ORIGINAL RESEARCH PAPER

Anaesthesiology

MONITORING PATIENTS IN THE FIELD OF ANAESTHESIA: IN OPERATION SUITES, AT REMOTE PLACES AND IN INTENSIVE CARE SETTINGS.

KEY WORDS: monitoring in anaesthesia, circulation, oximetry, capnography, depth of anaesthesia, neuromuscular block.

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ABSTRACT

The purpose of this article is to avail opportunity to impart and update awareness regarding importance of patient monitoring in the field of anaesthesia on medical students, nursing staff, medical fraternity of distinct specialities and whom so ever is directly or indirectly involved in delivering safe anaesthesia care. To significantly improve over all out come of patient management, they are dealt with in different situations like in, out patient departments, emergencies, operating rooms, remote radiology departments taking up interventional and diagnostic procedures, intensive care settings, pain clinics, dental chairs and so on. However an effort is made to highlight necessity, importance, short comings, challenges, difficulties, limitations and outcomes of monitoring patients in above mentioned situations. For a better understanding of the contents the standards formulated by various societies of anaesthesiologists all over the world is mentioned. Due consideration is given to what should be monitored and how?. According to National Standards set by ISA, blood pressure, pulse oximetry, capnography, ECG, temperature , neurological and neuromuscular block and if required EEG monitoring should be done to give information about ventilation,circulation, oxygenation, depth of anaesthesia and body temperature. Continuous clinical observations, use of invasive and non invasive technologies in monitoring to assess alteration in physiological status , their logical interpretation and timely execution of rescue measures is desirable in providing best services to patients in anaesthesia care.

INTRODUCTION:

Whenever any therapeutic or diagnostic intervention is taken up, given anaesthesia in the form of either general, regional or central neuraxial block invariably alters normal physiological functions of the body requiring monitoring. During such times vigilance is needed to assess patient's condition by time tested clinical observations along with aided technologies. The anaesthesiologist incharge of the case takes necessary action in such altered physiological situations to provide safe anaesthesia care well within time. The scope of such care ranges from operating room and intensive care units to locations remote from it-- starting from daycare therapeutic and diagnostic procedures to management of criticaliy ill patients.

Monitoring in anaesthesia is mandatory for all patients in order to support and improve physiological performance which in turn augments patient outcome in a positive direction. As quality of monitoring improves safety, an anaesthesiologist takes care of all the patients as a guardian while the patient is under anaesthesia or treated in critical care settings.

GUIDELINES FOR MONITORING PATIENTS IN ANAESTHESIA :

Various associations and societies of Anaesthesiologists like:

- American Society of Anaesthesiologists **(ASA) ,**
- Canadian Society of Anaesthesiologists **(CSA),**
- Association of Anaesthesiologists of Great Britain and Ireland **(AAGBI),**
- World Federation of Societies of Anaesthesiologists **(WFSA),**
- Indian Society of Anaesthesiologists **(ISA)** and many more have formulated their standards of monitoring which are more or less the same with slight variations. The basic requirement is the presence of a qualified anaesthesia personnel at all the times during the conduct of any intervention under anaesthesia. Selection of person left responsible to monitor patient's condition is the responsibility of the anaesthesiologist incharge of the case for his temporary absence in situations of an unavoidable emergency. It is also recommended that standard of monitoring during general and regional anaesthesia or sedation should be the same whether required in operation room or outside operation suite(1).

Monitoring in the past:

In the absence of modern technologies, monitoring in the past was done by visual observation of respiration, colour of skin, fingers on pulse , blood pressure and over all clinical appearance. Sir Harvey Cushing who is known as the father of anaesthesia monitoring invented and popularized anaesthesia monitoring chart in 1895. He being a famous neurosurgeon as well described the relationship between neurological events and vital signs for the first time such as increased intracranial tension leads to bradycardia and hypertension(2).

Delivering anaesthesia now in present time has become safer due to evolved modern technologies over time. First landmark of advancement was achieved in 1980 with the invention of pulse oximetry in anaesthesia practice. Gradually, warning through alarm systems regarding patient's changing physiological condition simplified assessment of his condition accurately.

WHAT SHOULD BE MONITORED:

Monitoring patients continuously, relevantly and closely should provide information regarding **ventilation, oxygenation, circulation, temperature and depth of anaesthesia** by clinical observations, non invasive or invasive technologies, investigations and over all clinical appearance.

ISA recommends mandatory National Standard for monitoring which includes : **noninvasive blood pressure (NIBP), pulse oximetry, electrocardiography (ECG), capnography** and **temperature** recording throughout the conduct of anaesthesia. If considered mandatory and appropriate a **continuous invasive blood pressure (IBP), central venous pressure (CVP), trans oesophageal temperature (TOeT),neurological and neuromuscular block (NMB)** monitoring with **Jugular venous oximetry** can be done according to need(3).

Ventilation :

Clinically is assessed by respiratory rate, pattern, chest excursions, breath sounds, movements of rebreathing bag and auscultation of chest to confirm position of endotracheal tube. **Tidal and minute volume, concentration of O_2** in inspired mixture and **end tidal CO_2 concentration (ET CO_2)** can be monitored by anaesthesia work station system. A sudden and rapid fall in $ETCO_2$ indicates air embolism often seen in cases of craniotomies. Respiratory rate and pattern can clinically be assessed anywhere in operating room or at remote locations. Capnography and capnometery requires presence of capnograph which can detect oesophageal intubation, airway obstruction, circuit leak or kinks and disconnections.

Oxygenation :

The simplest way to assess oxygenation is pulse oximetry which is a minimally expensive, non invasive and sometimes portable device measuring percentage of haemoglobin saturated with oxygen to assess tissue perfusion and pulse rate. **Arterial blood gas**

analysis measures partial pressure of oxygen and carbon dioxide in arterial blood which helps in deciding need for supportive invasive ventilation.

Circulation :

It is monitored clinically by keeping fingers on pulse observing its rate,rhythm and character. Monitoring of systolic, diastolic and mean arterial blood pressure is done by noninvasive and invasive technologies with use of sensors. For monitoring blood pressure where wide range of fluctuations are anticipated an appropriate artery like radial, brachial, axillary, femoral or dorsalis pedis is cannulated according to need for measuring beat to beat variations in blood pressure. The electrical signals are shown in the form of pressure wave on monitor giving information about haemodynamic variables where an upstroke indicates contractility of heart and downstroke is indicative of peripheral resistance(4).

Temperature monitoring :

Our body temperature is not homogeneous. Deep thoracic, abdominal and central nervous system temperature is referred to as core temperature.During general anaesthesia core temperature decreases by 1-2 degree centigrade which regains state of equilibrium within 3-4hrs in postoperative period. Normally hypothalamus is responsible to maintain core temperature. Under the effect of subarachnoid or epidural, vasodialatation due to sympathetic block results in hypothermia. Core temperature monitoring can be done by using thermometers having infrared sensor which is placed near tympanic membrane, oesophagus, **pulmonary artery catheter(PAC)**, nasopharynx, bladder or rectum. Leaving aside few exceptional operating situations where deliberate hypothermia is produced, patient's core temperature should be targeted to 36.1-37.2 degrees centigrade in all cases. Hypothermia causes vasoconstriction, decreased circulation , less tissue perfusion with oxygen, increased blood glucose level, altered coagulation and reduced rate of drug metabolism resulting into delayed recovery from anaesthesia. Possibility of postoperative infections increases with hypothermia (5). It is postulated that infective organisms remain inactive during hypothermia but multiply fast to produce symptoms when body temperature regains normalcy or rises. Apart from this patients protective body response to any infection is altered during hypothermia (6).

Monitoring depth of anaesthesia :

Electroencephalography (EEG), bispectral Index scale(BIS) and entropy can measure hypnotic component of anaesthesia and help tailoring the dose of anaesthetic agent for a particular patient. **BIS** varies between 0 to 100 where 0-20 represents cortical silence, and 20-40 is near suppression. Values between 40-65 is recommended for general anaesthesia and 65-80 for sedation. Complete wakefulness and intact memory is represented by values 80 and above upto 100 . Various studies have proved that risk of awareness is very low if BIS is maintained between 40 and 60 (7). **Anaesthesia patient safety foundation(APSF)** strongly recommends use of depth of anaesthesia**(DoA)** monitoring equipments during anaesthesia and sedation.(8 ,9).

In neurosurgery cases monitoring of **intracranial pressure(ICP)** and measurement of cerebral oxygenation is done. **Positron emission tomography (PET)** is the gold standard of measuring cerebral blood flow in relation to oxygen demand **and jugular venous oximetry (SjO2)** monitors **cerebral oxygenation.**

Neuromuscular block monitoring :

This is an essential part of patient monitoring under anaesthesia with nondepolarising muscle relaxents to ensure adequate muscular relaxation and detection of residual block before topping up with next dose .This optimizes duration of anaesthesia by giving **neuromuscular blocking agent (NMBA)** at right time in correct doses therefore minimizing chances of residual block and hence post operative complications requiring reintubation. To monitor this peripheral nerve stimulator electrodes are placed over the ulnar or facial nerve (10).

Anaesthesia work station: The modern integrated anaesthesia workstation provides facilities for new level of efficiently safe and accurate performance in delivering anaesthesia even with low fresh gas flow to patients of all age groups . Working with work station allows the anaesthesiologist to focus totally upon the patient as the task of manual ventilation is replaced by inbuilt ventilator. Few distinctive features of work station are auto self check, open architecture, incorporated flexible pulmonary function and ventilation parameters with monitoring and recording system. Anaesthesia drug library enables anaesthesiologist to calculate anaesthesia drugs accurately and quickly(11).

Monitoring anaesthesia Machine :

Checking and monitoring of anaesthesia machine : A very important aspect of vigilant anaesthesia care protocol for every patient irrespective of type, duration and place of anaesthesia includes following :-

- Checking and monitoring all functions before and during conduct of anaesthesia,
- Supply of oxygen, nitrous oxide and inhalational anaesthetic agent ,
- Proper functioning of accessory equipments for anaesthesia delivery and monitors with setting of alarm in systems,
- Checking for charging of workstation, monitors and drug infusion pumps,
- Availability of required drugs during anaesthesia and emergency.

Observing Various other things :

- **Endotracheal tube(ETT) pressure,** auscultation to assess respiratory sounds, kinking, disconnections and leaks in the circuit.
- Observations for diaphoresis, limb movements, grimaces and tears.
- Quality of intravenous access and fluid intake.
- Availability of blood if required.
- Calculations for intravenous fluid intake and out put with an eye over blood and fluid losses.
- Assessment of renal functions by measuring urinary output.

ANAESTHESIA MONITORING IN AREAS REMOTE FROM OPERATION SUITE :

Providing anaesthesia care in operation room is a well set routine for anaesthesiologist but delivering the same standard of care in places outside operation room is still challenging as there are different problems related to patient, staff, equipment, environment , available facilities and transport of recovering patients safely. **Anaesthesiologist's services are required in Cath labs, radiology department for various diagnostic and interventional procedures, in units of computed tomography (CT), magnetic resonance imaging (MRI), digital subtraction angiography(DSA), electroconvulsive therapy (ECT) , dental chair and so on.**

Patient related problems:

Most of the times patients who require some diagnostic or daycare procedures in out patient departments come without their pre anaesthesia evaluation and an anaesthesiologist is supposed to provide anaesthesia in an unplanned way. Assessment is done just before the required intervention. At times last moment postponement or cancellation of the procedure becomes unavoidable due to lack of most desirable investigation to justify patient's safety. His negligible awareness regarding importance of being nil per orally adds to it.

Staff ,equipment and environment:

Lack of proper anaesthesia equipment and trained staff to provide assistance to anaesthesiologist is another short coming creating difficult situation. ***This causes requirement of even more vigilant monitoring in providing anaesthesia care at such places.*** Darkness or dim light being a pre- requisite of better visualization of desired images on radiological monitors and endoscopes in radiology department is unavoidable. The presence of big size of radiological machinery and other equipments in

addition to above creates further problems of difficult access to patient, anaesthesia machine and monitors .

Adverse and hypersensitivity reactions with use of contrast agents may lead to immediate decision to abandon the procedure with management of airway, bronchospasm and shock to assist patient in recovering from life threatening event with limited resources available. The outcome of such situation depends upon vigilant monitoring and execution of rescue measures promptly.

Monitoring during CT :
It is painless until some CT guided procedure or intervention is planned like abscess drainage, biopsy or ablasion. At times sedation or anaesthesia is required in non co-operative adults or paediatric patients under such circumstances. Monitoring should be appropriate in view of airway management as patient's head end is not approachable during the conduct of CT scan.

Monitoring during MRI:
It is a radiation free technique which does not allow any kind of ferromagnetic material near its field. Gas cylinders, their keys, stethoscope, pens and other anaesthesia delivery equipments which may disturb MRI field are not allowed. Now a days pace makres, intramedulary nails ,implants, dental prosthesis and other devices in patients body are made of MRI friendly materials. Endotracheal tubes, airways and **laryngeal mask airways (LMAs)** to be used must be of plastic material free of stainless steel. NIBP monitors can be used safely if cuffs are made of plastic. Capnographs should have longer sampling lines which delay assessment by 20 seconds. Avoidence of thermal injuries and ear protection should be taken care of continuously(11).

Interventions in cardiac catheterization laboratory (cath lab):
Should be done under conscious sedation or under smaller doses(1mg/kg) of propofol to maintain **haemodynamic stability with minimum need to handle airway.**

Electroconvulsive therapy :
This requires administration of general anaesthesia. Haemodynamic monitoring is essentially required as there are fluctuations in the form of initial parasympathetic over activity just after administration of general anaesthesia followed by prominent sympathetic response. Use of proper bite block before administering GA is mandatory to avoid complications like injury to teeth, tongue and lips.

Dental chair procedures:
These procedures are performed under local anaesthesia **(LA) , LA + sedation** known as **monitored anaesthesia care (MAC)** or sometimes general anaesthesia. Monitoring to maintain airway is crucial as oral cavity is shared by the dental surgeon and the anaesthesiologist at the same time with risk of aspiration of secretions and water used for flushing.

MONITORING IN INTENSIVE CARE UNITS (ICU) :
Apart from regular monitoring few special aspects of monitoring in ICU need mention.

- Critical care is a multidisciplinary speciality dealing with life threatening conditions where an anesthesiologist plays vital role in maintaining airway, breathing, circulation, oxygenation, body temperature and nutrition 24hours X 7 till patient recovers from danger to his life and remains stable without life support systems.
- Early recognition of physiological and pathophysiological changes and their diagnosis is dependent upon monitoring various functions of patient's body.
- Administration of fast acting potent drugs and fluids according to patient's physiological requirement with preservation of peripheral or central intravenous access to mantain circulation.
- Assessment of respiratory function by arterial blood gas analysis.
- Invasive mechanical ventilatory support , provision of sedation to tolerate endotracheal and tracheostomy tube and administration of NMBAs according to requirement.
- Assessment of level of consciousness on Glasgow coma scale.
- Monitoring of fluctuating blood sugar level.
- Maintenance of Goal directed fluid theapy (GDFT) which was introduced by Emassual River in 2001 for critically ill patients. Pulmonary artery cathetor is primarily used to assess the requirement. Monitoring cardiac output and stroke volume determines requirement of fluid infusion in cardiac surgery and critically ill patients.Trans oesophageal echocardiography (TOE)is used for GDFT which is relatively safe and a noninvasive technology.
- Providing total parenteral nutrition (TPN).
- Weaning from invasive ventilatory support.
- Provision of improvement in ventilatory function through physiotherapist.
- Recognition and management of systemic inflammatory response syndromes(SIRS) and multiple organ dysfunction syndromes(MODS).

- **CONCLUSION:**

Vigilant monitoring is essential and an anaesthesiologist indispensible as early detection of mishappenings and emergencies with their timely diagnosis and management saves life.

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