MALAYSIAN SOCIETY OF ANAESTHESIOLOGISTS YEAR BOOK 2024/2025

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Foreword

It is with immense pride that I pen this message for this year's edition of our Year Book, centered on the timely and critical theme: **'Anaesthesiology in Health Emergencies'**.

This theme could not be more relevant. The recent global pandemic has cast a spotlight on the pivotal role our specialty plays far beyond the familiar confines of the operating theatre. When crisis strikes, anaesthesiologists are not just providers of anaesthesia; we are intensivists, resuscitation experts, and leaders in critical care. Our unique skill set - encompassing advanced airway management, expert resuscitation, pain control, and physiological stabilisation - positions us at the very heart of emergency response.

From managing critically ill patients in the ICU during the COVID-19 surge to being integral members of teams responding to mass casualty incidents or natural disasters, Malaysian anaesthesiologists have consistently demonstrated remarkable resilience, adaptability, and unwavering commitment. We are the calm in the storm, bringing order to chaos and providing a lifeline when it is needed most.

This Year Book serves as both a reflection and a call to action. It chronicles our collective experiences, shares invaluable lessons learned from the front lines, and explores innovations that will shape our future. It is a testament to your dedication and a resource to guide our continued efforts in strengthening Malaysia's preparedness for any health emergency that may lie ahead.

I extend my heartfelt gratitude to the editorial board for their exceptional work in curating this meaningful publication. To every member, thank you for your service and your relentless pursuit of excellence. May the stories and insights within these pages inspire us to continue our vital work with renewed purpose and collaboration.

Let us move forward, confident in our skills and united in our mission to serve and save lives, no matter the circumstances.

Dr Hasmizy Muhammad
President
Malaysian Society of Anaesthesiologists

Preface

We would like to express our heartfelt gratitude to the Malaysian Society of Anaesthesiologists (MSA) for entrusting us with the honour of serving as the editors of the MSA Year Book 2024/2025. Our utmost appreciation goes to all the authors and reviewers who have generously contributed their time, effort and expertise to make this publication possible. Your dedication and collaboration have been instrumental in bringing together the voices and experiences that reflect the strength and spirit of our anaesthesia community.

The theme **'Anaesthesiology in Health Emergencies'** reminds us of the vital role anaesthesiologists play when the unexpected unfolds. In times of crisis, the resilience and adaptability of anaesthesiologists shine brightest. It reflects our profession's pivotal role beyond the operating theatre - from managing critical care during pandemics and mass casualties to leading emergency responses and supporting humanitarian efforts.

This year's issue celebrates the dedication, courage, and innovation that define our anaesthesia fraternity when faced with uncertainty. It also highlights lessons learned, advances made, and the spirit of collaboration that continues to strengthen our practice in the face of evolving challenges.

We hope this Year Book serves not only as a reflection of our collective journey but also as an inspiration to continue advancing the art and science of anaesthesia - wherever and whenever it is most needed.

Dr Nik Rowina Binti Nik Mohammed
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Anaesthesiologists as Leaders in Multidisciplinary Emergency Teams

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INTRODUCTION

The role of the anaesthesiologist has traditionally been anchored in the operating theatre, yet over the past decades it has expanded significantly to encompass perioperative medicine, intensive care, pain management, and resuscitation. In times of health emergencies, these skills position anaesthesiologists as essential members - and often leaders - of multidisciplinary response teams.[1,2]

Health emergencies, whether arising from pandemics, mass casualty incidents, or natural disasters, are by nature chaotic and resource-constrained. Effective leadership is vital to ensure rapid assessment, clear communication, resource allocation, and safe patient care.[3,4] Anaesthesiologists are uniquely suited to this role, drawing on their expertise in airway management, physiology, pharmacology, and crisis resource management.[5]

Malaysia, like many countries in Southeast Asia, is vulnerable to floods, pandemics, and mass casualty events.[6,7] The COVID-19 pandemic in particular demonstrated how anaesthesiologists rapidly adapted to frontline roles in intensive care units (ICUs), operating theatres, and hospital emergency response committees.[2,8] This article discusses how anaesthesiologists have emerged as leaders in multidisciplinary emergency teams, drawing on global lessons and local examples.

CLINICAL LEADERSHIP: SKILLS THAT ANCHOR EMERGENCIES

Airway and Resuscitation Expertise

One of the most critical skills in emergencies is securing the airway. Anaesthesiologists are often called upon to lead airway management teams, whether in emergency departments, ICUs, or prehospital settings. During the COVID-19 pandemic, anaesthesiologists developed and implemented standard operating procedures for safe intubation under high-risk aerosol conditions.[3,9] In Malaysia, the Malaysian Society of Anaesthesiologists (MSA) and the College of Anaesthesiologists provided national guidance on safe airway management during the pandemic[2], ensuring consistency across public and private hospitals.

Critical Care and Organ Support

Anaesthesiologists frequently serve as intensivists in Malaysia, managing ventilation, haemodynamic instability, and organ failure. Their dual expertise in anaesthesia and critical care allowed for rapid ICU expansion during COVID-19, where anaesthesiologists led surge planning, ventilator allocation, and triage decisions.[8,10] Similar roles were observed internationally, reinforcing their leadership in critical care during crises.[11,12]

Perioperative Emergency Surgery

Mass casualty incidents often involve patients requiring urgent surgical intervention. Anaesthesiologists coordinate perioperative care, balancing anaesthesia safety with scarce resources and time constraints. In natural disasters such as floods in Kelantan and Pahang, hospital operating theatres operated under emergency protocols, with anaesthesiologists leading surgical triage and resource allocation.[13]

Organisational Leadership: Beyond the Operating Theatre

Anaesthesiologists are trained in crisis resource management (CRM), which emphasises leadership, communication, situational awareness, and teamwork under pressure.[5,14] This positions them naturally as leaders in hospital emergency response teams (HERTs). Malaysian hospitals utilise the

Hospital Emergency Response Plan (HERP) framework, where anaesthesiologists frequently assume leadership in ICU preparedness, operating theatre triage, and resuscitation task forces.[11]

Globally, anaesthesiologists contribute to national disaster planning, particularly regarding ICU surge capacity and airway management.[15,16] Locally, Malaysian anaesthesiologists have been part of the National COVID-19 Preparedness and Response Plan,[27] advising on ventilator allocation and perioperative risk mitigation. MSA also worked with the Ministry of Health (MOH) to develop perioperative and ICU guidelines, which shaped national policy during the pandemic.[2,26]

In rural and remote areas of Malaysia, particularly in Sarawak and Sabah, anaesthesiologists play crucial roles in retrieval medicine, including the Flying Doctor Service.[12] Their ability to stabilise critically ill patients during interhospital transfers underscores their importance in multidisciplinary retrieval teams.

Emergencies often place extreme psychological strain on healthcare providers. Anaesthesiologists, who are accustomed to high-stakes decision-making, have been instrumental in supporting colleagues' resilience during crises.[15,18] During COVID-19, Malaysian anaesthesiologists organised peer-support systems and wellness initiatives for ICU teams, recognising the risk of burnout.[14]

Resource scarcity in emergencies necessitates difficult ethical decisions, such as ventilator allocation or surgical triage. Anaesthesiologists, with their broad system perspective, often lead in facilitating ethical frameworks for fair allocation.[19,20] In Malaysia, anaesthesiologists were central to hospital triage committees during the COVID-19 ICU surge, ensuring transparency and fairness in decisions.[27]

Anaesthesiologists have long been leaders in simulation-based education. Simulation training in crisis scenarios - such as "code blue" drills, difficult airway simulations, and mass casualty triage - has been widely adopted in Malaysian anaesthesia training programmes.[13] Such initiatives not only build team competence but also reinforce the leadership role of anaesthesiologists as educators.

MALAYSIAN EXPERIENCES IN HEALTH EMERGENCIES

Malaysia offers rich examples of anaesthesiologists' leadership in emergencies:

- **COVID-19 Pandemic (2020 - 2022):** Anaesthesiologists led hospital preparedness committees, developed intubation guidelines, expanded ICU capacity, and staffed COVID ICUs. MSA and MOH collaborations shaped national policy.[2,8,27]

- **Kelantan Floods (2014, 2021):** Anaesthesiologists coordinated perioperative services when hospitals were flooded, managing surgical triage and ICU surge.[13]

- **Remote Retrieval Medicine in Sarawak:** Through the Flying Doctor Service, anaesthesiologists provide critical care leadership in aeromedical retrievals, often stabilising patients in austere environments.[12]

- **Mass Casualty Incidents:** Anaesthesiologists in tertiary hospitals have led disaster drills and responded to highway crashes and industrial accidents, applying CRM principles to coordinate multidisciplinary teams.[11,16]

These examples highlight how Malaysian anaesthesiologists act not only as clinicians but also as system leaders, educators, and advocates for preparedness.

FUTURE DIRECTIONS: STRENGTHENING THE LEADERSHIP ROLE

To further consolidate their leadership role in health emergencies, anaesthesiologists should integrate disaster preparedness, mass casualty triage, and crisis leadership into postgraduate anaesthesia curricula.[9,10] They should also strengthen multidisciplinary collaboration with emergency physicians, surgeons, intensivists, and nurses in joint drills and policy planning.[5,14]

Expansion of research and publications that generate local data on disaster response, clinical outcomes, and leadership roles will strengthen evidence to guide future preparedness initiatives.[13,19] Furthermore, advocating for comprehensive national disaster frameworks - with anaesthesiologists positioned as key advisors in the Ministry of Health and ASEAN emergency policy development - will enhance coordinated regional resilience and multidisciplinary response capacity.[16,17]

Lastly, enhancement of well-being strategies to protect mental health of anaesthesiologists and team members during prolonged crises will go a long way.[15,22]

CONCLUSION

Anaesthesiologists are uniquely positioned at the intersection of clinical expertise, systems thinking, and crisis leadership. Their skills in airway management, critical care, perioperative medicine, and crisis resource management make them natural leaders in health emergencies. The Malaysian experience - from floods to COVID-19 - has underscored the vital role of anaesthesiologists in guiding multidisciplinary emergency responses. As health systems face increasing challenges from pandemics, disasters, and resource constraints, the leadership role of anaesthesiologists will only continue to grow.

By embracing their responsibilities as clinicians, organisers, educators, and advocates, anaesthesiologists can ensure that healthcare teams remain resilient, effective, and compassionate in the face of future emergencies.

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Conscious but Calm: The Rise of Awake Tracheal Intubation in Airway Emergencies

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INTRODUCTION

Awake tracheal intubation (ATI) is a specialised technique of tracheal intubation performed while a patient remains awake or minimally sedated, preserving spontaneous ventilation and airway tone. The method relies on effective topical anaesthesia to blunt airway reflexes, while carefully titrated sedation ensures patient comfort without compromising airway patency or respiratory drive.[1] ATI plays a crucial role in airway management, particularly in situations where difficult airways are anticipated and loss of spontaneous ventilation could significantly increase the risk of failed oxygenation or intubation.[2] This deliberate approach mitigates the risk of a "cannot intubate, cannot oxygenate" (CICO) scenario by providing a safer, more controlled method for securing the airway while avoiding the potential catastrophe of complete airway collapse following the induction of general anaesthesia. The success of these high-stakes clinical situations, which will be discussed in this article, depends on early identification of difficult airway predictors, meticulous preparation of topical anaesthesia and sedation, and having the right equipment and expertise readily available.

The history of modern ATI can be traced to the early 20th century, when Franz Kuhn, a German surgeon, pioneered the blind awake intubation technique using digital palpation and flexible metal tubes. His innovations with flexo-metallic endotracheal tubes and the topical application of cocaine to anaesthetise the airway facilitated both nasotracheal and orotracheal intubation techniques in conscious patients.[3] After World War I, Sir Ivan Whiteside Magill made significant contributions by developing awake blind nasotracheal intubation techniques and inventing tools, including the Magill forceps, to aid the procedure. A vital advancement occurred in 1967 when Dr Peter Murphy, an English anaesthesiologist, reported the first awake fibreoptic intubation, performed using a surgical choledochoscope. This breakthrough introduced direct visualisation during intubation while the patient remained awake, marking a pivotal evolution in ATI techniques.[4] Since then, ATI has continued to evolve with ongoing improvements in topical anaesthetics, sedation protocols, and the development of advanced devices, including flexible endoscopes and video laryngoscopes, establishing ATI as the gold standard for managing anticipated difficult airways.

The 4th National Audit Project (NAP4), published in the Uunited Kingdom in 2011, represented a watershed moment for airway safety globally. The audit revealed that failure to use ATI, when clinically indicated, was a contributing factor in several preventable airway-related deaths and severe brain injuries. Consequently, NAP4 strongly recommended greater utilisation of ATI, particularly in cases with known or suspected difficult airways, and emphasised the need for improved training and preparation.[5] Following this, a similar National Audit on Anaesthetic Airway Management was conducted across 14 Ministry of Health (MOH) hospitals in Malaysia and published in 2016. The audit analysed major complications related to airway management during general anaesthesia, identified preferred airway devices, and studied patient outcomes following airway complications. The findings highlighted an overall incidence of major airway complications at 1,054 per 100,000 cases of general anaesthesia, with difficult airway accounting for the highest incidence at 1,017 per 100,000 cases. For managing difficult airways, videolaryngoscopy was the device of choice (44.6%), followed by the bougie (24.8%) and flexible fibreoptic scope (28.4%).[6] This local audit provided crucial data for developing evidence-based best-practice guidelines for airway management within Malaysia's clinical settings.

In recent years, international guidelines have firmly established ATI as a cornerstone of modern airway management. Landmark guidelines from the Difficult Airway Society (DAS) in 2019 and the American Society of Anesthesiologists (ASA) in 2022 have highlighted ATI as the preferred approach for the anticipated difficult airways, emphasising the critical importance of meticulous patient selection, thorough preparation, proper airway topicalisation, and carefully managed conscious sedation. These evidence-based frameworks stress that ATI should not be a technique reserved for airway experts, but rather a core competency for all anaesthesiologists involved in difficult airway management.[7,8]

This approach is echoed globally across multiple international societies. Other leading organisations, including the Canadian Airway Focus Group and various European anaesthesia societies, also endorse ATI for high-risk patients, particularly those with airway masses, restricted neck movement, previous radiation therapy or high aspiration risk.[9-11] The emergence of speciality-specific guidelines for obstetric and paediatric patient populations demonstrates an evolving understanding that the safest approach involves tailoring the most effective techniques to address the unique physiological and anatomical needs of every individual in our care.[12,13]

Table I: International Guidelines for Awake Tracheal Intubation (ATI) - Key Recommendations and Practice Emphasis

Organisation & Guideline	Key Recommendations	Unique Emphases
Difficult Airway Society - *Awake Tracheal Intubation in Adults* (2019)[7]	ATI as gold standard; topicalisation and cautious sedation; maximum 3+1 attempts; two-point confirmation before inducing GA	Limit attempts/early plan change; checklist use; capnography confirmation
American Society of Anesthesiologists (ASA) - *Practice Guidelines for Management of the Difficult Airway* (2022)[8]	Decision tree, including awake pathways; detailed sedation and topicalisation; oxygenation throughout	Team-based approach; situational awareness
Canadian Airway Focus Group - *Updated Consensus: Part 2 - Anticipated Difficult Airway* (2021)[9]	ATI in ICU and emergency settings; institutional readiness and protocols; applicability across OR/ICU/ED	Broad systems focus (checklists, roles, protocols)
French Society of Anaesthesia & Intensive Care - *Difficult Airway Guidelines* (2018)[10]	Algorithmic device selection for difficult intubation under anaesthesia; videolaryngoscopy first-line	Device-focused algorithms; limited ATI guidance
German Society of Anaesthesiology & Intensive Care / AWMF - *S1 Leitlinie Atemwegsmanagement* (2023 update)[11]	Algorithmic approach with integrated ATI options; maintain spontaneous ventilation when possible	Emphasis on videolaryngoscopy; stepwise algorithms in perioperative and ICU contexts
Obstetric Anaesthetists' Association & DAS (OAA/DAS) - *Obstetric Difficult and Failed Intubation Guidelines* (2015)[12]	Rescue ATI after failed asleep intubation; oral route; minimal titrated sedation	Maternal-fetal safety; aspiration and bleeding risk considerations; backup technique focus
Pediatric Fiberoptic Intubation Guidelines (Kaddoum et al., 2012)[13]	Specialised topical anaesthesia protocols; sedation with maintained spontaneous ventilation; continuous oxygenation	Rare indication; paediatric anatomical challenges; cooperation difficulties; age-specific steps and dosing

INDICATIONS AND ADVANTAGES OF AWAKE TRACHEAL INTUBATION

ATI is primarily indicated in patients with a predicted difficult airway where securing the airway after induction of general anaesthesia carries a significant risk or may be unfeasible.[7] The rationale is to maintain spontaneous ventilation and protective airway reflexes during intubation, reducing hypoxia risk and avoiding catastrophic CICO scenario.[5]

Key indications:

- Anticipated difficult bag-valve mask ventilation
  - Morbid obesity (BMI >35 kg/m^2)
  - Upper airway obstruction (e.g. tumours, masses, swelling)
  - Obstructive sleep apnoea (OSA)
- Anticipated difficult laryngoscopy/intubation
  - Limited neck movement (e.g. cervical spine injury, ankylosing spondylitis, rheumatoid arthritis)
  - Airway masses or anatomical distortion (e.g. tumour, post-radiation fibrosis)
  - Macroglossia, micrognathia, retrognathia
  - Previous documented difficult intubation
  - High Mallampati score (III, IV)
- Difficult optimisation for intubation (challenging positioning or access)
  - Limited mouth opening (<3 cm; e.g. trismus, temporomandibular joint dysfunction)
  - Inability to lie flat (e.g. cardiorespiratory compromise)
  - Fixed flexion deformities
  - Severe cervical spine pathology causing limited neck mobility
  - Need to preserve spontaneous ventilation due to risk of airway collapse on induction (e.g. neck mass or thoracic mass)

Advantages of ATI in Emergency Anticipated Difficult Airway Management[1,4,5]

In emergency situation, ATI provides similar advantages as compared to those observed in elective setting, including:

- **Preservation of spontaneous ventilation:** Maintains spontaneous ventilation, protective airway reflexes and muscle tone throughout the procedure, minimising risk of hypoxia and airway collapse that can occur during sleep intubation.[1]
- **High success rates:** Consistently high success rates (96-99.6%) with lower complications compared to asleep intubation attempts in difficult airways.[14]
- **Improved safety:** By securing the airway before induction of anaesthesia, ATI techniques reduce the risk of CICO emergencies, which carry significant morbidity and mortality and added margin of safety in scenarios in which securing the airway effectively and rapidly is critical.[5]
- **Anatomical tolerance:** The awake fibreoptic intubation (AFOI) method allows navigation through airway obstacles without traditional airway axes alignment.[13] This is particularly advantageous in patients with head and neck pathology, cervical instability, and obesity, where airway manipulation may be unsafe or impossible.
- **Enhanced decision-making:** Real-time airway assessment and patient cooperation, allow safer, more informed airway management decisions.[16]
- **Reduced emergency surgical airway intervention:** Successful ATI decreases the need for emergency front-of-neck access (eFONA), with its associated risks.[1]

AWAKE TRACHEAL INTUBATION TECHNIQUES

The DAS 2019 guidelines for ATI in adults provide a structured, evidence-based approach for ATI implementation, aiming to improve safety and success rate in patients with predicted difficult airways.[7]

Key steps in awake tracheal intubation

- **Assessment and Indication**
  - ATI must be considered when predictors of difficult airway management are present.[7]
  - Focused airway assessment helps determine ATI appropriateness.[8]
- **Cognitive Aids or Checklists**
  - Use standardised checklists to ensure systematic completion of all steps.[7] In emergencies, these serve as cognitive aids guiding teams and prompting corrective actions if complications arise.[17]
  - Standard checklist elements:
    - Monitoring readiness and IV access
    - Pre-oxygenation strategy
    - Antisialogogue and sedation planning
    - Stepwise topicalisation preparation
    - Intubation and rescue device readiness.
  - Simulation training demonstrates improved team coordination and procedural success with checklist use.[16,18]
- **Patient Preparation**
  - Informed consent and communication:
    - Obtain informed consent when possible, discussing the rationale of ATI using a concise and reassuring language:[7] *"For your safety, we need to insert this breathing tube while you are awake. We will numb your throat to minimise discomfort."*
  - Essential communication strategies:
    - Establish rapport: Project confidence through calm tone, steady posture, and eye contact.[19]

      Use clear language: Brief explanations, avoiding jargon, focusing on positive reassurance.[7]
    - Agree on non-verbal signals: Agreed on simple communication (e.g. raised hand for discomfort). This gives the patient a sense of control and autonomy during the procedure.
  - Apply standard monitoring (SpO_2, ECG, BP, capnography) and secure IV access before starting.[4]
- **Supplemental Oxygen**
  - Always administer supplemental oxygen throughout the procedure to maintain optimal oxygenation and minimise desaturation risk.[1]
  - Heated, humidified high-flow nasal cannula (HFNC) at 30-60L/min is recommended due to its added benefit of low-level positive airway pressure, improving oxygenation and reducing the need for multiple intubation attempts compared to conventional methods.[7,20]
  - Transnasal Humified Rapid-Insufflation Ventilatory Exchange (THRIVE), a specialised form of HFNC delivering 40-70L/min, extends safe apnoea time via apnoeic oxygenation and modest CO_2 clearance, making it ideal for complex or prolonged awake intubations.[21]
  - Various supplemental oxygen support strategies, including their suitability in ATI are summarised in Table II.

Table II: Oxygen Strategies during ATI[1,7,20,21]

Technique	Flow Rate	FiO_2 Range	Advantages	Limitations	Suitability for ATI
Nasal Cannula	1-6L/min	24-40%	Simple, comfortable, allows easy mouth access	Limited FiO_2, less effective for mouth breathers	Commonly used; may be inadequate in high-risk cases
Face Mask	5-15L/min	40-60% (up to 100% with non-rebreather)	Higher FiO_2 delivery than nasal cannula	Obstruct access, less tolerated by anxious patients	Less ideal due to interference during intubation
High-Flow Nasal Cannula (HFNC)	30-60L/min	Up to 100%	Heated/humidified CPAP - like effect; improved oxygenation	Requires equipment, potential discomfort at high flows	Highly suitable, especially for high-risk or hypoxemic patients

- **Airway Topicalisation**
  - Topicalisation may include nebulisation, sprays, gels or nerve blocks to anaesthetise the upper airway.
  - Lignocaine is commonly used with a maximum recommended dose of 9mg/kg lean body weight.[7]
  - Topical technique:
    - Nebulised 8mL of 2% or 4mL of 4% lignocaine over 10 minutes (optional).[22]
    - Gargle or swish 5-10mL of 2% viscous lignocaine for 2 minutes (optional).[8]
    - Apply co-phenylcaine spray (5% lignocaine + 0.5% phenylephrine) (2-4 sprays per nostril), 5 minutes prior to intubation to provide combined topical anaesthesia and vasoconstriction (for nasal AFOI).[7]
    - Spray 10% lignocaine (20-30 sprays over 5 minutes) to oropharynx, tonsillar pillars and tongue base.[7]
    - Spray 2mL of 2% lignocaine above, at and below the vocal cords via an atomiser.[7]
  - Regional nerve blocks provide superior anaesthesia quality, reducing discomfort, suppressing airway reflexes and facilitating a smoother and shorter intubation process, compared to topical anaesthesia alone.[22] Table III summarises various regional nerve blocks for ATI.
  - The adequacy of topicalisation should be tested gently. Reapply local anaesthetics up to maximum dose if insufficient.[7]

Table III: Regional anaesthesia techniques for ATI.[7,23]

Nerve Block	Target Area	Technique	Volume & Agent	Purpose
Glossopharyngeal Nerve	Posterior third of tongue, oropharynx, soft palate	Intraoral (palatoglossal arch) or peristyloid approach	1-2mL of 2% lignocaine per side	Suppress gag reflex, provide oropharyngeal anaesthesia
Superior Laryngeal Nerve	Supraglottic region (epiglottis, aryepiglottic folds)	External: below greater cornu or hyoid bone; Internal: ultrasound-guided	1-2mL of 2% lignocaine per side	Anaesthetise structures above vocal cords
Recurrent Laryngeal Nerve (Translaryngeal)	Infraglottic region (vocal cords and trachea)	Cricothyroid membrane puncture during inspiration	3-5mL of 2% lignocaine	Provide anaesthesia below vocal cords into trachea

- **Equipment and devices**
  - Maintain dedicated difficult airway trolleys with standardised equipment, immediately available for anticipated or emergency difficult airways.
  - Primary ATI devices:
    - ○ Flexible bronchoscopes (FB):
      - ~ Excellent for difficult airway anatomy and limited mouth opening.
      - ~ Allows navigation "around corners" making intubation possible without aligning the oral, pharyngeal, and laryngeal axes.
      - ~ Success rates range from 95-99%.[13,24,25]
  - Videolaryngoscopes (VL)
    - ○ Introduced in the early 2000s, VL provides video-assisted glottic visualisation and is increasingly popular for ATI.
    - ○ Comparable success rates to FB but with significantly shorter intubation times.[22,24,25]
  - Optical stylets:
    - ○ Alternative option for specific clinical scenarios with a relatively short intubation time.
  - Combined techniques:
    - ○ Video-assisted flexible intubation (VAFI) uses both videolaryngoscopy and a flexible bronchoscope or optical stylets simultaneously to improve visualisation and success in challenging cases.[23,24]

Table IV: Comparison between Awake Fibreoptic Intubation (AFOI) and Awake Videolaryngoscopy (AVL)

Aspect	Awake Fiberoptic Bronchoscope Intubation (AFOI)	Awake Videolaryngoscope/Video Stylet (AVL)
Visualisation	Excellent, flexible navigation around corners	Good glottic view; less flexible navigation
Preparation Time	Longer; requires assembly and cleaning	Shorter; portable, and quick deployment
Operator Skill	High expertise required, steep learning curve	Easier learning curve, more accessible
Intubation Time	Longer (~75-90 seconds)	Shorter (~40-60 seconds)
Patient Cooperation	Requires good cooperation	Generally well tolerated
Safety profile	Excellent safety, preserves ventilation; risk if prolonged	Similar safety; less haemodynamic disturbance
Limitations	Fogging, secretions, bleeding impair view	Requires mouth opening; less flexible

- **Team Preparation and Ergonomics**[15]
  - Team roles, communication and contingency planning:
    - Involve an experienced anaesthesiologist or ENT surgeon early for rapid backup if ATI is prolonged or fails.[7]
    - Before the procedure, brief all team members on their defined roles and establish clear escalation pathways.[17]
    - Discuss and agree contingency plans for unsuccessful ATI, such as transition to front-of-neck access or surgical airway, with designated individuals assigned to activate and lead escalation if needed.[7,17]
    - Whenever feasible, assign a team member to provide patient reassurance, monitor nonverbal cues of discomfort, and facilitate cooperation, particularly for anxious patients.
    - Maintain visual contact, clear sight lines, and closed-loop communication throughout.[1]
    - Assign a team member to handle communication with external help and ensure backup communication channels are accessible.
  - Strategic positioning:
    - Primary operator:
      - For videolaryngoscopy: At direct laryngoscopic position while ensuring patient neck stability.
      - For the fibreoptic approach: Stand at the head of the bed for optimal scope manoeuvrability.[7]
    - Patient positioning
      - Semi-recumbent with head elevated 30º for improved airway access.
      - Always preserve clear access to the neck for potential emergency front-of-neck access.[7]
  - Ergonomic setup:
    - Helps prevent operator fatigue and ensures procedural efficiency.[1]
    - Bed height: Adjust to operator's elbow or xiphoid level to prevent back strain
    - Video displays: Position at eye level to avoid neck strain.
    - Difficult airway trolley and suction apparatus: Place on the operator's dominant side, within immediate reach.[7]
    - Assistant positioning:
      - Sedation provider: Unobstructed view of the patient and monitors.
      - Equipment assistant: Positioned to pass instruments efficiently without encroaching the operator’s workspace.
    - Ensure all devices, medications, and rescue equipment are immediately accessible without compromising workspace flow.[7]
    - Recommended ergonomic setup for performing awake trachealintubation are shown in Figures 1 and 2.

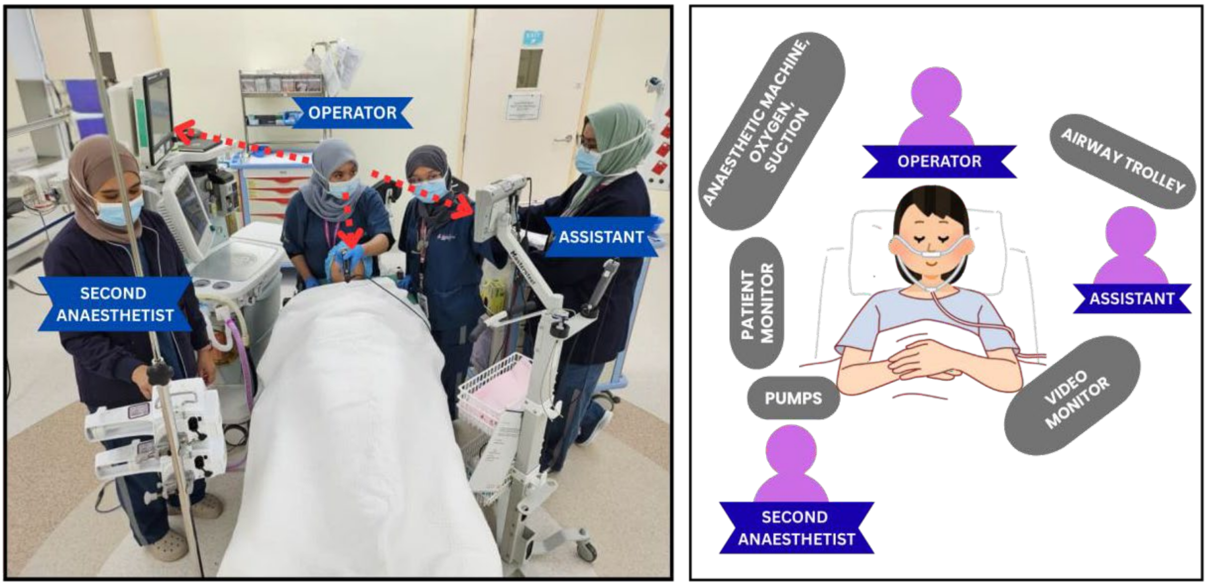

Figure 1: Awake videolaryngoscopy (AVL) performed with the operator standing behind the patient.

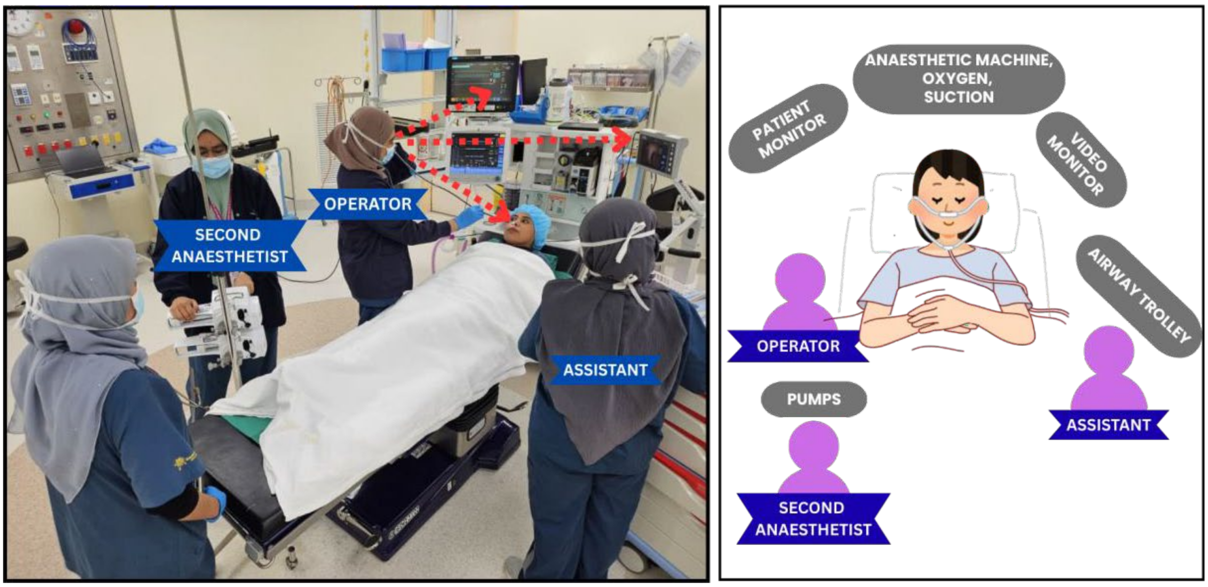

Figure 2: Awake fibreoptic intubation (AFOI) performed with the operator facing the patient in semi-recumbent position.

- **Procedure Execution**

  - Pharmacological preparation:
    - Careful, minimal sedation for comfort, ideally administered by an independent practitioner.[4]
    - Common sedative protocols include remifentanil and dexmedetomidine titrated to achieve adequate sedation while preserving spontaneous ventilation.[4]

  - ○ Consider 0.5-1.0mg midazolam for additional anxiolysis if a second anaesthesiologist is available.[8]

- Attempt limits:
  - ○ Maximum of three attempts, and one additional attempt by a more experienced operator if necessary ("3 + 1" rule).[7]
  - ○ Each subsequent attempt should involve technique modification or condition optimisation.[7]

- Communication strategies with an awake patient:
  - ○ Offer "running commentary" guiding each step and anticipated sensations, accompanied by positive reinforcements. This approach reduces anxiety, facilitates cooperation through specific breathing or swallowing commands.[19]
  - ○ Use pre-agreed non-verbal signals to indicate discomfort or request a pause.[19]

- Tube confirmation:
  - ○ Before inducing anaesthesia, conduct two-point verification:
    - ~ Visual confirmation of tracheal placement (tracheal lumen visualisation with flexible bronchoscopy OR tracheal tube through the cords with videolaryngoscopy)

      AND

      sustained capnography.[7]

- Once the patient is safely intubated, before inducing anaesthesia, briefly acknowledge the patient's cooperation:[17] *"You did well. We will now put you to sleep"*.

• Post-procedure

- Documentation using a standardised ATI forms:
  - ○ Pre-procedure: Indication for ATI, airway assessment findings, consent details
  - ○ Procedure: Technique/device used, number of attempts, difficulties encountered, operator details
  - ○ Outcome: Success/failure, confirmation method, time to intubation (if available), adverse events.[17]

- Structured debriefings to review technical aspects, patient comfort, equipment functionality, communication effectiveness, and identify improvement areas for institutional learning.[17]

INSTITUTIONAL SUPPORT AND STRATEGIES

DAS guidelines emphasise hospital support for trainees and anaesthesiologists to maintain ATI skills through comprehensive training and institutional frameworks. By prioritising thorough preparation and systematic institutional support, healthcare organisations can significantly improve ATI success rates and clinician confidence during emergency airway management scenarios.[7]

Table V: Essential Institutional Frameworks for Awake Tracheal Intubation.[1,7,17]

Strategy/Area	Key Institutional Action/Recommendations
Protocols & checklists	- Implement clear step-by-step ATI protocols. - Provide standardised cognitive aids and checklists. - Ensure systemic preparation and performance guidance.[7]
Equipment readiness	- Maintain dedicated difficult airway trolley in all clinical areas. - Establish standardised equipment lists and regular maintenance. - Ensure immediate availability for anticipated/emergency use.[7]
Team coordination	- Define roles and early backup involvement. - Clear escalation pathways to experienced operators. - Establish emergency consultation protocols.[17]
Training & Competency	- Conduct regular multidisciplinary ATI training and simulations. - Encourage involvement of all anaesthesiologists in the workshop series. - Establish mentorship programs pairing junior with senior practitioners.[1]
Documentation & Audit	- Use standardised ATI forms (e.g. stickers) and electronic templates to promote protocol adherence. - Track success rates, complications. - Enable quality improvement through systemic outcome monitoring.[17]
Post-procedure review	- Conduct structured debriefings for all ATI cases. - Foster a learning culture through experience-sharing sessions.[17]

Quality improvement and learning culture require systematic approaches to continuous enhancement. Post-procedure debriefings should focus on technical performance, patient cooperation, equipment functionality and preparation, and communication effectiveness to identify areas of improvement.[1] These structured reviews transform individual cases into collective learning experiences, building institutional expertise and confidence in managing difficult airway emergencies across Malaysian healthcare settings.

The integration of these institutional strategies alongside technical expertise creates a comprehensive framework that ensures both immediate ATI success and long-term organisational capability development.

TRAINING AND SKILLS ACQUISITION

Importance of Maintaining Competence

Maintaining ATI competence represents a critical challenge given its high - stakes, low-frequency nature. ATI is a highly complex procedure that requires a significant degree of skill and expertise, offering a considerable safety advantage by preserving the patient's intrinsic airway tone. Despite its high success rate and favourable safety profile, ATI remains under-utilised, due to infrequent performances leading to limited clinician experience and procedural reluctance. Both DAS and the Royal College of Anaesthetists (RCoA) emphasise ATI as a core competency, recommending formal departmental support to ensure skill acquisition, regular practice and the availability of equipment and protocols.[7] Recent international consensus emphasises defining clear competency milestones and structured assessment for awake intubation, ensuring critical care providers achieve and maintain proficiency through validated training curriculum.

Simulation and Deliberate Practice in ATI Training

Simulation-based training is a crucial component in anaesthesia training, essential for developing and maintaining both technical and non-technical competencies in airway management. It provides a safe and structured environment which allows for repeated practice, real-time feedback, and critical decision-making, supported by a well-planned instructional design and highly skilled educators proficient in both clinical practice and simulation methodology.[18,24] Multicentre trials comparing six videolaryngoscopes in simulated difficult airway scenarios demonstrate that regular, device-specific simulation markedly improves first-pass success and scope handling skills.[25] National training initiatives in Malaysia, such as the MSA-CoA Pre-Congress ATI Workshop, held in conjunction with MSA-CoA Annual Scientific Congress 2025, exemplify institutional commitment to structure, skill-based ATI. Embedding simulation within clinical training, reinforced by "train-the-trainer" programmes, is essential to sustaining professional competence and advancing patient safety in airway management.[18]

EVIDENCE AND OUTCOMES

Success Rate and Safety Data of ATI

Based on multiple reviews, the overall success rate of AFOI and AVL is more than 95%, especially in experienced hands.[4,14] A systematic review and meta-analyses of six randomised controlled trials involving 446 patients in 2018, comparing AFOI and AVL revealed no difference in overall success rate for both techniques (RR,1.00), but showed significant difference in terms of shorter intubation time in using VL (mean difference, 40.4 seconds, $p<0.01$).[15] No significant difference was also found in adverse events associated with both techniques such as oxygen desaturation ($SPO2<90\%$) and sore throat.[16] This multiple review also revealed similar levels of patient reported satisfaction, procedural discomfort and also operator satisfaction.

Compared to AFOI, AVL offers more advantages, being similar to conventional VL intubation, with the main challenge being management of the awake patient, requiring careful planning and cooperation.[26] Even for less experienced operators, AVL is relatively easy to learn, demonstrates a steep learning curve, and achieves a high success rate, with more opportunities for practice and skill consolidation. A systematic review done by Merola, R. et al included 11 randomised controlled trials with 873 patients and found that videolaryngoscopy reduced intubation time significantly and had comparable success and safety profiles to fiberoptic bronchoscopy for awake intubation. It also noted a marginal reduction in episodes of oxygen desaturation with videolaryngoscopy.[16] However, AVL technique has its significant limitations in patients with restricted mouth opening, oropharyngeal pathology or infection and severe distorted airway anatomy in which, AFOI is much more preferable or the only option available.[4,16]

Comparative Studies: Awake vs Asleep Intubation in Difficult Airways

There are very limited RCTs available when it comes to comparing awake versus asleep intubation in difficult airways. There are a few large observational and retrospective studies highlighting a few key differences.[14,26]

A large retrospective study done by Joseph et al involving reviewing anaesthetic records from 2007 till 2014, published in 2016 in which 1085 patients were involved, and AFOI performed 1055 patients.[14] Each awake intubation was compared to 2 controls in which intubation was performed following induction of anaesthesia (asleep) (2170 patients). Median intubation time was 16 minutes (interquartile range 13 to 22) in asleep intubation group compared to 24 minutes (interquartile range 19 to 31) in ATI group. Failure rate was 1% and complication rate was 1.6% in the ATI group. ATI was associated with a high success rate with a low rate of serious complications.[14]

In more recent years, Kriege et al (2023) had performed a retrospective observational study involving critically ill patients in ICU conducted using records obtained from 2020 till 2022 and it was published in 2023. They compared patients who required ATI with VL with a hyper-angulated blade (McGrath® MAC X-blade) vs patients who were asleep and intubated either via VL or direct laryngoscopy (DL). They concluded lower adverse events (hypotension, desaturation after adequate preoxygenation, peri-interventional cardiac arrest) in ATI group ($p<0.0001$).[26]

CONTROVERSIES AND CHALLENGES

One primary controversy in ATI is sedation management. Striking the balance between adequate anxiolysis and preserving spontaneous ventilation is often challenging. Over-sedation can cause hypoventilation and airway obstruction, whereas under-sedation may lead to patient discomfort and procedural failure.[4,8] The lack of consensus on optimal sedative agents and dosing contributes to variability in practice.

Another major challenge is clinician familiarity and skill maintenance. Despite guideline endorsements, many anaesthesiologists are reluctant to perform ATI due to limited exposure and lack of hands-on experience. Kristensen et al (2014) found that only a small percentage of anaesthetists in Europe (fewer than 20%) had performed more than five awake fibreoptic intubations annually, leading to a decline in proficiency and confidence.[26] Mastering AFOI requires more training and time than AVL, with competence (>90% success in under 3 minutes) typically achieved after at least 25 cases.[27] This skill gap is more pronounced among junior trainees and in institutions without regular airway workshops.[27] Moreover, anatomical variations, such as distorted airway anatomy due to trauma or tumours, may make awake intubation technically difficult even in experienced hands.[10]

Furthermore, time constraints during emergencies also discourage the use of ATI. In rapidly deteriorating airway scenarios, clinicians may default to rapid sequence induction (RSI) or asleep video laryngoscopy, perceiving ATI as time-consuming. However, such approaches may increase the risk of failed intubation and adverse outcomes, especially in anatomically difficult airways.[5]

Besides that, implementing ATI in resource-limited environments presents unique challenges. The availability of fibre-optic scopes, high-flow nasal cannula systems, and atomisers for topicalisation may vary between institutions, particularly in resource-limited settings. There may be fewer trained personnel or limited access to topical anaesthetics.[6] Additionally, the maintenance and decontamination of such equipment pose logistical issues. Despite these obstacles, practical and cost-effective solutions exist.

Affordable alternatives such as the Airtraq® laryngoscope or gum elastic bougies can be effectively used for awake intubation. Simplifying topical anaesthesia techniques (using lidocaine gargles or sprays) can make the procedure more feasible. Preparing for emergency airway rescue using available tools ensures safety even when resources are limited.

Patient-related factors such as refusal or anxiety also hinder ATI implementation. While adequate counselling and pre-procedural explanation are crucial, some patients may remain uncooperative despite best efforts. While clinicians may be reluctant to perform ATI due to concerns over patient comfort, evidence suggests this concern is often exaggerated. Studies on patient-reported outcomes indicate that with thorough preparation, the majority of patients find the procedure acceptable. In one study, 80% of patients considered the awake intubation process acceptable, generally reporting only mild pain and discomfort.[19,28]

Importantly, real world safety data reinforce ATI's role. Kriege et al (2023) demonstrated that ATI was associated with significantly fewer adverse events (hypotension, desaturation, and peri-procedural cardiac arrest) in critically ill ICU patients undergoing ATI versus asleep intubation, reinforcing its role when performed by skilled practitioners in appropriate settings.[26]

Despite these challenges, various national and international guidelines, as mentioned earlier in the previous section, continue to support ATI as the preferred technique in anticipated difficult airways. To overcome existing barriers, a concerted effort is needed to enhance training, ensure access to necessary equipment, and standardise sedation protocols. Simulation-based education and inclusion of ATI in competency frameworks may improve familiarity and confidence among trainees and consultants alike.[18,24]

Table VI: Summary of the Challenges of ATI

Challenge	Suggested Solution
Lack of advanced devices	Use Airtraq®, gum elastic bougies, direct laryngoscopy
Limited trained personnel	Basic training, high-fidelity simulation, remote learning
Inadequate topical anaesthesia	Lignoocaine gargles, sprays, incremental application
Patient cooperation difficulties	Clear counselling, use of interpreters and patient reassurance
Limited emergency backup	Prepare front-of-neck access plans, oxygen supplementation strategies

THE FUTURE OF AWAKE TRACHEAL INTUBATION

Awake tracheal intubation will continue to be an essential technique for managing difficult airways by preserving spontaneous ventilation and reducing the risk of critical airway emergencies. Future advancements will likely focus on improving airway topicalisation methods, as effective subglottic anaesthesia is crucial for ensuring patient comfort and procedural success. Innovations such as non-invasive topicalisation using epidural catheter sprays in combination with flexible bronchoscopes may help reduce airway irritation and minimise haemodynamic disturbances during ATI.[29] Furthermore, the incorporation of newer visual devices such as videolaryngoscopes and hybrid techniques alongside traditional fiberoptic scopes will be confirmed by comparative studies aimed at enhancing success rates, shortening procedure times, and improving patient tolerability.[29]

Looking ahead, the ongoing evolution of evidence-based guidelines will be vital to keep pace with technological advancements and insights derived from large multicenter registries. Tailoring ATI protocols to specific patient populations and clinical settings, particularly in resource-limited environments, will facilitate wider adoption and effectiveness. Continuous education, strong institutional support, and flexible airway management strategies will play a critical role in advancing global patient safety and outcomes, thereby securing ATI's position as a cornerstone of difficult airway management well into the future.[7,9]

CONCLUSION

Awake tracheal intubation (ATI) remains a crucial technique in managing difficult airways by preserving spontaneous ventilation and airway reflexes, thereby reducing critical airway emergencies and allowing continuous patient monitoring. Widely endorsed by major guidelines such as NAP4, ASA, DAS, and Canadian consensus statements, ATI has demonstrated improved safety and complication reduction over the past decade.[5,7-9] Nonetheless, ATI demands high operator skill, patient cooperation, and effective topical anaesthesia, with potential challenges including airway irritation and suboptimal sedation.[14] Its successful application, especially in emergencies, hinges on meticulous preparation and expertise. The future of ATI involves refining evidence-based guidelines, incorporating innovative devices, and adapting protocols to varying resource settings, with ongoing education and institutional support essential to enhancing global airway management outcomes.

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Optimising Anaesthetic Care in Massive Obstetric Haemorrhage

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INTRODUCTION

Obstetric haemorrhage remains the leading cause of maternal mortality in Malaysia and worldwide, and most of these deaths are due to postpartum haemorrhage (PPH).[1,2] The World Health Organization (WHO) estimates approximately 14 million women worldwide experience PPH annually.[3] The definition of obstetric haemorrhage lacks universal consensus.[2] According to the Royal College of Obstetricians and Gynaecologists, United Kingdom, antepartum haemorrhage (APH) occurs from 24 weeks of gestation, and major APH is defined as blood loss of 500 to 1000 ml without signs of shock, while massive APH refers to blood loss of ≥1000ml, or any amount of bleeding accompanied by clinical signs of shock.[2] Primary PPH occurs within 24 hours following delivery, whereas secondary PPH develops between 24 hours and 12 weeks postpartum.[2] Based on severity, it can be further stratified into major PPH as either moderate (1000 -2000ml) or severe (greater than 2000ml).[2] Timely and effective anaesthetic management is crucial to optimising outcomes of obstetric haemorrhage. This chapter provides a comprehensive overview of anaesthetic strategies, ranging from risk identification and preventive measures, to acute crisis management and post-resuscitation care.

RISK ASSESSMENT AND PREVENTION

Early identification of the parturient at risk during antenatal visit, allows for planning and preparedness. The antenatal risk factors of PPH include placenta praevia, abruptio placenta, multiparity, multiple gestation, previous history of PPH or caesarean section, bleeding disorders and comorbidities requiring anticoagulant.[4] During delivery, PPH risk is increased in the parturient with chorioamnionitis, coagulopathy, prolonged labour, instrumental delivery or caesarean section, and presence of tocolytics such as magnesium infusion (weak tocolytic) and volatile agent during caesarean section.[4] The '4Ts' causes of PPH are 'Tone' (uterine atony, uterine overdistension), 'Trauma' (uterine, cervical or vaginal injury), 'Tissue (retained product of conception) and 'Thrombin' (pre-existing or acquired coagulopathy). Uterine atony is the leading cause of PPH, responsible for about 80% of primary PPH cases.[4] Placenta accreta spectrum (PAS) is a common cause of massive obstetric haemorrhage (MOH), and its incidence is on the rise.[2] It ranges from placenta that is morbidly adherent to the myometrium (accreta), to that which invades the myometrium (increta), or extends through the myometrium into surrounding organs (percreta).[2] A parturient identified as having risk factors for PPH should give birth in a hospital equipped with an on-site blood bank.[4]

Multidisciplinary Planning and Communication

For high-risk pregnancies, antenatal multidisciplinary team (MDT) meetings involving obstetricians, anaesthesiologists, haematologists and neonatologists are crucial. A patient-specific delivery plan including location of delivery (e.g. tertiary centre), blood product availability, and escalation pathways should be documented.[5]

Haemoglobin Optimisation Prior to Delivery

Antenatal anaemia should be identified and managed appropriately as it may reduce the morbidity associated with PPH,[4] as well as preterm delivery, low birthweight and perinatal mortality.[6] Iron deficiency anaemia is a modifiable risk factor that can be managed within the Pillar One of Patient Blood Management (PBM). Patient Blood Management is a comprehensive, patient-focused strategy designed to optimise care for individuals at risk of requiring blood transfusions or experiencing anaemia-related issues. This evidence-based approach prioritises conserving the patient's own blood and reducing reliance on transfusions, thereby improving clinical outcomes, enhancing patient safety, and promoting efficient use of healthcare resources, ultimately contributing to lower overall healthcare costs.[6]

Strategies to Minimise Blood Loss During Delivery

Oxytocin and its longer-acting analogue, carbetocin, are the first-line uterotonics in preventing as well as treating PPH.[7] Prophylactic uterotonic should be routinely offered to all parturients during the third stage of labour, as it significantly decreases the risk of PPH.[4] For parturients without PPH risk factors undergoing vaginal delivery, intramuscular (IM) oxytocin 10 IU is the agent of choice for prophylaxis during the third stage of labour.[4] In 2019, an international consensus statement recommended an intravenous (IV) bolus of 1 IU oxytocin for elective caesarean delivery (CD), after the delivery of the baby and clamping of the umbilical cord, followed by an infusion of 2.5-7.5 IU per hour.8 In the case of intrapartum CD, 3 IU of oxytocin should be administered over at least 30 seconds, followed by an infusion at 7.5-15 IU per hour. In both cases, a second bolus of 3 IU over 30 seconds may be administered if required after reassessment at 2 to 3 minutes.[8] Alternatively, a single dose IV carbetocin 100 mcg over ≥30 seconds can be administered for elective and intrapartum CD.[8] A second-line uterotonic (ergot alkaloids or a prostaglandin) should be considered promptly if oxytocin or carbetocin fails to maintain sustained uterine tone. A review of the patient's clinical condition is essential before discontinuing oxytocin infusion, which typically occurs between 2 and 4 hours after initiation.[8]

MANAGEMENT OF MASSIVE OBSTETRIC HAEMORRHAGE

A multidisciplinary approach forms the basis of the management of MOH, with anaesthesiologists playing a crucial role in various aspects including resuscitation, anaesthesia for surgical or radiological rescue procedures as well as postoperative intensive care. Several essential principles in the management of MOH are meticulous assessment of severity followed by concomitant communication, resuscitation, monitoring and bleeding control.[4]

Assessment of Severity of Haemorrhage

Assessment of haemorrhage in parturient present as a clinical challenge due to difficulty in estimation of blood loss and physiological changes in pregnancy masking the clinical signs.[9] The possibility of occult bleeding in APH and mixture of amniotic fluid in PPH results in under-estimation of blood loss in both visual and quantitative estimations. Furthermore, physiological changes in pregnancy including lower baseline blood pressure (BP), higher heart rate (HR) and blood volume, prevent early signs of shock until 30% to 40% of blood volume is lost, in which circulatory collapse rapidly ensues.[4,10,11]

Shock Index (SI), defined as the ratio of HR to systolic BP, with a threshold value of more than 0.9 in parturient, can be an invaluable marker to predict haemodynamic instability, need for aggressive resuscitation and adverse maternal outcomes. Numerous guidelines advocate the use of SI in assessment and monitoring of MOH.[4,12,13] Together with 'Rule of 30', SI is an essential bedside parameter in the management of MOH. 'Rule of 30' refers to a drop in systolic BP by 30mmHg, an increase in HR by 30 beats/minute, a respiratory rate of more than 30 breaths/minute and a drop in haemoglobin/haematocrit level by 30%, indicating a blood loss of 30% of blood volume.[13,14]

Communication

Multidisciplinary communication involving a senior obstetrician, senior anaesthesiologist, experienced midwife, haematologist and blood transfusion staff, should be established at an early stage, within 60 minutes of diagnosis of haemorrhage, or blood loss more than 1000ml with ongoing bleeding or clinical shock.[4,14,15] All team members must be well versed with their responsibilities and local resuscitation protocol. Besides, clear communication should be offered to the parturient and her partner throughout the crisis.

Resuscitation

The main aims of resuscitation in MOH are restoration of blood volume, preservation of oxygen carrying capacity, reversing coagulopathy and foetal resuscitation. Its principles are based on an escalating regimen of haemostatic approach, comprising (1) initial stabilisation of the airway, breathing and circulation, which includes application of high flow oxygen, intubation and mechanical ventilation if clinically indicated, establishing at least two large bore cannulas, haemodynamic stabilisation by fluid resuscitation (2) prevention of hyperfibrinolysis (3) substitution of oxygen carrier by packed red blood cell (PRBC) transfusion, and (4) correction of coagulopathy.[11]

Warm crystalloids remain the first line fluid resuscitation in MOH, while waiting for the availability of blood.[3] However, aggressive crystalloids resuscitation may result in dilutional coagulopathy, thinning of endothelial glycocalyx with resultant shift of fluid into third space causing multiorgan failure.[13] Employment of restrictive fluid resuscitation (maximum of 2 litres of crystalloids) with early initiation of blood transfusion and hypotensive resuscitation (mean arterial pressure aim of 60-65mmHg) may reduce related complications.[4,10-13]

Although not recommended as a prophylaxis, evidence on tranexamic acid (TXA) use in management of MOH, in reducing mortality and surgical intervention, is well established.[16] Upon the diagnosis of PPH, IV TXA 1g over 10 minutes should be administered immediately, within 3 hours of delivery and prior to blood product transfusion, in cases with high clinical suspicion of hyperfibrinolysis. In occasions of continuous bleeding after 30 minutes or rebleeding within 24 hours, another dose of 1g can be given.[4,12,13,15,17]

Group-O Rhesus-negative blood should be available in maternity unit and be transfused as indicated and then switched to group-specific blood once available. There is no firm transfusion trigger but generally it was accepted that PRBC transfusion is indicated at a haemoglobin level of less than 7g/dl.[17] Nevertheless, in the setting of acute haemorrhage, a single haemoglobin level is not reliable and hence, precise clinical evaluation is a more important determinant for transfusion and activation of the massive transfusion protocol (MTP). Hence, delay of PRBC transfusion while waiting for laboratory result is not advisable.[13] Serial haemoglobin level together with serum lactate and base deficit is recommended to guide PRBC transfusion. Consider using a rapid infusion device with warming features.[4]

Haemostatic reanimation, referring to early transfusion of blood products in proportion to circulating blood, is the fundamental approach in reversing coagulopathy. A shift towards PRBC to fresh frozen plasma (FFP) transfusion ratio of 1:1 to 1:2 is suggested to minimise coagulopathy. The use of ratio-driven transfusion protocol in the initial phase of uncontrolled bleeding should be followed by goal-directed transfusion whenever feasible (Table I).[4,11-13] Notably, fibrinogen level is present at a higher level in the parturient at 3-6g/l and reduces rapidly during haemorrhage, therefore, a fibrinogen level of less than 2g/l holds 100% positive predictive value for progression into MOH as well as need for transfusion and surgical intervention.[2,4,14]

Table I: Recommended transfusion trigger and dosage for blood products

Blood products	Transfusion trigger	Dosage
FFP	PT/aPTT > 1.5x normal	20-30ml/kg
Cryoprecipitate	Fibrinogen < 2g/l	1 unit/5kg for 1g/l increment
Platelet	Platelet < 75 x 10^9/l	1 unit for 20-40 x 10^9/l increment

The data for routine use of fibrinogen concentrate, recombinant Factor VII (rFVIIa), prothrombin complex concentare (PCC) and desmopressin in management of MOH is controversial. Fibrinogen concentrate at 60mg/kg increases fibrinogen level by 1g/l and potentially reduces transfusion-related complications.[4] Up to date, rFVIIa is only proposed as a last resort in refractory bleeding at a dose of 60-90µg/kg, whereas PCC at 25IU/kg owns a theoretical benefit in the context of reduced factor VIII during pregnancy but without any robust study to support its use in MOH.[12] Desmopressin of 0.3µg/kg shares a similar fate and is only indicated in suspected acquired von Willebrand disease.[11,12]

Recently, cell salvage (CS), being an important part of PBM, has been gaining recognition in the field of obstetrics. International guidelines advocate the use of CS in patients with high risk or ongoing PPH and PAS disorders.[3,4,11,13] The advantage profile is promising in significantly reducing red cell transfusion and length of hospital stay. However, cost effectiveness is still unverified.[18] Concerns of amniotic fluid embolism and alloimmunisation was invalidated by recent meta-analysis.[19] These theoretical risks can be minimised by starting the CS after most of the amniotic fluid has been removed and use of a leucocyte-depletion filter prior to reinfusion.[10] Bearing in mind that CS blood is devoid of clotting factors and platelet, coagulation factors should be supplemented in high re-infusion volume.[11] Standard dose of anti-D immunoglobulin should be routinely offered to Rhesus-negative mothers delivering Rhesus- positive babies.[12]

Monitoring

Monitoring, comprising clinical, laboratory and point-of-care (POC) testing, is crucial in the assessment of progression of MOH, response to resuscitation and guiding further intervention. Close monitoring of vital signs, including BP, HR, oxygen saturation and temperature, alongside urine output and conscious level is essential. Establish invasive BP monitoring whenever feasible, but this should not delay resuscitative effort. As part of the initial management of MOH, 20ml of blood should be drawn and sent for baseline full blood count, renal profile, liver function test, coagulation profile, fibrinogen level, lactate level and arterial blood gas.[2,4,12,13] Decision for serial laboratory testing is up to the clinician's judgement, targeting to restore normal physiological and laboratory parameters (Box 1).[4,11-13]

Box 1: Therapeutic goals in management of MOH
- Core temperature > 34ºC
- Hb 7-9g/dl
- Platelet > 50 x 10^9/l
- PT/aPTT < 1.5x normal
- Fibrinogen > 2g/l
- pH > 7.2, base excess (BE) > -6mEq/l
- Lactate < 4mmol/l
- pCO2 gap <6mmHg
- Ionized Calcium > 0.9mmol/l

Considering that most laboratory test results are not readily available, it is impractical to be used as a guide for resuscitation in a rapidly changing circumstance. In contrast, POC viscoelastometry, such as thromboelastography (TEG) or rotational thromboelastometry (ROTEM), offer shorter test-to-result time, targeted correction of coagulopathy and has been associated with reduced blood loss and hence the need for blood or blood products transfusion. It was found that in parturients with blood loss of more than 1500ml, ROTEM results differ across various aetiologies of PPH.[12] Therefore, transfusion of a 'standard package' for MOH leads to unnecessary transfusion with resultant transfusion-related complications and wastage of blood products. Despite the benefits, POC test was not proven to reduce mortality and hence lacks strong evidence to support its routine use.[12]

Point-of-care ultrasound (POCUS) is well applied in critical care and emergency medicine setting. Its concept is emerging into numerous applications in MOH. Beside its relevance in assessment of volume status and fluid responsiveness, POCUS is also a useful bedside tool to guide resuscitation in complex obstetric conditions which may complicate MOH, such as hypertensive disorder with cardiac dysfunction, pre-existing cardiac disease in pregnancy or thromboembolic events.[20,21] In addition, obstetricians are also employing POCUS for diagnostic purposes to identify causes of MOH.[22]

Pregnancy presents unique physiological changes and pathological conditions with fluctuations of haemodynamic parameters which triggers the interest to measure them. Nowadays, various techniques of haemodynamic monitoring are available with minimally invasive pulse contour analysis emerging as the most commonly used method. Real-time parameters such as cardiac index, stroke volume variation and systemic vascular resistance index potentially offer invaluable guidance in resuscitation of MOH, particularly in complex cases. However, none of the haemodynamic monitoring techniques are validated in pregnancy, thus, raising the doubt of reliability in its use in MOH.[23]

Bleeding Control

Upon diagnosis of MOH, tremendous effort to identify causes of MOH must be made promptly. In most cases, definitive management for APH is delivery.[4] Whereas, subsequent intervention for PPH is dependent on the aetiologies, and can be either pharmacological, mechanical, surgical or radiological intervention.

Uterine atony, being the most common cause of PPH, often responds well to uterotonics. IV oxytocin (3-5IU as short infusion, followed by 10-40IU as continuous infusion) or IV carbetocin 100 µg are the recommended first-line therapy, followed by IM carboprost 250mcg or IM oxytocin 5IU/ ergometrine 0.5mg as second-line therapy.[2,4,13] Oxytocin and prostaglandin should not be administered simultaneously due to their synergistic hypotensive effect.

Mechanically, uterine massage, emptying the bladder and bimanual uterine compression can be performed. Uterine tamponade, by means of tamponade strips or balloon tamponade systems, is beneficial in treating PPH or as a temporary measure for haemodynamic stabilisation to allow preparation for surgical or radiological procedures.[11] Besides, a non-pneumatic anti-shock garment is also an effective non-invasive device that temporarily restores haemodynamic allowing inter- or intra-hospital transfer.[13]

Surgical measures include repair of genital tract trauma, removal of retained tissue, uterine compression sutures, stepwise uterine devascularisation by uterine artery ligation, internal iliac artery ligation and ultimately postpartum hysterectomy in the case of haemodynamic instability or life-threatening bleeding. Guidelines recommend against delaying hysterectomy in these circumstances, especially in MOH associated with PAS or uterine rupture. In a unit with interventional radiological services, selective endovascular balloon occlusion or arterial catheter embolization may be offered as uterus-preserving measures.[2,4,12,13]

Post-Resuscitation Care

After initial stabilisation and haemostatic effort, patients with MOH should be monitored in the intensive care unit (ICU) for at least 24 hours, considering the possibility of rebleeding, progression to disseminated intravascular coagulation or multiorgan failure. Also, attention should be paid to the risk of rebound hypercoagulable state and thromboembolic events, thus warranting mechanical thromboprophylaxis (graduated compression stockings or pneumatic cuff pumps) and pharmacological thromboprophylaxis to be started once feasible, within 24 hours of haemostasis.[2,11,12] Iron supplements should also be prescribed in accordance to pillar one of PBM.[17]

DAMAGE CONTROL RESUSCITATION

The concept of damage control resuscitation (DCR) was first applied by trauma surgeons in massive haemorrhage with the aim to prevent the lethal triad (coagulopathy, hypothermia and acidosis), minimise blood loss and maximise tissue oxygenation. Damage control resuscitation is usually reserved for severe MOH refractory to resuscitation, who may not survive definitive intervention in the operating theatre (Box 2).[13]

Box 2: Indications for early DCR
- Core temperature < 35ºC
- Blood loss > 1500ml
- Acidosis, BE < -8mEq/l, pH < 7.1
- Systolic BP < 70mmHg
- Persistent bleeding despite transfusion

Damage control resuscitation comprises damage control surgery (DCS), stabilisation of physiological parameters and definitive surgery. The primary aim of DCS is haemorrhage control and can usually be achieved by hysterectomy, pelvic packing and temporary abdominal closure. Following DCS, patient should be transferred to ICU for further resuscitation, correction of physiological derangements and close monitoring for rebleeding. In case of rebleeding with more than 400ml/hour in the absence of coagulopathy, re-laparotomy is indicated. After restoration of normal physiology, usually within 48 to 72 hours after DCS, patient shall be subjected to definitive surgery and closure of the abdomen.[13]

The main determinants for mortality and morbidity in DCR are the operative time of DCS, number of re-interventions and time to definitive closure of abdomen. Hence, it is crucial to complete DCS within 90 minutes and prescribe prophylactic antibiotics to reduce the risk of infection.[13]

CONCLUSION

Maternal mortality from MOH is highly preventable with the implementation of a high standard multidisciplinary management protocol, from early identification of risk factors, antenatal optimisation, intrapartum active prevention to postpartum aggressive resuscitation, monitoring and bleeding control. Vigilance and regular training are crucial in maintaining the standard of care and to ensure awareness of the responsibilities held by every personnel involved in the management of parturient.

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Seeing Life in Seconds: The POCUS Advantage in ICU Emergencies

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INTRODUCTION

In turbulent times marked by armed conflicts, extreme weather events, and the lingering threat of pandemics, the World Federation of Societies of Anaesthesiologists (WFSA) has spotlighted anaesthesiologist's critical role in health emergencies as its 2025 Annual Theme. Health emergencies, whether large-scale disasters or everyday ICU crises like sepsis, acute myocardial infarction, or obstetric haemorrhage, overwhelm health systems and daemand for rapid, expert intervention. When seconds count and diagnostic clarity can tip the balance between life and death, Point-of-Care Ultrasound (POCUS) has emerged as an indispensable ally in the intensive care unit. Portable ultrasound devices have evolved beyond their traditional settings in radiology suites and operating theatres. Now, they are in the hands of frontline intensivists, providing real-time insights into cardiac function, pulmonary status, vascular integrity, and more. By delivering imaging capabilities directly at the bedside, POCUS enables swift, informed decisions, often achievable within minutes instead of hours, through intricate assessments.

This paradigm shift has been echoed globally. The Society of Critical Care Medicine's 2024 focused update on adult critical care ultrasonography now recommends POCUS as a first-line diagnostic tool in five essential ICU situations: cardiac arrest, septic shock, acute respiratory failure, volume management, and cardiogenic shock.[1] By collapsing the gap between image acquisition and interpretation, POCUS enables immediate, actionable data, whether confirming pericardial tamponade in a peri-arrest patient or guiding fluid resuscitation in septic shock.

DEFINING POCUS AND ITS CORE BENEFITS

POCUS is a clinician-performed, goal-directed imaging modality that uses portable ultrasound at the bedside to answer focused clinical questions in real time.[1] POCUS merges the portability and immediacy of bedside scanning with the diagnostic sophistication of comprehensive echocardiography. It allows clinicians to assess haemodynamic stability by visualising cardiac contractility and chamber dimensions, to evaluate pulmonary pathology through lung sliding and B-lines, to guide vascular access under direct visualisation, and to perform targeted interventions such as pericardiocentesis or thoracentesis with ultrasound guidance. Beyond speed, POCUS enhances patient safety by reducing unnecessary transports to radiology and minimising the need for blind procedures. Real-time imaging cuts down complication rates in line placements, and it obviates ionizing radiation exposure for critically ill patients who are too unstable to leave the unit. By integrating POCUS into standard ICU workflows, healthcare teams can streamline diagnostics, deliver precision medicine at the bedside, and ultimately improve outcomes.

CARDIAC POCUS

Cardiac POCUS encompasses focused cardiac ultrasound (FoCUS) examinations that rapidly evaluate myocardial function, chamber dimensions, and pericardial space.[2] The principal views consist of parasternal long-axis, parasternal short-axis, apical four-chamber, subcostal four-chamber, and subcostal inferior vena cava (IVC) views, enabling clinicians to detect global and regional wall motion abnormalities, estimate left ventricular ejection fraction, assess right ventricular size and pressure overload, and identify pericardial effusions or tamponade physiology.[2,3]

In emergent settings, expedited diagnosis of pericardial tamponade is life-saving. Small-handed probes, when positioned in the subxiphoid window, can reveal anechoic pericardial fluid compressing the right atrium or ventricle, prompting urgent pericardiocentesis before haemodynamic collapse.[4] Similarly, in septic or cardiogenic shock, rapid

FoCUS facilitates differentiation between hypovolemia, pump failure, and distributive states by combining qualitative assessment of contractility with inferior vena cava (IVC) collapsibility indices. POCUS shifts ICU care from reactive rescue to proactive management.[5] A summary of various FoCUS patterns utilised to identify types of shock is presented in Table I.

Table I: FoCUS patterns in various clinical scenarios in the critical care setting

Clinical Condition	FoCUS Patterns
Acute LV systolic dysfunction	Global hypokinesia of LV (visual & increased EPSS) Absence of echocardiographic signs of chronic LV disease Present/Absent regional wall motion abnormalities
Acute RV systolic dysfunction	RV dilatation Hypokinesia of RV (visual & reduced TAPSE) Absence of echocardiographic signs of chronic RV disease Present/Absent systolic septal dyskinesia (pressure overload) Present/Absent diastolic septal dyskinesia (volume overload)
Acute Biventricular systolic dysfunction	Global hypokinesia of LV Hypokinesia of RV (visual & reduced TAPSE) Absence of echocardiographic signs of chronic RV or LV disease
Severe hypovolemia/ vasodilatation	Small LV end diastolic & end systolic size (Hyperdyanmic LV) Small RV size, hyperdynamic RV Small, collapsing IVC
Pericardial effusion	Anechoic/hypoechoic pericardial free space
Tamponade	Anechoic/hypoechoic pericardial free space Signs of compression (Collapse: RA systolic, RV diastolic, LA systolic, LV diastolic) IVC plethora
Suspected severe acute valve dysfunction	Abnormal valve motion (AV cusps flail, MV leadlet flail, prolapse, restriction) Leaflet/Cusps anatomical gaps Mass on leaflets/cusps
Suspected chronic cor pulmonale	RV dilatation RV hypokinesia (visual & reduced TAPSE) RV hypertrophy and RA dilatation Present/Absent septal dyskinesia
Suspected chronic LV dysfunction (Dilated cardiomyopathy)	LV and LA dilatation LV global hypokinesia Present/Absent regional wall motion abnormalities
Suspected chronic LV dysfunction (Hypertrophic cardiomyopathy, HOCM)	LV marked hypertrophy LA dilatation Present/Absent LV global hypokinesia Present/Absent regional wall motion abnormalities
Suspected chronic valve disease	Abnormal valve thickening Abnormal valve motion (AV cusps restricted motion, MV leaflet restricted motion, MV flail/prolapse) LA dilatation and/or LV dilatation or hypertrophy Present/Absent LV global hypokinesia

Abbreviations: EPSS = E-point septal separation; TAPSE = Tricuspid annular plane systolic excursion; IVC = Inferior vena cava; LV = Left ventricle; RV = Right ventricle; LA = Left atrium; RA = Right atrium; MV = Mitral valve; AV = Aortic valve.
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Despite these benefits, practitioners must acknowledge limitations. Frame rate and depth resolution trade-offs, operator dependency, and acoustic window constraints (e.g., due to dressings, chest tubes, or subcutaneous emphysema) can impair image quality. Thus, when FoCUS findings are equivocal, comprehensive echocardiography by a cardiologist remains indicated to confirm diagnoses and guide further advanced treatment.

FOCUS IN CARDIAC ARREST

Bedside cardiac and non-cardiac ultrasound has become an ubiquitous adjunct in the care of the critically ill, and its use during cardiopulmonary resuscitation (CPR) is increasingly common. The Focused Echocardiographic Evaluation in Life Support (FEEL) protocol was developed for use by both cardiologists and non-cardiologists as an adjunct to advanced life support.[6,7] Its purpose is to rapidly identify or exclude potentially reversible causes of cardiac arrest, most notably pericardial tamponade, massive pulmonary embolism, severe ventricular dysfunction, hypovolaemia, and fine ventricular fibrillation that may be missed on surface electrocardiography, thereby optimising peri-resuscitation decision-making.

The American Heart Association classifies ultrasound during CPR as a **Class IIb** intervention; it may be reasonable when it can be performed without prolonging interruptions to chest compressions and when findings are integrated with standard advanced life support.[8] Performed in tightly choreographed pulse-check windows by trained operators, focused transthoracic views can rapidly gauge the presence or absence of myocardial contractility and screen for reversible causes of arrest like hypovolemia (e.g., a small, collapsible IVC), pneumothorax (loss of lung sliding), pulmonary thromboembolism (acute right-ventricular dilation/strain), and pericardial tamponade (pericardial effusion with chamber collapse).

Importantly, FEEL is intended to inform and improve resuscitative efforts rather than to justify termination of resuscitation. A systematic review for the ILCOR Advanced Life Support Task Force found that the prognostic use of intra-arrest point-of-care echocardiography is supported by very low-certainty evidence, with heterogeneous methods and high risk of bias.[9] No single sonographic finding (including "cardiac motion/standstill") demonstrates sufficient or consistent sensitivity to justify termination of resuscitation on its own. Clinicians should therefore treat echocardiographic findings as adjunctive data, useful to search for reversible causes and to guide ongoing care, while avoiding overinterpretation and ensuring that image acquisition does not interrupt high-quality chest compressions. In essence, the utilisation of ultrasound during cardiac arrest serves as a supplementary modality to ALS-compliant management, rather than being employed to determine the futility of resuscitation in isolation. Furthermore, it is imperative to implement workflows that minimise CPR interruptions and seamlessly integrate scans within the standard pulse-check intervals.

LUNG POCUS

Lung ultrasound (LUS) extends the practicality of POCUS to the pulmonary domain, offering heightened sensitivity and specificity for detecting pneumothorax, interstitial syndrome, consolidation, and pleural effusions compared to auscultation or chest radiography.[10] The standardised six-zone scanning protocols encompass the anterior, lateral, and posterior chest fields, ensuring systematic evaluation.[11] Effective LUS hinges on appropriate probe selection and scanning technique. High-frequency linear probes optimise resolution for superficial structures, such as the pleura, ideal for detecting pneumothorax, whereas curvilinear and phased-array probes penetrate deeper, facilitating the evaluation of consolidations and effusions.

Key sonographic artefacts like lung sliding (motion of the visceral-parietal pleural interface), A-lines (horizontal reverberation artefacts indicating aerated lung), B-lines (vertical artefacts signifying interstitial fluid), and the lung point (transition between normal lung and pneumothorax) are well-validated markers.[12] The presence of multiple, diffuse B-lines correlates with pulmonary edema, while localised B-line clusters adjacent to areas of consolidation suggest pneumonia. Absent lung sliding with a visible lung point is highly specific for pneumothorax. During the COVID-19 pandemic, lung ultrasound enabled bedside monitoring of disease progression and weaning readiness, thereby avoiding patient transport to radiology and reducing exposure risk to healthcare teams. Table II summarises the lung ultrasound (LUS) findings associated with various pathologies.

Table II: Common LUS signs in various respiratory pathologies

Clinical Condition	Lung Ultrasound Findings
Pneumothorax	Absent Lung sliding A-lines present No vertical artifacts No lung pulse ± Lung point
Mainstem Intubation	Absent Lung sliding A-lines present B-lines may be present Lung pulse present
Atelectasis	Absent lung sliding B-lines present Positive Lung pulse Static Air bronchogram Pulsatile flow is likely absent on Color Doppler
Pulmonary Edema	Positive lung sliding Bilateral pathologic B-lines (≥3/intercostal space) Positive lung pulse
Pneumonia	Lung hepatization Pathologic B-lines (mostly bilateral in viral and unilateral in bacterial pneumonia) Irregular pleural line (Shred sign) Dynamic air bronchogram Pulsatile flow is likely present on Color Doppler
Pleural Effusion	Anechoic area between the parietal and visceral pleura Spine sign Sinusoidal sign Plankton sign (in complex effusion)
ARDS	Pathologic B-lines with spared areas and irregular distribution Lung hepatization Dynamic air bronchogram Loss of lung sliding Pleural line irregularities

Clinical Condition	Lung Ultrasound Findings
Lung Contusion	Pathologic B-lines Lung hepatization

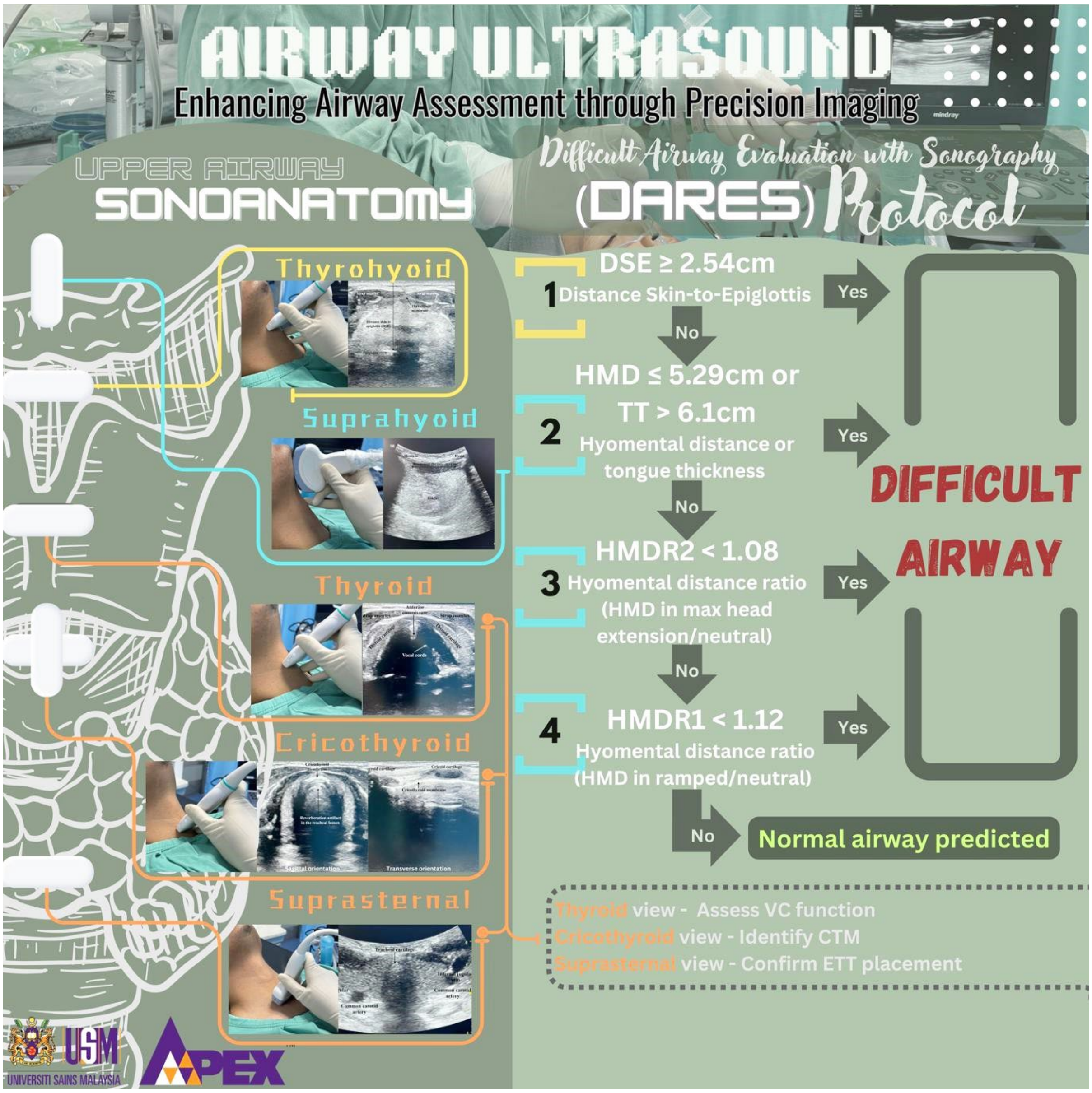
Adapted from Beshara M, Bittner EA, Goffi A, Berra L, Chang MG. Nuts and bolts of lung ultrasound: utility, scanning techniques, protocols, and findings in common pathologies. *Crit Care.* 2024 Oct 7;**28**(1):328. doi:10.1186/s13054-024-05102-y. PMID: 39375782

Standardised protocols, such as the BLUE (Bedside Lung Ultrasound in Emergency) and FALLS (Fluid Administration Limited by Lung Sonography) protocols, define scanning zones and decision algorithms, enabling the rapid categorisation of acute respiratory failure etiologies with high diagnostic accuracy.[12,13] The best-known is the BLUE protocol for the rapid evaluation of acute respiratory failure. In its simplified form, BLUE surveys three standardised "BLUE points" per hemothorax, first confirming lung sliding and then classifying profiles, in essence A (sliding with A-lines), B (sliding with B-lines), A/B (asymmetric), C (anterior consolidation), A' (A-profile without sliding), and B' (B-profile without sliding). Combined with vital signs and other clinical data, this yields high diagnostic accuracy for pulmonary edema, embolism, pneumonia, pneumothorax, and obstructive lung disease. However, the performance data comes largely from a single center with highly experienced operators, and overlap between patterns (e.g., early ARDS versus cardiogenic edema) can complicate dichotomous algorithms.

Beyond diagnosis, LUS guides therapy and monitoring. The FALLS protocol employs real-time cardiac views with LUS to sequence shock aetiologies and titrate fluids to the threshold of emerging pathological B-lines.[12,13] However, it is important to note that B-lines lack specificity and exhibit only moderate test characteristics for fluid responsiveness. To quantify disease burden and track response to treatments such as antibiotics, recruitment, or proning, severity scores like the Lung Ultrasound Score grade aeration loss from 0 (normal, ≤ 2 B-lines) to 3 (consolidation) across predefined regions, summing to a global score. Operationally, the I-AIM framework (Indication, Acquisition, Interpretation, Medical decision-making) provides a reproducible workflow, from defining the question and standardising image capture to integrating sonographic findings with history, examination, laboratory results, and imaging, underscoring the need to archive clips and document reports for follow-up and medicolegal completeness.

AIRWAY POCUS

Pre-intubation, airway ultrasound adds objectivity to bedside airway assessment. Using a linear probe over the submandibular, thyrohyoid, and suprahyoid regions, clinicians can quantify sonographic predictors of difficult airway.[14,15] The Difficult Airway Evaluation with Sonography (DARES) protocol is a concise, standardised ultrasound assessment designed to predict difficult laryngoscopy using upper-airway measurements with the strongest evidence base.[14] It limits the exam to two views - the thyrohyoid and suprahyoid - from which clinicians obtain the distance from skin to epiglottis (DSE), hyomental distance (HMD), hyomental distance ratios in ramped and extended positions (HMDR1 and HMDR2), and tongue thickness. These metrics collectively encompass the three validated domains of difficult-airway sonography: anterior neck soft-tissue thickness (TTD), anatomic position (APD), and oral space (OSD). By distilling a long list of proposed parameters into a practical two-view workflow, DARES provides an organised pre-intubation screening tool that integrates seamlessly with clinical algorithms. The authors note, however, that prospective validation is still needed to confirm its predictive utility across various settings. These parameters are summarised in Figure 1.



Adapted from Lin J, Bellinger R, Shedd A, Wolfshohl J, Walker J, Healy J, Taylor J, Chao K, Yen YH, Tzeng CT, Chou EH. Point-of-care ultrasound in airway evaluation and management: a comprehensive review. *Diagnostics (Basel).* 2023 Apr 25;**13**(9):1541. doi:10.3390/diagnostics13091541. PMID: 37174933

Figure 1: DARES two-view workflow (Winner of Best Infographic Presentation, APSS ROBAC 2025)

During and immediately after intubation, POCUS facilitates confirmation and detects malposition when capnography is unreliable (e.g., in low-flow states or during cardiac arrest). Airway ultrasound confirms endotracheal tube (ETT) placement using either a dynamic or static approach.[15,16] In the dynamic technique, a linear probe over the anterior neck visualises real-time passage of the tube across the cords as a fluttering, echogenic "snowstorm" with a characteristic bullet sign and intratracheal flutter that obliterates the tracheal cartilage reverberation artifact - findings consistent with correct tracheal intubation. In the static technique performed immediately after intubation, a transverse scan at the trachea demonstrates a single air-mucosa interface with a thin hyperechoic line posterior to the trachea when the ETT is intratracheal, whereas esophageal intubation produces a second air-mucosa interface - the "double tract"/"double bubble" sign - as the tube is seen within the esophagus lateral to the trachea.

For invasive airway procedures, in the Fourth National Audit Project on major airway complications, 52% (15/29) of cricothyrotomy attempts failed, including a 36% success rate (9/25) among anesthesiologists, with device misplacement a frequent error, suggesting that ultrasound-guided identification of the cricothyroid membrane could improve correct device placement and overall cricothyrotomy success.[17] Dynamic scanning precisely localises the cricothyroid membrane (the "string-of-pearls" of tracheal rings with an anechoic cricothyroid space), which is frequently misidentified by palpation, especially in obesity.[18,19] In percutaneous dilatational tracheostomy, longitudinal and transverse views guide midline puncture, confirm pre-tracheal depth, avoid thyroid isthmus or aberrant vessels (with color Doppler), and monitor guidewire and cannula placement, reducing posterior wall injury and bleeding.[20-22] The same approach supports the establishment of emergent surgical airways by translating uncertain surface anatomy into a clear sonographic target.

POCUS continues to add value at the far end of the airway timeline, specifically during extubation and post-extubation care. Measurement of the air-column width at the glottis while the cuff is deflated, combined with assessment of vocal cord mobility, helps predict laryngeal edema and risk of post-extubation stridor, guiding steroid administration or delayed extubation.[19,23,24] In neurologic or postsurgical patients, ultrasound can be used to screen for unilateral vocal cord paresis, informing swallow assessments and aspiration precautions. Taken together, airway ultrasonography with POCUS complements clinical examination and capnography, shortens time to definitive decisions, and raises the safety floor for both routine and high-stakes airway management, provided it is embedded in a competency-based training pathway and used alongside, not instead of, gold-standard techniques when uncertainty persists.

ABDOMINAL POCUS

POCUS is now a cornerstone of bedside haemodynamic assessment because it delivers rapid, non-invasive, and repeatable insight across the cardio-pulmonary-vascular axis. In shock, where oxygen delivery is impaired through hypovolemic, cardiogenic, obstructive, or distributive mechanisms, POCUS enables the linkage of macrocirculatory findings to actionable decisions. This involves characterising cardiac output and filling pressures, screening for venous congestion, and prioritizing dynamic over static metrics in line with contemporary sepsis guidance. By embedding cardiac, lung, and great-vessel imaging within the clinical exam, POCUS shortens time to diagnosis, individualises resuscitation, and limits the hazards of over-resuscitation and unnecessary invasive monitoring. Parameters include IVC size and collapsibility, IJV distensibility, and the venous excess ultrasound score to reflect right-sided preload and systemic congestion, while TAPSE, RVOT-VTI, and S' gauge right-ventricular systolic function and afterload status, with D-sign and TR velocity aiding inference of pulmonary pressures.[25] On the left, EPSS and fractional shortening screen systolic performance, and LVOT-VTI track stroke volume and cardiac output to guide fluid administration, inotropes, and vasopressors. Lung ultrasound quantifies extravascular lung water through B-lines, sharpening the distinction between cardiogenic and non-cardiogenic edema. Dynamic maneuvers such as passive leg raise with LVOT-VTI, end-expiratory occlusion testing, and corrected carotid flow time outperform static pressures when predicting fluid responsiveness, even when ventilation settings or arrhythmias complicate interpretation.

Venous Excess Ultrasound (VExUS) refines bedside assessment of fluid intolerance by combining IVC size with pulse wave Doppler interrogation of the hepatic, portal, and intrarenal veins to grade systemic venous congestion and its risk to organs.[25-27] The sequence is straightforward: first, measure the IVC diameter, then sample the hepatic, portal, and renal venous waveforms, which together yield a congestion score that adds context to IVC findings in volume-overloaded states. Physiologically, VExUS leverages the transmission of rising right atrial pressure to peripheral venous beds, with hepatic venous flow remaining pulsatile and closely tracking right atrial pressure. Portal flow is normally continuous, becoming pulsatile as congestion increases, and intrarenal venous flow, typically continuous, progresses to discontinuous patterns as renal venous pressure rises. Clinically, higher VExUS grades correlate with adverse outcomes across several cohorts. In cardiac surgery patients, Grade 3 VExUS strongly predicted postoperative acute kidney injury and outperformed central venous pressure. In broader ICU populations, severe grades were linked to higher mortality among patients with existing acute kidney injury and in acute decompensated heart failure. Grade 3 scores were associated with worse 100-day survival, early readmission, and renal dysfunction. Taken together, VExUS offers a structured, organ-specific view of venous congestion, enabling clinicians to balance decongestion against perfusion during resuscitation and diuresis.

VExUS demonstrated substantial interrater reliability and good interuser reproducibility for grading systemic venous congestion in a multicenter study, with agreement improving further when ECG tracings were accompanied by Doppler waveforms.[28] Variability in signals from individual venous sites, especially the renal vein, indicates overall feasibility but underscores the need for targeted training and workflows that incorporate ECG to optimise consistency.

CONCLUSION

POCUS delivers immediate, high-yield imaging at the bedside across cardiac, lung, airway, and abdomen, accelerating diagnosis, guiding targeted resuscitation, and improving procedural safety when embedded within Advanced Life Support-compliant, quality-assured workflows. Beyond this review, critical care ultrasound also encompasses transcranial Doppler for neurocritical monitoring, ultrasound-guided interventions, ultrasound-guided lung recruitment, assessment of diaphragmatic function, and DVT detection, among other applications that further expand its clinical value.

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Crisis Standard of Care - Are Malaysian Anaesthesiologists Prepared?

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Reflecting on the Recent Past…

The COVID-19 pandemic has heightened a global awareness on the role of the anaesthesiologist in crisis management. The regular person was quickly introduced to the terms of 'intubation and mechanical ventilation'. Doctors working in the intensive care unit (ICU) were hailed as *heroes without capes* who rose above an unprecedented crisis despite overwhelming pressure. Many of us witnessed first hand the transformation of the ICU and operating theatre (OT) overnight from the outset of an international health crisis. Amidst the chaos, there was careful planning to mitigate the spread of a deadly infection. It still feels surreal when we consider those trying times that led to fatigue and burnouts amongst us. Yet we stayed together and fulfilled a felt need. Even within Malaysia, intensive care doctors were mobilised to different centres in other states. We persevered through it all, and prayed earnestly for an end to our peril as frontliners.

In retrospect, there was a silver lining at the end of it. Many ICUs received upgrades with brand new mechanical ventilators from government and non-governmental organisations. Videolaryngoscopes became widely available as the expected standard of care for intubation. There was an increase in the use of high flow nasal cannulas (HFNC). Innovation was key as we survived amidst a shortage of personal protective equipment, utilising our own manpower to put together face shields and personal protective equipment. We swiftly transitioned to the use of electronic communications for family updates and documentation. The skills for intubation and performing invasive monitoring improved by leaps and bounds amongst medical officers. There was an acute need to keep abreast of the current literature available as the virus rapidly evolved. On a global stage, Malaysian healthcare workers did phenomenally well in mobilising manpower and working with other authorities to contain the pandemic.

REFLECTING ON THE CURRENT LITIGIOUS CLIMATE

Yet our times and seasons have now changed. Presently, the anaesthesiology fraternity has been jolted with the onslaught of malpractice suits in the past year. It is both disheartening and discouraging to the practising anaesthesiologist. A wave of fear spread amongst us as we considered our crisis management practices. The societies had responded to the mounting fear by encouraging the organisation of advanced airway workshops. There was greater emphasis on familiarity with performing an emergency front of neck access (eFONA) as an appropriate last resort in a 'cannot intubate, cannot ventilate' scenario.

The plight of the anaesthesiologist remains fresh as we reflect on some of these malpractice lawsuits. While nobody can be fully prepared for a crisis, we surely must rely on the need to stay calm and composed. Only then, we can take the lead based on our knowledge, experience and available resources. It is common that varying practices can be scrutinised.

Even within the fraternity, we have now learnt not to cast the stone of blame as only the attending doctor and his/her team can fully account for the events during a crisis. In a crisis scenario, it is often easier to reflect on the *'should haves'* and *'could haves'* retrospectively. This can be useful for the anaesthesiologist with a progressive mind who desires improvement but it can also be a double-edgeds word in a litigious climate. Lawyers may pick up on what is done or not done as negligence or incompetency.

This then leads to blame shifting and defensiveness in the practice of medicine. For instance, some centres may not be comfortable receiving certain cases for fear of being blamed for a poor outcome or inadequately managing the associated risks.

While the need for debriefing post crisis management and continuous learning is necessary, we must also accept that we cannot truly control every situation despite our best efforts. It is important to remain empathetic towards one another, recognising the second victim phenomenon could impact any of us in a crisis. Furthermore, there has been increased traction on education of medical law and ethics and the need for doctors to be insured in the event of a lawsuit. These are not steps taken by the pessimist, but rather important preparations made by the forward-thinking anaesthesiologist. We must warm ourselves to the idea of indemnity insurance, knowing that the outcome of a crisis has many anglesand not everyone may be on the same page with us.

REFLECTING ON OUR LIMITATIONS

It is a known fact that the anaesthesiologist is a gatekeeper of the OR and the ICU. Surgeons may disagree with cancellation of cases or refuse a change of sequence on a surgical list leading to the occasional disagreement.

Social media is full of memes that misrepresent the anaesthesiologist as a sloppy figure downing coffee and playing sudoku during a case. While these are merely for entertainment, it is well known that sometimes we shoulder the blame of not catering to the requests of our peers. We may even be guilt tripped into serving our patients and closing an eye on the ‘time of the day’ or the ‘fatigue of the staff’or ‘the lack of resources’. Many a time, we may secretly have names for colleagues who cancel cases and colleagues who readily oblige the surgeon or physician.

It is imperative that we mature in our decision making and learn to draw the line when we have limitations, both in our team and our resources. Perhaps we can also be humble to consult a superior or a fellow colleague when we are conflicted on some grey areas. Perhaps we can do well with better communication and mutual respect towards both our patients and peers. Perhaps we must be cautious with playing bravado, and yet remain confident in the most complex situations, knowing that good and safe practices and principles will get us through. Perhaps it must be made feasible to train and learn with the experts in areas that we lack and consider expanding our horizons via international exposures. Finally, with all these measures, we must again find work life balance to process our struggles and pains and have a good support group. Beyond that, we must heed the call for careful consent taking and documentation. In some cases, we must be bold to have open disclosures to ensure that we address the pain and anger of our patients and their next of kin.

REFLECTING ON THE FUTURE

They often say that *necessity is the mother of invention*. Malaysian anaesthesiologists have braved through a great storm caused by a deadly virus that claimed millions of lives. We have been challenged to be on our toes with our skills and standards of practice.

While crisis management remains the *bread and butter* of our practice, we shall not shrink back because of our recent predicaments as a fraternity. Neither must we take anything for granted, upholding the need for a clear mind while at work, good team effort, continuous learning, planning in anticipation of an unexpected outcome and recognising personal and geographical limitations.

POCUS Assisted Resuscitation in Paediatrics

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INTRODUCTION

Point-of-care ultrasound (POCUS) has emerged as a transformative adjunct in the resuscitation of paediatric patients. In critical situations, particularly cardiac arrest and peri-arrest scenarios, accurate and timely information is crucial, and POCUS allows the treating anaesthesiologist to obtain real-time diagnostic insights at the bedside. Traditionally, paediatric resuscitation relies on clinical examination and adjuncts such as monitors and laboratory tests, but POCUS now fills a gap by providing immediate visualisation of internal anatomy and physiology, with anaesthesiologists and other acute care physicians now integrating portable ultrasonography in the perioperative period to guide critical decisions in real-time.[1] Modern paediatric advanced life support guidelines explicitly encourage the use of focused ultrasound during resuscitation, for example, recommending "thoracic ultrasound" in the breathing assessment and "point-of-care cardiac ultrasound" in circulatory assessment.[2] The rationale is clear; POCUS can rapidly identify reversible causes of arrest or shock (the "4 H's and T's") and guide life-saving interventions without the delays of formal testing and imaging. This chapter will review the clinical applications of POCUS during paediatric resuscitation in the operating room, covering airway management, respiratory and cardiovascular assessment, trauma evaluation, shock differentiation, and ultrasound-guided procedures.

CLINICAL APPLICATIONS OF POCUS IN PAEDIATRIC RESUSCITATION

POCUS can be applied to virtually every aspect of paediatric resuscitation, broadly spanning diagnostic assessments and procedural guidance.[3,4] Its role can be conceptualised along the "ABCDE" priorities of resuscitation; ensuring Airway patency, assessing Breathing, supporting Circulation, identifying Disability (e.g. neurologic or abdominal pathologies), and Exposure (full body survey, such as in trauma). In practice, a multi-organ POCUS approach in an unstable child allows the clinician to rapidly narrow the differential diagnosis and identify life-threatening, treatable causes of deterioration such as cardiac tamponade, pneumothorax, severe hypovolaemia, or cardiac dysfunction, thus expediting the initiation of life-saving interventions.[5,6] Key applications of POCUS in paediatric resuscitation are summarised in Table I.

Collectively, these applications make POCUS a versatile and key extension of the clinician's exam. Beside ultrasound has been shown to improve diagnostic accuracy and streamline management of acutely ill paediatric patients.[3,4] In a study conducted in the paediatric intensive care setting, incorporating POCUS into clinical evaluation altered or provided further clarification of the haemodynamic status in 67% of children diagnosed with septic shock.[7] Another study demonstrated that integrating POCUS into fluid management decisions led to significantly less fluid overload and fewer diuretic requirements without delaying shock resolution.[8] Although formal imaging (e.g. radiography, comprehensive echocardiography) remains essential for full diagnostic evaluation, the immediacy and focus of POCUS enable it to answer critical yes/no questions during resuscitation (e.g. "Is there cardiac activity?", "Is the pleural line sliding?", "Is there free abdominal fluid?") with a high degree of reliability.[3,5] The following sections summarise the evidence and techniques for each major application of POCUS in paediatric resuscitation.

Table I: Key Clinical Applications of POCUS in Paediatric Resuscitation

Airway management	• Confirming endotracheal tube placement and patency • Assessing adequacy of ventilation (e.g. detection of endobronchial intubation) • Assessing airway anatomy (e.g. identification of icothyroid membrane for emergency front of neck access) • Estimating optimal endotracheal tube size
Breathing (Respiratory) assessment	• Evaluation of lung pathology such as pneumothorax, pleural effusions, pulmonary oedema, atelectasis and pneumonia
Circulation (Cardiovascular) assessment	• Focused cardiac ultrasound (echocardiography) to assess cardiac contractility, chamber size, volume status, and the presence of pericardial effusion or cardiac tamponade • Shock differentiation and haemodynamic monitoring
Trauma assessment	• Performance of Focused Assessment with Sonography for Trauma (FAST) or extended FAST (eFAST) exam to detect free fluid in the abdomen, hemothorax, pneumothorax, or pericardial effusion
Ultrasound-guided procedures	• Facilitate performance of vascular access (venous or arterial), thoracocentesis and chest tube insertion, pericardiocentesis and nerve blocks for pain management

Airway Management

Securing a patent airway is the foremost priority in paediatric resuscitation, and POCUS can assist in multiple aspects of airway management. One of its key roles is in confirming endotracheal tube (ETT) placement. Real-time ultrasound of the anterior neck can immediately verify if an ETT is correctly placed in the trachea rather than the oesophagus; by observing the ETT within the trachea rings in conjunction with absence of a “double tract” sign which is seen in inadvertent oesophageal intubation.[9] This rapid confirmation can be especially useful during cardiopulmonary resuscitation (CPR) when capnography or clinical assessment may be unreliable. A recent systematic review of airway ultrasound in paediatrics concluded that airway ultrasound has unique advantages for confirming successful intubation in children and can quickly differentiate tracheal and oesophageal intubation, with reported diagnostic accuracy as high as 90% in several studies.[9] Even in neonates and infants, where traditional methods such as auscultation and carbon dioxide detection have limitations, studies have found that POCUS is a fast and effective technique to verify correct placement of the ETT.[10] Furthermore, ultrasound can be used to assess ETT depth via detection of mainstem endobronchial intubation. By visualising bilateral lung sliding or diaphragmatic movement, the operator can ensure both lungs are ventilated symmetrically.[9] Ventilation of only one lung, e.g. in a mainstem endobronchial intubation, will reveal absence of pleural sliding on the contralateral side, prompting adjustment of the ETT position until ventilation is seen in both lungs. A prospective study found that a concise ultrasound protocol, comprising a three-point scan of the neck and both lungs, was highly accurate in identifying oesophageal or endobronchial intubation in a paediatric emergency setting.[11] (Figure 1)

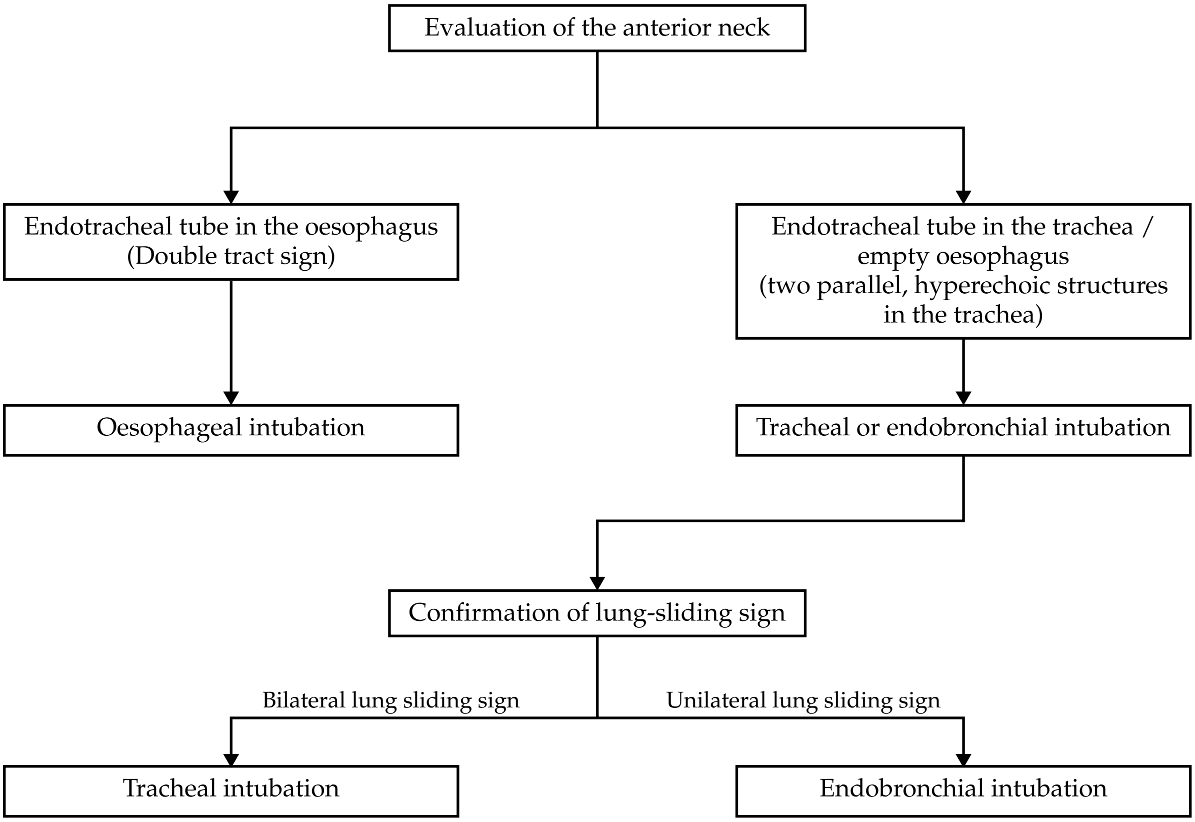

Figure 1: 3-point approach to detect oesophageal or endobronchial intubations (adapted from Mori et al, 2018)

An additional airway application of POCUS is in selection of appropriate ETT size. Traditional ETT sizing in paediatrics relies on age-based formulae, which are imprecise and often result in multiple intubation attempts to find the right fit.[9] Ultrasound measurement of the subglottic airway diameter at the cricoid level has been shown to dramatically improve sizing accuracy with lower frequencies of tube exchange compared to age-based calculation.[12,13] In one study, ultrasound-based sizing was 87.8% accurate, versus only 27.5% accuracy using age formulae, and significantly reduced the need for exchanging tubes that were too tight or too loose (tube exchange rate 12% with ultrasound vs 52% by formula).[14] This is highly relevant in emergency intubations where time and airway trauma must be minimised. Operators can perform a quick transverse scan at the level of the cricoid cartilage to estimate the subglottic diameter and choose a best-fit ETT, which can increase first-pass success. (Figure 2)

Airway ultrasound can also identify airway pathology such as upper airway swelling, a neck mass compressing the airway, vocal cord dysfunction, or the presence of a foreign body in the upper airway.[12,15-17] While the need for emergency front of neck access (eFONA) in a "can't intubate, can't oxygenate" scenario in children remains thankfully rare, identification of the cricothyroid membrane (CTM) by digital palpation has been shown to be inaccurate in various paediatric age groups.[18] Ultrasound can be used in premarking the CTM in an anticipated difficult airway, though there is limited evidence to support its use particularly in infants and small children.[19] In summary, POCUS extends the clinician's view to the hidden airway and allows more precise, real-time decisions in airway management.

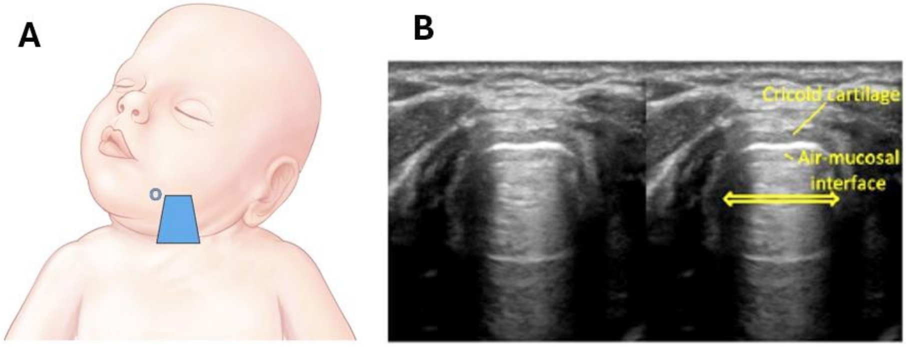

Figure 2: Airway ultrasound. (A) Placement of the ultrasound transducer with the orientation marker (o) towards the patient's right side with the neck in extension. (B) Transverse view of the anterior neck to measure tracheal diameter for appropriate endotracheal tube size. (adapted from Pan et al, 2023)

Respiratory Assessment

Respiratory failure and distress are common paediatric emergencies, and lung ultrasound (LUS) has become an indispensable tool for their evaluation. In paediatric intensive care and emergency settings, LUS can accurately diagnose a variety of pulmonary conditions with greater sensitivity than chest radiography without the risks of radiation exposure.[20] Healthy aerated lung is mostly air and thus "invisible" to ultrasound, but disease processes that increase lung density (e.g. consolidation, interstitial oedema, atelectasis) create characteristic ultrasound artifacts and images. Clinicians have learned to interpret these signs to differentiate among causes of respiratory distress:

- **Pneumonia and consolidation:** LUS visualises pneumonia as areas of lung consolidation, often appearing as tissue-like, liver-like echotexture (hepatisation) of the lung with dynamic air bronchograms (moving bright echoes of air in bronchi with respirations).[20,21] The pleural line overlying a pneumonia may be irregular or fragmented, and a parapneumonic pleural effusion may be present. In paediatric studies, LUS has shown excellent diagnostic performance for pneumonia, frequently out-performing chest radiography. A meta-analysis encompassing over 1,500 children found that LUS has pooled sensitivity of 95.5% and specificity of 95.3% for diagnosing childhood pneumonia, compared to chest radiography which had a sensitivity and specificity of 86.8% and 98.2% respectively.[22]

- **Bronchiolitis and asthma:** in predominantly airway diseases like bronchiolitis or acute asthma, LUS often shows a normal aeration pattern (A-lines and lung sliding) in many lung regions, because the pathology is bronchiolar obstruction rather than alveolar fluid accumulation.[20] One study noted that A-lines were the most frequent finding in bronchiolitis and asthma, helping distinguish them from pneumonia which had more consolidations and B-lines.[23] Thus, a normal LUS in a child with respiratory distress might steer the clinician to consider an asthmatic or bronchospastic cause, whereas visualisation of subpleural consolidations and effusion would favour pneumonia. Ultrasonographic pleural line assessment can also be useful; a smooth, sliding pleural line with A-lines suggests airway disease rather than primary parenchymal disease.[20]

- **Pulmonary oedema and interstitial syndrome:** presence of multiple B-lines, vertical, ray- like artifacts arising from the pleural line, indicates increased lung water or decreased aeration. (Figure 3) In children, presence of more than 2-3 B-lines per intercostal space is considered pathological and suggests and alveolar-interstitial process.[24] Diffuse bilateral B-lines can indicate cardiogenic pulmonary oedema or acute respiratory distress syndrome (ARDS). Thus, LUS can help differentiate diffuse processes such as cardiogenic pulmonary oedema, which tends to produce bilateral and symmetric B-lines, from ARDS, which produces bilateral but more heterogenous B-lines with spared areas, and from pneumonia, which typically results in focal or unilateral B-lines.[20]

Figure 3: B-mode lung ultrasound. Presence of multiple B-lines (*) suggestive of an alveolar interstitial process. (adapted from Chidini et al, 2024)

- **Pneumothorax:** POCUS is extremely sensitive for pneumothorax detection and is now the preferred modality in critical care for rapid diagnosis.[20] The classical signs on LUS are absence of lung sliding and absence of B-lines, often accompanied by a pathognomonic lung point, the point on the chest wall where normal sliding lung contacts the pneumothorax, visible as an alternating appearance of sliding versus no-sliding on B-mode or change of "Barcode sign" into a "Seashore sign" on M-mode.[25] (Figure 4). A meta-analysis comparing neonates and adults found LUS to be highly effective in the diagnosis of pneumothorax in neonates with a sensitivity and specificity of 96.7% and 100% respectively.[26] In any critically ill child with sudden hypoxemia or hypotension on a ventilator, a quick check for lung sliding on each side can promptly identify a tension pneumothorax requiring urgent decompression. Given its speed and accuracy, LUS is now an integral part of the eFAST exam in paediatric trauma to screen for pneumothorax, and guidelines strongly endorse its use in this context.[27]

- **Pleural effusion:** ultrasonography is the gold standard for pleural effusion detection; even small fluid accumulations of a few millilitres can be seen as an anechoic or hypoechoic layer in the costophrenic angle on ultrasound, whereas they would remain occult on a chest radiograph.[28] (Figure 5) Additionally, POCUS can characterise an effusion, simple versus complex septated effusions and quantify the volume to some extent.[20] In paediatric pneumonia, ultrasound can guide the decision for drainage by revealing loculations or fibrinous septations in the effusion that indicate that is it an empyema. Moreover, ultrasound-guided thoracocentesis is considered standard practice, with real-time imaging or pre-procedural marking shown to increase success and reduce complications such as organ puncture, especially in children where safe zones are relatively smaller.[20] Current guidelines recommend use of POCUS to guide appropriate site and depth of pleural fluid drainage.[27]

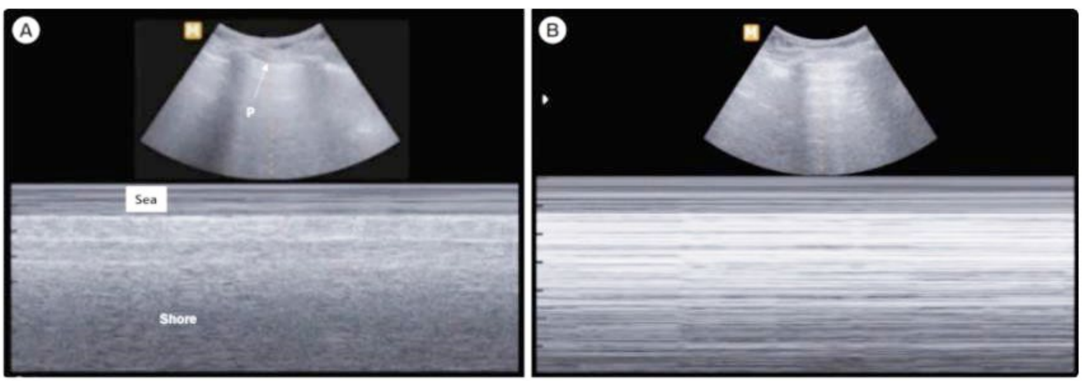

Figure 4: M-mode lung ultrasound. (A) Normal lung with sea-shore sign in M-mode. P indicates the pleural line. (B) Pneumothorax with the barcode sign in M-mode indicating no movement below the pleural line. (adapted from Choi et al, 2023)

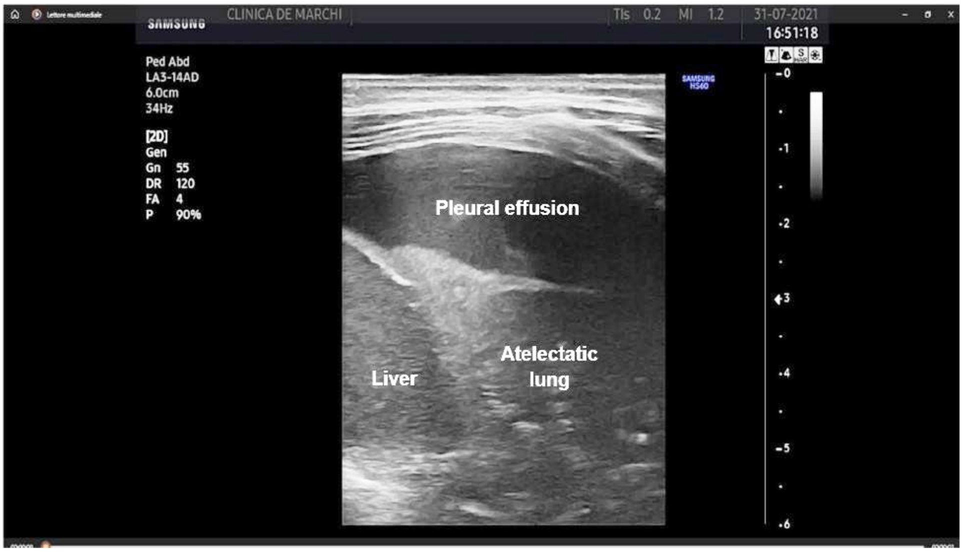

Figure 5: B-mode lung ultrasound with pleural effusion. (adapted from Chidini et al, 2024)

In summary, LUS has revolutionised paediatric respiratory assessment during resuscitation. It allows rapid bedside distinction between pneumonia, atelectasis, asthma, pulmonary oedema, and pneumothorax, diagnoses that traditionally required chest radiographs or CT scans, and provides immediate guidance for therapeutic decisions such as chest tube insertion with potentially life- saving implications.

Cardiovascular Assessment

During paediatric resuscitation, rapid and accurate cardiovascular assessment is essential to determine the cause of haemodynamic collapse and to guide appropriate therapy. Focused cardiac ultrasound, a component of POCUS, allows the operator to evaluate cardiac function, chamber size, volume status, and the presence of pericardial effusion within seconds.[29] Even qualitative visual assessments can be extremely informative, for instance, presence of poor cardiac contractility suggests cardiogenic shock, whereas a "hyperdynamic", and under-filled heart with near-complete chamber collapse suggests severe hypovolemia. The American Society of Echocardiography endorses the use of cardiac POCUS for evaluation of the physiologic causes and subsequent effects of hypotension, shock, and circulatory arrest, including preload and volume responsiveness, qualitative left ventricular systolic function and right ventricular size and systolic pressure, as well as presence of pericardial effusion.[30] In practice, a focused echocardiographic exam during paediatric resuscitation should include windows such as the subcostal (subxiphoid) four-chamber and parasternal long-axis or short-axis, which can be obtained even during CPR pauses or with minimal disruption.[29] (Table II)

Children in shock present a diagnostic challenge; different etiologies (hypovolemic, distributive/ septic, cardiogenic, obstructive) require different treatments, yet clinical signs such as tachycardia, hypotension, and poor peripheral perfusion, can appear similar across subtypes. POCUS offers the ability to differentiate types of shock at the bedside by revealing the underlying physiology and to continually monitor the child's response to therapy in a noninvasive manner.[12,27] Structured shock ultrasound protocols like the Rapid Ultrasound in Shock & Hypotension (RUSH) have been adapted to the paediatric population to assist clinicians in pinpointing the predominant cause of shock in a matter of minutes.[31,32] Typical cardiac POCUS findings in different types of shock are summarised in Table III.

Table II: Essential Imaging Windows for Cardiac POCUS

Window	Transducer Position	Potential Goals
Subcostal 4-chamber 		• Assessment for pericardial and/or pleural effusion • Assessment of biventricular systolic function
Apical 4-chamber 		• Assessment of LV and RV size and systolic function • Assessment for gross atrial dilation • Assessment for pericardial effusion
Subcostal IVC 		• Qualitative assessment of IVC size and hydration status
Parasternal Short Axis 		• Assessment of LV and RV size and systolic function • Assessment of interventricular septal configuration • Assessment for pericardial effusion
Parasternal Long Axis 		• Assessment of LV size and systolic function • Assessment for pericardial effusion

Arrows indicate direction of index marker. 1, aortic valve; 2, mitral valve; IVC, inferior vena cava; LA, left atrium; LV, left ventricle; RA, right atrium; RV; right ventricle; Ao; aorta Adapted from Boretsky et al, 2019, & Lu et al, 2023

Table III: Cardiac POCUS Findings in Different Types of Shock

Type of Shock	Heart	IVC	Abdomen	Lungs	Diagnosis
Cardiogenic	Hypokinetic, dilated	Plethoric	Normal	Interstitial fluid (e.g. B-lines)	Heart failure (e.g. myocarditis)
Obstructive	Pericardial effusion Right ventricle strain	Plethoric	Normal	Absent lung sliding (e.g. pneumothorax)	Cardiac tamponade Tension pneumothorax Massive pulmonary embolism
Hypovolaemic	Hyperkinetic	Collapsed	Positive FAST (e.g. trauma)	Normal	Haemorrhage, Dehydration
Distributive	Hyperkinetic	Normal or collapsed	Normal	Possible features of pneumonia	Sepsis Neurogenic shock Anaphylaxis

IVC, inferior vena cava; FAST, Focused Assessment with Sonography in Trauma Adapted from Park et al, 2015, & Assies et al 2025

Critically, cardiac ultrasound can identify pathologies that are immediately treatable. For example, a pericardial effusion causing cardiac tamponade can be rapidly seen as an anechoic fluid collection compressing the heart, signalling the need for urgent pericardial drainage, while detection of ventricular dysfunction or acute right ventricular dilatation might indicate cardiogenic shock or massive pulmonary embolism respectively.[33-35] Cardiac POCUS can also guide the management of cardiac arrest rhythms; in pulseless electrical activity (PEA), the presence of coordinated cardiac motion on ultrasound suggests pseudo-PEA and influences the decision to continue resuscitation, whereas true standstill without motion is often a poor prognostic sign.[36] Current resuscitation guidelines highlight that trained providers may use POCUS during cardiac arrest to identify reversible causes provided that there is no interruption to provision of high- quality chest compressions.[2] Imaging is best performed during the brief pauses for rhythm checks, with the team preplanning the ultrasound exam to maximise the information obtained in a 10- second pause.[2,29] Similar to adults, the subcostal four-chamber view is recommended as the imaging window of choice in the event of cardiac arrest and CPR due to ease of performance and minimal disruption to chest compressions.[29] When used in this focused manner, cardiac POCUS has been shown to improve diagnostic accuracy for causes of cardiac arrest and shock.

Ultrasound-Guided Procedures

Beyond its diagnostic applications, one of the most concrete benefits of POCUS in paediatric resuscitation is improving the safety and success of procedures. Key procedures enhanced by POCUS are summarised in Table IV.

Table IV: Key Procedures During Resuscitation Enhanced by POCUS

- Venous access: central and peripheral
- Arterial cannulation
- Thoracostomy and needle decompression
- Pericardiocentesis
- Nerve blocks and regional analgesia

At present, ultrasound-guided internal jugular vein catheterisation is regarded as the standard approach for central venous access in pediatric populations.[37] Although the supporting data for subclavian and femoral vein cannulation is comparatively limited, available literature indicates a reduction in complication rates when ultrasound guidance is employed.[38] Furthermore, ultrasonography serves as a valuable tool for verifying the position of catheter tips in central venous cannulation, demonstrating high concordance with conventional chest radiography for tip localisation in pediatric patients.[39] In the context of arterial cannulation in children, a Cochrane systematic review demonstrated that ultrasound guidance significantly improves first-attempt success and lowers the incidence of complications.[40] Ultrasound has also proven advantageous in facilitating peripheral venous access among pediatric patients. A randomised trial found that ultrasound-guided peripheral intravenous insertion yields higher success rates on the first attempt and extends the lifespan of the inserted line when compared to traditional techniques.[41] In all these procedures the overarching theme is that ultrasound guidance improves outcomes. It increases success rates, often halves or more the complication rates, and speeds up procedure completion in many cases.[20,27] This is crucial in resuscitation where failed attempts can cost valuable time or cause harm. Given the small margin for error in children, the role of POCUS in procedures cannot be overstated.

CONCLUSION

As with any clinical tool which is largely operator-dependent, it is important for all operators and resuscitation team members to understand that POCUS has its limitations. Image quality can be suboptimal in certain circumstances and both false negatives and positives can occur, hence clinicians must synthesize POCUS findings with the whole clinical picture rather than interpreting ultrasound findings in isolation.

Nevertheless, POCUS in paediatric resuscitation exemplifies the paradigm of modern critical care; immediate, patient-focused, and data-informed intervention. It has fundamentally enhanced the conduct of paediatric resuscitation, serving as a bridge between clinical suspicion and definitive diagnosis at the bedside. In the hands of anaesthesiologists, it provides immediate visual answers in scenarios where time is critical, and uncertainty abounds. The evidence base, though still evolving, consistently demonstrates that paediatric POCUS is a powerful adjunct that complements and augments traditional clinical assessment. With continued education and research, POCUS is posed to become an integral, standard component of paediatric advanced life support. The ultimate goal is that every critically ill or injured child has the benefit of both excellent clinical acumen and real-time ultrasound insight in those pivotal moments, thereby ensuring the best possible outcome for our young patients.

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Standardising Anaesthesia for Endovascular Thrombectomy: Experience from Hospital Sultan Abdul Aziz Shah and Challenges in the Malaysian Context

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INTRODUCTION

In acute stroke management, the maxim "time is brain" is a central guiding principle. Saver quantified this urgency starkly: approximately 1.9 million neurons are lost each minute in the context of untreated large vessel occlusion.[1] While this quantifiable urgency (1.9 million neurons lost per minute) is profound in theoretical terms, its critical implications are most acutely observed in clinical practice, particularly within environments like an angiography suite where prolonged delays directly threaten irreversible neurological damage.

The advent of reperfusion therapies has reshaped stroke care. Intravenous thrombolysis is recommended within 4.5 hours of onset. Alteplase, a recombinant tissue plasminogen activator (rt-PA), is a thrombolytic agent administered at a weight-based dose of 0.9mg/kg (maximum 90mg). The regimen consists of a 1-minute bolus of 10% of the total dose, immediately followed by a 60-minute infusion of the remaining 90%. Endovascular thrombectomy (EVT) on the other hand, has extended therapeutic benefit up to 6-24 hours in selected patients, as demonstrated by the DWI or CTP Assessment with Clinical Mismatch in the Triage of Wake-Up and Late-Presenting Strokes for Neuroprotection (DAWN) and Diffusion and Perfusion Imaging Evaluation For Understanding Stroke Evolution 3 (DEFUSE-3) trials.[2,3] These interventions are only effective when supported by an efficient healthcare delivery system. Unfortunately, delays are common, whether in ambulance transfer, emergency department triage, imaging, or procedural consent.

In Malaysia, national Clinical Practice Guidelines (CPG) emphasise rapid imaging, timely reperfusion, and coordinated care pathways.[4] These recommendations provide a framework for institutions like HSAAS to align their local protocols with broader national standards.

At HSAAS, the RESQ protocol seeks to streamline this process. Upon activation of "Stroke Code Red or Yellow," a multidisciplinary team comprising neurology, radiology, interventional radiology, intensive care, and anaesthesiology is mobilised.[5] While this provides early integration of services, the practical role of anaesthesiologists remains conditional, shifting from standby to active involvement only when airway instability, agitation, or haemodynamic compromise necessitates intervention.

THE RESQ PROTOCOL: PROACTIVE IN STRUCTURE, REACTIVE IN EXECUTION

The RESQ protocol for acute stroke care is a dynamic, time-stratified system initiated upon patient arrival at the emergency department. The immediate determining factor for the clinical pathway is the time of symptom onset, which triggers one of two distinct alerts: a "Code Stroke RED" for patients within the hyperacute 4.5-hour window, or a "Code Stroke Yellow" for those presenting in the 4.5 to 24-hour timeframe. This initial stratification is critical, as it mobilises a specific multidisciplinary team and establishes aggressive, time-sensitive targets for intervention.

Within the "Code Stroke Red" pathway, the focus is on a rapid, parallel evaluation for both intravenous thrombolysis (IV rtPA) and endovascular thrombectomy (EVT). This protocol mandates a seamless workflow from the door through imaging to treatment, targeting computed tomography (CT)/CT angiography(CTA) completion within 20 minutes and a door-to-needle time for rtPA of under

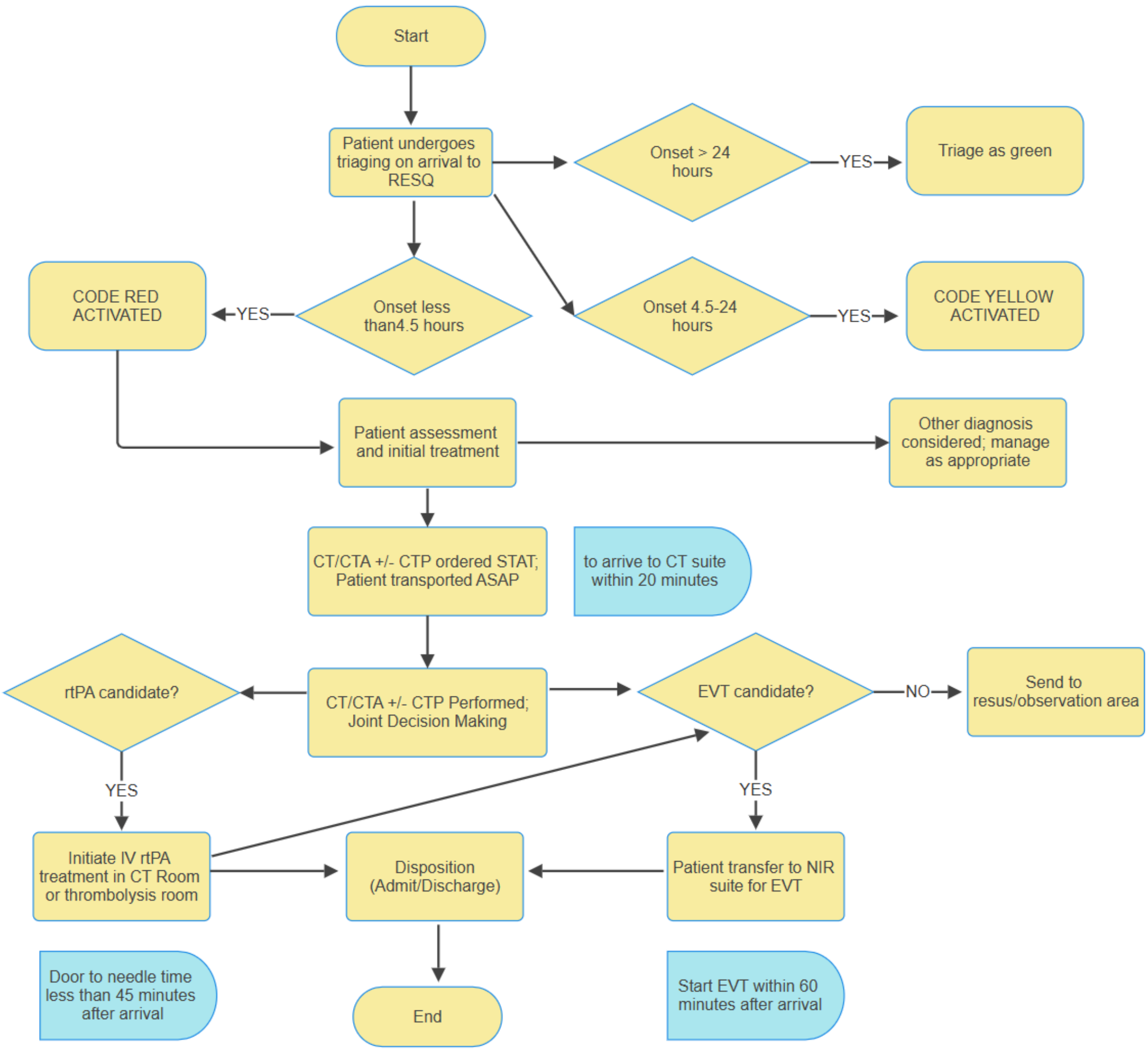

Figure 1: The clinical RESQ protocol for stroke patients presenting in less than 4.5 hours and extended 4.5 to 24-hour window. The workflow prioritizes rapid imaging and assessment for rtPA and endovascular thrombectomy candidate. Abbreviations: **ASAP** = as soon as possible; **CT** = computed tomography; **CTA** = CT angiography; **CTP** = CT perfusion; **CT suite** = CT imaging room; **Disposition** = admit/discharge decision; **Door-to-needle time** = time from hospital arrival ("door") to initiation of IV thrombolysis ("needle"); **EVT** = endovascular therapy (mechanical thrombectomy); **IV** = intravenous; **NIR** = neuro-interventional radiology; **Resus** = resuscitation area; **rtPA** = recombinant tissue plasminogen activator (IV thrombolysis); **STAT** = immediate/urgent order; **Triage** = acuity-based sorting on arrival; **CODE RED/CODE YELLOW** = internal activation codes for acute stroke pathways (<4.5 hours and 4.5-24 hours from onset, respectively); **RESQ** = Regional Emergency Stroke Quick Response

Source and note: Figure modified from the original HPUPM/UPM RESQ Stroke SOP document flowcharts for <4.5 hours and 4.5-24 hours pathways; content unchanged, layouts combined into a single diagram for clarity.

45 minutes. The workflow explicitly integrates decision-making for both modalities, ensuring eligible patients receive thrombolysis while being simultaneously assessed for mechanical clot retrieval **(Figure 1)**.

In contrast, the "Code Yellow" pathway for the late-window cohort is primarily focused on assessing candidacy for EVT **(Figure 1)**. While the initial triage and imaging steps mirror the hyperacute protocol, the central objective is performing advanced imaging (CT/CTA +/- CT perfusion (CTP)) to identify salvageable brain tissue. This informs the joint decision on thrombectomy, with the protocol targeting procedure initiation within 60 minutes of arrival.

While anaesthesiologists are integrated into the initial activation for both pathways, their direct intervention is purposefully reactive. For stable patients who can cooperate, EVT may proceed under conscious sedation with anaesthesiology on standby. However, the anaesthesiologist's role becomes primary in cases of airway compromise, significant agitation, or a low Glasgow Coma Scale, where they manage general anaesthesia and haemodynamic stability. This structured yet adaptable model aligns with international guidelines from the American Heart Association and European Stroke Organisation, illustrating the paradox of the anaesthesiologist's role in modern stroke care: integral to the system's readiness, but strategically reactive in its execution.

Although anaesthesiologists are included in the initial notification loop, their active engagement depends on patient-specific factors. If the patient demonstrates cooperation, stable airway reflexes, and minimal agitation, EVT may proceed under conscious sedation managed by interventional radiology, with anaesthesiology on standby.[2,5,6]

Conversely, should patients exhibit airway risk, restlessness, vomiting, or a low Glasgow Coma Scale, anaesthesiologists assume a primary role by administering induction, securing the airway, establishing invasive monitoring, and managing haemodynamics.[2,5,6]

This structured approach, as outlined in the RESQ SOP, is consistent with both the American Heart Association and European Stroke Organisation recommendations, underscoring its alignment with international standards of acute stroke care.[2,5,6]

This reflects the paradox of their role; integral to the activation process, yet frequently reactive in practice.

ANAESTHESIOLOGISTS AND THE TEMPORAL ARITHMETIC OF STROKE CARE

Stroke management is measured in discrete time intervals, such as door-to-imaging, door-to-needle, and door-to-puncture; each delay in these metrics carries significant clinical implications.

Anaesthesiologists are sometimes perceived as contributors to delay, particularly during intubation and stabilisation. However, their involvement prevents more harmful setbacks such as failed sedation, aspiration, or intra-procedural haemodynamic collapse. Their value can be described through four key contributions:

- Readiness: Early notification ensures preparedness for immediate intervention without delay.

- Clarity of decision-making: Pre-set criteria for conscious sedation versus general anaesthesia (GA) reduce uncertainty, even under pressure.

- Physiological optimisation: Careful control of blood pressure, oxygenation, and glucose reduces the risk of secondary injury.[2]

- Continuity of care: Anaesthesiologists provide stability during transitions across emergency, imaging, angiography, and intensive care.

Consequently, although their involvement might extend specific time intervals, it ultimately mitigates systemic risks, thereby safeguarding patient outcomes.

INTERNATIONAL COMPARISONS

In Europe and the United States, consensus guidelines favour conscious sedation as the first approach,[6] reserving GA for patients unable to tolerate sedation. Early observational studies suggested that sedation reduces delays.[7] However, randomised trials, such as General Or Local Anesthesia In Intra-Arterial Therapy (GOLIATH) and Anesthesia During Stroke (ANSTROKE), have shown that GA can achieve comparable functional outcomes when induction is rapid and haemodynamics are tightly controlled.[8-10] Consequently, the debate has shifted from "sedation versus GA" to the quality and execution of the technique.

Regional practice varies. Singapore and Thailand employ hybrid approaches, beginning with sedation but converting promptly when instability occurs. In Malaysia, heterogeneity persists. While HSAAS has embedded anaesthesiologists within the activation framework, other centres such as Hospital Kuala Lumpur, Penang, and Sarawak adopt differing models. Some relying on neurologists or interventional radiologists for sedation, involving anaesthesiology only if complications arise.

DISCUSSION

The Malaysian Clinical Practice Guidelines (CPG) emphasise the importance of minimising in-hospital delays, encouraging hospitals to adopt streamlined workflows and multidisciplinary coordination.[4] Incorporating these national standards into local practice helps reduce variability and ensures alignment with internationally recognised benchmarks.

The contrasting approaches seen internationally and regionally highlight the continuing uncertainty surrounding anaesthesia management in EVT. While guidelines provide broad recommendations, their practical implementation is deeply influenced by local resources, staffing models, and institutional culture.

Recent randomised trials have demonstrated that GA does not necessarily worsen outcomes compared to conscious sedation in endovascular stroke therapy. The GOLIATH[8] and Simonsen[9] trials both reported that infarct growth and functional outcomes were comparable between the two strategies, with GA even showing higher rates of successful reperfusion and favourable neurological recovery. Similarly, the ANSTROKE[10] trial found no significant difference in outcomes when induction was performed rapidly and haemodynamic stability was maintained, shifting the debate from 'which technique is superior' to the quality and execution of anaesthetic management. Collectively, these studies[8-10] suggest that the negative perception of GA is largely related to delays in induction and poor haemodynamic control, rather than the technique itself.

This underscores the need for training programmes that emphasise rapid sequence induction, haemodynamic vigilance, and multidisciplinary teamwork.

The overall general condition of the patient is another crucial factor that influences the decision to administer GA. Conscious sedation is generally appropriate for cooperative patients who maintain airway reflexes; however, in individuals with a low Glasgow Coma Scale or significant agitation, deferring intubation until instability arises may paradoxically prolong the procedure compared to a planned, early induction. In such scenarios, the expertise of anaesthesiologists becomes particularly evident as they expertly balance the competing demands of efficiency and safety in situations where the available evidence can be complex.

The persistence of heterogeneity across Malaysian centres is shaped by disparities in staffing models, availability of 24 hours a day anaesthesia coverage, and critical care capacity, as well as by the absence of a unified national guideline on anaesthesia for EVT. As a result, hospitals are often forced to adapt flexibly to local resources, but this adaptability comes at the cost of inconsistent patient outcomes.

In some centres, sedation is primarily managed by interventional radiologists or neurologists, with anaesthesiologists only called in during emergencies. Such a reactive approach not only increases the risk of compromised patient safety but may also prolong procedures if unanticipated complications arise.

CHALLENGES WITHIN MALAYSIA

Several systemic barriers complicate anaesthetic integration in stroke care:

- Workforce limitations: Many centres cannot provide dedicated 24/7 anaesthesia coverage for EVT.
- Delayed transfers: Patients referred from non-EVT hospitals often arrive beyond therapeutic windows.
- Variability in practice: Absence of national guidelines results in inconsistent anaesthesia involvement and variable time metrics.
- Critical care constraints: Limited ICU capacity forces competition between stroke patients and other critically ill groups, undermining post-procedural care.

FUTURE DIRECTIONS

To address these challenges, several strategies are proposed:

- Development of a national consensus guideline on anaesthesia for EVT, encouraging uniform practice.
- Structured training pathways for junior anaesthesiologists, ensuring competency in stroke pathways beyond ad hoc exposure.
- Expansion of the National Stroke Registry to include anaesthesia-specific metrics, facilitating clearer outcome attribution.
- Local research comparing anaesthetic approaches in Malaysian patient populations.
- Incorporation of technological innovations, including pre-hospital stroke alerts and telemedicine triage, to reduce delays.

Beyond these, strengthening multidisciplinary teamwork will be central. EVT represents a high-stakes intervention where neurology, radiology, and anaesthesiology intersect. A shared mental model, fostered through simulation training and cross-departmental collaboration, may prove as valuable as any guideline. Furthermore, integrating stroke management drills such as simulation practice into anaesthesiology training curricula could help young clinicians build confidence and familiarity with this time-critical pathway.

CONCLUSION

Stroke exemplifies an emergency in which every minute carries profound implications for outcome. At HSAAS, the RESQ protocol demonstrates the benefit of embedding anaesthesiologists from the outset, ensuring preparedness for complications while supporting continuity of care. The critical task ahead is to translate these institutional practices into nationwide standards, so that all patients, regardless of location, can benefit from timely and consistent stroke management.

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Safeguarding Lives in Health Emergencies: The Expanding Role, Innovation, and Preparedness of Anaesthesiologists

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INTRODUCTION

Health emergencies remain a pressing challenge for healthcare systems worldwide. From natural disasters and pandemics to everyday crises such as airway obstruction, shock, trauma, and obstetric emergencies, their impact on lives and health services is profound.[1]

In Malaysia, natural disasters, road traffic accidents, and infectious outbreaks place constant strain on the healthcare system. At the frontline of every crisis, anaesthesiologists safeguard lives through expert airway management, advanced ventilation, circulatory stabilisation, and critical care that extend beyond the operating theatre.[2] The COVID-19 pandemic further highlighted that health system resilience depends on the availability of trained anaesthesiologists and access to essential equipment.[3]

AIRWAY AND CRITICAL RESUSCITATION IN EMERGENCIES

Airway obstruction represents one of the most time-critical health emergencies encountered in anaesthetic practice. Whether due to trauma, infection, or malignancy, delayed intervention can rapidly result in hypoxia, cardiovascular collapse, and death. Anaesthesiologists are often the first responders, bringing expertise in airway assessment, awake techniques, and resuscitative strategies to ensure patient survival.[4]

CLINICAL VIGNETTE: MALIGNANT AIRWAY CRISIS AT HASA

A 59-year-old man with a right apical lung mass presented to Hospital Al-Sultan Abdullah (HASA UiTM) with worsening dyspnoea, stridor, and orthopnoea. CT imaging revealed rapid tumour progression with mid-tracheal compression and mediastinal involvement. Recognising the imminent risk of airway obstruction, a structured multidisciplinary airway plan was implemented with ENT surgeons on standby.

Awake fibreoptic intubation (Plan A) was unsuccessful due to bloody secretions and severe desaturation. Plan B, awake videolaryngoscopy under remifentanil target-controlled infusion, successfully secured the airway beyond the compressed segment while maintaining spontaneous ventilation. A tracheostomy (Plan C) was subsequently performed to provide long-term airway access.

This case highlights the importance of flexibility in airway strategy. While fibreoptic bronchoscopy remains the gold standard for anticipated difficult airways, awake videolaryngoscopy may be a valuable rescue technique when anatomical distortion, bleeding, or secretions impair visualisation.[5] Early multidisciplinary involvement and preservation of spontaneous breathing are crucial for safe outcomes in malignant airway emergencies.

BROADER PERSPECTIVE

Across Malaysia, anaesthesiologists frequently face airway crises arising from head and neck tumours, trauma, or severe infection. The ability to adapt airway plans in real time by integrating awake techniques, videolaryngoscopy, supraglottic devices, or even extracorporeal support is essential. International guidelines emphasise the importance of structured planning, team communication, and maintaining oxygenation as the central priority during resuscitation.[6]

HEALTH EMERGENCIES IN THE OPERATING THEATRE

The operating theatre is a unique environment where planned procedures can rapidly turn into life-threatening crises. Anaesthesiologists play a pivotal role in anticipating, detecting, and responding to emergencies such as major haemorrhage, anaphylaxis, malignant hyperthermia, or cardiovascular collapse.[7] Our ability to combine advanced monitoring with rapid resuscitation directly influences surgical outcomes.

CLINICAL VIGNETTE: SUCCESSFUL ECMO RESCUE AT PPUiTM

A recent case at Pusat Perubatan UiTM (PPUiTM) involved a patient who developed severe cardiogenic shock following coronary artery bypass grafting (CABG). Despite maximal pharmacological support and intra-aortic balloon pump therapy, the patient remained in refractory low-output state. In a coordinated effort between cardiac anaesthesia, cardiothoracic surgery, cardiac physician and perfusion teams, veno-arterial extracorporeal membrane oxygenation (VA-ECMO) was initiated.

The patient stabilised on ECMO, allowing myocardial recovery and eventual weaning. This successful outcome illustrates how anaesthesiologists, with expertise in perioperative resuscitation and advanced circulatory support, are integral to managing catastrophic intraoperative and postoperative cardiovascular emergencies.[8]

BRIDGING CRISIS TO RECOVERY

ECMO use in cardiac surgery is expanding worldwide as a rescue strategy for postcardiotomy shock.[9] Its success depends on early recognition, timely initiation, and multidisciplinary coordination. In Malaysia, where cardiac surgical capacity is increasing, anaesthesiologists are at the forefront of perioperative ECMO programmes that bridge acute crises and improve survival in high-risk patients. The Ministry of Health guidelines now support its deployment in tertiary centres, and Malaysia's ECMO survival rate for postcardiotomy shock aligns with global benchmarks, with up to 40% survival to discharge in high-risk cases.[10,11]

ANAESTHESIA IN INFECTIOUS DISEASE EMERGENCIES

Infectious disease outbreaks remain a recurrent source of health emergencies worldwide. From Severe Acute Respiratory Syndrome (SARS) and influenza to the more recent Coronavirus Disease 2019 (COVID-19) pandemic, these crises expose vulnerabilities in health systems and demand rapid adaptation from frontline providers.[12]

Anaesthesiologists played a central role during COVID-19 - managing high-risk airways, delivering invasive ventilation, and leading critical care teams.[13,14] Our role extended beyond the operating theatre, encompassing infection-control compliant workflows and simulation training to prepare staff for aerosol-generating procedures.

In Malaysia, emergencies such as dengue with shock, leptospirosis with pulmonary haemorrhage, and severe influenza pneumonia continue to challenge healthcare teams. Anaesthesiologists contribute by providing advanced organ support while ensuring perioperative infection control to protect both patients and staff. The pandemic underscored enduring lessons: preparedness, teamwork, and adaptability remain vital.

ANAESTHESIOLOGISTS IN MASS CASUALTY AND DISASTER RESPONSE

Mass casualty incidents (MCIs) and disasters, whether from transport accidents, industrial mishaps, or natural hazards can overwhelm healthcare systems within minutes. In these crises, anaesthesiologists contribute to both immediate patient care and system-level response, bringing expertise in triage, resuscitation, airway management, and perioperative support.[15]

LOCAL CASE HIGHLIGHT: GERIK BUS CRASH, 2025

Malaysia records over 600,000 road accidents annually, with 6,443 deaths in 2023.[16] On 9th June 2025, Malaysia experienced its deadliest road accident in over a decade when a bus carrying university students collided with an MPV along the East-West Highway in Gerik, Perak. The tragedy claimed 15 lives and injured more than 30 others.[17] Hospitals in the region rapidly activated disaster protocols, with emergency departments and operating theatres inundated by critically injured patients.

Anaesthesiologists were central to the response, securing airways in unstable trauma victims, initiating fluid and blood resuscitation, and supporting urgent surgeries for head, thoracic, and abdominal injuries. Their leadership in coordinating operating theatre resources and liaising with surgical teams demonstrated the specialty's crucial role in maximising survival during chaotic mass casualty scenarios.

GLOBAL CASE HIGHLIGHT: THAI CAVE RESCUE, 2018

The 2018 Tham Luang cave rescue in Chiang Rai, Thailand, demonstrated the indispensable role of anaesthesiologists in extraordinary health emergencies. Twelve members of a youth football team and their coach were trapped deep within a flooded cave system for over two weeks, facing imminent risk of drowning, starvation, and hypothermia.

Anaesthesiologist Dr Richard Harris, working alongside an international team of cave divers, played a pivotal role in the rescue. Each child was rendered unconscious using intramuscular ketamine and maintained with airway adjuncts and protective gear to prevent panic, hypoxia, and drowning during the perilous underwater extraction.[18] The unprecedented use of anaesthesia in a confined, submerged environment illustrated both innovation and courage.

This operation, hailed as one of the most complex rescue missions in history, highlighted how anaesthesiologists can adapt their expertise far beyond traditional hospital settings. By combining pharmacological knowledge, airway safety principles, and crisis decision-making, anaesthesia professionals were integral to saving all 13 individuals. The Thai cave rescue stands as a global example of anaesthesiology's contribution to multidisciplinary teamwork, innovation, and humanitarian response in extreme health emergencies.

FUTURE DIRECTIONS: INNOVATION AND PREPAREDNESS IN ANAESTHESIOLOGY

As health emergencies grow in complexity, the future of anaesthesiology lies in embracing innovation and expanding capacity. Malaysia currently has approximately 26 registered anaesthesiologists per million population, underscoring the need for continued workforce development.[19] Training pathways such as the Master of Medicine (Anaesthesiology) and FCAI Malaysia programme remain vital in producing skilled specialists.

Technological advancements are reshaping the emergency landscape. AI-assisted diagnostics, ultrasound-guided vascular access, and portable monitoring systems are increasingly integrated into perioperative and critical care, offering improved efficiency, accuracy, and safety.[20,21] Malaysian institutions are also innovating: UiTM pioneered the Spinal Epidural Positional Pillow (SEPP) to enhance neuraxial block safety, while Gleneagles Johor implemented Enhanced Recovery After Surgery (ERAS) protocols, improving recovery and reducing complications.[22,23]

Health emergencies also expose ethical and resource allocation dilemmas. Advanced interventions such as ECMO, while life-saving, are costly and concentrated in tertiary centres, forcing difficult decisions when resources are scarce. Surge capacity during pandemics and disasters further highlights uneven workforce distribution, with rural and peripheral hospitals left vulnerable. Addressing these gaps requires not only investment in training and technology, but also policies that ensure equitable deployment of anaesthesiologists nationwide. Preparedness training, including simulation drills, disaster exercises, and ethical decision-making frameworks, must be embedded into national strategies to strengthen resilience.

Looking ahead, anaesthesiologists must be equipped not only with advanced clinical skills but also with disaster response training, simulation-based drills, and leadership capabilities. By investing in education, innovation, and multidisciplinary coordination, Malaysia can ensure that anaesthesiologists remain agile responders ready to safeguard lives in an increasingly unpredictable healthcare landscape.

CONCLUSION

Safeguarding lives is at the heart of anaesthesiology. From leading disaster responses to extraordinary global rescues, anaesthesiologists consistently bridge crisis to recovery. As health emergencies grow more complex, Malaysia must expand its anaesthesia workforce, embrace technological innovation, and invest in preparedness training. Above all, sustained investment in anaesthesiology through workforce development, equitable distribution, and integration into emergency preparedness strategies will ensure the specialty remains resilient, innovative, and ready to protect lives in an unpredictable future.

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Anaesthesia for Stroke Thrombectomy: Leading the Response in Health Emergencies

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The role of an anaesthesiologist has expanded beyond the confines of the operating theatre and intensive care unit. Alongside the rapid evolution of medical interventions, anaesthesia must likewise constantly conform to the expanding need to move beyond its conventional boundaries to meet the increasing demands of modern, multidisciplinary care.

Hospital Sultan Abdul Aziz Shah UPM is steadily establishing itself as a key centre for acute stroke care in Malaysia, offering endovascular thrombectomy and comprehensive stroke services in collaboration with neurology, radiology, and anaesthesia teams.

As this emerging intervention continues to evolve, multidisciplinary teams are actively and diligently working to identify best practices that optimise patient outcomes, while at the same time developing local protocols to serve as practical guides.

WHEN TIME IS BRAIN: RESPONDING TO STROKE CODE

It's 3 am on a quiet on-call night. The phone rings.

"Stroke code. 68-year-old male. Sudden-onset right hemiplegia, aphasia. NIHSS 16. Possible large vessel occlusion. KIV thrombectomy."

(NIHSS -National Institutes of Health Stroke Scale)

Within an instant, the anaesthesia team shifts gears. Prepping the angiography suite and arranging rapid access to monitoring, airway equipment, and emergency drugs.

As the patient is wheeled in, time becomes your most precious resource. The radiology team confirms a left Middle Cerebral Artery occlusion on CT Angiography. With a quick nod from the neurologist, the decision is made - proceed with thrombectomy.

The next critical decision now lies with anaesthesia: general anaesthesia or sedation?

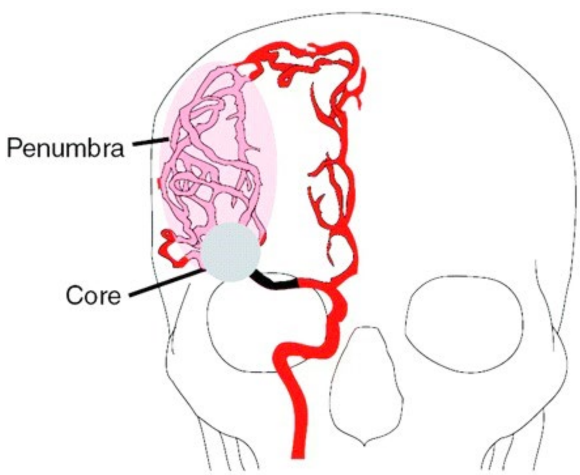
With a GCS of 8 and labile blood pressure, you opt for general anaesthesia. You intubate swiftly, aiming to minimise delay while maintaining stable haemodynamic. In the background, the IR team prepares the groin site. Within minutes, the first pass is made.

Recanalisation is achieved. As the angiogram confirms TICI 2b flow, there's a shared sense of relief - another race against time, battled and hoping that we have won.

(TICI- Thrombolysis in Cerebral Infarction)

As anaesthesiologists, it is crucial to acknowledge that every decision we make - from the choice of anaesthetic technique and induction agents to the management of haemodynamic - has a direct impact on patient outcomes, in tandem with interventional radiologist's technical performance.

THE ISCHEMIC PENUMBRA



Occlusion of a major cerebral artery (e.g. proximal right Middle Cerebral Artery (MCA) produces variable haemodynamic changes depending on collateral circulation, such as from the right Anterior Cerebral Artery (ACA). Perfusion is heterogeneous: some regions form the infarct core (irreversible damage), while others constitute the ischemic penumbra (viable but dysfunctional).

The penumbra remains salvageable if timely reperfusion is achieved.

Adapted from González RG, AJNR Am J Neuroradiol, 2006;27(4):728-735

Who Gets the Clot Removed?

- Age: ≥18 years old
- Clinical:
  - Disabling neurological deficit (NIHSS ≥6)
  - Pre-stroke mRS (modified Rankin Scale) 0-1 (functionally independent prior to stroke)
- Time Window:
  - Within 6 hours of symptom onset or
  - 6-24 hours with favourable imaging
- Imaging Confirmation:
  CT or MR angiography showing large vessel occlusion in anterior circulation:
  - Internal carotid artery (ICA)
  - Proximal middle cerebral artery (M1 segment)
- Imaging Core - Infarct Mismatch Criteria:
  In extended window (6-24 hours), use advanced imaging (CT perfusion or MRI DWI/PWI [Diffusion-Weighted Imaging/Perfusion-Weighted Imaging]) to demonstrate:
  - Small infarct core (ASPECTS ≥6 or infarct core volume <70mL)
  - Significant salvageable penumbra (mismatch ratio >1.8)
  - Time last known well up to 24 hours (DAWN / DEFUSE 3 criteria)

The DAWN and DEFUSE 3 trials were landmark studies that expanded the treatment window for mechanical thrombectomy from 6 hours to up to 24 hours after stroke onset, but only for carefully selected patients.These trials used advanced imaging (CT perfusion or MRI) to identify patients who still had *salvageable brain tissue* - that is, a small infarct core and a large ischaemic penumbra.

Based on DAWN and DEFUSE 3 trials, the patient may still benefit if:

- Large vessel occlusion (e.g. M1, ICA)
- Small infarct core (e.g. <70mL)
- Good mismatch between infarct core and penumbra
- Good pre-stroke functional status (mRS 0-1)

Posterior circulation stroke may be considered even beyond 24 hours, but evidence is less robust. In patients with mild deficits or extensive infarct, benefit is uncertain - requires individualised decision.

Infarct Core

This is the irreversibly damaged brain tissue - already dead due to lack of blood flow.

Cannot be saved.

Detected on imaging as very low cerebral blood flow (CBF <30%) or low cerebral blood volume on CT perfusion or diffusion restriction on MRI.

Ideal for thrombectomy:
Small infarct core (e.g <70mL)
Larger infarct core = poorer outcomes and higher risk of bleeding

Penumbra (Salvageable Brain)

The area around the core that is at risk but not yet dead.

Still viable if blood flow is restored quickly.

Shows up on perfusion imaging as prolonged time-to-peak or Tmax >6s, but not yet infarcted.

Mismatch

Mismatch refers to the difference between:
Infarct core volume
Penumbra (tissue at risk)
Good mismatch = Small core, large penumbra

GENERAL ANAESTHESIA (GA) OR CONSCIOUS SEDATION (CS)?

The choice between GA or CS during mechanical thrombectomy for acute ischemic stroke is a critical decision - and both approaches have pros and cons, which can influence time to reperfusion, patient stability, and neurological outcomes.

"Either GA or CS is reasonable during thrombectomy, and the choice should be based on the patient's clinical status, operator experience, and institutional protocols."

(American Heart Association / American Stroke Association (AHA/ASA) 2019)

"Use of either GA or CS is acceptable, with no strong recommendation for one over the other.

Selection should aim to minimise del ays and maintain haemodynamic stability."

(European Stroke Organisation (ESO) - ESMINT Guidelines 2023)

No clear superiority of GA or CS - what matters is:
- Speed of reperfusion
- Haemodynamic stability (avoid hypotension)
- Patient safety (airway protection, agitation)

HAEMODYNAMIC MANAGEMENT

Before Recanalisation

- SBP 140-180mmHg (permissive hypertension), avoid >185mmHg if candidate for thrombolysis; MAP ≥70mmHg

- Supports collateral flow to ischemic penumbra, avoids hypoperfusion

After Successful Recanalisation

- SBP <140mmHg (some centers use <160mmHg if concern for hypoperfusion)

- Reduces risk of reperfusion injury and intracranial haemorrhage

After Unsuccessful Recanalisation

- Maintain pre-recanalisation targets (SBP 140-180mmHg)

- Continue maximising collateral flow

RECANALISATION

Recanalisation is the primary objective of mechanical thrombectomy in acute ischemic stroke, aiming to restore blood flow to the occluded cerebral artery and salvage the ischemic penumbra. The degree of reperfusion is typically assessed using the modified Thrombolysis in Cerebral Infarction (mTICI) scale, with grades 2b-3 representing successful recanalisation. Achieving timely and complete recanalisation is strongly associated with improved functional outcomes, reduced disability, and lower mortality. However, the benefits are time-dependent; delays in intervention can lead to expansion of the infarct core and irreversible neurological injury. Optimal recanalisation requires not only technical expertise but also coordinated multidisciplinary care, including precise haemodynamic management before and after the procedure. Effective communication between anaesthesia, neurology, and interventional radiology teams ensures that procedural milestones - such as the moment of recanalisation - are promptly recognised, allowing immediate adjustment of blood pressure targets to minimise reperfusion injury while maintaining cerebral perfusion.

Successful recanalisation stands as the critical determinant of outcome in mechanical thrombectomy for acute ischemic stroke. Its benefits are maximised when achieved rapidly, under meticulous haemodynamic control, and with seamless collaboration between all members of the stroke team. By aligning technical expertise with evidence-based peri-procedural management and clear, timely communication, we can preserve viable brain tissue, reduce disability, and ultimately improve survival. The future of stroke care lies not only in advancing interventional technology but also in refining the multidisciplinary processes that enable swift and safe restoration of cerebral blood flow.

POST-THROMBECTOMY MANAGEMENT

Post-thrombectomy care is a crucial extension of peri-interventional management, aimed at preserving neurological recovery and preventing secondary brain injury.

Airway and ventilation should be managed according to the patient's status- in intubated patients, maintain normoxia and normocapnia while in non-intubated patients, ensure adequate oxygenation using nasal cannula or high-flow oxygen, avoid hypoventilation and monitor for loss of airway protection as consciousness fluctuates.

Haemodynamic stability remains the cornerstone of post-procedure care. Following successful recanalisation, SBP $<$140mmHg (some centres $<$160mmHg) is recommended to minimise reperfusion haemorrhage. If stent placement has been performed, many centres maintain SBP 140-160mmHg in the first 12-24 hours to ensure stent patency. After incomplete or failed recanalisation, SBP 140-180mmHg with MAP $\geq$70mmHg should be maintained to support collateral perfusion.

Neurological monitoring is essential to detect re-occlusion, intracranial haemorrhage, or cerebral oedema. Temperature should be kept normal, and fever treated promptly, as pyrexia worsens infarct expansion. Glycaemic control should avoid both hypo- and hyperglycaemia. In non-intubated patients, close observation for airway obstruction, aspiration, and respiratory effort is vital, particularly in those with reduced bulbar reflexes.

Early extubation can be considered in haemodynamically and neurologically stable patients to shorten ICU stay and facilitate rehabilitation. Optimal recovery depends on multidisciplinary coordination - neurology, radiology, anaesthesia, and intensive care teams must collaborate closely for imaging follow-up, secondary prevention, and comprehensive neurorehabilitation planning.

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Psychological Resilience and Burnout Among Anaesthesiologists During Emergencies

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INTRODUCTION

Burnout is a psychological syndrome characterised by emotional exhaustion, depersonalisation, and reduced personal accomplishment.[1,2] Anaesthesiologists are uniquely exposed to stressors including high-stakes decision-making, complex airway management, resuscitation duties, and perioperative complications.[3,4] These stressors intensify during emergencies such as pandemics, mass-casualty events, and disasters.[5,15]

BURNOUT DURING EMERGENCIES

Public health emergencies significantly amplify burnout risk. During COVID-19, anaesthesiologists experienced extended shifts, redeployment to ICUs, and high-risk aerosol-generating procedures, increasing stress and anxiety.[3,5,15,17] PPE fatigue and uncertainty further exacerbated emotional exhaustion.[3,5] Historical outbreaks, including SARS, MERS, and H1N1, reveal long-term psychological effects such as posttraumatic stress, depression, and anxiety.[24,33,34] Malaysian anaesthesiologists faced ICU capacity constraints, resource shortages, and rapidly changing protocols, leading to heightened moral distress.[11-13,17]

PSYCHOLOGICAL RESILIENCE

Resilience is the capacity to adapt positively under stress - mitigates burnout.[6,7] It encompasses cognitive flexibility, emotion regulation, social support utilisation, and adaptive coping.[21,22] High resilience is associated with lower burnout, improved job satisfaction, and better mental health outcomes.[19,20] Individual strategies include mindfulness, cognitive behavioral techniques, reflective practice, exercise, and rest.[27,29] Post-traumatic growth allows resilient clinicians to derive meaning from stressful experiences.[8] Organisational approaches involve leadership support, structured debriefings, adequate staffing, and access to mental health services.[4,28,31] Systemic strategies include national guidelines, emergency response frameworks, and professional society initiatives.[11,12,16]

Table I: Burnout Prevalence Among Anaesthesiologists and Critical Care Staff During Emergencies

Study / Location	Sample	Setting	Emergency Context	Burnout Prevalence (%)	Key Findings
Kannampallil et al., 2020[3]	393 trainees	USA	COVID-19	50%	Exposure to COVID-19 patients increased stress and burnout.
Lim et al., 2021[5]	345 healthcare workers	Malaysia	COVID-19	42%	Higher emotional exhaustion among ICU staff; resilience protective.
Mealer et al., 2012[19]	744 ICU nurses	USA	Routine ICU / Emergencies	38%	Resilience associated with lower burnout risk.
Maunder et al., 2006[24]	769 hospital staff	Canada	SARS outbreak	29%	Long-term psychological effects persisted post-outbreak.
Phoon et al., 2022[17]	210 Malaysian anaesthesiologists	Malaysia	COVID-19	41%	Higher resilience correlated with lower burnout and better coping.

INTERVENTIONS AND PREVENTIVE STRATEGIES

Effective interventions target individual and organisational factors. Examples include mindfulness and stress reduction programmes,[27,29] leadership and organisational support.[4,28,31] crisis resource management and team training,[10,32] peer support and debriefing,[23] and systemic policy measures.[11-13,16] Multi-component interventions integrating individual and organisational strategies are most effective.[26,28,29]

BURNOUT AND RESILIENCE IN THE MALAYSIAN CONTEXT

Malaysian healthcare workers, particularly anaesthesiologists, experienced significant burnout during COVID-19.[5,17] Resilience was protective, reducing emotional exhaustion and promoting coping.[6,7,17,19] The Malaysian Society of Anaesthesiologists (MSA) implemented initiatives such as structured debriefings, reflective practice, and peer support programmes.[13] Local studies show higher resilience correlates with better job satisfaction.[17]

LEADERSHIP AND TEAM-BASED RESILIENCE

Anaesthesiologists often lead emergency teams, coordinating airway management, critical care interventions, and resuscitation.[10,18] Leadership effectiveness influences team resilience, staff well-being, and patient outcomes.[4,31] Key strategies include clear communication, supportive supervision, and promotion of peer support. [4,10,18,23,31] Team-based resilience improves adaptability during crises.[10,32]

Table II: Resilience Strategies and Interventions for Anaesthesiologists During Emergencies

Intervention Type	Examples / Methods	Target Level	Evidence / References
Individual	Mindfulness, cognitive-behavioral techniques, reflective practice, exercise	Anaesthesiologist	[6,7,19,27,29]
Organisational	Leadership support, workload management, structured debriefings, mental health services	Hospital / Department	[4,28,31]
Team-based	Crisis resource management, simulation training, role clarity, peer support	Multidisciplinary team	[10,23,32]
Systemic / Policy	National guidelines (HERP), emergency frameworks, professional society recommendations	National / Ministry	[11,12,13,16]
Combined / Multi-component	Integration of mindfulness, leadership engagement, team training, and policy support	All levels	[26,28,29]

CHALLENGES AND FUTURE DIRECTIONS

Challenges remain as limited awareness of burnout, stigma regarding mental health, and insufficient structured support.[5,15,17] Future research should focus on longitudinal studies of burnout and resilience trajectories, evaluation of interventions, and integration of resilience training into postgraduate anaesthesiology curricula.

CONCLUSION

Burnout is a major concern for anaesthesiologists during emergencies. Psychological resilience mitigates stress and supports effective performance. Multi-level interventions - including individual, organisational, and systemic strategies - are essential. Leadership, structured support, and national guidance are vital for clinician well-being, workforce sustainability, and patient safety.

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