

# ANAESTHESIA IN 2050 – HOW DO I VISUALISE

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It is bright sunny morning of October 16 , 2050 I am posted to this new place it's a premier institution of my state, I stand anxious in front of the major Operating Room (OR) complex where its written in Sanskrit translating lead me from untruth to truth, from darkness towards light, from death to immortality, Om peace.

My nerves calmed and I entered, suddenly a 3D holographic gentleman greeted me and said "Welcome sir I suppose you are the new anesthesiologist here, I am Info Murthy, I am self awareness artificial general intelligence assistant to you, let me show you around ."

" Sir go through the scanner into the decontamination room and put on your assigned gown" . I did as he said . "Sir scanner monitor displayed your vitals to be high, don't be nervous, the work climate here is very positive ,only 8 hour shifts with weekly holidays, there are stress management therapies , nap periods , ratio of anaesthesiologists to surgeons is also high. Institution promotes you autonomy and supports your decisions, the burn out rates are very low here." I was puzzled and asked How did you know ? "Sir I am integrated to all the systems here". I am in Elysium I thought.

" We have 70 modern surgical suites, 20 hybrid suites, 10 septic modern surgical suites", he spoke through the clean zone .In the aseptic zone their it is my assigned operation suite .

## MANUAL TO AUTOMATION – “COMPLEX INSIDE, SIMPLE OUTSIDE”

**Pre Anesthetic Evaluation** is done at the reception area we are not just equipped for static but also dynamic assessment is done, as to how physiological variables will behave on stress, hypoxic challenges, all risk assessment indices are evaluated, Cardiopulmonary testing and maximum oxygen consumption and simplified scoring class is provided by me, post examination done by you .3D holographic USG image of the site for regional anaesthesia , virtual bronchoscopy ,3 D printing of anatomical models for trials especially in difficult intubation, Genolyte for genomic assessment, biomarkers testing and state of art scanning, perfusion modalities, live streaming from labs and radiological suites with virtual and augmented reality are at your disposal. Consent obtained after virtual visualization of anaesthesia delivery with vernacular informed ,video documentation is stored in my database and is available through Internet of Medical Things (IoMT) for actionable insights into management

## INVASIVE TO NON INVASIVE, INTERMITTENT TO INTEGRATED CONTINUOUS

**Monitoring** values and parameters measured are more accurate and less subject to influence or interference by extraneous nonclinical factors. Modular concept of groups of specific parameters are presented as different modules (metabolic module, neuromuscular module, anesthesia gas module, etc.) enabling the user to choose the combination of parameters most suitable for the given patient. Reliable functioning of equipment over a wide range of clinical situations. Ultra compact micro rotor capnograph, USG guided gastric monitor , ECG, ORi enabled Co oximetry and Cerebral oximetry, Continuous hemoglobin and total oxygen content, Real time 3D cardiac output monitoring by Transthoracic Doppler, Transesophageal Echo, Optic nerve sheath diameter measurement for non invasive ICP monitoring, Evoked potential monitoring, TEG, Cardiac enzyme monitoring, Transcutaneous ABG, Acceleromyograph, TOF Watch, Pupillometry, BIS, Entropy for depth of anaesthesia and sedation monitoring. Continuous multi parameters are interlinked and interpreted, simplified integrated numerical, graphical and real time 3D pictorial information display is available and is connected to artificial intelligence for autonomous monitoring, through IoMT for cloud sharing and a guided assessment, action plan from broad database of similar case scenarios from various sources specific to ethnicity and population is evaluated reducing the reaction time , error of misinterpretation or chances of missing the information for prior anticipation of any adverse outcomes, also for optimum usage and minimizing wastage to save environment.

## ENHANCED SAFETY, ACCURACY AND RELIABILITY

**Anesthesia workstation** with reliability over a wide range of age, weight, flow rates, adequate and safe ventilation for patients with diseased lungs by choosing appropriate mode, hypoxia prevention even at low flows , efficient closed circuit system and firewall protection for cyber security. Extensive but customizable alarm systems , autocalibration and advanced vaporizers delivering accurate output without being affected by temperature, pressure, fresh gas flow etc, are linked to machine learning that can be operated autonomously via artificial intelligence or you can manually override them to feel the case in classical way. We have portable anesthesia system for space mission STONY'S Vapo-Ject for controlling anesthesia delivery in zero gravity and other portable anesthesia delivery systems for disaster management. Murthy we owe a lot to

mother earth and we need to keep her clean . **Environment friendly** Anesthesia workstations are available that will enable the users to deliver anesthesia that are safe and help in developing green operating rooms. Technologies to prevent wasting anesthesia into the atmosphere example Silica zeolite are employed. Xenon ready anesthesia workstation (TANGENS 2C) with no known detrimental ecotoxicological effect is used here. We have zero emissions and bio-friendly waste segregation and disposal management here”.

**Anesthetic drugs** “ Newer near ideal anesthetic agents with rapid action and emergence, adequate relaxation, wide margin of safety, unchanged excretion, absence of toxic metabolites, useful for age groups and high degree of specificity are dispensed by ROBOT -Rx on the basis of pharmacogenetic susceptibility and sensitivity of the patient determined from PAE and also tailor made 3D printed drugs which are bar and colour coded , prefilled , preservative free ,target specific ,electrochemical markers for detection and therapeutic drug monitoring through intravenous ,inhalational ,intranasal , polymeric , transdermal ,nano particle ,multiphasic liposomal drug , etc delivery systems are available.”

“**Anesthesia robots** including the Kepler Intubation System, designed robotic arm to place an endotracheal tube, DaVinci surgical robot to perform regional anesthetic blockade, and Magellan robot to place peripheral nerve blocks. Pharmacological robots include the McSleepy intravenous sedation machine, designed to administer anesthetics, narcotic, and muscle relaxant, and the iControl-RP machine, a closed-loop system intravenous anesthetic delivery system which makes its own decisions regarding the intravenous administration based on EEG level of consciousness via a BIS monitor device. All medical apparatus and devices are tagged for easy location”.

Ok Murthy I get it, access to safe anesthesia for essential surgery is a basic human right. Targeted attempts through technology to maximize efficiency, ease of care, communication and data management by Hospital Capacity Command Centre to nullifying medication errors and give economical care. ‘TO ERR IS HUMAN’ Human factors can make a significant difference to the outcome of anesthetic management independent of the technology available. Dedication, interest in profession, knowledge and skills, good communication and team working attitude weighing responsibilities over duty, adherence to established protocols and rules of evidenced based practice can improve outcome even when the technology is not very advanced or sophisticated. WHO-WFSA standards of safety for the referral institution are in place for conduct of safe anesthesia practice with regard to personnel, professional aspects, facilities and equipment, medications and monitoring.

“ Sorry for the interruption sir, Anesthesiologist is an epitome of dedication with single minded purpose of good patient care and enormous physical stamina.”

**Life saving equipment** implanted cardioverters ,pacemakers , intra aortic balloon pump ,ventricular assist devices ,ECMO ,cell salvage system ,intraplipid ,satellite blood bank with centrifuge for apherisis is also available.

Murthy how about **Regional anaesthesia** ‘If there is a nerve it must be blocked’. “Sir I already have given information on the robot operated blockade but I assume you are old school, we have various advanced ultrasound machines with 3D, 4D holographic imaging and model imprinting for training. Piezoelectric polymer sensing needles non insulated, advanced fluoroscopic module for regional anesthesia is available”. Sorry Murthy you do not use phantom limb for training then. “Yes sir and importantly this is your personal pocket ultrasound probe linked to your Heads Up Display, post PCPNDT act reforms”. Thank you Murthy. With regional blocks health care costs have drastically come down, increased cases of ambulatory day care surgery, better surgical outcomes and patient satisfaction has increased especially with POCUS block on arrival in trauma care while shifting the patient to OR rather than casualty room management for appropriate attention causes minimum stress and maximum comfort . “Sir we also have nano electrode percutaneous near nerve ,small electrical stimuli applicator for sensory blockade and there are studies planned to extend it to natural sleep anesthesia by electrode mediated direct action on various cerebral sites , intra operative amnesia and immobility without administration of apnea causing agents. Neuromodulation with principle of blocking the gate control pathway for decreased sensitization of pain especially in chronic pain management”.

Murthy your knowledge is updated but I am a mere mortal what is the scope for further learning or residency program here. “Sir we practice **Open mind, Shared care model** that enhances rather than limits the content and quality of anesthesia training and subsequently strengthens the workforce with hands on training for wide range surgical services. Additional education in non clinical basic sciences for in depth knowledge, also inculcate teaching abilities and leadership qualities for holistic competency based medical education. Nothing is possible without supporting Microsystems and auxillary staff so adequate training for further engagement is essential”. I agree Murthy as Roosevelt said ‘I believe that the more you know about the past, the better you understand the future’.

Anesthesiologist must work as a member of a multidisciplinary team specializing in certain type of surgery or procedure his/her roles being extended to intensive care, pain management, trauma care, disaster management and resuscitation trainer. At every stage clinical knowledge and skills are important. It’s impossible to train in all the techniques and complexities involved in the practice of anesthesia on the patient. This is because of ethical considerations , decreased infections and the potential risks for the patients, so purpose-oriented technology in simulation like learning anatomy using

HoloLens an augmented reality system in which the wearer interacts with a digital model which in this case is a w-D anatomical model, built using actual MRI data of real patients. Serious gaming simulation related technology wherein entertainment and education simultaneously take place ex. disaster management and difficult airway. Here multiple participants can interact from different places and performance is automatically scored without instructor being required. GASMAN ,TIVA TRAINER are also available”.

Murthy how about post discharge care? “Sir anesthesiologists have an extended role in ERAS where evidenced based protocols for standardized care in expediting recovery and decreased hospital stay has made Perioperative Surgical Home (PSH) more significant in patient care. Anesthesiologists are leaders in PSH, for continuous monitoring of physiological, biochemical parameters done with tracking location apps. Which as the scope of anesthesiologist has surpassed from peri operative physician to complete operative care physician including home care monitoring with pulse oximeter (SpHb ,SpMet ,SpCO,SpOC,PVi,RRa), blood pressure, non invasive blood sugar monitoring in wearable devices, with smart phone electrocardiogram are a few. These are low cost high accuracy screening, monitoring and diagnostic tools which can be used remotely”. Yes Murthy follow up and continuous home monitoring especially pain therapies for opioid free multimodal analgesia PCA ,PCRA ,CI-PCEA and returning back to the normal way of life is of paramount importance in the quality of anesthesia so as to explore functional status outcomes, cancer survival growth, cognitive decline, sustained analgesia, proper health care utilization and health care analytics is vital in all operative procedures.

“Sir **Anaesthesia data** is an important source of information and is a vital medicolegal document as well , electronic documentation of your voice data will be integrated into hospital central command system, so as it recognizes you for voice control in the OR and in critical care units, leading to accuracy, indestructibility, prevention of subsequent manipulation, encryption for preventing it from being hacked , digital immunization towards malware and poor network performance and remote accessibility. Patient records are important sources of medicolegal investigations and clinical research as well. Patient is implanted with a microchip under his skin so that he can access his health information wherever they wish, privacy is maintained and also can be accessed by treating doctor when complete records are required, if not available in the cloud.

**Data sharing and Big Data** is a logical consequence of collection of enormous data in an electronic and digital form in anesthesia information system for clinical decision support system and reporting to SAFE-T, WFSA and protocol updation has led to a large pool of scientific data across the world. With the advances in software, it is possible to share these data and analyze them to recognize various pattern and extract lot of information about various aspects of anesthetic management including patient responses to medications, prediction of complications etc. This has also benefited in training and Tele-anesthesia. This is also solving the biggest challenge of bringing all anesthesia fraternity together uniting them so as to innovate and improve patient care .Clinical early warning algorithm is an example of use of big data, to detect early onset of clinical deterioration in anaesthesia.

“Novel experiments on zero gravity OT tables for ease of positioning ,continuous thermal imaging techniques over the table for tissue oxygenation, ventilation. Custom made silicon device peeled off 3D printed heart with multiple sensors and enhanced electronics for measuring acidic conditions, oxygenation, heart strain, temperature . Airway transformer device that can form either into a supraglottic or intraglottic device which is multiported for various systems like stylet, fiberoptic, thermistor, gas monitoring, trans tracheal lung imaging with an innate secretion absorbing technology and converting it to sealant with nanomer technology is also custom made with 3D print . Ventilator pod technology for space travel where a person can hibernate with minimal metabolism and breathe through gill transformed skin through tissue engineered skin with multiple impregnated oxygenators or embryonic lung tissue imprint similar to an African lung fish for long periods are under phase trials this can also be used in organ preservation in brain dead for organ transplantation. Point mutations of the Zfhx2 gene for complete pain alleviation post admission and in the perioperative period are also in phase 4 trails” .

Murthy despite all the technological developments it always has a drawback of availability, accessibility, accuracy, portability and cost factor which hamper its wide spread usage especially in remote and peripheral locations. Government needs to formulate policies and take up on subsidizing the health care costs , wide implementation of its holistic healthcare policy and reform health insurance sector. Lastly I thought, Have we become addicted to gadgets and robots? and does AI overpower our instincts ? So, I am of the opinion that basic clinical acumen, conventional skills, machine checks and operation etc i.e “Hand on pulse and Eyes on monitor” will never be obsolete anesthesia practice . As anesthesiologists we are trained to be amphibious, multitasker, eternally vigilant so we need to work with head( quick decision making), hand(procedural skills) and heart (affiability) towards better patient care and comfort which is unquestionable.

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