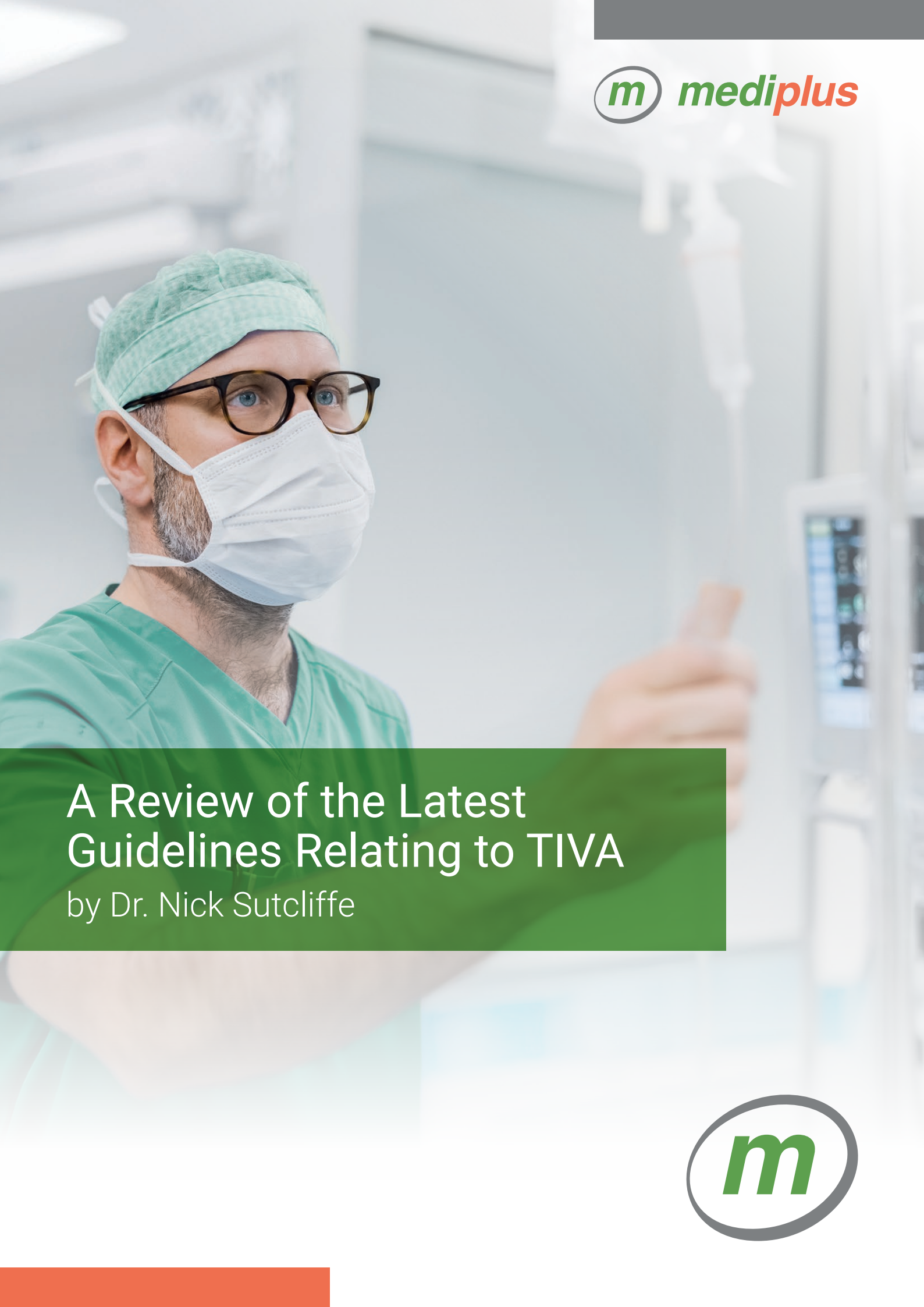

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A Review of the Latest Guidelines Relating to TIVA

by Dr. Nick Sutcliffe

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About the Author: Dr. Nick Sutcliffe

Dr. Nick Sutcliffe is a UK-trained senior clinician with over 30 years of experience in Medicine and Anaesthesia. Specialising in Intensive Care Medicine (ICM) and Total Intravenous Anaesthesia (TIVA), he is internationally recognised for his expertise in TIVA and frequently delivers lectures and workshops worldwide. Dr. Sutcliffe serves as a board member of the European Society of Intravenous Anaesthesia (EuroSIVA). Originally trained in Renal Medicine, he transitioned to Anaesthesia to focus on Intensive Care Medicine. His most recent role was Deputy Chairman of Anaesthesia in Doha, Qatar, where he combined clinical responsibilities with leadership in e-health and clinical governance within the state healthcare system.

Introduction

All anaesthetists have a duty to keep up to date with best practice to deliver safe and effective treatment to their patients. In this paper, I will summarise the various guidelines that have been published, as they relate to the delivery of Total Intravenous Anaesthesia (TIVA).

In 2014, the NAP 5[1] report documented two issues that came as both a surprise and a disappointment to TIVA enthusiasts, such as myself. NAP 5 documented that the use of TIVA was only 8% in the UK, despite the acknowledged benefits of the technique. Also, and more concerning, was the fact that TIVA was associated with a twofold increase in the risk of awareness compared to volatile anaesthesia (VA). This, despite previous international studies suggesting no difference in the incidence of awareness between the two techniques[2]. Perhaps these two issues were related. Anaesthetists in the UK at this time were predominantly using VA; thus, training in the technique of TIVA was somewhat deficient. The report showed that many of the cases of accidental awareness associated with TIVA could have been prevented, highlighting poor technique and dosing strategies as a major concern. The report recognised that TIVA is not only advantageous but may offer the only option for general anaesthesia in certain circumstances. Given this, they recommended that all anaesthetists should be trained in the maintenance of anaesthesia with intravenous infusions. Also, the relevant anaesthetic organisations should establish a set of standards and recommendations for best practice in the use of TIVA.

Several guidelines have now been produced for both the conduct of TIVA and the application of TIVA in particular clinical circumstances. The Association of Anaesthetists of Great Britain and Ireland (AAGBI), together with the Society for Intravenous Anaesthesia (SIVA), have published guidelines on the safe practice of TIVA[3]. NHS England has produced a report under the Getting it Right First Time (GIRFT) initiative, giving guidance on anaesthesia and perioperative medicine[4]. This report references the environmental impact of anaesthesia and the benefits of Enhanced Recovery After Surgery (ERAS), both of which can be impacted by using a TIVA technique.

The guidelines published by the AAGBI/SIVA in 2018 can be broadly considered under two headings, namely education and standardisation.

Education

All anaesthetists should be trained and competent in the delivery of TIVA.

Target Controlled Infusion (TCI) is the preferred technique for TIVA.

Initial TCI targets should be chosen based on patient characteristics and the clinical situation.

Anaesthetists should be familiar with the principles, interpretation and limitations of processed electroencephalogram (pEEG) monitoring, and pEEG is recommended when muscle relaxants are used.

Educational TIVA modules have long been part of the syllabus for the Royal College of Anaesthetists (RCoA); despite this, the incidence of TIVA in the UK remains disappointingly low. Practical teaching in the operating room (OR) to increase experience and knowledge in our trainees, is the only way to achieve the objective of producing practitioners equally comfortable with both TIVA and VA. This is difficult to achieve in practice when the majority of general anaesthesia remains volatile-based. Anaesthetic schools and individual anaesthetists have a responsibility to make sure our trainees and speciality doctors, have exposure to TIVA enthusiasts working within their departments. Thus, ensuring competence in the technique so that they can incorporate it into their clinical practice moving forward.

VA has become easy to dose and control with the development of calibrated vaporisers. Manual infusions of anaesthetic agents, whilst having the advantage of direct access to the blood, are more complex to administer and require a knowledge of pharmacokinetics (PK) and pharmacodynamics (PD). Such regimens require weight-based calculated bolus and infusions, with frequent rate changes to maintain stable blood concentrations. TCI allows the anaesthetist to simply select a target blood concentration. The system then calculates and delivers the complex infusion profile required to maintain that concentration, without the need for further input from the clinician. Further titration simply requires a new target concentration to be selected. This allows TIVA to be delivered in a manner similar to the use of a calibrated vaporiser. In my experience, given access to one-on-one teaching in the OR, trainees can become proficient in the use of TIVA using TCI, in a relatively short time frame. They can also learn the limitations of the PK/PD models, so that appropriate targets can be selected for particular patient groups and clinical circumstances. In general, when using TCI, practitioners should stick to one PK/PD model, as targets selected when using one model, may not deliver the same dose using a different model.

PK/PD models are becoming more accurate, and the general purpose model for propofol can be used in a wide range of patients, including children and obese individuals[5]. However, the blood and effect-site concentrations displayed by a TCI system are calculated values and will not be 100% accurate in all patients. Similarly, the end-tidal concentration of volatile anaesthetic agent (VAA) does not equate to blood concentration, due to V/Q mismatch. Typically, with both techniques, we see a 20-30% variability between measured blood concentrations and calculated blood concentrations or end-tidal values. Even if we could measure real-time blood concentration of our agents, it would not guarantee an exact depth of anaesthesia, as patients differ in their response to a given concentration of agent. The practitioner always needs to titrate to patient response. Clinical signs such as movement, respiratory rate and cardiovascular response to stimulation, can help gauge the depth of anaesthesia. However, the use of muscle relaxation negates the utility of much of this clinical information. The application of processed EEG (pEEG) markers, although not foolproof, can give useful extra information when titrating anaesthesia, particularly in the presence of neuromuscular blocking agents. I would certainly recommend the use of pEEG when using muscle relaxants with both TIVA and VA. I also find this information useful when titrating anaesthesia. Particularly, towards the end of the procedure, to achieve rapid wake-up times, whilst avoiding the embarrassment of patient movement before the end of the procedure.

> Target Controlled Infusion (TCI) is the preferred technique for **TIVA**

Standardisation

Within an anaesthetic department, it is preferable to stock only one concentration of propofol and to dilute remifentanil to a single, standard concentration.

The infusion set through which TIVA is delivered should have a Luer-lock connector at each end, an anti-siphon valve on the drug delivery line(s) and an anti-reflux valve on any fluid administration line. Drug and fluid lines should join as close to the patient as possible to minimise dead space. The use of administration sets specially designed for TIVA is recommended.

Infusion pumps should be programmed only after the syringe containing the drug to be infused has been placed in the pump.

The intravenous cannula or central venous catheter through which the infusion is being delivered should, whenever practical, be visible throughout anaesthesia.

When TIVA is administered outside the operating room, the same standards of practice and monitoring should apply as for anaesthesia in the operating room.

These measures are designed to make sure that the correct concentration of anaesthetic agent reaches the patient in the correct dose. There is little merit in having a sophisticated PK/PD model calculated infusion regimen, if the drug doesn't get into the patient's bloodstream.

When multiple concentrations of anaesthetic agents are available for use in the OR, sooner or later, the wrong one will be used, resulting in over- or underdosing of the agent. Each department should standardise on 1% or 2% propofol; I would suggest 1% as there is less pain on injection. With remifentanil, the choice is wider, and I have seen concentrations ranging from 20 mg/ml right up to 100 mg/ml. Personally, I would recommend 20 mg/ml, as this means the pumps run at higher rates, which are delivered more accurately. Also, there is less detrimental effect from a bolus inadvertently delivered in the recovery room, caused by flushing an IV cannula containing residual anaesthetic agent.

Dedicated TIVA sets with the appropriate valves, low dead space and kink-resistant tubing go a long way to smooth out any potential interruption of drug delivery (Fig. 1). Bonded multi-lumen lines allow simultaneous delivery of multiple drugs whilst avoiding the risk of tangling, which is particularly important during patient transport and in the ICU setting. Many times, I have observed TIVA being given via Heath Robinson-inspired infusion sets, often resulting in backflow of blood or intravenous fluids, or drug infusion diverted away from the patient, by poorly positioned 3-way taps. TIVA drug delivery is too important to trust to such home-made arrangements.

TIVA drug delivery is too important to trust home-made arrangements.

Programming the pumps after inserting the drug syringes reduces the risk of inadvertently using a remifentanil model to drive a propofol infusion and vice versa. This results in an underdosing of propofol and an overdosing of remifentanil. This is another reason to use a low concentration of remifentanil, as the effect is worsened by using higher remifentanil concentrations. Clearly, this is something to avoid, but if it does occur accidentally, there is less chance of awareness from the low propofol concentration and less chance of bradycardia from high opiate concentration.

The delivery of TIVA agents depends on a patent correctly placed IV cannula. It stands to reason, therefore, that the cannula should be visible throughout the procedure, to ensure it can be regularly checked for signs of kinking or “tissuing”. I would add to this guidance that appropriate dynamic, rate-based alarms are set on the TCI pump. This will detect line blockage in a reasonable time frame, whilst avoiding false alarms during the initial rapid infusion rate associated with the induction phase of a TCI system.

Given that a disproportionately high number of awareness cases occur outside the OR, these same standards should equally apply to anaesthesia delivered in these circumstances.

Environmental Impact of Anaesthesia

All VAAs are potent greenhouse gases (GHG); desflurane is the worst offender, expressed by a high global warming potential (GWP) value[6]. A full day of desflurane anaesthesia has the same GWP effect as driving a car 2000-3000 km. Both the UK and the EU have banned the routine use of desflurane and nitrous oxide due to their environmental impact. NHS England aims to become net-zero in terms of CO_2 emissions by 2040. Given that VAA are responsible for 5% of the acute care NHS sector carbon footprint, a switch to TIVA would be a significant step towards achieving this goal.

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Recommendation	Actions	Owners	Timescale
Use data on sustainability of surgical and anaesthetic practice to drive down the environmental impact of the surgery.	**a.** Develop strategies to reduce the use of volatile anaesthetic agents and nitrous oxide in anaesthesia.	Trusts	Within 12 months of report publication
	b. Develop sustainable procurement of anaesthetic consumables, including waste recycling.	Trusts	Within 12 months of report publication

Table 2. GIRFT recommendation on sustainability.

Enhanced Recovery after Surgery (ERAS)

The GIRFT report on anaesthesia and perioperative medicine recognises the anaesthetist's critical role in the process of ERAS. ERAS not only benefits patients in terms of outcomes, but also improves the efficiency of medical institutions, freeing up resources to treat more patients. ERAS is a package of measures designed to improve postoperative morbidity and reduce hospital stay. A key part of the programme is early mobilisation and early hospital discharge. Many factors can affect this aspect of recovery. One key issue is the quality of recovery, particularly relating to post-operative nausea and vomiting (PONV) and cognitive function. Such issues may defer mobilisation and lead to delayed discharge. It has long been documented that TIVA has a lower incidence of PONV compared to VA. It is well recognised that TIVA can be a useful tool to reduce PONV and improve the efficacy of ERAS, particularly in patients at high risk of PONV[7]. A recent meta-analysis comparing TIVA and VA showed a better recovery profile for TIVA with regard to PONV, postoperative cognitive dysfunction (POCD) and emergence delirium[8].

TIVA can be a useful tool to reduce PONV and improve the efficacy of ERAS, particularly in patients at high risk of PONV

Summary

The benefits of TIVA are well documented, and in some circumstances, it is the preferred or indeed, the only option for general anaesthesia. In the past, there was a lack of experience in the technique, which led to suboptimal practice, as highlighted by the NAP 5 data. The various governing bodies have made efforts to improve training and issued guidelines to standardise practice and enhance the safety and efficacy of the technique. The wide availability of TCI has led to an ease of dosing that now mirrors the simplicity of using a calibrated vaporiser. Progress has been made; the NAP 7 (2023) report showed that the incidence of TIVA-based general anaesthesia in the UK has increased from 8% to 26% since 2014[9]. This is likely due to improved training and the recognition that TIVA is a more sustainable choice for the environment. The technique also offers an improved patient recovery profile, thus facilitating the benefits of ERAS.

TIVA-based general anaesthesia in the UK has increased from 8% to 26% since 2014

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