

Peri-operative neuromuscular blockade monitoring: a comparison between tertiary centres and with existing guidelines

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Abstract

Aim

The aim of this study was to compare the use of, and attitudes towards the use of neuromuscular blockade monitoring at two large training hospitals, Cork University Hospital in Ireland and Fiona Stanley Hospital in Australia.

Methods

This prospective, double-centre observational study examined 45 cases at both Cork University Hospital and Fiona Stanley Hospital. Data were collected by direct observation in theatre during which anaesthetists of all levels were asked standardised questions relating to their use of neuromuscular blockade monitoring during the cases.

Results

In Cork University Hospital and Fiona Stanley Hospital, neuromuscular blockade monitoring was employed in 9% (4) and 58% (26) of cases, respectively. The most common reason not to monitor in both Cork University Hospital and Fiona Stanley Hospital was that it is viewed as unnecessary (38% (17) vs 24% (11), respectively). In Cork it was viewed as unnecessary by 56% (10) primarily due to the availability of Sugammadex, whereas in Australia accurate timing and dosing of neuromuscular blocking drugs was cited by 64% (7).

Discussion

The utilisation of neuromuscular blockade monitoring between Cork University Hospital and Fiona Stanley Hospital differs and falls below recommended standards. Usage varies widely between the centres. Improvement is required to meet the monitoring guidelines.

Introduction

Neuromuscular blockade (NMB) drugs are usually administered during anaesthesia to facilitate endotracheal intubation and to improve surgical conditions. Over seven decades since their introduction, anaesthesiologists continue to confront challenges in correctly managing NMB. Monitoring of the NMB is useful to avoid patient harm as these drugs increase the risk of developing unrecognised residual paralysis, which is associated with poor patient recovery, ranging from airway impairment and respiratory failure to death^{1,2}.

Guidelines have been established to mitigate these complications that may arise from the absence of NMB monitoring. For the purpose of this, a pragmatic study of developed and resource-rich centers, we compared practice at Cork University Hospital (CUH) in Ireland to the Association of Anaesthetists' guidelines (2021), which emphasises that "quantitative neuromuscular monitoring is essential for all stages of anaesthesia when neuromuscular blocking drugs are administered"³. Similarly, we compared practice at Fiona Stanley Hospital (FSH) in Perth to the Australia and New Zealand College of Anaesthetists 'PG 18 (A) guidelines on monitoring during anaesthesia 2017'. These guidelines recommend that, "quantitative neuromuscular function monitoring should be used when the anaesthetist is considering extubation following the use of non-depolarising neuromuscular blockade"⁴. While the guidelines are from authorities local to those centers then, their practical implications are the same.

Contemporary data shows a high incidence of inadequate management of neuromuscular blockade, leading to an increased frequency of harmful complications⁵. Motivated by this observation, our aim was to assess the gap between standards and actual clinical practice. Our primary objective was to compare the use of, and attitudes towards the use of NMB monitoring in two cohorts of anaesthesia practitioners: those in Ireland and in Australia.

Methods

This prospective, double-center observational study involved two distinct audit phases, which collectively examined a total of 90 cases during January and June 2023.

CUH and FSH were selected as the audit sites as they are both major tertiary hospitals and large training centers with 800 and 783 beds, respectively. This was to fit with scheduled medical student electives in both hospitals and included cases using NMB drugs during elective surgical cases on adult patients.

An identical audit was conducted at both CUH and FSH, over two-week periods in January and June 2023. The data in both audits was collected by the study's lead author through direct observation in the surgical theatre during which anaesthetists of all levels were asked

standardised questions relating to their use of NMB monitoring during the cases. Direct observation was employed to ascertain the utilisation of an NMB monitor and the presence of such equipment within the operating theatre.

We collected data on the type of surgery, the availability of quantitative TOF monitors in the theatre, whether a monitor was being used and the reasons for that choice. We assessed the use of a reversal agent and duration of the surgery. The same set of questions was used for both the Irish and Australian groups.

All adult patients (aged ≥ 18 years) who underwent surgery with tracheal intubation in conjunction with neuromuscular blocking drugs and then had their tracheas extubated immediately after the procedure were eligible for inclusion. Patients who had a tracheostomy tube in-situ were not studied as we were specifically investigating residual neuromuscular blockade prior to tracheal extubation. Patients extubated in ICU were also not studied.

Ethical approval was obtained from the Clinical Research Ethical Committee of the Cork Teaching Hospitals (CREC).

Statistical analyses and graphs were generated using SPSS statistics 28.0. Descriptive statistics were used for data analysis and frequency tables were used to summarize the results within each cohort of anaesthesia practitioners.

Results

A total of 45 cases were analysed in CUH and a total of 45 cases analysed in FSH for comparison of practices in different settings with different guidelines. Across the total of 90 cases, responses were provided by a different anaesthetist.

In CUH, neuromuscular blockade (NMB) monitoring was employed in 9% of cases, while in FSH, it was utilized in 58% of cases (*figure 1*). Quantitative TOF monitors were available 93% of the time in CUH and 100% of the time in FSH. The most common surgical specialty of the cases examined in both CUH and FSH was General Surgery (33%, 42% respectively). There was an equal number of plastic surgery cases included from both CUH and FSH (16%, $n=7$). Surgeries of a shorter duration were associated with lower rates of monitor usage. For example, in surgeries of up to one hour long, no monitor was used in 75% of cases in FSH, and 80% in CUH. In FSH, the likelihood of utilising a monitor concurrently increased with the duration of surgery. Specifically, regarding surgeries lasting 3-5 hours, a monitor was employed in 75% of instances. In CUH, the duration of procedures did not appear to influence monitor usage, as monitors were seldom utilised at any duration.

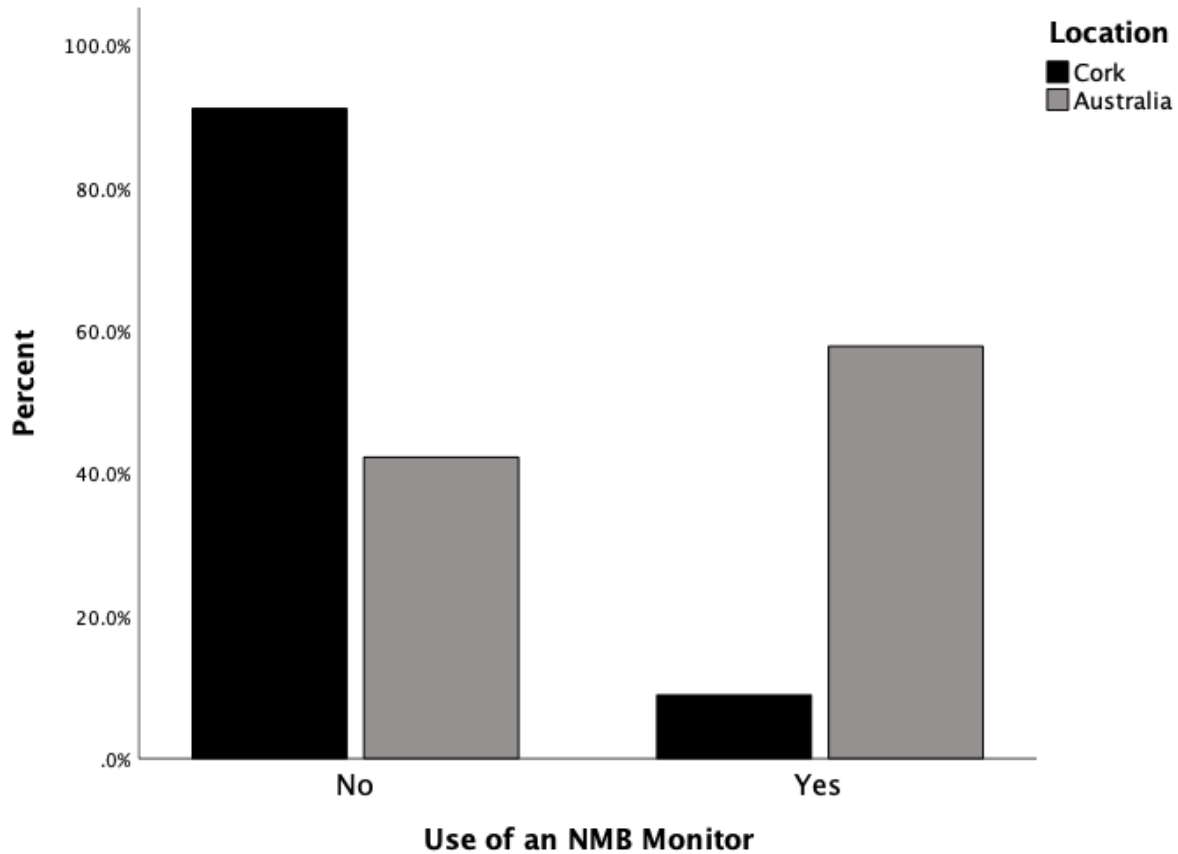


Figure 1: The Use of an NMB monitor in CUH, Cork compared with FSH, Australia.

Data on the use of various neuromuscular blockers and reversal drugs are outlined in Table 1. For example, the table shows the most commonly used muscle relaxant in CUH was Vecuronium (71%), compared with Rocuronium (62%) in FSH. Routine pharmacologic reversal was less common in Australia than in Ireland (86% vs 91%, respectively). Sugammadex was predominantly used for reversal prior to extubation in both CUH and FSH (80%, 76% respectively), with only 11% at CUH and 20% in FSH using neostigmine. No reversal agents were employed in the remainder of cases at CUH and FSH (9%, 4%). In all cases where NMB monitoring was used and Sugammadex was given prior to extubation, the standard 200mg dose of Sugammadex was administered without tailoring the dose based on the NMB monitor.

Question	No. (%) of cases in Cork (N = 45)	No. (%) of cases in Australia (N = 45)
Which neuromuscular blocking drug was used to facilitate tracheal intubation in this case?		
Rocuronium	10 (22)	28 (62)
Vecuronium	32 (71)	15 (33)
Cisatracurium	0	2 (5)
Pancuronium	3 (7)	0
Reversal agent used at the end of this case?		
Sugammadex	36 (80)	34 (76)
Neostigmine	5 (11)	9 (20)
None	4 (9)	2 (4)

Table 1: Use of Different Neuromuscular Blocking and Reversal Drugs.

Impediments to the use of NMB monitoring are presented in figure 2. The most common reason cited to forego monitoring in both CUH and FSH was that it was viewed as unnecessary (38% vs 24%, respectively). In CUH it was viewed as unnecessary primarily due to the availability of Sugammadex to reverse an NMB (56%), whereas in Australia the main reason was the view that the careful timing and dosing of NMB drugs was sufficient (64%). Significantly, respondents from Cork (11%) reported that NMB monitors are unnecessary as clinical signs (such as the ability to sustain a 5-s head lift) are reliable indicators of the adequacy of neuromuscular recovery. This belief was not articulated in the Australian cohort (*figure 3*). All respondents in Ireland and Australia reported being aware of their respective guidelines and the recommendation that TOFR > 0.9 is required for extubation.

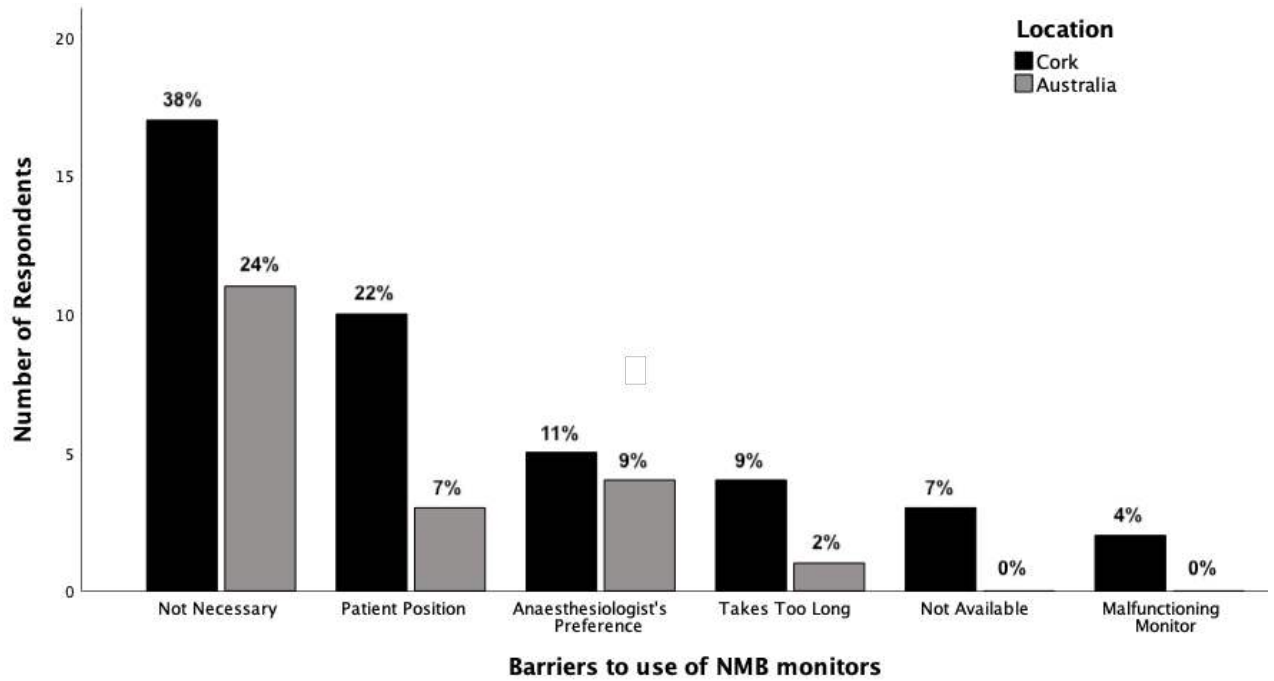


Figure 2: Barriers to the use of an NMB monitor in CUH, Cork compared with FSH, Australia.

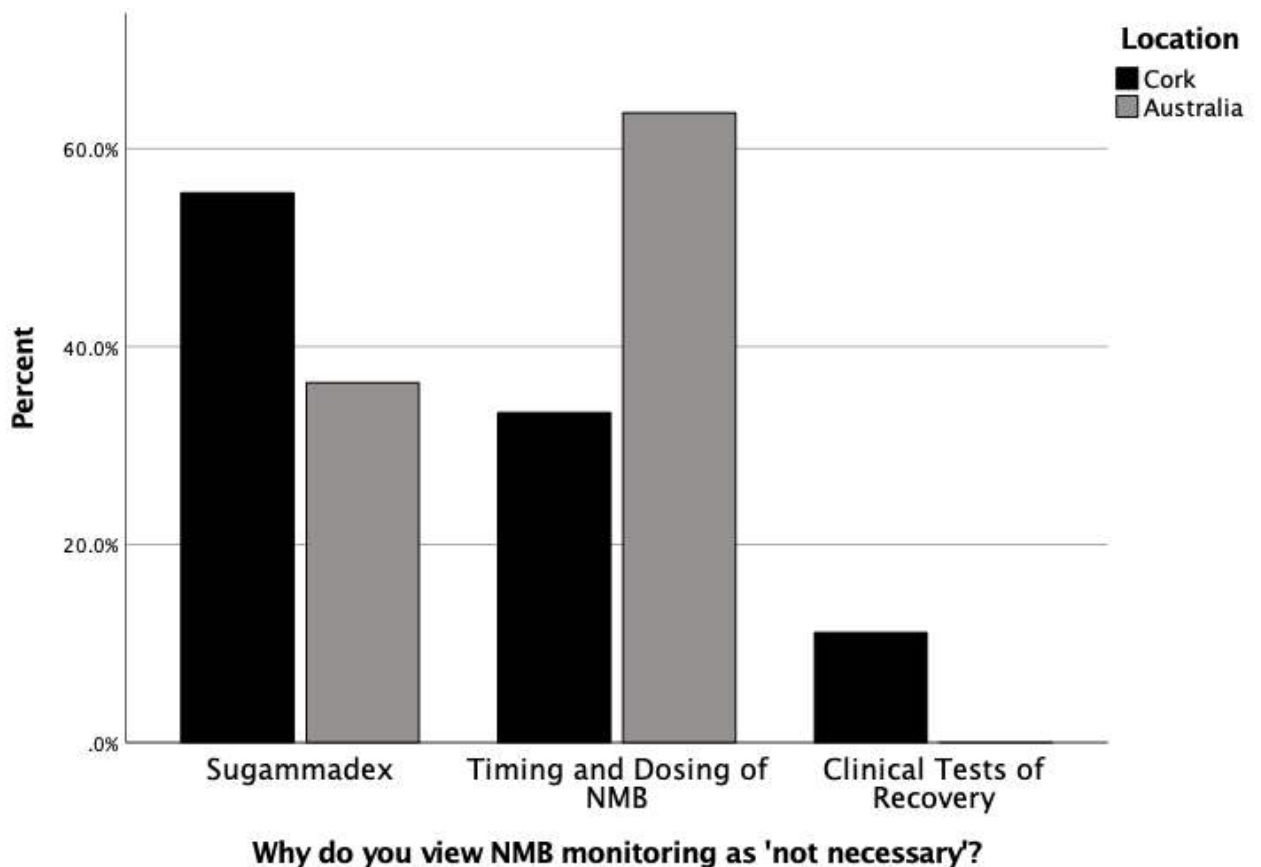


Figure 3: Reasons cited why NMB monitoring is viewed as not necessary in CUH, Cork compared with FSH, Australia.

Discussion

Our results indicate that despite the existence of numerous guidelines advocating for neuromuscular monitoring in conjunction with NMB drugs during anaesthesia, the reality is that these recommendations are widely ignored. Monitoring is underused, despite the widespread availability of relevant equipment and awareness of the guidelines. This phenomenon may, in part, be attributed to longstanding attitudes and beliefs. These include the view that monitoring is superfluous for experienced anaesthetists, the perception that it lacks the accuracy to confer clinical advantages in terms of patient safety (despite robust supporting evidence in the literature)⁶, and concerns that setting monitors is inconvenient and time-consuming. The recent introduction of Sugammadex has undeniably had an adverse impact on the utilisation of NMB monitors, with an increasing reliance among anaesthetists on its perceived effectiveness.

As previously alluded to, recent literature has recommended that quantitative monitoring be performed, and specifically, documentation of a TOF ratio ≥ 0.9 be considered as the only reliable method to confirm sufficient neuromuscular function recovery⁷. Our investigation revealed a discrepancy between a high knowledge-base and actual practice patterns amongst anaesthesiologists. Despite all respondents in Ireland and Australia being aware of their respective monitoring guidelines and the recommendation for a TOF ratio > 0.9 prior to extubating, almost 40% of anaesthesiologists in CUH (24% in FSH) still believe it is not necessary to use an NMB monitor. The clinician needs reliable information as to the patient's neuromuscular function before emergence from anaesthesia. As there is growing evidence that the risk of adverse complications during early recovery from anaesthesia can be reduced by correct use of quantitative monitoring^{8, 9, 10}. Insufficient training or familiarity with NMB monitoring techniques could be a contributing factor to the reluctance among anaesthetists to incorporate these monitors into their practice. Another factor may be that established routines and practices are resistant to change, and anaesthetists may keep to traditional methods even in the face of evolving evidence. Therefore, opportunities to accelerate adoption of quantitative monitoring and improve patient outcomes need to be identified.

The majority of Irish anaesthesiologists who did not use monitoring (vs 36% in the Australian cohort), believe that administration of the standard 200mg dose of Sugammadex in isolation is satisfactory to ensure adequate NMB recovery, irrespective of the surgical duration. Sugammadex has been available in Europe since 2008 to reverse intermediate-action

neuromuscular blockades. Despite the rapid and reliable pharmacodynamics of Sugammadex, monitoring remains vital to confirm reversal of NMB. The optimal dose to be administered should be determined based on objective monitoring of the depth of the NMB. Multiple studies have demonstrated that the empirical use of sugammadex, without considering the level of neuromuscular blockade, does not eliminate the occurrence of residual NMB¹¹. Sugammadex administration without monitoring can result in up to 9.4% of patients having residual paralysis at extubation¹¹. Therefore, the possibility of an inadequate Sugammadex dose cannot be excluded in the absence of NMB monitoring and a recorded TOFR > 0.9 prior to extubation. In this respect, we have identified a clear need for re-education of anaesthetists in CUH and FSH. It appears that some anaesthetists are not fully aware of the limitations of Sugammadex, and the risks associated with relying solely on it.

Among anaesthesia practitioners at FSH who do not employ NMB monitoring, 64% (and 33% at CUH) alarmingly asserted that the timing and dosing of NMB drugs is an adequate strategy for evaluating NMB recovery, thus highlighting a dangerous misconception on the management of NMB's. This practice is not supported by any evidence but, rather, based on subjective opinion. Given the unpredictability surrounding the duration of action of NMBs and variation among individuals, there is no specific time that can guarantee spontaneous, adequate recovery.

A potential limitation of our study is the use of direct observation as a data collection method due to the potential for the Hawthorne effect, whereby behaviour changes in response to being observed. It is also a small, and entirely pragmatic study based around periods of observation coinciding with medical student electives.

A strength of our study is the use of a standardised questionnaire and direct observation which allows for consistent and accurate data collection which increases the internal validity of the study. Our study mitigated potential sources of variability, particularly as the study's lead author assumed sole responsibility for data collection in both audits.

Further studies are required to examine in greater detail the implications on patient safety and incidence of postoperative residual paralysis when NMB monitors are not used perioperatively. Efforts should be undertaken to enhance monitoring practices, which could include the implementation of a multimodal educational strategy encompassing tutorials and posters as cognitive aids. It is important to begin fostering an enhanced safety culture in which NMB monitoring is prioritised.

NMB monitoring is not universally used in practice according to observations made at teaching hospitals in Ireland and Australia. This raises concerns about adequacy of recovery of muscle strength after anaesthesia. It is imperative to increase awareness on the importance of NMB monitoring in enhancing patient safety.

Declarations of Conflicts of Interest:

None declared.

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