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**Editorial**

# Integrating augmented reality in anaesthesia: A step towards future

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Augmented reality (AR) is a rapidly developing, interactive artificial intelligence (AI) empowered technology that enables users to experience the real-world environment enhanced by virtual elements. By overlaying digital images and information onto the physical world, AR provides an innovative, immersive experience that can aid in numerous fields, including healthcare.[1-4] In the context of anaesthesia, AI empowered AR has begun to make significant strides, with the potential to improve various aspects of anaesthesia practice, including better patient outcomes, more efficient training for practitioners, and enhanced operational efficiencies, besides offering new opportunities in research.

The core of AR technology consists of two main components: software and hardware. The software is responsible for processing and displaying virtual information, while the hardware serves as the medium for displaying the augmented images. The hardware used for AR applications commonly used include Hololens or head-mounted displays, or more recently smartphone cameras, all of which serve to superimpose virtual information onto the user's real-world view. The interplay of software and hardware makes this an interactive approach which not only helps professionals make more informed decisions but also allows patients to engage with their environment in ways that were previously not possible.

In the field of anaesthesia, the integration of AR technology has led to several innovative applications that improve patient care and practitioner training. One of the first successful uses of AR in anaesthesia was in regional anaesthesia techniques, particularly in the identification of structures during procedures like epidural anaesthesia. One such system, the Augmented reality system for epidural anaesthesia (AREA), was developed by Al-Deen Ashab et al.[5] This system uses ultrasound imaging to detect the lumbar region and then overlays the information onto a live video image of the patient's back. The goal of this technology was to assist anaesthesiologists in locating the correct epidural insertion point, improving the precision of the procedure. This system, and others like it, have also shown promise in guiding needles for spinal anaesthesia and ultrasound-guided peripheral nerve blocks, which are complex procedures requiring high accuracy.[5]

Another area where AR is showing potential is in the management of preoperative anxiety, particularly in paediatric patients. It is well-documented that children undergoing anaesthesia often experience high levels of anxiety, which can lead to negative psychological effects and complications, such as emergence delirium. AR has been observed to reduce anxiety in children aged 5-17 years related to difficult cannulation,[1] induction of anaesthesia,[2,3] and facilitate peribulbar block.[6] It has also been explored as a potential aid for preoxygenation in one year child.[7] AR devices allow children to interact with playful animations or experience virtual tours of the medical process, all designed to make the medical procedures feel less intimidating. The engaging and non-threatening nature of AR and its interfaces possibly led to reduction in anxiety in children and hence compliance with the anaesthesia procedures. These

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interventions have been shown to significantly lower observable signs of anxiety like heart rate along with objective measures of anxiety scores using mYPAS and STAI-C scales.[3,4] Thus, AR can be a highly effective, non-pharmacological intervention for paediatric patients aged 5-17 years.[1-4] Further studies are required to evaluate its potential role in younger children for reduction of perioperative anxiety.

AR has also made its mark in the field of airway management, particularly in training anaesthesiologists and other healthcare providers in airway procedures such as endotracheal intubation. Intubation is a critical procedure during anaesthesia, and a lack of familiarity with the airway anatomy or equipment can lead to complications. Rolland et al. introduced an innovative training system known as the Ultimate intubation head (UIH), which works in conjunction with human patient simulators.[8] This system uses AR to provide a visualization of the airway anatomy, helping practitioners better understand the airway and improve their skills in difficult intubation scenarios. By using AR to simulate various situations, such as a patient with a complicated airway, practitioners can train in low-risk environments and gain the confidence necessary for crisis management. This technology can also assist in optimizing tube positioning during the procedure, leading to better patient outcomes in both routine and emergency surgeries.[8]

AR technology can also support continuous monitoring during surgeries. Traditionally, anaesthesiologists have had to divert their attention away from the surgical field to monitor vital signs, such as heart rate, blood pressure, and oxygen saturation. With AR, head-mounted displays can show this vital information directly in the anaesthesiologist's line of sight.[9] This allows for real-time monitoring of the patient's condition without the need to take one's eyes off the procedure. Such continuous monitoring is particularly beneficial during high-pressure situations, such as emergency surgeries, where every second counts and accurate decision-making is essential for successful outcomes.[9]

A further promising use of AR is in assisting with difficult cannulations. In situations where patients have hard-to-find veins, such as those who have had chemotherapy or are obese, cannulation can be difficult and take longer. A study evaluated the use of the AccuVein® Vein viewing system,[10] which integrates AR technology to display peripheral veins. By providing a visual representation of the veins, this system has shown to improve the success rate of cannulation and decrease the time needed to successfully insert the needle. This is especially useful in patients who have a history of long-term hospitalizations, where veins may be scarred or difficult to locate. In these cases, AR can greatly improve the overall patient experience and reduce discomfort by making the cannulation process more efficient and accurate.[10]

The integration of AI empowered AR technology into anaesthesia practice holds immense potential to enhance patient care and anaesthesiologists' performance. From improving the accuracy of regional anaesthesia techniques to reducing preoperative anxiety in children and streamlining training for difficult airway management, AR is proving to be a valuable tool (**Figure 1**). The system's ability to overlay critical information onto real-time images gives anaesthesiologists a clearer understanding of the patient's condition, which in turn leads to better outcomes.

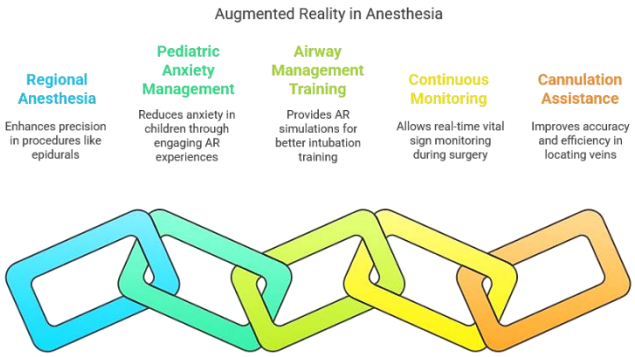


**Figure 1:** Applications of augmented reality (A.R.) in anaesthesia

Despite the promise AR holds, it is important to note that the technology is still relatively new, and the literature on its application in anaesthesia is somewhat limited. Additionally, many AR tools and interfaces are expensive, and their widespread implementation may require significant investment. This necessitates the need for more cost-effective, user and patient friendly interface/ technology providing similar results to currently available AR interfaces/ technology for its widespread implementation and evaluation. Further research will be essential to explore the full potential of AR in anaesthesia, including its use in pain management and other areas of anaesthesia practice. If these studies prove successful, AR could become an integral part of anaesthesia practice, significantly enhancing patient care and improving the training and decision-making processes for healthcare professionals.

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