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Anaesthesiology in 2050 - How do I visualise

Anaesthesiology has made tremendous growth since its birth. It has remarkably revolutionized the practices in medical and surgical branches. I see a lot more potential for its future progress due to its omnipresence in all fields of medicine.

I visualise anaesthesiology in 2050 to be transformed into finer combination of information, automation and technology with preservation of human touch, care and empathy. Thirty years from now anaesthesiology may be recognised as a multithreading branch including '3Ps' and '3As' i.e. 'Perioperative, Pain and Palliative care' medicine and 'Artificial intelligence, automation and aesthetic anaesthesia'. Different aspects of anaesthesiology, including perioperative care, clinics, pain and analgesia, palliative care medicine, non-operating room anaesthesia, day care, intensive care, resuscitation and emergency medicine, would be complemented by artificial intelligence and machine learning, informatics based automated medication management systems, robotics and nanotechnology.

Pre-pre-anaesthetic assessment: There would be specially designed global health information system registering patient data from all the registered hospitals across the world with separate sections for external (patient) and internal (doctor) users. The patient would be able to visit the anaesthesiology related section and fill-up the basic history-based questionnaire of the pre-anaesthetic check-up and the software would recommend a basic set of investigation to be done and other evidence based health related advices by consulting the perioperative physician before their first encounter to the OPD. These recommendations would be based on information and evidences on the internet.

Pre-anaesthetic assessment: Now, when the patient comes on his first appointment to a PAC clinic, the physician would already be aware of their patient list and brief history, saving time at both the ends as well as giving extra time for empathic counselling. Patient would be clinically examined in the clinic and the whole data would be stored on the cloud drive, building a complete e-information of PAC. Digital preoperative assessment tool would utilize artificial intelligence to judge patient's risk profile and suggest therapies for better optimization before procedure. On the whole these modifications would help to establish better doctor-patient relationship and standardization of management across hospitals. Also the anaesthetist can learn, revise and build up his knowledge and confidence in taking best clinical decisions.

Perioperative care wards: Separate wards with ICU facilities would be dedicated to perioperative care where patients would be prepared and served with great hospitality. The patients would be counselled about the procedure and anaesthesia-related issues and given a choice to choose the anaesthesia technique if possible with best opinion from the experts.

Intravenous cannulation: A robot with an arm having LED-based vein finder would secure intravenous access in a single prick being made painless with the application of newer rapidly acting topical local anaesthetics. Lignocaine-centred nanoparticle formulation in a gel based form with faster onset and higher efficacy, would be applied prior to prick. So, needle pricks would no longer be a terror for the patient.

Modular Operating room equipped with advanced, miniaturised machines and equipment: I expect newer generation of anaesthesia machines and equipment with nanochips that not only

provides better accuracy and precision in work but also capable of recording and memorising the events the number of times it is used. Also those bulky machine and hefty equipments would be replaced by lighter and sleek apparatus with artificial intelligence. The future machines would have a hyperattentive monitoring system which would read the changes in the hemodynamic parameters of the patient and use it as a feedback to suggest titration in the dosage of anaesthetics, thereby effortlessly maintaining constancy in depth of anaesthesia and deepening of the plane wherever needed.

The safety features of the system would be upgraded to achieve zero error. Gas extractor-concentrator for manufacturing of oxygen and medical air, would be available thereby replacing the conventional gas supply system. These gases would be stored in the cylinder and supplied through pipelines. Password-coded attachments of the pipelines and light weight cylinders with a sensor attached would avoid the issues related to failure of Pin index and Diameter index safety system. Digitalization of workstation with GPS, 10G features and intelligent assistant similar to 'Siri in iPhone' is expected.

The vaporizers would be reduced into built-in nano-cassettes. Nitrous oxide and fluoride-based inhalational agents may be withdrawn from the practice with the advent of newer novel inhalational agents like Xenon or artificially engineered inhalational agents. The newer agents would be designed to achieve quicker onset and recovery from anaesthesia without any side effects by action on specific sites on GABA receptors and NMDA channels in specific areas of brain like hippocampus with least systemic solubility. The vaporizers would be smart enough to change the concentration of gases delivered according to the individualized MAC values, EEG, entropy and BIS values.

I visualize sophistication of anaesthesia equipments and adjuncts as lighter, stronger, fibre-based material. The procedure like intubation, securing of invasive lines would be done with precision and accuracy by the robots after scanning of patients anatomy. So a CICO situation could be brought done to zero. The equipments would be single-use, cost-effective made up of biodegradable materials minimizing the risk of contamination and wear & tear; also saving the cost of sterilization.

Anaesthetic drugs and drug delivery system: Induction of anaesthesia and emergence, as always desired, would be like smooth take-off and landing of an aeroplane. Anaesthetic drugs would include specially designed nanoparticles regulated by a computer program so that it can be activated to recognize and target only a particular receptor subtype of interest and on the desired locations. These particles would be novel, non-reactive, non-coagulable and could be easily withdrawn from the body from the same vein used for injection by deactivating it. There would be an option to transform the same particle to act on different sites of the same receptor and also on different types of receptors at varied locations in the body to bring about agonistic or antagonistic actions. Therefore we can achieve different actions by the same set of nanorobots. Also the regulating program would be able to divide the number and actions of nanorobots reaching each location.

So, now the same nanoparticle would act to cause $GABA_A$ mimetic action, NMDA receptor action, AchR agonistic or antagonistic actions, μ_1 or μ_2 or κ receptor activation, α or β agonistic or antagonistic actions as per the key selected on its master computer. The machine would be connected to the monitoring devices so that it can itself sense and calculate the individualized anaesthetic dose requirements of the patients to bring about optimum effects. This task would be made possible through artificial intelligence and machine learning which would integrate the information and evidences on internet and its own memory for carrying out anaesthesia in different individuals. The anaesthesiologist therefore gets assistance in making clinical decisions swiftly and dosing accurately. With these technological advancements, it would be possible to increase,

decrease and reverse the effects of anaesthetic drugs as well as withdraw the nanodrugs from the body whenever it is not needed. So, the anaesthesia would be completely devoid of side-effects due to actions on undesired sites and overdosage.

Reversal could be done by just withdrawing the nanodrug by deactivating it and switching off of the inhalational agents. We would not have to wait for the drugs to get metabolised and eliminated from the body.

The fluids used intraoperatively would be balanced salt solutions with much more resemblance to blood biochemically. Artificially engineered nano-blood products like vasculoids, respirocytes, clottocytes and microbiovores mimicking various transport function of plasma, carriage of oxygen to cells & carbon dioxide from cells, haemostasis and phagocytosis, respectively, would be available.

Regional Anaesthesia: The central neuraxial and peripheral nerve blocks would be provided with the help of minirobots which would have an ultrasound probe arm for scanning the anatomy, while the other arm would inject the drug. The pain at the site of injection would be taken care of by application of transdermal patch at the selected area with microneedles progressively injecting lignocaine and increasing the length of needle up to the required depth. These needles would have pico-calibre so that it won't irritate the local nerves hence causing pain-free pricks. Designer liposomal bupivacaine with longer action might be available. Also antidote of bupivacaine, as nano-substances, would be easily available which would electrically attract the charged bupivacaine molecule towards itself, neutralize its effects and render it non-toxic, easily metabolizable.

Anaesthesia at peripheries and day care: I can imagine portable mini-anaesthesia machine of the size of a laptop with oxygen concentrator, nano inhalational agent cassettes and monitoring devices & circuits being attached to the same. So the same quality of care can be provided anywhere.

Pain and palliation: Pain is counted as the 5^{th} vital sign in clinical practice. So separate division for pain and palliation would become a part of each and every health care system. Artificially engineered, liposomal preparations of potent anaesthetic agents like topical or transdermal bupivacaine, saxitoxin, etc, would be used for the treatment of chronic pain. These would target the C and Aλ pain fibres without producing systemic side-effects.

Anaesthesiology training: Training of anaesthesiology would be more of knowledge and evidence based practice rather than a procedure learning. Education would become more and more vivid with assistance of learned machines and provision to receive expert opinion. The cumbersome and dexterous jobs would be done by robots, the calculations and recording of vitals & events shall be done by the machine, assistance in clinical decision-making with explanations for the same would be provided by the artificial assistant. So the learning curve would hype with better understanding and gain of knowledge at work. There would be uniformity in practice and diversity in the speciality. But protection must be provided against misuse of privileges and dependency on learned machines during work.

So, the future aim would be providing improvised care and achieving quality in quantity. Sounds "impossible"! But I see it in the coming future. Thirty years are enough to turn the game by 360˚.

Abbreviations:

OPD – Outpatient department, ICU – Intensive Care Unit, LED – Light Emitting Diode, GPS – Global Positioning System, GABA – Gamma Amino Butyric Acid, NMDA – N-Methyl- d-aspartate , MAC – Minimal Alveolar Concentration, EEG – Electroencephalogram, BIS – Bispectral Index, CICO – Cannot Intubate Cannot Oxygenate, AchR – Acetylcholine Receptor.