anaesthetist is likely to be exposed to greater amounts of potent inhalational agents than perhaps the more experienced anaesthetist. As part of the initial assessment of competence curriculum, the Royal College of Anaesthetists recommends that trainees are able to conduct inhalational induction of anaesthesia, and administer inhalational sedation for clinical procedures [2].

A 28-year-old ACCS emergency medicine trainee with a known diagnosis of malignant hyperthermia and undertook a 6-month period of novice anaesthetic training within a large teaching hospital. This report is written 18 months after he acquired the initial assessment of competence. We focus on both his experiences and those of the anaesthetic department of this little-encountered scenario, looking at how we may apply what has been learned from this case together with what is known about the triggering of the condition, to future malignant hyperthermia-susceptible individuals wishing to pursue training in anaesthesia.

Report

The trainee underwent testing for malignant hyperthermia while at medical school due to a positive family history, and I was found to be susceptible. I was provided with a letter from the specialist malignant hyperthermia unit detailing the occupational risks of individuals with malignant hyperthermia in operating theatre environments, and was reassured that there should be no contra-indication to him undertaking a period of anaesthetic training (Fig. 1).

At the start of each theatre list, the trainee informed the supervising anaesthetic consultant of his diagnosis and highlighted it at the safety brief. However, this is a large department and the trainee found that on an almost daily basis he was having to explain himself to one or more colleagues whom he was meeting for the very first time. Understandably, he felt uncomfortable repeatedly having to reveal an aspect of his private medical history shortly after introducing himself, and at times felt irritated by the level of angst and then questioning that he was subsequently met with. To try to reduce the frequency of these somewhat awkward interactions, he approached a trusted consultant for advice, and an email was sent out to all anaesthetic consultants along with a copy of the advice from the malignant hyperthermia unit.

This led to some improvement in terms of a greater awareness among the department of his presence. However, the trainee found that he was still not infrequently encountering a degree of uncertainty from supervisors surrounding what he could and could not do in terms of exposure to inhalational anaesthetic agents. This was particularly apparent on paediatric lists, where despite the advice from the malignant hyperthermia unit, he was often asked to step out of the anaesthetic room for gas inductions, and indeed missed out on ever performing one himself. On occasions this anxiety led to him missing an entire case – one such example being a microlaryngoscopy and bronchoscopy, where a volatile agent was used to maintain spontaneous ventilation without a definitive airway in situ.

Ultimately, this led to the trainee experiencing fewer paediatric lists than his fellow novice anaesthetists, instead being allocated largely to adult lists where inhalational induction of anaesthesia was much less frequent, and supervisors therefore felt more comfortable allowing him to acquire hands-on experience. With the exception of demonstrating an inhalational induction or sedation technique, the trainee successfully achieved all assessments required to pass the initial assessment of competence and to progress with his training in emergency medicine.

Discussion

As anaesthetists, malignant hyperthermia is a condition that every one of us will learn about within the first few months of anaesthetic training. We commit to memory the pathophysiology behind the diagnosis as part of our college examinations, and undergo simulation training in order to try and prepare us to treat the life-threatening emergency should we be unfortunate enough to encounter it.

Despite this, our case demonstrates that having a colleague with malignant hyperthermia working in the theatre environment causes a great degree of apprehension among even experienced anaesthetists. There are many reasons for this, including the relative rarity and severity of the illness; the reputation that malignant hyperthermia is challenging to treat; and a feeling of responsibility for the trainee's safety. However, we found an in-depth understanding of how the disease is triggered was imperative in having a considered approach for optimising this trainee's experience.

Triggering of malignant hyperthermia is related to the dose of inhalational anaesthetic agent received and the duration of exposure [1]. All inhalational agents have been found to trigger the condition, except nitrous oxide [1, 3]. The minimum dose capable of causing a malignant hyperthermia crisis is unknown, but it is not uncommon for a susceptible patient to have been exposed to an inhalational anaesthetic without consequence [1], indeed one study found that the average number of anaesthetics received before triggering was three [3]. There is a lack of reports of malignant hyperthermia being triggered by working in the theatre environment [1] and several anecdotal cases of known malignant hyperthermia-susceptible operating theatre personnel working without the need to alter their practice [4].

Perhaps not unexpectedly, our trainee encountered the most apprehension on paediatric lists. Occupational exposure to inhalational agents is predictably higher in paediatric cases than in adult as a result of gas inductions and open breathing systems with high gas flows [5]. Typical concentrations of potent inhalational anaesthetics found in the atmosphere in operating theatres and recovery rooms are approximately 1000 times lower than the minimum dose thought to trigger malignant hyperthermia. The Control of Substances Hazardous to Health (COSHH) regulations stipulate a maximum 8-hour time weighted average concentration of 50 ppm for isoflurane, but have not been updated to provide guidance for newer agents such as

The Risk of Occupational Exposure to Potent Inhalational Anaesthetics in individuals susceptible to Malignant Hyperthermia

Malignant Hyperthermia is a condition characterised by excessive metabolic heat production under general anaesthesia. It occurs as a result of a genetic predisposition and is triggered by the commonly used potent inhalational anaesthetics (Isoflurane, Sevoflurane, Desflurane) or the depolarising neuromuscular blocking drug Suxamethonium. Unless exposed to these agents during anaesthesia the great majority of people susceptible to Malignant Hyperthermia have no manifestations of the condition and lead normal healthy active lives.

Unlike an allergy to drugs, Malignant Hyperthermia triggering is a dose dependent phenomenon. Triggering of the condition is related to the dose of potent inhalational anaesthetic inhaled and the duration of exposure. Typical concentrations of potent inhalational anaesthetics found in the atmosphere in operating theatres and recovery rooms are approximately 1000 times lower than the minimum dose thought to trigger Malignant Hyperthermia. The maximum permitted environmental concentrations of potent inhalational anaesthetics as stipulated by the Control of Substances Hazardous to Health (COSHH) regulations are 100 times lower than the minimum dose required to trigger Malignant Hyperthermia in susceptible individuals. There are examples of MH susceptible individuals who during the course of their working life have been regularly exposed to even higher levels of potent inhalational anaesthetics than currently permitted who have shown no untoward effects.

In conclusion, as long as COSHH regulations are complied with, there is no contra-indication to individuals susceptible to Malignant Hyperthermia working in operating theatre or recovery room environments.

Figure 1 Letter provided by the malignant hyperthermia unit to the trainee.

sevoflurane or desflurane [6]. This COSHH regulation for isoflurane is 100 times lower than the minimum dose thought to trigger malignant hyperthermia.

Hoerauf et al. measured the occupational exposure to sevoflurane and halothane during gas induction of anaesthesia in paediatric patients. In the breathing zone of the anaesthetist, environmental concentrations of volatile agent were on average 3–5 ppm, and were 40–50% lower when stood 4 metres from the anaesthetist [5]. In some cases, higher concentrations of >10 ppm were demonstrated for several minutes during mask induction, but following tracheal intubation mean concentrations were comparable with those measured during adult cases [5].

As an emergency medicine trainee, it is very unlikely that the ability to perform an inhalational induction in a child will be required outside of operating theatre settings, particularly not without an experienced anaesthetist being present. However, it is certainly possible that an emergency physician may be the first doctor to see a child in need of airway support. Managing a paediatric airway is not directly transferable from adult airway management, and arguably this skill is best developed under accomplished supervision and with hands-on experience in the peri-operative settings.

The solution to this rarely-encountered situation is not clear cut, nor is it 'one size fits all'. A salient reflection from a consultant within the department was one of having been re-educated. As she put it "I have been an anaesthetist for 20 years and I learned so much more from [the trainee] than I ever have before". This trainee has lived with his diagnosis for a number of years, and perhaps the most important learning point from this case is that the trainee was the expert in this setting. Allowing the expert trainee to educate the department greatly improved the training we were able to provide. I shared the detailed information I had received and discussed what he would like to get out of his anaesthetic attachment and what he felt was safe for me. Our trainee was very keen to receive the same experience during his anaesthetic attachment as his peers with one specific request to not be present when vaporisers were re-filled, having had a bottle of sevoflurane spilled onto the floor in front of him as a medical student. We endeavoured to give him this experience, while acknowledging that there was also an element of judgement for the trainers to exercise during each theatre list.

Finally, on as an malignant hyperthermia-susceptible individual working in the theatre environment, one may need to expose this part of one's personal medical history on several occasions. It is also a diagnosis that is usually discovered following an experience or even death of a relative, and therefore treating these conversations with due sensitivity is essential. Our 'expert novice' highlighted many issues around training, misconceptions in the management of a well-known anaesthetic emergency, dealing with the dissemination of sensitive information carefully and most of all, keeping the trainee at the centre of their training.

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