techniques, was found to be associated with improved quality of analgesia, reduced breakthrough pain, and ultimately increased patient's overall perioperative experience.[4,5] However, multiple recent studies have shown limited differences between dosing regimens.[6] For paravertebral catheters in thoracic surgery, PIB improved postoperative analgesia and quality of recovery compared to CI.[7,8] This is also supported by a cadaver study showing increased spread of dye following PIB through a TAP block catheter compared to CI.[3] Limitations include the specialized delivery systems that are required, extensive dense block following a bolus, and or missed boluses in case of malfunction. Obviously, results from epidural or paravertebral PIB are not necessarily transferable to FPBs considering the differences in anatomical target, LA used, pump settings and spread of LA.

Continuous Infusion

CI provides a constant infusion of LA at a fixed dose throughout the infusion. This can be delivered with any type of syringe pump and thus rarely requires additional resources. It is considered a simple and straightforward method of infusion allowing continuous drug delivery. As such it can easily prolong postoperative analgesia. Consequently, extensive research into this technique has been performed, showing the safety and efficacy following multiple surgical procedures. The limitation of CI includes the time until reaching a therapeutic drug concentration. Moreover, especially following prolonged infusions, the risk of LA accumulation increases in susceptible patients and can result in systemic toxicity.

Comparative research

A recent review by Jagannathan et al.[9] comparing intermittent bolus to CI in truncal and peripheral blocks identified only 13 studies but failed to show the superiority of any particular delivery regimen.[9] They, however, included only 3 studies investigating FPB which showed limited to no differences between PIB and CI for TAP blocks. Recently, other trials have been published comparing PIB to CI for several of these newly described FPBs.

Aoyama et al.[10] compared the effects of QLB with PIB (n=21) to CI (n=20) for postoperative analgesia followingla-paroscopic colorectal surgery. Both groups received an equivalent amount of LA (i.e., levobupivacaine 0.15% at 12ml every 4h compared to 3 ml/h, respectively). These authors identified no differences in any of the assessed outcomes.[10]

Following midline laparotomy, the RSB has been demonstrated to be an appropriate analgesic technique. Purdy et al.[11] performed a trial comparing different delivery regimens of LA following midline laparotomy through bilateral RSB catheters. Levobupivacaine 0.125% 10 ml every 4 hours in the PIB-group (n=12) was compared to 5 ml/h in the CI-group (n=17) and continued up to 48h after surgery.[11] No difference was detected in their primary outcome being oxycodone consumption.[11] Nevertheless, compared to the CI-group, patients in the PIB-group reported lower pain scores and higher satisfaction scores.

For thoracic surgery, the ESPB has been postulated to provide postoperative analgesia. Taketa et al.[12] compared the effect of ESPB using PIB (n=25) to CI (n=24) on desensitized dermatomes following thoracoscopic surgery.[12]Ropivacaine 0.2% 8ml every 2h in the PIB-group was compared to 8ml/h in the CI-group. They identified a wider anesthetized area with lower consumption of LA when using a PIB method compared to CI.[12] However, this did not result in any relevant difference in opioid consumption, pain scores, or other measured outcomes.[12]

Conclusion Currently, PIB has been investigated for epidural, paravertebral, and peripheral nerve catheters, where it has been shown to be safe. However, reviews have highlighted multiple limitations which include among others the differences in LA used, dosing regimens, dosing intervals, or inequivalent LA dosage. In addition, these studies rarely report on any relevant patient-centered or patient-reported outcomes. Furthermore, comparative research into these different delivery methods for FPBs is even more limited.

Based on the limited and small trials comparing PIB to CI for FPBs, we can hardly conclude that PIB delivery methods are safe. However, the potential reduction in the cumulative dose of LA seems to be beneficial. However, this technique requires additional resources (i.e., advanced pump devices) which likely increase healthcare costs. Therefore, the decision should be weighed on patient characteristics and resource availability of the center.

#36915 D37 – THE GREEN FOOTPRINT OF REGIONAL ANESTHESIA

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Today, humanity is experiencing unprecedented rapid global warming thrusting us in the midst of our most profound existential crisis. Indeed, climate change is a process due to human activity's – primarily burning fossil fuels and generation of greenhouse gases (GHGs). Human activities are warming up the atmosphere, hydrosphere, and lithosphere, producing widespread and rapid changes across the entire planet, which is the result of Earth's delicate energy balance being skewed by the excessive production of GHGs. Some of Earth's outgoing thermal radiation is normally absorbed by GHGs in the troposphere and subsequently reflected to Earth; however due to anthropogenic GHGs, this absorption and reflection of thermal radiation has increased, now amounting for 342 Wm^{-2} of incoming thermal radiation and placing the Earth in a net positive energy state.[1] This has profound impacts on the necessary conditions for life. GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases including hydroxyfluorocarbon, perfluorocarbon, sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3);[2] fluorinated gases also include anesthetic gases such as inhalational anesthetics desflurane, isoflurane, sevoflurane, and halothane. Owing to their chlorine and bromine groups, isoflurane and halothane have the potential to deplete the important stratospheric ozone layer – a layer which absorbs incoming ultraviolet (UV) radiation limiting the earthward transmission of harmful UV-B-radiation.[3,4]

Production of electricity (38%), the transport sector (22%), and the pharmaceutical and chemical industry (10%) have the greatest impact on GHGs production. However, the healthcare sector also poses significant burdens on global carbon emissions, being responsible for an estimated 4.4-4.6% of all global carbon dioxide-equivalent (CO_2e) emissions in 2019.[5,6] Six countries have calculated their national health system's carbon footprints: USA (8%), Australia (7%), NHS (6.1%), Canada (4.6%), Japan (4.6%), and China (2.7%). The NHS provides a deeper analysis, with the supply chain representing the largest proportion of emissions in 2022 (62%); other components included direct provision of care (19% of which anesthesia gases and metered dose inhalers were responsible for 5%); and all healthcare travel-related factors (patients, visitors, staff) at 10%. Altogether, healthcare's impact needs to be put in perspective with other societal sources of emissions. In 2014-2015, 'the Australian health care CO_2e emissions were about half those of the construction of every single building, house, pipeline, dam, oil rig, road and rail line'.[7]

Unfortunately, climate impacts of healthcare pervade into all facets of ecology, beyond carbon emissions. US healthcare centers produce more than 4 billion tons of waste every year, making it the country's second largest contributor to waste. Operating rooms provide a quarter of all hospital waste, with up to 25% of that from anesthesia. Longer surgical procedures can generate up to 25 to 100 kg of waste.

Furthermore, it must be specified that even metabolically almost inert drugs such as propofol (minimal metabolization), can cause ecological harm and are likely hugely underestimated as an environmental risk. These drugs need to be eliminated appropriately and not disposed of in sinks, toilets, or garbage bins. Specific drug waste bins are the solution for disposal of unused drugs, and their use is best practice to protect staff, patients, and the environment, while simultaneously reducing drug waste. Using sharps bins to dispose of unused drugs and related packaging is an unnecessary expense. Specific drug waste bins are a compliant alternative to sharps bin and can be safely deployed in any healthcare setting (hospitals/pharmacies/clinics). The drug waste bins for liquid drugs contains a sachet, which creates a unique blue gel when drugs are emptied into the gel. With the drugs encapsulated in the blue gel, the drug waste bin is sent to a waste stream bound for incineration. A specific drug waste bin is available to dispose of oral tablets and capsules, which, when covered with water, renders the drugs irretrievable and unrecognizable before being bound for incineration and final destruction. This system also prevents drugs from being stolen or misused at any time between the point of disposal and incineration.

Anesthesia and its general anesthetic agents (inhalation anesthetics, propofol, opioids, antibiotics, sugammadex, and paracetamol) both directly (through their ecological effects) and indirectly (through the carbon footprint of procurement processes) contribute to global warming and climate change. By providing healthcare, we are also harming health through our environmental impact. Therefore, as doctors, we must 'step up' and learn to reduce our carbon footprint. This accountability extends to all specialties within medicine, including anesthesiology. Although this may require a change of mindset, we can achieve this and maintain our primary focus of doing the very best for the patients we care for.

Anesthesiologists care for patients at all extremes of the human experience; from patients of 0 to 100 years of age, undergoing minor or major surgical interventions of elective or emergency nature, and in varying states of health, disease, disability, and frailty. Providing anesthesia, peri-operative medicine, critical care, and pain management to 350 million patients worldwide every year comes with the generation of greenhouse gases, vast amounts of waste, and medications causing ecological contamination. Propofol is considered a safe drug, though it can result in aquatic toxicity and eutrophication, with its measurable detection in drinking water and in fish tissues. This is primarily due to the irresponsible disposal of surplus propofol, being emptied into sinks rather than in drug waste bins, with wastewater treatment methods being incapable of assuring its complete removal. Furthermore, the practice of anesthesia generates large amounts of landfill, microplastics, and noxious pollutants due to healthcare's reliance on single-use devices. Many disposable devices have emerged in hospitals and in operating rooms, including ECG cables, wire systems, hospital attire, laryngoscope blades, blood pressure cuffs, monitoring equipment, equipment for vascular access, and airway devices. This results in a profound total waste production of one ton per hospital bed. The processing of hospital waste results in different types of environmental pollution, notably greenhouse gas emissions, energy consumption, and water and soil pollution due to landfill and incineration. Sustainable alternatives to plastics are lacking, although sterile packaging can be reused. Compounding this, anesthesia is waste-intensive practice owing to its use of volatile anesthetics including nitrous oxide, most of which is wasted due to leaks in cylinders or pipes.

The solution is unfortunately not as simple as 'we must avoid all volatile anesthetic gases, sedatives, pain killers and muscle relaxants; we no longer use plastics in the operating room; we drastically reduce electricity consumption …'. These are not viable and realistic solutions. We need electricity to monitor our patients and to provide safe operating conditions, for example through artificial ventilation. We also need to keep patients warm with artificial warming techniques, as hypothermia is a major factor that results in a host of complications including altered medication metabolism, surgical site infections, cardiac arrhythmias, coagulation problems and blood loss, increased pain, and longer stays in recovery.

Due to the harmful environmental effects of general and volatile anesthetics, one might suggest the avoidance of these techniques altogether. However, this is not a viable solution as we cannot avoid all general anesthetics and use only regional techniques. While some patients can undergo surgery using loco-regional anesthesia alone (spinal, epidural, combined spinal-epidural, and plexus nerve blocks), there are certain patients who require general anesthesia either alone or in combination with loco-regional anesthesia.

The decision is ultimately circumstantial and individualized for the patient and requires utmost situational awareness on the part of anesthesiologists. In the case of frail or elderly patients, the likelihood of experiencing postoperative morbidity (respiratory tract infection, myocardial infarction, acute renal failure, and cognitive decline/delirium), increased length of stay, readmission, and long-term functional dependence can dictate the choice of anesthetic. In the frail population, the maximum dose of local anesthetics should not be exceeded. Its absorption rate of absorption depends on local blood flow. In frail patients, this absorption rate can be higher due to a confluence of factors including reduced adipose tissue and inadequate vasoconstriction. Hence, dose and concentration of local anesthetics need to be reduced. It is better to use a larger volume of a diluted local anesthetic that the surgeon can use as an infiltration block. This reduces postoperative pain and decreases opioid consumption, making local anesthesia one of the first-choice techniques whenever possible in frail elderly patients.

What can anesthesiologists do to reduce the impact of anesthesia on the environment and aim for an environmentally sustainable practice?

1. Create awareness of the problem and engage in shared decision-making and an open discourse with our colleagues regarding sustainable practices. Making the operating room

greener is everybody's responsibility, and necessary to protect humanity.
2. Apply the '6 R's' in the operating room to minimize waste generation: rethink, refuse, reduce, reuse, recycle, and research. The first concerted mental step is asking ourselves 'Is there a greener, more environmentally friendly alternative to what we do?'. The reuse of resources is crucial, e.g., using reusable and rechargeable laryngoscope blades and handles instead of single-use plastic disposable alternatives can substantially reduce waste quantity produced (both direct plastic waste and disposable batteries).
3. Minimizing energy expenditure is paramount, especially in operating rooms. Lights, air conditioning, and electronic equipment (ventilators, monitoring machines) should be switched off when the operating room is not in use. Furthermore, both oxygen production and equipment sterilization require vast amounts of electricity, so wasteful use of these must be avoided.
4. Regional anesthesia alone or loco-regional blocks in conjunction with general anesthesia are promising from an ecological sustainability perspective, however, these practices likely also have noteworthy carbon footprints. The clinical benefit of these techniques (which include neuraxial, peripheral, and plane blocks) is marked – they attenuate the surgical stress response by blocking afferent neuronal transmission and preventing transmission of pain to the central nervous system. Reducing pain to improve quality of recovery and promoting normal functional recovery significantly reduces the use of opiates and perioperative morbidity. However, regional anesthesia requires the substantial use of sterile equipment, and supplemental oxygen is often administered in larger amounts intraoperatively than with other techniques. Greater production of plastic waste and intraoperative oxygen consumption increase the environmental burden, potentially yielding no net environmental benefit of regional anesthesia over general anesthetics.
5. When volatile anesthetics are used, a concerted effort must be made to use the least environmentally damaging with the avoidance and desflurane and nitrous oxide. Inhaled volatile anesthetics are potent greenhouse gases contributing to global warming by increasing the absorption and reflection of infrared radiation, trapping energy inside the atmosphere. Greater than 95% of volatile gases are exhaled unmetabolized and unchanged by the patient and are ultimately released into the atmosphere. Volatile anesthetics have high global warming potentials over a 100-year time horizon (GWP-100), which is a relative measurement of a gas' ability to contribute to the greenhouse effect (calculated in comparison to a reference species of CO_2 in kg, whereby CO_2 has a GWP of 1). Volatile anesthetics have differing GWP-100s owing to their different atmospheric lifetimes, with a GWP-100 of 510 and atmospheric lifetime of 1 year for sevoflurane, 130 and 3.2 years for isoflurane, and 2,540 and 14 years for desflurane.[8] Additionally, nitrous oxide is a relatively weak anesthetic gas, yet is often used in higher doses/concentrations in combination with the other volatiles. It has a GWP-100 of 298 and an atmosphere lifetime of 114 years and also functions as an ozone-depleting agent. The harmful emissions produced by desflurane and nitrous oxide have called for their worldwide limitation or even elimination.
6. When using volatile anesthetics, low-flow techniques should be employed (i.e., flow rates <1L/min). By implementing low-flow anesthesia intraoperatively, waste gas production is minimized and anesthetic gases can be re-breathed via a closed circular circuit. '*Go low with the flow*' is the way forward. Novel technologies such as: automated control of inhaled anesthetic agent delivery; the use of vapor capture and destruction which permits the removal of excess inhalation agents (but not N_2O); and the use of catalytic destruction technology ('N_2O cracking') to break down exhaled N_2O are options that still await widespread implementation in hospitals.
7. Total intravenous anesthesia (TIVA) and total controlled infusion (TCA) warrant consideration as alternatives to volatile anesthesia; however, these techniques also impact climate change with a poorly defined magnitude. TIVA and TCA involve the use of intravenous infusions of sedatives, thereby avoiding inhaled anesthetic gases. Although TIVA and TCA reduce the amount of volatile anesthetics, the drugs used (e.g., propofol) and equipment burden (e.g., syringe pumps, disposables, plastic syringes, glass vials, processed electro-encephalography monitors) also engender environmental hazards such as wastage, pollution, eutrophication, and aquatic toxicity.
8. Superfluous intraoperative drug preparation and dispensing should be avoided, as this leads to large quantities of unused drugs which are wasted or inappropriately disposed. We must avoid drawing-up additional drugs to be used 'just in case'.
9. Accordingly, unused drugs (local anesthetics, propofol, neuromuscular agents) must be appropriately disposed using special drug waste bins to prevent ecotoxicity in the forms of eutrophication, aquatic toxicity, and air pollution.[9] Similarly, effective waste anesthetic gas (WAG) scavenging systems should be implemented in operating rooms to prevent pollution with volatile anesthetics. These systems involve canisters placed into scavenging circuits that are capable of capturing WAGs to permit their purification and reuse.
10. Behavioral change is paramount. As anesthesiologists, we must adopt a green lifestyle in- and outside of our work environment. Waste segregation (paper, plastic, and glass) further helps to reduce individual impact and safeguard health, provided hospitals further guides the waste in the right direction. Plastics (even from within the hospital) can easily be collected and delivered to local plastics recycling firms, which can repurpose these materials for practices such as road surfacing. An exorbitance of sterilization wrap (blue wrap) made from polypropylene is used for packaging medical devices to maintain their sterility before their use, and thus enormous quantities of this are found in landfill. Establishing recycling programs to collect plastic wraps, reprocess and transform them into other useful products (such as bags, bins, and scrubs) would further help in reducing waste.
11. Despite all good intentions, prioritizing environmental sustainability may not always be feasible due to other competing factors. In the pediatric population induction usually requires inhalation anesthetics, generating a twofold (if sevoflurane is used) or a ninefold (if nitrous oxide is used) increase in CO_2e compared with TIVA with propofol and remifentanil.[10] In obstetrics, childbirth is often unpredictable, and techniques must be adjusted to meet the

clinical need. For example, the lowest carbon footprint would be achieved with an uncomplicated vaginal delivery not requiring pharmacological analgesia. Unfortunately, this is seldom the case, and a large carbon footprint is to be expected in prolonged labor necessitating N_2O-mediated analgesia, followed by an emergency cesarean delivery.

As anesthesiologists, we have a supreme responsibility to take care of safety and well-being of our patients undergoing surgery. However, we equally have an ethical obligation toward environmental sustainability and protection, as this directly affects the health of the general population. By assuring environmentally conscious practices, we are safeguarding humanity's viability for healthy coexistence. Raising awareness is the first step to lessening our daily carbon footprint.

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#36852 SPINAL ANAESTHESIA FOR AWAKE LUMBAR SPINE SURGERY: A NICHE BUT EMERGING INDICATION?

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Spinal anesthesia for lumbar spine surgery is a technique that provides excellent operating conditions and patient satisfaction. The ability to avoid a general anesthetic and the requisite management of the airway is attractive to many patients. In contrast to the frequently-challenging period after emergence with spine surgery under general anesthesia, spinal anesthetic provides a 'soft landing' in the early postoperative period as the block of the lumbar area recedes slowly. In this lecture, I will discuss our experience with awake lumbar spine surgery under spinal anesthesia and provide perspective on several important considerations including:

- What does 'awake spine surgery' really mean? Are all patients wide awake? Is some sedation ok? What sedative agents/plans are appropriate and safe in this setting?
- Patient selection: Who CAN get awake spine surgery? Who should NOT be considered for awake spine surgery?
- Communication with patient and surgeon: How to set expectations ahead of time with the patient, the surgeon, and the perioperative team?
- Technique: The how, where, when and what of our intraoperative regimen with a recipe for success
- Pitfalls: What can go wrong in awake spine surgery? How to predict and prepare for these
- Outcomes: Why do we do this? Are we really making a difference? Here we discuss some of the important data that support the use of awake spine surgery in selected patients.

Expert opinion

#36755 ANAESTHESIA CONSIDERATION IN SCOLIOSIS SURGERY

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Scoliosis Is an abnormal lateral curvature of the spinal column. Cobb angle of 10 degrees regarded as a minimum angulation to define it. The most common form of scoliosis is idiopathic.

Preoperative evaluation include assessment for the presence and severity of pulmonary dysfunction from restrictive lung disease. It`s unlikely will improve during scoliosis surgery and may make intraoperative and postoperative ventilation challenging. Significant postoperative atelectasis should be anticipated, and in severe cases of scoliosis, prolong postoperative ventilation may be required. Cardiac function is one more important side that we have to consider. Regional hypoventilation caused by abnormal diaphragm movement and chronic hypercarbia and hypoxemia from advanced pulmonary disease can lead to pulmonary hypertension and of the right ventricle failure.

A large incision may lead to loss of up to one half of a patient's blood volume. To prevent haemorrhage complication next steps are require: preoperative iron supplementation or erythropoietin, Cell Saver mashing, Deliberate hypotension, arterial access for PPV, SVV and CO, goal directed fluid therapy, Thromboelastography, proper prone positioning, neuromonitoring.

Due to the large wound area and traumatic spinal correction, patients suffer from severe pain immediately after scoliosis surgery. The treatment of this postoperative pain remains one of the major challenges in scoliosis surgery, and insufficient treatment can increase postoperative morbidity, complication rates, and length of hospitalization.

We have following options – epidural anaesthesia, intrathecal morphine, Lidocaine iv and ketamine, ESP block.

Epidural founds its place in pain management after spinal surgery. Epidural catheter can be used as an effective means of postoperative pain management for children with scoliosis, it is more effective than intravenous patient-controlled analgesia in postoperative pain management after posterior spinal fusion. It accelerates postoperative mobilization, independent