MIND TO MIND
Creative writing that explores the abstract side of our profession and our lives

Stephen T. Harvey, M.D., Editor

Trance-it to the Future

Neeraja Ajayan, M.D., Ajay Prasad Hrishi, M.D., D.M., E.D.A.I.C.

Sofia held my hand gently as I heaved myself into the doctors' suite. She knew I was a tad out of breath while climbing the flight of stairs into the office, even though I was feeling refreshed after the morning stroll. Although she was just a robotic assistant, it was a solace to have her after my son and grandchildren had left for a Mars odyssey of 30 days. I had just updated her operating system, day before yesterday, and ever since, her uplink with the Central Registry has improved. As she gently swabbed my oral mucosa for real-time measurement of glycosylated saliva amylase, she read out to me the day's schedule. After performing a whole-body scan and automatically feeding the medical information to the master population health record, she gave me the green signal, "Dr. M, you are ready to go." As part of the "Doctors' Health Campaign," eligibility to work and retirement was dependent on the fitness report of the Central Artificial Intelligence Assisted Health Registry.

Preanesthetic Check-up: Telemedicine and Virtual Reality

In the doctors' suite, I kickstarted the day with six virtual consultations. Reclining on the armchair, I made a swift wrist rotation, which auto-enabled my spectacles to be in virtual reality mode. The electronic medical record of my first patient was right in front of my eyes. A rice grain–sized single laboratory analytical kit (or as the layman calls it "lab chip") which was capable of testing not only all quintessential biochemical profiles but also proteomics and genomics, had generated the report that the patient's parameters were "screened safe" for surgery and anesthesia. As the next step in the virtual reality check-up's protocol, I walked through the detailed reconstructed images

From the Division of Neuroanesthesia, Department of Anaesthesiology, Sree Chitra Tirunal Institute for Medical sciences and Technology, Trivandrum, Kerala, India. drajay@sctimst.ac.in

Accepted for publication November 19, 2020. Published online first on December 16, 2020.

 Anesthesiology 2021; 134:493–7. DOI: 10.1097/ALN.0000000000003652

created from the patient's scans. The patient sitting in any corner of the world could just wear a full-body apron which not only recorded the whole-body scan but also reconstructed the scans to 3D images and electronically transferred them to a faraway doctor's virtual reality goggles! Ruminating on the degree of verisimilitude to reality the wearable technology offered, I scrutinized the 3D cardiac magnetic resonance imaging of the patient. The artificial intelligence incorporated in the system detected a left main coronary artery occlusion in my patient who was posted for an arm regeneration surgery. The patient, on being informed of the same, requested a telemedicine two-way holographic video conference calls for understanding the interpretation of his health status. As the camera captured my face and streamed it on to 4D volumetric units, I empathetically greeted my patient whose image was displayed in real-time (the fourth dimension) in space. After a prompt teleconference cardiology consultation, I obtained his advice to schedule the patient for CLOTOLYSE before taking him up for the elective procedure. I demonstrated to him with the aid of virtual images, how the nanorobotic agent pool CLOTOLYSE, which operated through Swarm intelligence, would be instilled inside the bloodstream to lyse the clot. I instructed Sofia to take my patient for a virtual tour of his perioperative course in the hospital before leaving for the simulation lab.

A paradigm shift in the preanesthetic check-up was brought about by telemedicine and virtual reality. I mused about the past when a few of my peers were skeptical of advancements in technology. Only those who had embraced and adopted it with renewed enthusiasm, despite it being uncharted territory back in 2020, had maintained their relevance in the practice of anesthesia.

Anesthesia Training: Augmented Reality, Simulation Labs, and 4D Printers

The clock struck 8:00 AM as I sauntered to the 4D simulation lab for anesthesia trainees. The field of anesthesia had withstood the test of time and technology, which was once believed to threaten the future of anesthetists in the form of robots. I had conducted the anesthesia aptitude test for postgraduates the previous day. Multiple-choice questions were a thing of a bygone era. Simulation exams were conducted to test their theoretical knowledge and assess their practical skills before enrolling them in the coveted "anesthesia program."

Miss J, my second-year resident, was practicing epidural anesthesia on a phantom model she had printed using the patient's real-time imaging data. She had intelligently used a shape memory polymer, which was nonperishable and reusable compared to

the previous generation gelatin, which had the disadvantage of leaving needle track marks after repeated use. The fourth dimension of time and motion enabled her to visualize how the model contorted when the epidural needle touched the nerve root. I reminisced how in my residency days, as I scrubbed for regional techniques, my professor had warned "not more than two attempts," and here we were with opportunity at its best!

This training method by simulation was proven efficient in honing the residents' skill levels and made them confident in their competence before patient interaction. 4D technology enabled comprehension of complex anatomy and was valuable not just in training but also in preoperative planning and intraoperative decision making.

Robotics

While I contemplated the engineered biomedical marvels of this generation, my resident asked if robotic intubation should be the preferred mode of securing the airway in a case of a difficult airway. If my teachers were there, they would have asked for a trial expert intubation; but this was a time of significant medico-legal implications and I did not want to play with fire. I suggested microrobotic guided intubation; they were designed to navigate the airway with the attached self-inflatable endotracheal tube made from medical grade thermoplastic elastomer, which prevented compression trauma and sore throat in the postoperative period. I pondered how decades back anesthetic robots were significantly larger than their human counterparts and acted as slave arms to their master human. Time saw the upsurge of microrobots that could travel inside the human body designed to perform specific assigned tasks that could range anywhere from delivering targeted drug therapy to a particular area of interest or attaching itself to airway gadget and escorting it to the right place.

As I passed across the corridors to the theater complex, the patients were being escorted by robotic assistants. At the door, the 3D holographic projection of the surgical and anesthesia safety list was being scrutinized by the robotic nurse. I smiled at the patient, and he smiled back. I thought to myself…some things can only be done by a human, and smile was one such thing!

Inside the Operating Room: Artificial Intelligence, Deep Machine Learning, Advanced Pharmacotherapeutics

In the theater, I checked the patient's requisite list. His gustatory wishes had already been fulfilled by the "micro pill" administered on the morning of the surgery. It had all the required calories and catered to his nutrition requirements while also providing

him with a feeling of satiety. My attendee pressed the buttons of the panel to digitally ensure the patient's wish list of "by the beachside, listening to Beethoven, smelling sandalwood" in his transit to anesthesia, the apron he had worn acted as a biosensor which monitored his systems.

To initiate anesthesia, I connected the closed-loop drug delivery system "Hypnalgos version 10.4" to the patient's cannula. The drug kalamantolium, which was a hybrid molecule of propofol, remifentanil, and cisatracurium, had revolutionized anesthesia with the components of hypnosis, analgesia, and muscle relaxation being offered in a single drug. Thanks to nanomedicine, the reversal molecule Sucafolyl could be carried by nanorobots to selectively bind to each specific component of the hybrid molecule reversing only that component. Individualized pharmacokinetic models were used for drug delivery, and the feedback was not just from auditory evoked potentials but also electromyogaphy and nociception index. As I put Hypnalgos in semiautomatic mode, it communicated through a voice prompt whether the planned anesthesia was pure total intravenous anesthesia to which I gave the "yes" voice command. Inhalational agents had become obsolete due to the "Greta Thunberg protocol"; hospitals had to be at least platinum green grade to get a license to function.

After briefing the robotic nurse, I walked to my research lab. A holographic projection of the monitor's data had made telepresence and teleanesthesia a reality. As the in-charge, I could monitor the whole of the theater consoles and will be given prompt alarms from the machines, thanks to artificial intelligence. Decision support systems had evolved a long way to provide timely audiovisual warnings about critical events after collecting data from the monitors. As the decision support systems alerted me by a holographic projection of causes and the remedies for decreasing cerebral oxygenation values of my previous patient, I called my attendee, who was promptly correcting the hypotension induced by sudden unanticipated hemorrhage. The fluid infusion system was controlled by real-time input of cardiac output and corrected flow time from the cardiac monitors ensuring goal-directed therapy. As the patient's parents had already deposited in the stem cell bank during his birth, autologous genetically engineered blood was in ample store.

Gavel to gavel, the anesthesia and surgery recordings were live-streamed through virtual reality to rural hospitals' residents for providing them with a vantage point. The day was still long, and Sofia suggested a 5-min power nap. Well, artificial intelligence

is still not advanced enough to teach her that I always preferred my cup of joy to the catnap. Anesthetists could "take a break and have a coffee," and that was something time could not change!

Staying abreast with the advances in technology, anesthesia had made giant leaps over the years. Removing the clouds of uncertainty, the once perceived "utopian ideas" were a reality.