Title: Analyzing the Implementation of Intra-operative Monitoring (IOM) Service

Period of Performance: September 8, 2008 – December 8, 2008

Date Submitted: December 8, 2008

FINAL REPORT

To

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Executive Summary

Intra-Operative Monitoring (IOM) is a service used during nerve, spine, and brain surgeries to provide feedback to the surgeon regarding the neurological integrity of the patient. During surgery a technician, certified in Neurophysiologic Intra-Operative Monitoring (CNIM), monitors the patient’s waveforms on a computer in the operating room (OR), while a neurologist views the same waveforms remotely via intranet connection. Cascade and Endeavor are the computer programs used to interpret patient waveforms. Each case requiring IOM requires one CNIM, however due to quality of care standards a neurologist can monitor up to three cases simultaneously.

Prior to surgery, the CNIM records and sends initial patient baselines to the neurologist. During surgery, if the patient’s waveforms deviate significantly from the baselines, the CNIM can contact the neurologist for interpretation, via the onscreen messaging service of Cascade. The neurologist will interpret the waveforms and advise the CNIM and surgeon on the proper course of action to prevent patient nerve damage. Both the CNIM and neurologist will monitor the patient for the duration of surgery.

Currently, the University of Michigan Health System (UMHS) offers IOM service through the Department of Neurology. UMHS has only recently become capable of providing all IOM services, with much of the past demand for IOM being met by contracted IOM service. Because of the increasing capability and demand for UMHS IOM Services, Team Six has been asked to examine the IOM service model in an effort to eliminate dependence on expensive IOM contractor use and improve UMHS quality of patient care and customer service. Observations and analysis of the UMHS Neurology IOM Service Continuum were conducted by Team six from September 8, 2008 to December 8, 2008.

The main objective of Team Six’s analysis was to develop a CNIM schedule to meet IOM demand without use of the outside contractor. Upon obtaining IOM case data, including times and dates from the operating room (OR) administrator and Program & Operations Analysis (POA) department, Team Six was able to determine that demand for IOM services peak on Tuesdays and Thursdays between 7 AM and 1 PM, and that these service peaks require no more than five CNIMs at one time. Following the existing policy of having one “floater” CNIM available to relieve others for breaks, Team Six has developed a weekly schedule focusing on full time equivalents (FTE) that would meet this demand. It was determined that nine FTE CNIMs and an additional neurologist are needed to meet the current IOM demand. Team Six recommends hiring one neurologist and four additional EEG workers that are IOM certified. These new workers combined with the eight CNIMs and five neurologists currently employed will allow UMHS to cover all IOM demand, while only needing the contractor in case of unusually extreme high peaks of demand. Based on Team Six’s calculations, eliminating the use of contracted IOM services will save an estimated $500,000 a year. Factoring in the annual salaries of the new EEG workers and additional neurologist, an estimated annual savings of over $200,000 is achieved.

In addition to these costs savings Team Six has also determined the current IOM record keeping methods are outdated and cause confusion. The CNIM techs currently record dates, case
numbers (independent of ORMIS case number), physician and patient information, and modalities monitored in two hand-written log books. Team Six recommends an upgrade from these hand written log books to an electronic method of data entry and recording. Additionally, more data fields should be recorded, including the time the CNIM tech begins work on a case, the time they are finished, and the ORMIS case number. This will provide easily retrievable data, a more robust database, and easier data entry for future analysis.

Finally, there is no current policy stating when IOM case reports must be filed. This has caused a current backlog of over 160 IOM cases waiting for audit. Because the CNIM billing information must be verified with the case reports, billing cannot proceed until case reports have been submitted by the neurologist. As a result, there is over $140,000 of professional fee charges and $120,000 of facility/tech fee charges in accounts receivable for IOM cases. Team Six recommends instituting a policy for case reports to be filed within 24 hours of surgery end. This will prevent the backlog of cases and uncollected revenue.
Introduction and Background

Intra-Operative Monitoring (IOM) enables surgeons to monitor a patient’s neurological status during surgery associated with the brain and central nervous system. State-of-the-art monitoring technology, IOM-certified neurologists, and technologists (CNIMs) provide surgeons with essential real-time information about the functional integrity of the patient’s nervous system, enabling surgeons to better ensure patient safety and well-being in the operating room. IOM is used primarily during orthopedic spinal and Interventional Radiology (IR) neurological embolization cases to provide feedback to the surgeon regarding the patient’s neurological state. This information is derived from measuring the patient’s neurological signals, called waveforms, which are displayed on a monitor. An IOM technician observes these waveforms in the operating room while a neurologist monitors the waveforms remotely, via a secure intranet connection. By observing waveforms, the technologist (with input from the neurologist) is able to inform the surgeon when a patient is at risk of paralysis or other surgery-induced injury. Patients are monitored from approximately an hour before surgery begins until they awake from anesthesia. IOM monitors patient brain function, rather than cognition; therefore, multiple variables can cause complications with the service. These complications are seen as spikes in neurological signals caused by anesthesia level, physical movement of the patient, change in blood pressure, and change in temperature. IOM-assisted cases require one dedicated CNIM present per patient in the operating room. IOM-assisted cases should involve a supervising neurologist, who can remotely monitor up to three cases at once.

Increasingly during the past several years, staffing for Neurology-managed IOM service capacity within the University Hospital (UH) has fallen behind requirements for IOM services. Since 2000, IOM-assisted cases have more than doubled to the current level of approximately 1000 cases annually. Despite this growth in activity and the need for operational change, the Neurology-managed IOM service’s manpower has not significantly increased, nor has the service schedule been modified to accommodate changing case activity. Currently, in-house IOM service is limited to weekdays from 7 AM to 3 PM, with little latitude for support outside these hours. In addition, the IOM schedule is not aligned with many surgeon operating room (OR) block times and lacks flexibility for emergencies.

A service agreement with a private IOM contractor was implemented as consumer (surgeon) needs increased. Originally envisioned as a supplementary service option for emergency or weekend cases, contractor service requests increased rapidly and soon matched or exceeded UH-monitored IOM cases. However, policies regulating UH department access to the contactor IOM service were not enacted with the agreement. The contractor service agreement also did not provide real-time supervision by a qualified neurologist. The cost of contractor delivered service is more than the cost of the same service delivered by UH’s program, resulting in contractor fees of more than one half UH annually. The use of the contractor has also raised concerns about contractor case supervision and risk for UH.

To address this issue, UH, aided by an IOM Steering Committee, is seeking to establish a well-managed, fully integrated IOM service within the hospital. By doing so, UH hopes to engage all IOM stakeholders to improve risk management, satisfaction, and margin in a sustained manner.
Working with direction from the Neurology department, an IOM Project Team is developing a new IOM service model supported by a sustainable financial pro forma aligned with UH’s vision. To help inform and accelerate these planning activities, a University of Michigan student engineering team, IOE 481 Team Six, partnered with the IOM Project Team and 1) investigated and documented the existing IOM service and 2) gathered data and designed an expanded, continuous and mostly in-house IOM service model. The purpose of the report is to present our findings and recommendations regarding IOM scheduling and elimination of the contractor.

**Key Issues**

The following issues with the current system, discovered through interviews with various technicians and faculty, were determined:

- Current IOM demand not met without outside contractor
- There is no set staffing plan for nights and weekends
- IOM service does not have a standardized data management system to coordinate documentation and billing

**Goals and Objectives**

Primary goals:
- Develop plan to provide IOM service exclusively with UMHS staff
- Ensure all cases are monitored by neurologist

Secondary goals:
- Provide Neurology with a map of complete IOM process
- Develop sample management plan for UMHS staff

**Project Scope**

This project included IOM operations within:
- University Hospital Operating Room
- Cardiovascular Center - Interventional Radiology
- Mott Children’s Hospital Operating Room

This project did **not** include IOM operations within:
- East Ann Arbor Surgery Center
- Livonia Surgery Center
- Kellogg Eye Center Operating Rooms
- Cardiovascular Center Operating Rooms
- Cancer Center

The aspects of the IOM service that were addressed are:
- Scheduling and availability of CNIMs
- Contractor usage
The aspects of the IOM service that were not being addressed are:
- Complications with service such as patient movement and change in temperature
- Implementation of the service
- Tasks related to the actual care of the patient

**Approach and Methodology**

Team Six conducted a three-phase approach to the project: collecting data, analyzing data, and developing recommendations. With this information, along with data on past IOM demand, Team Six developed a new staffing plan to meet IOM demand using in-house staff. Team Six also produced a weekly schedule for current CNIMs.

**Literature Search**

Background information regarding IOM was found and used to familiarize Team Six with the project. Unfortunately, Team Six could not find details about IOM scheduling information in other hospitals, and the literature found was not very applicable to the main project goals.

It is important to note that the team has adhered to all Confidentiality and Protected Health Information rules during on-site observations, data collection, and interviews.

**Observations**

Approximately 10 hours of observational data regarding CNIM activities and times in the OR were collected. Team members observed and timed setup for the technicians, as well as activities during surgery.

Team Six also observed a Neurologist monitoring a case in progress. This led to a better understanding of how the patient is monitored and the interactions between the neurologist and the CNIM.

These observations provided valuable insight into the IOM delivery process.

**IOM User Interviews**

An M.D. from Urology created an Intra-Operative Neurophysiology Monitoring User Survey and interviewed 15 IOM users, such as neurosurgeons and orthopedic surgeons. The results of these interviews were given to Team Six. A copy of the survey and its results has been attached in Appendix A. Team Six also spoke to faculty from two other IOM customers: Otolaryngology and Interventional Radiology.

**CNIM Interviews**

The team conducted informal interviews with a neurologist and three CNIMs, as well as the CNIM supervisor. At these interviews, Team Six discussed the steps CNIMs take to set up for a
case, as well as what the post monitoring process entailed. At this point, Team Six discovered the issue of backlogged case reports.

**IOM Demand Analysis**

To determine what the pattern of IOM demand was for each hour of each day, Team Six took the data from the ORMIS database provided by OR Administration and Programs & Operations Analysis (POA) for Fiscal Year 2008, and arranged it so that it would show the number of cases in progress at any given point. The data regarding contracted IOM cases consisted of 391 data points, and the data regarding UMHS IOM cases consisted of 385 data points. Team Six also received data collected by the CNIMs which indicated that the average time from the start of setup to the time the patient entered the operating room was 34 minutes (the sample size for this data was 15).

For both contracted and UMHS data, Team Six took the CNIM start time as 34 minutes before the start time of the operation, since a CNIM was required during that time period. This figure was determined by CNIMs logging their start and end times compared to the actual patient in and patient out times (sample size = 15). Although this 34 minute set time was not applicable to the time it took contractor CNIMs to set up their equipment, Team Six included it in the analysis since the new model had UMHS CNIMs covering all of the demand. Team Six then arranged the data by day and by start time, and counted the number of cases that began in each hour. Team Six then did the same counting procedure with the data arranged by day and end time. With this data recorded, Team Six was able to determine the total number of cases in progress during each hour of each day for all of Fiscal Year 2008 (a case during an hour was any case that started, ended, or was ongoing from the start of the hour until 59 minutes past the hour).

The next step in the analysis involved dividing the total number of cases during each hour of each day by 52 (the number of weeks in a year). This gave Team Six the average number of cases ongoing during each hour of each day. Team Six plotted this data on a graph, shown in Figure 2 in the *Key Findings* section.

Since the data showed the average number of cases, 50% of the data exceeded this value. To account for this, Team Six decided to calculate the standard deviation of each set of cases during each hour of each day of Fiscal Year 2008, and added that to the average number of cases two times to achieve two standard deviations. Since the first standard deviation accounts for 34.1% of cases above the mean, and the second standard deviation accounts for 13.6% of cases above that, adding these two standard deviations to the average (which already accounted for 50% of the cases) results in 97.7% of the demand being covered.

Standard deviations were calculated by looking at the number of cases ongoing for each hour of each day by week. After this data was compiled for every week in which cases occurred, a standard deviation was calculated for each hour. For example, all the data points on Tuesday April 1st would occupy one row, where the number of cases ongoing at each hour would be displayed in a spreadsheet (the column headings were the hours of the day). The row below that would contain all the data points for Tuesday April 8th, and the pattern would repeat all the way down to the end of June, and all the way up to the beginning of July. The standard deviation of
the entire row with the heading 7 AM would be calculated, and would be added two times to the average number of IOM cases for the time period of 7 AM on Tuesday. This process was done for each day of the week. The results are shown in Figure 3 in the findings section.

Additional graphs including breakdowns of the data by day of the week are located in Appendix B.

**UMHS Neurology Intra-Operative Monitoring Service Continuum (Process Map)**

The process map for the UMHS Neurology Intra-Operative Monitoring Service Continuum can be seen in Figure 1. Magnified portions of the process map can be seen in Appendix F. The process starts when a surgeon determines IOM is necessary. The surgeon’s secretary emails or calls the IOM schedulers to check for availability. At this point, some surgeons automatically request IOM service from the contractor because the UMHS IOM has only recently become capable of certain services which had previously been offered by the contractor. Additionally, an email system has been developed for IOM scheduling requests that automatically emails the IOM Technician Supervisor and IOM schedulers. There is currently no name for the email service.

Once the IOM scheduler receives the request, availability for the service is checked in the Enterprise Wide Scheduling (EWS) system. If the IOM service is available, the IOM scheduler inputs service for the desired time and sends confirmation to the surgeon’s secretary. If IOM service is not available, the IOM scheduler will contact the Neurology Technician Supervisor to determine if alternative scheduling is possible. If the supervisor is able to resolve the issue, IOM service is scheduled and confirmation is sent to the surgeon’s secretary. If no resolution can be determined, the surgeon’s secretary will be informed and the contractor IOM Service will be requested. The UMHS staff does not have any contact with the vendor; requests for contractor service are made by the surgeon’s secretary.

CNIM Technicians prepare for each case prior to surgery. In some cases up to 10 days beforehand. This preparation involves determining and gathering necessary IOM equipment based on requested case modalities. On the day of surgery the CNIM transports the IOM cart from the Electroencephalogram (EEG) Lab storage to the OR. The cart contains the computer, IOM unit, and connection leads used to monitor the patient. Once in the room, the CNIM will setup the cart and log into Endeavor or Cascade. Endeavor and Cascade are computer programs used to view patient waveforms. Endeavor is currently being phased out as the new IOM units utilize Cascade.

IOM equipment must be in the OR for the sterile field to be setup. Therefore the CNIM cannot proceed until the sterile field is completed and the patient arrives. Once the patient has arrived, the CNIM attaches leads to the patient based on the requested modalities. When finished the CNIM records and sends initial patient waveform baselines to the neurologist. From this point, both the neurologist and CNIM are observing the patient waveforms. The neurologist views the waveforms remotely via internet connection and can observe up to three cases simultaneously.
The CNIM take waveform readings by sending a 35mA current through the patient every five to ten minutes for the duration of surgery. If the waveforms deviate significantly from the baseline readings, the CNIM contacts the neurologist using the on screen messaging service within Endeavor or Cascade. The messaging service allows the CNIM and neurologist to communicate during surgery and can be used to page the neurologist if he/she is away from the computer. The neurologist will advise the CNIM on the proper course of action, or provide feedback to the surgeon in person.

Once surgery is complete the CNIM will break down the IOM equipment and return it to the EEG Lab storage. The CNIM then writes the date, monitoring time, modalities monitored, patient name and number, and surgeon name into two IOM log books, and completes the CNIM portion of the bill. The bill is then given to the Transcriptionist.

The neurologist produces a bill and case report detailing any abnormal events that may have occurred during surgery. The bill and case report are given to the Transcriptionist, who combines the billing information from the CNIM and Neurologist to produce a final bill and report. The final bill and report is given to EEG Billing. EEG Billing notifies Professional Billing Reimbursement, Compliance, & Education (RCE) that bills are ready for audit. RCE collects the bills once a week and verifies the charges against the reports. RCE will make any necessary modifications to the bills during the audit. Once approved, the bills are returned to EEG Billing, where they are scanned into HealthQuest and sent out.
Figure 1 – UMHS Neurology IOM Service Process Map
Key Findings, Conclusions and Recommendations

Team Six’s analysis resulted in two major findings regarding the IOM service. The first involved mapping the pattern of IOM demand by day and by hour of the week, and the second involved identifying the cause of a backlog of unfinished IOM case reports. In addition to this, Team Six also identified issues with CNIM book keeping methods.

IOM Demand

Through the analysis mentioned in the methodology section, Team Six was able to determine a pattern of IOM demand. The average number of cases by day and by hour is presented below in Figure 2.

![Figure 2 - Average UMHS & Contractor Combined IOM Demand by Day Fiscal Year 08, n = 776](image)

The same data with the two standard deviations added in to account for demand fluctuation is shown below in Figure 3.

Team Six found that demand for IOM service is higher on Tuesdays and Thursdays than on any other days. Demand generally peaked between the hours of 7 AM and 1 PM, and maintained a relatively similar pattern across the five weekdays. On weekends, demand was highest in the time period from 10 AM to 3 PM, however, it should be noted that the results for weekends are skewed due to the small sample size (n = 8) and that the information for weekends shown on the graphs does not accurately reflect IOM demand.
Figure 4 below shows a closer look at the peak hours of IOM demand for weekdays, with the two standard deviations added in. Figure 4 shows that the point during the week at which demand reaches its peak requires five CNIMs at once. The current policy is that there must be one CNIM “floater” available to take over a case for the purpose of lunch and bathroom breaks, illness, etc. Keeping with this policy means that the most CNIMs that ever need to be scheduled at one point in time is six, and that this many CNIMs would only need to be scheduled for a short time on Tuesdays and Thursdays. Most of the days would require no more than five CNIMs.

With this information, Team Six was able to develop a management plan that would cover all the demand with UMHS CNIMs and eliminated need for the contractor. A sample CNIM management plan (focusing on FTEs) is located in Appendix C. Since one neurologist can only monitor three cases at once, Neurology must rework neurologist monitoring schedules or hire an additional neurologist to provide remote monitoring service for all the cases in a week. In addition, an IOM stakeholders diagram showing which parties are involved with which parts of the IOM model is located in Appendix D. Team Six performed calculations in order to find the number of FTEs necessary to cover the demand. The total number of hours that CNIMs are required for per week is 323. Team Six subtracted the 54 hours from over hours cases (cases that extended late into the night, past the time when cases begin) from this number to get a value of 283 hours per week. Team Six then took the 40 hours per week for an FTE and multiplied it by 0.85, to account for vacation time and earned time off. The value from this multiplication was 34. Team Six then divided 283 hours per week by 34 hours per week and determined that 8.3 FTEs
were necessary to cover the total demand, meaning 9 FTEs are actually required. These calculations are shown in Appendix E.

![Graph showing the number of cases per hour of the day](Figure 4 - Average Plus Two Stdevs. Combined IOM Demand by Day (Weekday Peak Hours) FY08, n = 768)

**Contractor Costs**

Based on the contractor data Team Six received from Neurology, the total amount of money charged by the contractors from May 7, 2007 to May 6, 2008 was $631,929.94. By dividing this total cost by the 481 patients over the same time period, the average cost of a contracted case was found to be $1313.78. Team Six applied this figure to Fiscal Year 2008 (391 contracted cases) and found that using contractor services costs approximately $513,689.

**Survey Responses**

Based on the survey responses of the 15 IOM users surveyed by an M.D. in Urology, Team Six has found that:

1) Each of the customers uses IOM service for approximately 50% of cases
2) The majority of the users would use the UMHS IOM service if it were more available
3) The majority of the users think a fully staffed IOM service would be sufficient and acceptable if availability and equipment changes were made to the UMHS service
4) The majority of the users think that the contractor service is more efficient and responsive than the UMHS service, but show concern over the lack of a monitoring physician in those cases.
5) The majority of the users believe quality of care is most important and IOM is now considered a standard of care.

**Case Backlog and Delayed Billing**

Another key finding Team Six has identified involves unlogged and undocumented IOM case reports. While collecting data, Team Six discovered that 160 IOM cases occurring over the last six months, have yet to be billed for. Using a data sheet provided by the Chief Department Administrator of Neurology, Team Six calculated the average fee for an IOM case (including professional fees and facility/tech charges) to be $1,635 per patient. Therefore 160 cases results in over $250,000 of revenue that has yet to be collected. To prevent the buildup of backlogged cases, Team Six recommends a standard procedure for neurologists to file reports for monitored cases within 24 hours of surgery end. This would ensure that cases are billed on time prevent loss of revenue due to health insurance companies not being billed in a timely manner.

**Book Keeping**

Team Six recommends that a new method of record keeping for the CNIMs be implemented. Currently, the IOM service schedule is recorded by hand in two separate books, one which records case numbers, dates, and times, and the other which records the physician and whether it was an inpatient or outpatient procedure. Team Six recommends switching to an electronic system and recording all information in one file. Information in the file should include but not be limited to: ORMIS case number, date, time, and physician. An example of what this electronic file could look like is shown in Figure 5 below. This would allow for faster data retrieval and a more robust database.

<table>
<thead>
<tr>
<th>ORMIS Case #</th>
<th>CPI Patient #</th>
<th>Physician</th>
<th>CNIM Tech</th>
<th>Modalities</th>
<th>Date</th>
<th>Time In</th>
<th>Time Out</th>
<th>Day</th>
<th>Hours</th>
</tr>
</thead>
</table>

*Figure 5 – Sample Book Keeping Format*

**Expected Impact**

Eliminating the use of the vendors will result in large savings for UMHS. Team Six’s calculations showed that over $500,000 in fees were paid to the contractor in Fiscal Year 2008. If the recommendations presented in this report are implemented, that cost would be eliminated. Nine FTEs would be required to operate under this model, and there are currently eight EEG technologists trained to perform IOM. In addition, Appendix C shows that there are more than three cases occurring at once on some days. Since the current system involves only one neurologist monitoring the IOM cases on each day, this system would have to be changed. Neurology must either re-work the neurologists’ schedules or hire an additional neurologist. Although eight EEG technologists are currently trained to perform IOM, these workers do not
spend time exclusively performing IOM tasks, and have other work to do in the EEG lab. For this reason neurology must hire more than one additional CNIM EEG worker based on Team Six’s recommendations that nine FTEs are needed. Team Six assumes that hiring four more workers into the existing pool of CNIMs will allow Neurology to meet the IOM demand.

For confidentiality reasons, Team Six was not provided with information on the salaries of EEG technologists and neurologists, so payroll figures have been estimated. According to http://www.payscale.com, the average salary of a neurologist ranges from $120,000 per year to $180,000 per year. Team Six used an average $150,000 per year to determine final costs. From the same website, the average pay rate of an EEG technologist ranges from $15 an hour to $20 an hour. Team Six used an average of $17.50 an hour ($36,400 per year) to determine final costs. The recommended four new CNIM’s and one new neurologist will cost an estimated $295,600 per year. When deducted from the contractor elimination (over $500,000), an estimated annual savings of over $200,000 is achieved.

Implementing a new policy for case reports and book keeping will result in less money queued in accounts receivable and a more organized set of records for IOM service. In the event that the IOM service is revisited in the future, this book keeping policy will make future analysis easier.

Summary

The current IOM service model cannot meet demand without support from contractors. Case reports are not being filed promptly, service logs are incomplete or unclear, and an outside contractor is performing cases that could be performed by the in house staff, resulting in excess costs to the hospital. Team Six has analyzed the current service model and current demand level, and developed a new management plan for CNIMs as well as recommended changes to improve the clarity of the model. By hiring four new CNIM’s and an additional neurologist, Neurology will save over $200,000 per year and eliminate the need for the IOM contractor.

Support

Team Six thanks the following people for their support with this project:

- Project Client: Robert Davies, Chief Dept. Administrator, Neurology
- Project Coordinator: Dr. Richard Coffey, Director, Program & Operations Analysis
- Art Christensen, OR Administration
- Sam Clark, Program & Operations Analysis
- Lisa Lovely, CNIM Technical Coordinator
- Daniela Minecan, M.D., Neurology
- Jeff Montgomery, M.D., Urology
- CNIM Technicians
Appendix A: IOM User Survey

Who to survey:

**Neurosurgery**
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Karin Muraszko, MD  
Paul Park, MD  
Stephen Sullivan, MD  
B. Gregory Thompson, MD  
Lynda Yang, MD

**Orthopaedics**
Gregory Graziano, MD  
Fran Farley, MD

**Otolaryngology**
Paul Kileny, PhD  
Lawrence Marentette, MD

**Interventional Neuroradiology**
Dheeraj Gandhi, MD

**Neurology**
Daniela Minecan, MD  
David Fink, MD

**Anesthesiology**
George Mahour, MD

**Cardiac Surgery**
Pending

**Physical Medicine and Rehabilitation**
Edward Hurvitz, MD
Intra-Operative Neurophysiology Monitoring (IOM)

User Survey

Thank you for agreeing to participate in the IOM user survey. This work will help us create an in-house IOM service that most-conveniently and efficiently serves you, the IOM customer. In total, our meeting will take approximately 30 minutes of your time. Please be candid in your responses to the questions listed below during our encounter. There is no need to complete the survey prior to our meeting. I’m sending it to you now to give you a chance to consider the questions and your responses, possibly during one of your cases that utilizes IOM.

I am in no way personally linked to the IOM project, financially or professionally. My goal is generate a collective voice for the users of IOM so that this project meets all of your expectations and clinical needs. Your responses will be kept confidential.

Sincerely,
Jeffrey S. Montgomery, MD
Department of Urology
Intra-Operative Neurophysiology Monitoring (IOM)
User Survey Initial Results

Statement of Purpose
The survey below was developed and administered to the main users of IOM at UMHS to better understand their use of this monitoring modality and to identify major issues in developing an in-house IOM service. Individual answers are listed below each question. The answers are listed in random order and are de-identified to protect the anonymity of the responders.

1. Characterization of your IOM Use:
For what cases do you use IOM?
- ½ of all cranial cases and all trans-oral, brainstem and any spinal cord compressions.
- All cord involved cases and minimally invasive cases.
- Open, microsurgical and endovascular; the ENT service does most of my skull based (cranial nerve) monitoring.
- All peripheral nerve and spine cases
- We provide monitoring for neuroautology and neurosurgery (skull base tumors), head and neck cases (parotid, laryngeal, thyroid), audiology cases (pediatric, mastoid cases, brachial cleft cysts, middle ear surgery, cochlear implants) and audiological diagnostic procedures under anesthesia (pre-cochlear implant surgery)
- The ENT IOM techs specialize in cranial nerve monitoring; they are licensed clinical audiologists and therefore can function independently.

What percentage of your practice requires IOM?
- 50%
- 50%
- All vascular cases
- 50%

How many IOM cases do you perform per week on average?
- 2
- 2-3
- 5-7 microvascular cases per week, 1 with ENT per week, 1-2 endovascular per week.
- 2-3
- 5 for the neurology portion of the IOM service (300-350/yr)

On average, how far ahead of the OR date do you request IOM coverage?
- 10 days; several urgent consults do arise that need monitoring 2-12 hours after presentation.
- Up to 6 weeks.
- 70% 2-3 weeks; 25% <2 weeks; 5% emergent
- 2 weeks
- 2 week lead time is sufficient to have the IOM service cover a case
- 2 weeks

2. **Do you have any specific equipment requirements for your practice that the in-house IOM service would need to provide?**

- No
- No
- SEP, EEG, Brainstem evoked responses; rare cases require a monitor directly on a nerve; <1% visual evoked potentials.
- NAP electrodes (infant and adult), SSEP electrodes, EMG electrodes
- We need equipment that can monitor SSEPs and cranial nerves

3. **Describe your ideal IOM interaction (i.e. timeliness of service, availability of proper equipment, ability to communicate with the CNIM throughout the case).**

- I communicate with the CNIM often throughout the case. They need to be on-the-ball and paying attention to their monitors at all times. They need to be committed to staying through the entire case, not taking frequent breaks. It would be best if the CNIM met the patient in the preop area to explain what they will be doing. Leads are best placed under anesthesia and don’t need to be placed in preop.
- I think the department of neurology techs are good, reliable and professional, but at times their service is less available. Having a service that is responsive, efficient and willing to work as part of the team caring for the patient is key.
- From the perspective of Anesthesiology, communication is essential. Flexibility is also an essential quality, as sometimes the anesthetics cannot be standard.
- The IOM tech should be setting up at the same time that the surgeons are setting up; should be ready to place leads right after patient is asleep. They may be able to place leads for SEP and EEG in preop holding to save OR time. Open communication throughout the case is key and always having a tech present throughout the entire case.
- The most important things are having an IOM team whose goal is to provide the best service possible, no matter what the circumstance. The willingness to do what it takes to accommodate for the benefit of patient care. Communication is key as well.

4. **What do you see as the major positive and negative aspects of the current in-house IOM service and our IOM vendor?**

- I have had no problems with the contractors. They are efficient, responsive, timely and their techs are good. I have developed relationships with the techs and know I can trust what they say. I have been completely frustrated with the neurology service performing IOM. They put up frequent road blocks; the only answer they seem to know is “no”.
- Scheduling off hour and semi-emergent case with our in-house service is difficult. There is no issue with the contractors; they are a for-profit service and therefore focus and service and availability.
- Communication is a big issue for our service. I have had a good relationship with the contractors. I feel it would be better, however, to be able to maintain quality control, as well as education for the techs.
- The contractors costs a lot, but they give great service; the neurology service has not been responsive, efficient or accommodating in my experience.
- The service from the contractors excels in every way. The neurology service has limited availability, limited hours, lacks equipment and at times lacks knowledge.
- Currently, users of the contractors sacrifice the expertise of the in-house team for convenience.

5. **What do you see as the major obstacles to forming an in-house, sole-provider of IOM?**

   - They need to find some solid leadership on the physician and tech sides. They need to take ownership of the service and model it after a business, like the contractors. The benefit is that we would have our own people doing the monitoring and our MDs overseeing it.
   - The willingness to be on call for off hour cases.
   - None, from the perspective of our service.
   - The service will need techs that are available and service-minded; it needs adequate staffing and strong leadership.
   - Funding and leadership.
   - Resources and organization

6. **Are there any ways that we can make IOM at Michigan more efficient than it is now (eg. Scheduling, preop set up, intraop concerns, postop)?**

   - Their availability and willingness to view this entity as a service provider are major issues. They need to be willing to cater to the users to avoid frustration on both sides which would lead to the quick demise of the service.
   - We need an efficient means of scheduling cases and a protocol for adding emergent cases.
   - Have the default answer be “yes” not “no” which is the current status.

7. **Do you feel that having a fully staffed IOM service from 7am to 10pm Monday through Friday, with overnight and weekend staffing available on an on-call basis would be sufficient and acceptable for your practice?**

   - This would be sufficient as long as there is a plan in place for cases that go late or need to go in the middle of the night. Also, I’d be concerned about concurrent cases. I often run up to 3 rooms at a time and our department may have 4-6 cases that need monitoring going at once.
   - This would be sufficient
- This should be sufficient; my cases go past 10pm 2% of the time and up to 10pm 15% of the time.
- Depends if fully staffed truly means fully staffed; need to have back up plans as well because things can come up unexpectedly.
- We will need more staffing for on-call and short notice cases.

8. **How often do you use IOM on an emergent basis?**

- There’s at least one case a week.
- Once a month; problems usually occur with add ons at the end of the day.
- 1-6 cases per week are added on.
- Rarely for spine

9. **How would you design the oversight committee for IOM and what should be its primary concerns?**

- They had a similar oversight committee before and it didn’t work. Lisa Lovely is the only person who seems to make decisions on a daily basis. Everyone involved needs to take ownership of this service and be committed to making it work.
- This group would need to be available and attentive to user concerns. Also, the techs should have a way to give input.
- I think there should be an Executive Committee with representation from all major services involved. Availability, precision and communication issues should be major focuses.
- Neurology needs to understand neurosurgery’s stake in this; they need to try to understand how surgeons function and how IOM can make cases and patient care more efficient instead of an obstacle.
- Need physician leadership by someone with intellectual interest in subject with committed representation from various departments.
- We need an operational group meeting every month and a meeting of the heads of the involved departments on a less frequent basis to provide oversight.

10. **Are there any other concerns regarding IOM or points you would like to make?**

- Everyone involved needs to realize that our department is MUCH busier than we were when this service was attempted previously. Also, IOM is now considered standard of care. If we encounter difficulties and frustrations we’ve had with this service as we have had in the past, we will be forced to seek other IOM coverage, not to be confrontational or difficult, but for the benefit of our patients.
- The department of neurology needs to be certain that they are willing to make this work. It’s just going to lead to conflict and frustration if they are not able to provide the level of service that we are seeing from the contractors. If we don’t have everyone on board, it would be best to just keep the system we have now.
- From my perspective, I would like to ensure that the record kept by the anesthesiologist is the only record that is valid. Parallel records by IOM service should not be valid for legal or QA purposes; i.e., they should not be considered the anesthetic record.
- They need a good crew of techs and good leadership; in the past, this service seemed as if it was forced upon neurology and they weren’t interested in making it work. We need everyone involved to have a stake in making this a success.
- Current IOM services are not dependable (cancel day of, have poor equipment, won’t stay or take breaks and leave, are late to the OR, don’t have equipment set up ahead of time). Contractors is all of these things.
- The main goal should be quality of care.
- I would not want a loved-one to have surgery using contractor techs; quality of care should be the main motivation to having an all in-house service. We need redundancy in the system but need to recognize the specialties of the component staff. We need sufficient resources to keep up with the IOM needs and have the ability to grow. ENT service would maintain the cranial nerve specialization and would integrate with other techs as well. We will need 1-2 techs that can cross over between cranial nerves and peripheral monitoring.
Appendix B: IOM Demand

Figure B1 - Average Plus Two Stdevs. Combined IOM Demand (Monday Peak Hours) FY08, n = 121

Figure B2 - Average Plus Two Stdevs. Combined IOM Demand (Tuesday Peak Hours) FY08, n = 210
Figure B3 - Average Plus Two Stdevs. Combined IOM Demand (Wednesday Peak Hours) FY08, n = 156

Figure B4 - Average Plus Two Stdevs. Combined IOM Demand (Thursday Peak Hours) FY08, n = 195
Figure B5 - Average Plus Two Stdevs. Combined IOM Demand (Friday Peak Hours) FY08, n = 85
Figure C1 – Sample CNIM Management Plan

* Based on analysis of IOM case data from ORMIS, n = 776
* Numbers on time blocks equal hours per that shift

Floater for breaks 30
On Call Coverage 40
Regular Coverage 199
Total Hours 323
# Appendix D: IOM Service Continuum Stakeholders

## Intra-Operative Monitoring (IOM) Service Continuum Stakeholders

<table>
<thead>
<tr>
<th>Task</th>
<th>Service Request</th>
<th>Scheduling of Service</th>
<th>Prep for Surgery</th>
<th>Surgery Time (Patient In - Patient Out)</th>
<th>Surgery Cleanup</th>
<th>Bookkeeping</th>
<th>Billing Information Recorded/Sent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery Time (1st Incision - End of Nerve Involvement)</td>
<td></td>
<td></td>
<td></td>
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</tbody>
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Source: Intra-Operative Monitoring (IOM) Service Continuum Process Map  
Period: Oct '08 - Dec '08

Figure D1 – IOM Stakeholders Service Model
Appendix E: FTE Calculations

<table>
<thead>
<tr>
<th>Coverage</th>
<th>FTE's:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular Coverage: 199</td>
<td>Hours Per Week: 40</td>
</tr>
<tr>
<td>Floater Hours: 30</td>
<td>*Actual Hours: 34</td>
</tr>
<tr>
<td>Over-Hours: 54</td>
<td></td>
</tr>
<tr>
<td><strong>Total:</strong> 283</td>
<td><strong>FTE's Needed:</strong> 8.3</td>
</tr>
</tbody>
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*Actual hours are 40 x 0.85 to account for vacation time and earned time off.
Appendix F: Magnified UMHS Neurology IOM Service Continuum Process Map

Figure F1 – Magnified Process Map Part 1
Figure F3 – Magnified Process Map Part 3