

hypothermia,<sup>5</sup> neuroanaesthesia,<sup>6</sup> anaesthetic action,<sup>7</sup> equipment,<sup>8</sup> neuromuscular blocking agents,<sup>9,10</sup> tumour biology,<sup>11</sup> perioperative science,<sup>12</sup> and airway management.<sup>13,14</sup>

The College Arms, reproduced on the front cover, were granted in December 1999.

The shield contains a semee of poppy heads; the cloud symbolizes the drift to the other side by way of haziness (unconsciousness) with the healing hand of the physician in attendance. The Supporters, in the form of dolphins, are unusual and were granted for the first time in Ireland. They are contained on the 'MacDonnell of the Glens' Coat of Arms and in heraldic terms provide a link to the administration of the first anaesthetic in Ireland by John MacDonnell, on January 1, 1847, in the Richmond Hospital, Dublin. The natural intelligence of dolphins is acknowledged. The Helmet affords protection to the Shield over which is the Harp of Ireland in the figure Nike (victory) associated with overcoming disease. The wording underneath 'Salus Dum Vigilamus' is literally translated as 'safety while we watch'—which speaks for itself.

Partnership between the Irish College and this international journal will support the academic ambitions of the Irish anaesthetic community. The Council of the College of Anaesthetists of Ireland and the BJA Board unite in saying *Céad míle fáilte* (a hundred thousand welcomes) to this exciting collaboration.

## Declaration of interest

None declared.

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## EDITORIAL II

# Difficult peripheral veins: turn on the lights

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Peripheral venous access is one of the most frequent procedures performed in our hospitals. Above 90% of hospitalized patients may require a peripheral cannula to deliver i.v. therapy,<sup>1</sup> and more than 1 billion venipunctures per year are performed to obtain blood samples for testing.<sup>2</sup>

Although, peripheral venous access may be difficult, time-consuming, and frustrating, for instance, in neonates and children, obese patients, dark skin patients, i.v. drug abusers, shock patients, and patients previously treated with chemotherapy.

Many factors may cause a difficult peripheral venous access. Previous venipunctures and cannulations may have caused thrombosis of the vein. Obesity and previous chemotherapy may cause intimal damage and alter subcutaneous fat distribution, thus reducing the visualization of peripheral veins or making it impossible. Anaesthesiologists and infusion nurses play an important role in these scenarios because of their vast experience in inserting venous lines in their daily practice. Unfortunately, their assistance is commonly asked only when multiple venous punctures have already been attempted by less experienced operators and the patients may have lost their will to collaborate.

The article by Chiao and colleagues<sup>3</sup> that appears in the current issue of *British Journal of Anaesthesia* introduces the 'eco-IV' idea for the first time. The authors' aim is to underline the importance of peripheral vein preservation. In order to use the patient's venous patrimony properly, it is necessary to locate all visible superficial veins and map them before choosing the proper cannulation site. Superficial peripheral veins are precious: they represent the first choice for resuscitation, short-term intermittent infusion, and some i.v. therapies apart from chemotherapy, high osmolarity and low/high pH infusions, and short-term intermittent therapies. Various methods have been recently introduced to improve the technique of achieving a fast and effective peripheral venous access, most notably the so-called near-infrared (NIR) technology.

NIR rays have been used in medicine for a number of clinical applications for more than a decade. The first device using NIR technology for the visualization of superficial veins, VeinViewer, was developed in 2006. A few devices using infrared light—such as VeinLite and Venoscope—were already available at that time, but they were absolutely different from VeinViewer since they were based on transillumination and not on NIR technology, which implies a selective absorption of a specific wavelength of NIR rays by the desaturated haemoglobin present in the venous system. In fact, the VeinViewer was designed to use NIR light coupled with advanced technologies to display an image of superficial vasculature (from 0 to 8 mm below the skin surface) directly onto a patient's skin. The device projects the image of the patient's superficial veins exactly in the same anatomical location where the veins are. This image should hopefully give the clinician a 'roadmap' to work with in order to be more efficient in gaining i.v. access.

There is no probe or transducer, so that both of the clinician's hands are free to deal with venous access. Considering these characteristics, it was hypothesized that VeinViewer might prove particularly effective in locating superficial veins to be punctured, cannulated, or both.

The first published report of the clinical use of VeinViewer was in 2006:<sup>4</sup> an early prototype of the device was used to identify varicose veins, which were invisible to the eye but too shallow to be visualized by ultrasound.

In the following years, the first version of the VeinViewer (which was expensive and quite bulky, as a large fluoroscopy cart) was tested in several USA hospitals with the specific goal

of facilitating the percutaneous puncture and cannulation of superficial veins in paediatric patients. In particular, the effectiveness of the device was measured as success rate of venipuncture, number of attempts before success, overall time used for the procedure, reduction in patients' pain, or discomfort as declared by the patient or as perceived by the nurse. For a few years, the reports of these clinical experiences were published only informally on the web or on the websites of industries producing the devices and in nationwide newspapers. The first clinical studies on VeinViewer-assisted venipuncture were published in scientific journals from 2010. Most of these studies were carried out in limited samples of neonates, children, or both requiring a peripheral venous access. A prospective, non-randomized study<sup>5</sup> and a prospective non-controlled study<sup>6</sup> suggested that VeinViewer might facilitate venipuncture and venous cannulation, by improving the venipuncture success rate at first attempt and decreasing the procedure time. The results of subsequent controlled randomized trials were less positive. Phipps and colleagues<sup>7</sup> reported that VeinViewer might help placement of peripherally inserted central catheters in neonates, most significantly in subjects with greater gestational age. In another randomized study,<sup>8</sup> no significant advantage of VeinViewer could be found, with a possible exception of a decreased procedural time in a subgroup of infants <2 yr. The same year, a randomized crossover study could not detect any advantage of VeinViewer vs traditional methods in terms of success of venipuncture and procedural time. The results of a very recent randomized controlled study<sup>9</sup> suggest VeinViewer facilitates venipuncture only when venous access is difficult.

In 2010, AccuVein Inc. released on the market a device technologically very similar to VeinViewer, but somehow simplified, easier to use, and portable.<sup>10</sup> The only randomized controlled study carried out with this device<sup>11</sup> showed that it improves the visualization of superficial veins, but that it was not associated with any significant difference in clinical outcome. In recent years, a new version of the VeinViewer has been developed, significantly smaller (VeinViewer Vision) and even portable (VeinViewer Flex).

Both Accuvein and VeinViewer are currently used in hundreds of paediatric hospitals, although a clear evidence-based rationale for using NIR technology for vein visualization is still missing. It is interesting that most of the papers published with such devices share the same biases: exclusive focus on paediatric population; sampling of limited number of cases (50–150); difficult or inappropriate randomization; wrong definition of the clinical endpoints; poor standardization of the procedure; lack of consideration of the need of a proper training with the device; little or no consideration of the level of experience of the operator; or little attention to the cost-effectiveness of the methodology.

This precludes any robust conclusion about the efficacy of NIR technology for peripheral veins cannulation even through meta-analysis.

In the current observational study by Chiao and colleagues,<sup>3</sup> the authors describe the effectiveness of a new NIR

light device (Veinsite) in improving visibility of superficial veins when compared with the traditional visual method. This new portable NIR device was able to visualize significantly more veins than the conventional method not only in normal patients but also in difficult cases. The authors suggest that many factors may actually modify the visibility of superficial veins in standard conditions: infants have a more superficial distribution of adipose tissue, which implies a limited transparency of the hypodermis, as in obese patients, while Asians have a reduced cross-sectional diameter of their superficial veins, which makes them less evident to the eye. Dark skin, on the contrary, may not be a predictor of veins' visibility. These considerations, although limited to a small subgroup of difficult patients (8.3%), demonstrate how this new technology increases the average number of visible superficial veins and the possibility to observe and map them.

Chiao and colleagues claim that this technology might be helpful in difficult cases, improving the number of additionally identified veins from 1.7 in infants to 4 in obese patients. Furthermore, their device seems to be easy to use in terms of ergonomics and adaptability of the gaze during the displays of veins. Unfortunately, their study is just a patient characteristic study on vein visualization and does not address the actual effectiveness of the device during attempts of venous cannulation.

There are three main unresolved issues regarding the use of NIR technology that makes its application still far from real life and clinical practice in our hospitals.

First: what about training? It is not clear how operators should be trained in the use of this new technology. Most of the studies do not report how many procedures the operators had to perform before being considered proficient with this new method. To define an operator proficient in a new technology or procedure, two main outcomes should be satisfied: goal achieved and time to success. Considering these devices, first-time successful cannulation should be considered the main goal and a learning curve should be calculated on this parameter;<sup>12</sup> this would suggest the average number of procedures required before obtaining a minimal training for getting proficiency.

Cannulation time is not less important, if we consider that these portable devices should also be used in the emergency room to obtain a prompt venous access. It is mandatory to define a training curriculum on the use of NIR devices, if we want to use them properly every time, those superficial veins are not easily visible, palpable, or both.

Second: cost-effectiveness. In other words, is this technology affordable in this period of international financial crisis? New technologies may be difficult to be accepted by our hospital managers, if not supported by a proper economical and clinical rationale. A budget impact analysis<sup>13</sup> of this technology should include not only the raw cost of the device (from \$4500 up to \$25 000) and the cost of training vs the time-saving benefit, but also the advantage of a convincing improvement in the quality of venous cannulation in terms of perception of pain by

patients and handiness of the device by operators. Should the results of this analysis show a significant cost-effectiveness, the technique should be progressively introduced in the clinical practice, with the clinical goals of (i) preserving the peripheral vein patrimony of the patients and (ii) avoiding the risks associated with a potentially unnecessary central vein cannulation.<sup>14</sup>

Finally, there is a technical concern about vein visualization. Difficult venous cannulation may be related to the small diameter of the vein (as in infants) or to their deep location (as in obese patients) or to poor visibility or palpability due to other factors (oedema, pigmentation, etc.). It is still not clear whether NIR devices can be effective not only in venous visualization but also in venous cannulation; more specifically, since NIR technology does not provide a depth of field, accidental puncture of the posterior wall of the vein, and extravasation may easily occur. Ultrasound guidance has been proposed in recent years<sup>15</sup> to improve the visualization of difficult superficial veins in paediatric patients, but the results of these studies are controversial in terms of improved success rate, first-time success, and overall time to cannulation.

As far as we know today, both NIR technology and ultrasound guidance are useful in the visualization of peripheral veins; the first should be useful for very superficial veins (not deeper than 5–8 mm) and easily collapsible veins, the second for deeper veins. Studies on the effectiveness of both technologies for a better visualization, higher successful cannulation, and reduced time to cannulation will be essential to guarantee that we are really going in the right direction. It is time ... to turn on the lights.

## Declaration of interest

None declared.

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## EDITORIAL III

# Tidal volume measurement: OK for science, but too difficult for a workstation standard?

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International standards for anaesthetic machines and clinical monitors have developed piecemeal over the last few decades, in large part without substantial consultation with clinicians. Anaesthesia workstations developed rather in the way that smart cars will now park themselves, keep the driver in lane, and even avoid high kerbstones in mediaeval streets. A recent car review noted that a simple new car was one that could be driven away within 3 min, whereas a truly smart car took ~30 min to get going!

In the first half of the twentieth century, anaesthetists used relatively simple ‘machines’ in which the works were visible. The user could see how the gases went round, and where the pipes and tubes and valves were placed. Anaesthetists learnt to use simple ‘Boyle’s’ machines, and ventilated the lungs by squeezing a reservoir bag. Even current textbooks reflect these origins in their illustrations. Ventilators were available, but considered too complex and dangerous to use in the operating theatre, even for prolonged thoracic operations. Flammable anaesthetic agents contributed to a ban on electrical apparatus on anaesthetic machines. The authors had to contest a ruling of the Common Services Agency of the Scottish

National Health Service before attaching electrical supplies to anaesthetic machines to provide power for ECG monitors and ventilators.

On these machines, we were able to see everything, and work out where and if it was connected, and see if it was working or not. It was especially important to be able to see that the valves on circle systems had not stuck, because capnography was far from universal. In the 1980s, monitoring increased enormously: devices that allowed invasive arterial and venous pressure measurement, pulse oximetry, capnography, rapid response non-invasive arterial pressure measurement, volatile agent analysis, and to track cerebral function were all heaped on to overloaded machines. The logical response was to ‘integrate’ these in the ‘workstation’ and manufacture a box with a smooth outside and a work surface that could be wiped down.

Unfortunately, these workstations now shroud the works in mystery. Non-return valves may be shown, but their housings are hidden, where they can be fractured without the break being obvious. Modern trainees have become ignorant of the gas flow patterns inside these workstations. Most are