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IMPOSSIBLE BECOMES POSSIBLE – THE NIKOLET VIKING IV USAGE IN INTRA-OPERATIVE MONITORING

Recent advances in surgical technology have encouraged many surgeons to explore new ways of helping patients, potentially increasing the risk to the patient`s neurological system. A complication of surgery, especially neurosurgery, is the development of a post-operative neurological deficit. The original purpose for the use of various neurophysiological monitoring procedures was to reduce the incidence of neurological deficit, regardless of its origin. VIASYS Healthcare (Nicolet Biomedical) has created Nicolet Viking IV that fulfils all criteria of a good intra-operative monitoring instrument. Viking IV can perform routine and computer-aided Electromyography, Evoked Potentials Studies, Nerve Conduction Studies and Intra-Operative Monitoring.

Nicolet Viking IV is also very useful in other branches of medicine like: neurology, internal medicine, obstetrics and gynaecology, neonatology and many more.

Today we use intra-operating monitoring for several additional purposes, including improving overall surgical outcomes, monitoring the efficacy of intervention strategies and monitoring neurological structures that are at risk due to secondary/perisurgical variables.

Intra-operative neurophysiologic monitoring (IONM) allows the detection of neurological compromise early enough that permanent deficits may be avoided.

Neurosurgical operations are one of the biggest challenges of contemporary surgery. Due to accumulation of many life-significant structures and frequently hampered access, serious complications occur quite often. These appear in the form of: paralysis or paresis, pyramidal or extrapyramidal syndrome or brain stem, cranial nerves and peripheral nerves functioning disorders.

The sources of these deficits can be divided into two main groups: surgical and perisurgical. Surgically-induced deficits caused by the direct result of the surgery usually appear due to surgeon’s efforts to eliminate an existing pathology. A perisurgically-induced deficit occurs as an indirect result of the surgery and is typically due to anaesthetic effects, malpositioning of the patient on the operating table, etc. For example, the cerebello-pontine angle (CPA) surgery is performed in the sitting position of the patient. This enables spontaneous outflow of blood and cerebrospinal fluid (CSF) and allows eliminating the necessity of using the aspirator in this sensitive area. Using this device could lead to many malfunctions.

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Because of this fact, many specialists all over the world have been trying to answer the question of how to avoid these complications.

In 1848, Du Bois-Reymond demonstrated the action potential of nerves for the first time. He also is credited with describing the electrical activity of muscle, the first EMG. Electrical activity of the brain was described by Caton in 1875. Han Berger, in 1928-29, was the first to report EEG tracings from human brains. The first use of intraoperative EEG was by Foerster and Alternberger in 1935. From the late 1930s to the 1950s, Herbert Jasper and Wilder Penfield were developing this technique, using electrocorticography (ECoG) for localization and surgical treatment of epilepsy. They also performed careful mapping of cortical function by direct electrical stimulation. Dawson recorded the first SSEP in 1947. Understanding of other evoked potentials, including those produced by motor activity and by visual and auditory stimulation, followed. In 1978, the first intraoperative use of BAEP was reported.

IOM has become the gold standard for ensuring the patient's safety while undergoing operations which put the central or peripheral nervous system at risk.

To fulfil the criteria of a good intra-operating monitoring instrument, it should have special features: multi-modality capacity (Cranial Nerve Monitoring – CNM, Brain Stem Auditory Evoked Potentials – BAEP, Somatosensory Evoked Potentials – SSEP, triggered and spontaneous Electromyography – EMG and Electroencephalography – EEG), simultaneous test administration, trending and documentation of data and ease of use. VIASYS Healthcare (Nicolet Biomedical) has created Nicolet Viking IV that fulfils all that criteria.

Viking IV can perform routine and computer-aided Electromyography, Evoked Potentials Studies, Nerve Conduction Studies and Intra-Operative Monitoring, including real-time, quantitative analysis and simultaneous display of live waveforms, colour graphs and alphanumeric data. Separate software programs and optional accessories let us customize Viking IV to meet some specific clinical and intra-operative monitoring needs. With up to 8 EMG/EP channels, multiple stimulators and a minimum 528Mb of data storage, the Viking IV provides a wide range of advanced applications for the doctor's practice. Designed primarily for clinical use, the Viking IV D features up to 4 amplifier channels, easy-to-read, windowed menus and default test parameters that can be tailored to suit one's needs. All systems feature dedicated controls, colour coded touch keys and an ultra-high resolution colour monitor to simplify operation. A high quality printer generates standard or custom reports and screen copies. The standard Viking IV System Software consists of: 233 MHz or faster, Pentium® microprocessor with 32 Mb of RAM memory; 4.0 Gb or larger hard disk drive; 3 ½ -inch, 1.44 Mb floppy disk drive; 14 inch, high resolution, full colour monitor; CD ROM Drive, high quality printer; multi-function control panel; 101-key, full function keyboard; 2 channel amplifier with extension arm; mouse; speaker; custom mobile cart equipped with an isolation transfer unit and power supply and storage area.

Brainstem auditory evoked potentials (BAEPs) are used to evaluate the auditory pathways from ear to the upper brainstem. The most consistent and reproducible potentials are series of five (I-V) submicrovolt waves that are seen within 10 msec from an auditory stimulus. The anatomical correlates of the five reliable potentials have only been roughly approximated. Wave I of the BAEP is a manifestation of the action potentials of the VIII nerve and is generated in the distal portion of the nerve adjacent to the cochlea. Wave II may be generated by the VIII nerve or cochlear nuclei. Wave III is thought to be generated at the level of the superior olive, and waves IV and V are generated in the rostral pons or in the midbrain near the inferior colliculus.

Somatosensory evoked potentials (SSEPs) are recorded by stimulating peripheral afferent nerves, usually electrically; they are recorded with the help of scalp electrodes. In intraoperative use, the median nerve in the wrist is the most common stimulation site for upper extremity monitoring. In the lower extremity, the posterior tibial nerve just posterior to the medial malleolus is used most commonly. Other sites that can be utilized include the ulnar and peroneal nerves. Amplitude, shape, and latencies of the responses are monitored. Serially recorded responses are compared with laboratory norms. Establishing a reproducible baseline recording prior to any positioning or surgical manipulations is important. Changes from the baseline responses are the most important indicators of neurological dysfunction.

Owing to Nikolet Viking, both neurosurgeon, examiner, anaesthesiologist, scrub and circulating nurses have permanent insight into procedures that are being carried out because everything is registered and recorded by Nikolet. Any comments or annotations of conversations, important facts (administration of an anaesthetic drug, neurosurgeon actions) and the appearance of time events are possible to read after the operation. Now Nikolet is not only used for IOM, but also for archiving the data process from the operation. Thus I was able to analyse more than 200 IOM data reports of the patients who had underwent CPA tumours removal in Department of Neurosurgery (Medical University of Silesia in Katowice). Using Nikolet Viking IVD, me and two colleagues of mine, were trying to judgewhether SSEPs and BAEPs IOM help to avoid complications in operations of CPA tumours removal.

BAEP is a sensitive, noninvasive diagnostic test for the diagnosis of cerebello-pontine angle tumours. This test is used to differentiate cochlear from VIII nerve hearing defects and, on some occasions, to demonstrate an auditory abnormality when behavioural audiometric testing is still normal. The majority of patients with acoustic tumours have abnormal responses. The absence of waves III and V has been seen in some patients with vestibular schwannoma and in cerebello-pontine angle meningiomas. Abnormal interwave latencies

(I-III or I-V) are the most specific and sensitive abnormalities seen within cerebello-pontine angle tumours. The abnormal prolongation or absence of wave V at increased click rates is also characteristic for retrocochlear pathology.

We analysed intra- and perisurgical course of 122 patients operated due to CPA tumour after 1999 (in 1999 Nikolet Viking was introduced in Department of Neurosurgery in Katowice). After operation audiometry was carried out at 97 patients.

To estimate the level of hearing preservation we used American Academy of Otolaryngology (AAO) and American Council of Otolaryngology (ACO) Classification. Postoperative brain stem functions data were obtained from the case records. For further analysis the patients had been classified into 4 groups depending on the evoked potentials recordings: with correct recording, with reduced amplitude, with total or partial disappearance of evoked potentials and with correct recording return after prior disturbances.

83% of the patients with correct brain stem functioning after operation demonstrated correct SSEP recording, in 1% of the patients the recording disappeared, whereas in 3% of the patients the evoked potentials recording could not be registered from the beginning of the operation. In group of the inmates with brain stem dysfunction only 38% of the patients had the correct recording (all demonstrated minor postoperative extrapyramidal paresis); in case of 16% of the patients the EP recording disappeared during the operation, whereas in 11% from the very beginning of the procedure the recording could not be recorded (the tumours were large, however these patients demonstrated postoperative pyramidal paresis and bulbar syndrome).

As far as the range of hearing preservation, in 16% total hearing loss (>100 dB) was affirmed; in 39% the significant hearing impairment (55-99dB) appeared (though hearing aid enabled improvement of hearing), whereas at 45% acusis (<55dB) was maintained. In the first of the mentioned groups, in 37%, total, and, in 17%, partial EP disappearance appeared. Only at 25% the correct recording was displayed. In the group with acusis correct EP recording or correct EP recording return was monitored in 83% of the patients.

On the basis of our results, we are able to assert, that intraoperative EP monitoring, by means of Nikolet Viking IVD, enables quick reaction in case of disorders affirmation, which reduces frequency and difficulty of the complications after CPA tumours surgery.

Nicolet Viking is also very useful in other branches of medicine, like neurology: in swallowing disorders caused by stroke or by inadequate hyolaryngeal motion (targeted intramuscular electrical stimulation can elevate the resting larynx, and, if applied during swallowing, may improve airway protection in dysphagic patients), graft survival and function after nerve transplantation, multiple sclerosis, epilepsy, Alzheimer disease, Charcot-Marie-Tooth disease (CMT, HMSN – Hereditary Motor and Sensory Neuropathy), neurofibromatosis, sustained clench, psychogenic paralysis; in internal medicine in metabolic diseases (Fabry disease, Wilson disease), diabetes, antiphospholipid syndrome or in obstructive sleep apnea (OSA); in obstetrics and gynaecology (stress incontinence), neonatology (neonatal nonhaemolytic hyperbilirubinaemia) and in surgery (carotid endarterectomy or TAAA – Thoracic-Abdominal Aortic Aneurysms).

Today we use intra-operating monitoring for several additional purposes, including improving overall surgical outcomes, monitoring the efficacy of intervention strategies and monitoring neurological structures that are at risk due to secondary or perisurgical variables.

Intraoperative neurophysiological monitoring has been utilized in attempts to minimize neurological morbidity from operative manipulations. The goal of such monitoring is to identify changes in brain, spinal cord, and peripheral nerve function before an irreversible damage occurs. Intraoperative monitoring has been also effective in localizing anatomical structures, including peripheral nerves and sensorimotor cortex, which helps guide the surgeon during dissection.

IOM should be available in all major surgical centres and in many community hospitals. More than 6000 Viking systems have been sold around the world. In Poland, VIASYS Healthcare has been distributing Nicolet system since 1990. EMG/NCS diagnostic version is being ordered for the most part (a bit rarely EMG/NCS/EP version).

The prices depend on the selected options and start from 24,000 USD (4-channel Viking Quest with IOM option) to circa 200,000 USD (10-channel Viking Select with full version of monitoring).

Intra-operative neurophysiologic monitoring (IONM) allows the detection of neurological compromise early enough so that permanent deficits may be avoided. By dint of Nicolet Viking and other intra-operative monitoring appliances, we are able to guarantee the patient's better tomorrow and we have the sense of well done job. Thus let's comply with the saying: "Prevention is better than cure".

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