Medical Science

A survey of the awareness level of intraoperative neurophysiologic monitoring among students of the college of medicine in Umm Al-Qura University, Saudi Arabia

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ABSTRACT

Background/Aim: The neurodiagnostic test known as 'Intraoperative Neurophysiological Monitoring' (IONM) is critically important in providing live-feedback during neurosurgery on the functional integrity of the nervous system. IONM is the use of electrophysiological methods and evoked potentials to detect neurological impairments, reducing the risk of iatrogenic damage. This study examines the awareness level of IONM among students of the College of Medicine in Umm Al-Qura University, and recommends strategies to bridge this knowledge gap. *Methodology:* A survey-based study was carried out on students from the College of Medicine, Umm Al-Qura University between Septembers to December 2021. *Results*: There were 322 participants in the current study, with a mean age 22.03 ± 1.47 years. The male participants made up 73.9% against 26.1% females. The majority were 3rd-year students, while intern students were the smallest group. This study did not find any association between the level of awareness of IONM and the participant's demographics. However, the association between students attitude towards IONM and their academic year was significant, particularly upon completing both neurosurgical and orthopedics courses (P-value, 0.000). Moreover, the correlation between students attitude towards IONM and gender distribution was significant as well, mainly males participants who is completing both neurosurgical and orthopedics courses (P-value, 0.001, 0.000, respectively). *Conclusions:* conceptual understanding of basic principles of IONM helps minimize medical errors and provide optimal care. We recommends for further studies investigating level of knowledge among health population and Saudis' medical collages.

Keywords: Intraoperative neurophysiologic monitoring, IONM, health students, awareness, knowledge, Kingdom of Saudi Arabia.

1. INTRODUCTION

Surgical techniques are steadily improving our ability to restrict aggressive tumors. However, unintended post-operative complications can occur (Park et al., 2017; Lall et al., 2012). Therefore, Intraoperative Neurophysiologic Monitoring (IONM) has a major role to play in many surgical procedures, and allows the surgeon to perform more aggressive maneuvers to remove almost the entire tumor (Park et al., 2017; Malhotra & Shaffrey, 2010).

Intraoperative neurophysiological testing was first utilized in the 1930s on patients with epilepsy, to identify their motor cortex by direct cortical stimulation (Kim et al., 2013; Penfield & Boldrey, 1937). The 1980s saw the technique became commonly utilized with the development of the commercial IONM machine (Kim et al., 2013; Nuwer, 2008). In addition in the 1990s, transcranial motor evoked potentials (TcMEP) became popular as a method of monitoring cortical spinal cord activity (Kim et al., 2013; Kothbauer et al., 1997) and as a method of predicting post-operative motor impairment (Kim et al., 2013; Kothbauer et al., 1998). IONM employs a plethora of modalities with sensory and motor evoked potentials being most widely used (Husain et al., 2011; Nuwer et al., 1995; Radtke et al., 1989). Both sensory and motor evoked potentials (EPs) are used in the surgical operations to assist surgical decision-making. Additionally, it is used as a substitute for post-operative clinical endpoints of motor and sensory wellbeing (Ali, 2019; Holdefer et al., 2015). Because of the widespread proliferation of computer and connected systems, IONM can now be performed from remote locations. These advances have increased the potential application of this technology and further contribute to the popularity of the IONM (Kim et al., 2013; Greiner et al., 2012). However, limited research is available concerning the awareness level of IONM globally. We aim to investigate the awareness level of IONM among health-related students in Umm Al-Qura University.

2. METHODOLOGY

Study design

This is a cross-sectional study conducted using a self-administered structured questionnaire at Umm Al-Qura University (UQU), City of Makkah, Kingdom of Saudi Arabia. The study was carried out between December to January 2021. After obtaining the necessary ethical approval from Umm Al-Qura University's research ethics committee with ethical number: (HAPO-02-K-012-2021-09-768). Convenience samplings were implemented to stratify students to academic year at UQU.

Sample size

The intended sample size in this study was determined by Epi Info™ 7.1.5 (Center for Disease Control and Prevention; Atlanta, Georgia, USA). Thus, the least possible sample size to achieve an accuracy of ± 5% with a 95% confidence interval (CI) is 313. However, the final sample size was 322 was targeting during collection of data.

Questionnaire development and scoring system

The questionnaire was organized into three sections. The first section was regarding educational and demographics. The second section questioned general students' attitude about IONM includes: (finishing neurosurgical and orthopedics courses, IONM experts in their University, perceptions of IONM course, and he importance of IONM course in medical students curriculums). The third part questioned basic information about IONM as it showed in (Table 1). All questions were adapted by IONM expert.

We utilized the modified bloom's criteria for estimate knowledge score (Sullivan, 2009). Whereas, each incorrect answer was given a score of zero and correct answers were given a score of one. All the scores were summed up and a value above 75% was characterized as having good knowledge IONM, while a value below 75% was characterized as having poor knowledge of IONM. Any inquiry about the questionnaire from the participants was answered on the spot by the researchers. Participants were asked to give their consent, and they completed the questionnaire on their own volition.

Statistical analysis of data

Before the analysis, the data were coded into MS Excel in addition to the dataset was processed and reviewed for missing data. Then, data was imported to SPSS software version 23 for statistical analysis. The frequency was calculated for categorical data and the mean ± standard deviation [SD] for continuous variables. The Chi-square test was used for comparing categorical variables. P-value less or equal to 5% was considered statistically significant.

3. RESULTS

Overall, 322 students were surveyed from collage of medicine, out of which 73.9% were males and 26.1% were females. The mean ages (SD) of the students' were 22.03 ± 1.47 years. The largest age group was the 21 and 22 years (27.6% and 23.9%, respectively). The smallest groups were the 32 and 19 years (0.3% and 0.6%, respectively). Third year students were predominant (23.9%) compared with intern students (3.1%) (Table 1). Those students who were not aware of IONM accounted for 73%, while only 27% were aware. Therefore for the most of students were characterized to have poor knowledge of IONM (90.8%) (Table 1 and Figure 1).

Students' attitude about who should have IONM is shown in (Figure 2). Majority of students believe that IONM should be available in any secondary and tertiary healthcare center 24.14%, while number of presenting cases were representing the lest responding rate between students 6.90%. 9-subgroups questions were aimed to identify students' knowledge about general aspects of IONM (Table 1); Most of the questions show incorrect responses among students, while correct responses were shown in questions related to indications for spine IONM and the availabilities of IONM (51.7, 63.2, respectively).

| Table 1 Demographic data		
Variable	Category	No. of students (%)
Age *(mean [SD])*	(22.03 ± [1.47])	
	19	2 (0.6%)
	20	41 (12.7%)
	21	89 (27.6%)
	22	77 (23.9%)
	23	59 (18.3%)
	24	41 (12.7%)
	25	12 (3.7%)
	32	1 (0.3%)
Gender	Male	238 (73.9%)
	Female	84 (26.1%)
Academic year	2nd year	62 (19.3%)
	3rd year	77 (23.9%)
	4th year	62 (19.3%)
	5th year	69 (21.4%)
	6th year	42 (13.0%)
	Intern	10 (3.1%)
Heard about IONM	Yes	87 (27%)
	No	235 (73%)
Knowledge of IONM	Good Knowledge	8(9.2%)
	Poor Knowledge	79(90.8%)
Percentage of the respondents' corrects responds		
Question		Correct responds (%)
The Responsible physician for Running IONM		26.4
Consideration of Intraoperative Neurophysiological Monitoring		33.3
The Responsible physician for detriments Patient IONM Needs		28.7
Indication of spine IONM		51.7
Indication of brain IONM		48.3
Modalities for brain IONM		40.2
The commonest modality for IONM		19.5
Evidence significances for IONM		25.3
Availabilities of IONM		63.2
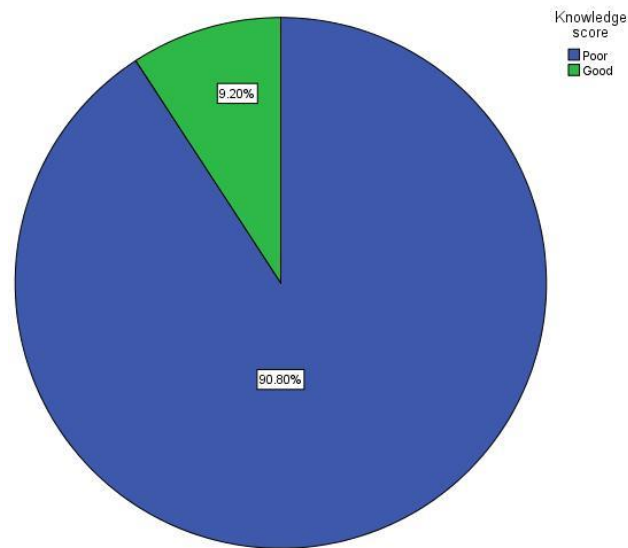
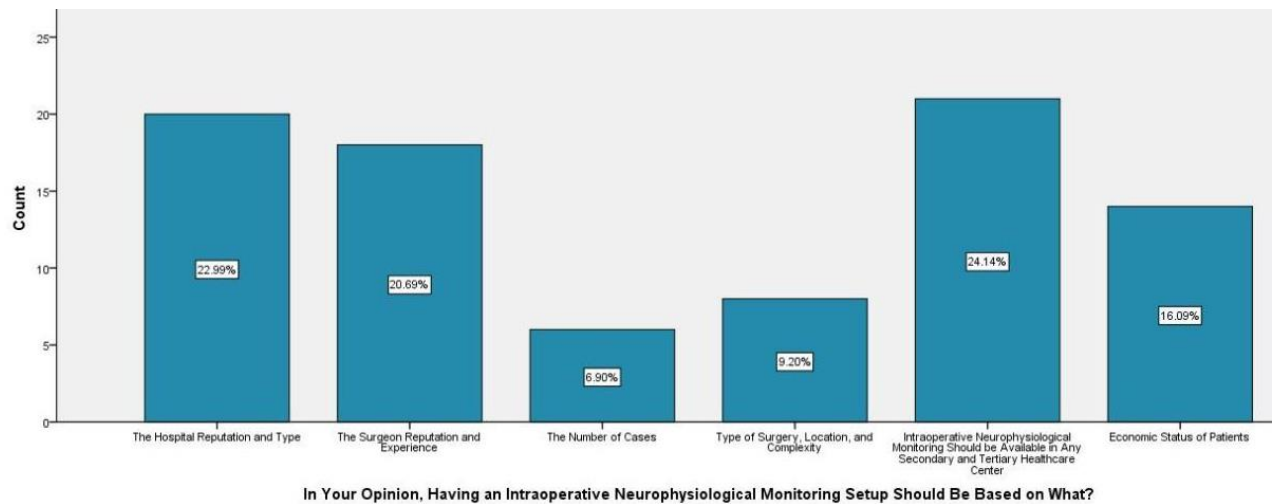**Figure 1** Pie chart for knowledge score of UQU' health-related students

Figure 2 Students' attitude about having IONM setup

The correlation between students' collages and general attitude of IONM were ladled in (Table 2); 6th year students and interns were corresponds significantly with completion of both neurosurgical and orthopedics courses (P-value, 0.000). While no significant associations were found towards if university has a certified intraoperative neurophysiologist, applied IONM in students courses (P-value, 0.589, 0.502, respectively). Furthermore, applied IONM programs from students' point of view show no significant variation (P-value, 0.129) (Table 2).

Table 2. The correlation between students' collage and students' general attitude about IONM								
Category	Answers (%)	Collages						p-value
		2th year	3th year	4th year	5th year	6th year	internship	
Did you finish the neurosurgical course?	Yes	3.6%	3.6%	0.0%	20.0%	60.0%	12.7%	0.000*
	No	3.1%	9.4%	12.5%	65.6%	6.3%	3.1%	
Did you finish orthopedic	Yes	3.8%	1.9%	3.8%	9.6%	67.3%	13.5%	0.000*

course?	No	2.9%	11.4%	5.7%	77.1%	0.0%	2.9%	
Does Your University Have a Certified Intraoperative Neurophysiologist?	Yes	5.3%	2.6%	2.6%	42.1%	39.5%	7.9%	0.589
	No	0.0%	0.0%	5.6%	27.8%	55.6%	11.1%	
	Don't know	3.2%	12.9%	6.5%	35.5%	32.3%	9.7%	
Does Your University Have course in Intraoperative Neurophysiological Monitoring?	Yes	8.0%	0.0%	0.0%	32.0%	44.0%	16.0%	0.502
	No	0.0%	6.9%	6.9%	37.9%	37.9%	10.3%	
	Don't know	3.0%	9.1%	6.1%	39.4%	39.4%	3.0%	
From a medical student Point of View, Should Intraoperative Neurophysiological Monitoring Be Part of study Programs?	Yes	6.9%	0.0%	3.4%	51.7%	27.6%	10.3%	0.129
	No	0.0%	9.1%	0.0%	33.3%	45.5%	12.1%	
	Don't know	4.0%	8.0%	12.0%	24.0%	48.0%	4.0%	

Additionally, the relations of gender distribution towards general attitude of IONM were stated in (Table 3); males' participants demonstrated a significant relation with completion of both neurosurgical and orthopedics courses (P-value, 0.001, 0.000, respectively). while the awareness of whether university haves a certified intraoperative neurophysiologist, applied IONM in students courses, and the importance of application of IONM in students programs from students point of view shows no significances (P-value, 0.084, 0.914, 0.636, respectively) (Table 3).

Table 3 The correlation between students' gender distribution and students' general attitude about IONM				
Category	Answers (%)	Gender		p-value
		Male	Female	
Did you finish the neurosurgical course?	Yes	58.2%	41.8%	0.001*
	No	90.6%	9.4%	
Did you finish orthopedic course?	Yes	51.9%	48.1%	0.000*
	No	97.1%	2.9%	
Does Your University Have a Certified Intraoperative Neurophysiologist?	Yes	65.8%	34.2%	0.084
	No	55.6%	44.4%	
	Don't know	83.9%	16.1%	
Does Your University Have course in Intraoperative Neurophysiological Monitoring?	Yes	68.0%	32.0%	0.914
	No	69.0%	31.0%	
	Don't know	72.7%	27.3%	
From a medical student Point of View, Should Intraoperative Neurophysiological Monitoring Be Part of study Programs?	Yes	75.9%	24.1%	0.636
	No	69.7%	30.3%	
	Don't know	64.0%	36.0%	

No significant difference between participants IONM knowledge and their demographics (age and gender) and academic years (Table 4) (P-value, 0.972, 0.691, 0.661, respectively).

Table 4 Association between level of awareness and students' demography

Variable	Level of knowledge		P-value
	Poor level of knowledge N. (%)	Good level of knowledge N. (%)	
Age			
20	1 (100%)	0 (0%)	
21	6 (100%)	0 (0%)	
22	7 (87.5%)	1 (12.5%)	
23	26 (89.7%)	3 (10.3%)	0.972
24	28 (90.3%)	3 (9.7%)	
25	11 (91.7%)	1 (8.3%)	
Gender			
Male	56 (91.8%)	5 (8.2%)	0.691
Female	23 (88.5%)	3 (11.5%)	
Academic year			
2nd year	3 (100%)	0 (0%)	
3rd year	5 (100%)	0 (0%)	
4th year	3 (75%)	1 (25%)	
5th year	28 (87.5%)	4 (12.5%)	0.661
6th year	32 (91.4%)	3 (8.6%)	
Intern	8 (100%)	0 (0%)	

4. DISCUSSION

IONM enables surgeons the tools they need to evaluate the functional integrity of particular brain structures in real time. This technique has been routinely used to assess damaged peripheral nerve function, regardless of the etiology (Rodríguez et al., 2021; 17 Sanders et al., 2020). However, errors from IONM can occur and have been the subject of several studies (Skinner et al., 2017). A review by Skinner, (2017) lay out their 'error-reduction concepts'; mainly the design of a forgiving system, and system redundancy of multimodality of IONM to reduce the number of false-positive alarms. Furthermore, the same review observed that within operating rooms, observational and controlled experiments showed that improved communication, collaboration, and situational awareness lead to fewer errors (Skinner et al., 2017). Several studies reveal that recognizing IONM modalities and comprehending the basic IONM principles are essential to improve outcomes and reduce errors (Rabai et al., 2016; Wing-hay & Chun-kwong, 2019; Michels et al., 2017).

This study showed that most of the students that took part in our questionnaire in UQU had low awareness and poor knowledge concerning IONM principle concepts. However, students with higher academic years correspond significantly with general attitude and principle concepts of IONM. Our study recommends further investigation regarding awareness and knowledge between students in the health fields and practicing health care providers. Future studies will involve students across in Saudi Arabian universities. This study carries some possible limitations; this study conducted at single university; thus, our results are not representative among all Saudis' universities.

5. CONCLUSION

Minimizing medical errors mainly depends on the corporations between health staff and fully understanding the basic knowledge of IONM principles. Overall, our study shows the low level of awareness and poor level of knowledge concerning basic principles of IONM. However, the association between students' positive attitude towards IONM and their academic years was significant. This promising observation implies that upon completing both neurosurgical and orthopedics courses students' attitude towards IONM improved significantly. This survey targeting health-related students at UQU and concludes that the knowledge and awareness of IONM is presently insufficient, but can be improved. This is the first study investigating the level of awareness, knowledge, and practical perception of IONM among health-related students in Saudi Arabia to the best of our knowledge.

Conflict of interests
The authors declare that there are no conflicts of interests.

Data and materials availability
All data associated with this study are present in the paper.

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