Section 14: Neuroanaesthesia

Edited by Dr Judith Dinsmore

14.1 Prevention of hyperthermia in acutely brain injured patients

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Why do this audit?

Pyrexia is known to be detrimental to the acutely injured brain.[1] Patients with acute brain injury (ABI) frequently develop elevated temperatures. Intensive care units should have guidelines in place to monitor and treat pyrexia in brain injured patients during the first week of admission or longer if there is evidence of ongoing cerebral ischaemia/inflammation.

Best practice: research evidence or authoritative opinion

For every 1°C rise in admission temperature the relative risk of a worse outcome is doubled for stroke patients.[2] The European Stroke Organisation guidelines state that hyperthermia should be avoided to limit the cerebral metabolic rate.[3] In acute ischaemic stroke they advocate a prompt search for concurrent infection and treatment with paracetamol and fanning should the temperature reach 37.5°C.[4]

Fever is an independent risk factor for poor outcome following aneurysmal subarachnoid haemorrhage, and it is recommended that temperature is controlled using pharamacological and/or physical means.[1] Pyrexia has also been shown to independently worsen survival and increase secondary injury after traumatic brain injury.[5]

Recent evidence from patients following out of hospital cardiac arrest suggests that normothermia may be just as advantageous as hypothermia, (33°C versus 36°C[6]).

Suggested indicators

All patients admitted to intensive care with an ABI are at risk of pyrexia, either as a primary complication or from secondary infection. Examples of ABI may include traumatic brain injury, subarachnoid haemorrhage, stroke and post cardiac arrest.

Proposed standard or target for best practice

- 100% of patients with an ABI have their core temperature measured and recorded hourly.
- 100% of those patients who have a temperature ≥37°C should receive interventions/attempts to reduce their temperature within an hour.
- No ventilated patients should have their temperature rise above 37.5°C.
- Any patients whose temperature does rise above 37.5°C should have prompt initiation of a search for concurrent infection.

Suggested data to be collected

- Patient core temperature hourly from admission to intensive care (or diagnosis of ABI) until discharge from ITU.
- Time after temp ≥37°C that active cooling was commenced.
- Reason for delay in treatment if >1 hour to active cooling.
- Time after temp ≥37.5°C to culture samples being taken.
- Peak spike of temperature.
- If infective component suspected, time to commence antibiotics.

Common reasons for failure to meet standard

- Lack of awareness that hyperthermia is detrimental to outcome in ABI.
- Lack of adequate cooling methods/equipment.
- Temperature high despite adhering to agreed management protocol: Need for more aggressive protocol?
- Transfer for CT/other reason cooling had to be put on hold.

CPD and Curriculum mapping

CPD matrix codes: **2C01, 2C03, 2F01, 3F00**

Syllabus for the CCT in Intensive Care Medicine: Domains and sections: **2.7, 3.1 and 3.6**.

References

1 Thorston Steiner et al. European Stroke Organization Guidelines for the Management of Intracranial Aneurysms and Subarachnoid Haemorrhage. *Cerebrovasc Disease* 2013;**35**:93–112.

2 Kammersgaard LP et al. Admission Temperature Predicts Mortality After Acute Stroke, The Copenhagen Stroke Study. *Stroke* 2002;**33**:1759.

3 European Stroke Organisation guidelines (http://bit.ly/U76EW2).

4 European Stroke Organisation – Guidelines for Management of Ischaemic Stroke 2008 (http://bit.ly/U76H4c).

5 Helmy A, Vizcaychipi M, Gupta A. Traumatic brain injury: intensive care management. *BJA* 2007;**99**:32–42.

6 Niklas Nielsen et al. Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest. *N Engl J Med* 2013;**369**:2197–2206.

14.2 Quality of transfers of patient with severe traumatic brain injury

Dr I Tweedie

Why do this audit?

It has been known for many years that poor management during the transfer of patients with a severe traumatic brain injury (TBI) submits them to high burden of secondary insults, with the potential to have a deleterious effect on outcome. Many transfers are time critical due to the urgent need to drain haematomas. Regional transfer audits continue to show that not all critical care transfers match the standards.

Best practice: research evidence or authoritative opinion

In 1990 Peter Andrew demonstrated the secondary insult potential during transportation of patients with brain injury even within the same hospital.[1] The AAGBI have drawn up expert guidance for the transfer of patients with TBI,[2] which is echoed in the NICE guidance[3] on the early management of TBI. This is underpinned by the guidance in the ICS transfer document.[4] In patients with an assumed compromise to intracranial compliance it is important to manage factors, which can compromise that further, such as oxygenation, hypotension, hyper- and hypo-carbia, and inadequate sedation. These standards of care should be used for all patients with brain injury who need to be transferred sedated, intubated and ventilated, whether intrahospital or interhospital.

Suggested indicators

All patients with severe TBI who need to be transferred for treatment or diagnostic procedures, but distinguished by whether they are an intra- or inter- hospital transfer.

Proposed standard or target for best practice

All transfers should happen in a timely manner.

100% of patients must be adequately resuscitated prior to transfer.

100% of patients should be transferred by a suitably experienced team.

100% of patients should have care that follows national guidelines. For example:

- Patient's airway controlled by intubation.
- Patient mechanically ventilated with $EtCO_2$ monitoring.
- Patient sedated with continuous intravenous infusion.
- Patient monitored including ECG, SaO_2, and IBP, plus ICP if being monitored.
- Target MAP, SaO_2 and EtCO2 achieved and recorded?
- SaO_2 and $EtCO_2$ checked against arterial blood gases prior to transfer.
- Pupillary reaction observed and recorded.
- There should be a written record of transfer and patient observations.

Suggested data to be collected

Data should be collected over a sufficient period of time to get adequate numbers of cases for analysis.

- Type of transfer e.g. emergency or planned, inter- or intra-hospital.
- For emergency transfers - total time from injury to receiving definitive treatment and length of time from decision to transfer to actual transfer.
- Grade of doctor undertaking the transfer, have they had transfer training?
- Evidence that patient was adequately resuscitated prior to transfer.
- Patient's airway controlled by intubation, mode of ventilation and EtCO2 monitoring during transfer.
- SaO_2 and $EtCO_2$ checked against arterial blood gases prior to transfer commencing.
- Additional patient monitoring during transfer.

- Are target MAP, SaO_2 and $EtCO_2$ achieved and recorded? If not, is there evidence that they were treated, e.g. inotropes administered, ventilation adjusted.
- Type and dose of sedation.
- Pupillary reaction observed and recorded.
- Seizures controlled.
- Other injuries satisfactorily managed pre transfer, e.g. fractures splinted, haemo-pneumothoraces drained.
- Patient condition on arrival.
- For interhospital transfers – team communicated in advance that they were on the way and gave satisfactory handover on arrival.
- There should be a written record of transfer and patient observations.
- Untoward events during transfers
  - Equipment failures.
  - Patient deterioration, e.g. pupils becoming unreactive.
  - Transport problems, e.g. delays or navigation errors.
  - Missed injuries identified at receiving hospital.

Common reasons for failure to meet standard

- Lack of training in safe transfer of critically ill patients with TBI.
- Failure to agree local guidelines.
- Lack of senior input into the preparation of the patient for transfer.

CPD and Curriculum mapping

CPD matrix codes: **2A11, 2C04, 2F01, 3F05**

Syllabus for the CCT in Intensive Care Medicine: Domains and sections: **10, 10.1**.

References

1 Andrews PJD, Piper IR, Dearden M. Secondary insults during intrahospital transport of head-injured patients. *Lancet* 1990;**335**:327–330.

2 Recommendations for the Safe Transfer of Patients with Brain Injury. *AAGBI*, London 2006 (http://bit.ly/U7awGo).

3 Head injury: Triage, assessment, investigation and early management of head injury in children, young people and adults (CG176). *NICE*, London 2014 (www.nice.org.uk/guidance/CG176).

4 Guidelines for the transport of the critically ill adult (3rd Edition) *ICS*, London 2011 (http://bit.ly/1jmpKTz).

14.3 Subarachnoid haemorrhage

Dr J Dinsmore

Why do this audit?

Subarachnoid haemorrhage (SAH) accounts for approximately 5% of all cerebrovascular events in the UK.[1] It tends to affect relatively young people, the mean age is 50 years, and the outcome is generally poor with about 50% dying within 1 month. Those who survive the initial bleed are at risk of rebleeding, hydrocephalus and delayed cerebral ischaemia (DCI).

Best practice: research evidence or authoritative opinion

The severity of bleed is graded on a 5-point scale: the World Federation of Neurological Surgeons (WFNS) scale based on Glasgow Coma Score and motor deficit. Lower WFNS grade patients are associated with a better outcome. Acute management is similar to that for other forms of brain injury. Extreme hypertension must be avoided to reduce the risk of rebleeding. Definitive treatment involves either coiling or clipping the aneurysm. Current best practice advises treatment within 48hrs in good grade patients (WFNS I-III).[2] The timing of intervention in poor grade patients is less clear.[3] Nimodipine has been shown to be effective in reducing reduce poor outcome from DCI. The use of triple H therapy is controversial with no controlled studies showing a positive effect from any component. However it is important to avoid hypotension and hypovolaemia.[4] Documentation of consent for intervention is frequently inadequate in these patients.[5] Deaths following SAH often occur in young patients and therefore consideration for organ donation is highly appropriate.

Suggested indicators

I patients admitted to the intensive care unit with aneurysmal SAH.

Proposed standard or target for best practice

- Administration of nimodipine within 24 hours of admission.
- Hypertension (Systolic arterial pressure < 160 mmHg, MAP>110mmHg) should be treated in patients with unsecured aneurysms. Hypotension must be avoided.
- Definitive neurovascular intervention (coiling or clipping) within 48 hours in good grade patients (WFNS grade I-III).
- Appropriate consent taken, documented and discussion of risk recorded in notes.
- Low readmission rate to ICU.
- The consideration of organ donation as part of end of life care in all suitable patients.

Suggested data to be collected

- Age, gender
- WFNS grade
- Date and time of SAH bleed and admission to ICU
- Complications such as rebleeding or delayed cerebral ischaemia
- Medical complications
- Date and time of starting nimodipine
- Blood pressure targets
- Episodes of sustained hyper / hypotension
- Date and time of definitive intervention
- Date and time of any other surgical procedures
- Reason for delay if > 48 hours between onset of SAH bleed and intervention?
- Appropriate documentation of consent / type of consent in notes
- Date and time of discharge from NICU
- Place of discharge
- Functional status on discharge
- Readmission to ICU
- In event of death:
  - Did brain stem death testing occur?
  - Patient suitable for donation after cardiac death?
  - Was the patient suitable for organ donation?
  - Did organ donation occur, if not why not?

Common reasons for failure to meet standard

- Delay in primary diagnosis and referral.
- Lack of appropriate services at weekends.
- Lack of local guidelines or protocols.
- Pressure on ICU beds.
- Failure to recognise inability to give informed consent.
- Failure to consider suitability for organ donation by medical staff.

CPD and Curriculum mapping

CPD matrix codes: **2C06, 3C00, 3F00**

Training curriculum competencies: **NA_HK_02**.

References

1 Stroke Statistics. The Stroke Association, London 2013 (www.stroke.org.uk).

2 National Clinical Guideline for Stroke (4th Edition). Prepared by the Intercollegiate Stroke Working party. *RCP*, London 2012 (www.rcplondon.ac.uk/sites/default/files/national-clinical-guidelines-for-stroke-fourth-edition.pdf).

3 Molyneux AJ et al. International subarachnoid aneurysm trial (ISAT) Collaborative group. International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomized trial. *Lancet* 2002;**360**:1267–1274.

4 Diringer MN et al. on behalf of the Neurocritical Care Society. Critical care management of patients following aneurysmal subarachnoid haemorrhage: recommendations from the Neurocritical Care Society Multidisciplinary Consensus Conference. *Neurocrit Care* 2011;**15**:211–240.

5 Managing the Flow? A review of the care received by patients who were diagnosed with an aneurismal subarachnoid haemorrhage. *NCEPOD*, London 2013.

14.4 Initial management of patients with acute Spinal Cord Injury

Dr X Watson, Dr A Zoumprouli

Why do this audit?

Spinal cord injury (SCI) is a major cause of morbidity, often resulting in severe and permanent disability. The annual estimated incidence of traumatic SCI is 15 per million in the UK and approximately 50% of those have an incomplete lesion. The potential for neurological improvement is therefore significant. Early recognition and prevention of secondary injury is paramount to the future of quality of life and has major implications on the long-term outcome. Management is initially targeted at preserving spinal cord function, minimising secondary injury and avoiding further morbidity.

Best practice: research evidence or authoritative opinion

Evidence for best practice in the management of SCI is published by the British Association of Spinal Cord Injury Specialists, the National Spinal Cord Injury Strategy Board (NSCISB) and by American Association of Neurological Surgeons and the Congress of Neurological Surgeons (AANS/CNS).[1–3] Local protocols may vary according to the services available but should all be in accordance with National recommendations. Initial management includes immobilisation of the injured spine, maintenance of the airway, systemic oxygen delivery and treatment of neurogenic shock.

Suggested indicators

All patients with cervical or high thoracic (above T6) SCI should be admitted to intensive care for monitoring and acute management.

Proposed standard or target for best practice

- 100% of patients who sustained an injury with a mechanism compatible with spinal damage should have spinal immobilisation as part of the immediate resuscitation phase.
- 100 % of patients with a SCI above T6 should be admitted to intensive care.
- 100 % of patients should meet proposed targets within 4 hours of admission to intensive care including:
  - Referral to SCI Specialist centre.
  - Airway secured or regular vital capacity (VC) measurement.
  - Target mean arterial pressure (MAP) documented.
  - Insertion of arterial line.
  - Insertion of nasogastric tube (NG) tube.
  - Urinary catheter inserted.
  - Venothromboembolism (VTE) assessment documented.
  - ASIA scoring assessed and documentation of complete or incomplete injury.
  - Stress ulceration prophylaxis prescribed.
- 100 % of patients should meet proposed targets within 24 hours of admission to Intensive care:
  - ASIA scoring documented.
  - Surgical plan documented.
  - Spinal clearance form completed.
  - Secondary survey completed and documented.
  - Referral to Physiotherapists and Occupational therapists.
  - Bowel care protocol implemented.
  - Regular neurological observations (every 2 hours).
  - Regular turning of patient (every 2 hours).

Suggested data to be collected

- Mechanism and time of injury.
- Time from injury to spinal immobilisation.
- Time from injury to admission to intensive care.
- Time of referral to SCI Specialist centre.
- Airway interventions and timing.
- Evidence of regular VC measurement.
- Target MAP documented.
- Time to insertion of arterial line.
- Time to insertion of NG tube.
- Time to insertion of urinary catheter.
- Timing of VTE assessment.
- ASIA scoring assessed and documentation of complete or incomplete injury.
- Time to stress ulceration prophylaxis prescribed.
- Time to documentation of surgical plan.
- Timing of spinal clearance form completed.
- Time to completion of secondary survey and documentation.
- Time to referral to physiotherapists and occupational therapists.
- Time to implementation of Bowel care protocol.
- Frequency of neurological observations.
- Frequency of patient turning.

Common reasons for failure to meet standard

- Lack of awareness or understanding of guidelines
- Assessment not carried out in timely fashion
- Poor documentation in notes
- Lack of agreement of protocol per unit

CPD and Curriculum mapping

CPD matrix codes: **2C06, 3C00, 3F00**

Training curriculum competencies: **NA_IS_14, NA_IK_14, NA_IK_13**.

References

1 Managing patients with SCI within major trauma. *National SCI Pathways*, 2013 (www.mascip.co.uk/sci-roadmap.aspx).

2 Guidelines on the Management of Acute Traumatic Spinal Cord Injury in a General Hospital. *BASCIS*, Shropshire (www.bascis.org.uk/?page_id=33).

3 Guidelines for the Management of Acute Cervical Spine and Spinal Cord Injuries. American Association of Neurological Surgeons and the Congress of Neurological Surgeons. *Neurosurgery* 2013;**72(suppl 2)**:1–259.

14.5 Ensuring best practice in the management of the patient with raised intracranial pressure in patient with severe traumatic brain injury

Dr R Lightfoot

Why do this audit?

Despite the development of specialist neurointensive care severe traumatic brain injury (STBI) (GCS <8) is still a common cause of morbidity and mortality.[1–4] The early transfer of patients to and the implementation of evidence based protocols in these specialist units have been shown to reduce mortality in patients with STBI.[2,4] The adoption and adherence of local guidelines for the management of raised intracranial pressure is still not fully understood.

Best practice: research evidence or authoritative opinion

No universal UK guidelines.
Locally agreed guidelines based on best practice and evidence.

Suggested indicators

All patients admitted to specialist neurointensive care with severe traumatic brain injury requiring intracranial pressure monitoring.

Proposed standard or target for best practice

- All patients have a documented management plan.
- Patients should have ICP monitoring where appropriate.
- 100% patients have a target CPP with a trigger for escalation in treatment.
- Management should comply with level of care for ICP.

Suggested data to be collected

- Reference point for CPP measurement (position where arterial line transducer is placed).
- Cerebral Perfusion Pressure (CPP) target.
- Trigger for escalation in treatment (target ICP).
- Levels of care for ICP management.
- Compliance with each level of care for ICP management.
- Ventilator targets.
- Target of serum sodium level.
- Use of surgical interventions for reduction of ICP (decompressive craniectomy or external ventricular drain insertion).
- Use of hyperosmolar therapy (including mannitol and hypertonic saline).
- Use of cooling (including mechanism and target temperature).
- Use of barbiturate coma and mechanisms of monitoring used.

Common reasons for failure to meet standard

- No locally agreed guidelines.
- Limitation of access to resources.

CPD and Curriculum mapping

CPD matrix codes: **2F01, 2F03, 2A11, 2A02 3F00**

Training curriculum competencies: **NA_IK_20, NA_IK_04**.

References

1 Dinsmore J. Traumatic brain injury: an evidence-based review of management. *CEACCP* 2013;**6**:189–195.

2 Patel HC et al. Trends in head injury outcome from 1989 to 2003 and the effect of neurosurgical care: an observational study. *Lancet* 2005;**366**:1538–1544.

3 Clayton TJ, Nelson RJ, Manara AR. Reduction in mortality from severe head injury following introduction of a protocol for intensive care management. *BJA* 2004;**93**:761–168.

4 Harrison DA et al. Risk Adjustment In Neurocritical care (RAIN) – prospective validation of risk prediction models for adult patients with acute traumatic brain injury to use to evaluate the optimum location and comparative costs of neurocritical care: a cohort study. *Health Technol Assess* 2013;**17(23)**:1–350.

14.6 Compliance with guidelines for the management of the unconscious patient at risk of spinal injury

Dr R Lightfoot, Dr M Galea

Why do this audit?

The incidence of cervical, thoracic and lumbar spine trauma is reported at 5% in patients with blunt multi-trauma.[1–2] A delay in diagnosis can result in up to an eight fold increase in neurological deficits. 1 In addition any delay in spinal clearance, or in diagnosis, predisposes the unconscious patient to the complications of immobilisation and resultant increase in morbidity. This group of patients may be unconscious for a long time and so waiting for Glasgow Coma scale (GCS) to improve prior to clearance is not appropriate. However, there is little consensus on spinal clearance in the sedated patient so it can be difficult to get someone to accept responsibility.2 Optimal management will involve adequate imaging in a timely manner, with access to reporting by a consultant radiologist. A multidisciplinary approach to defining aspects of care including number of personnel for turns and the use of a hard collar is vital to reduce the risk of complications before a diagnosis can be made.[3] Local unit guidelines should include a named person for spinal clearance and record of management plan.

Best practice: research evidence or authoritative opinion

Existing evidence based management guidelines for cervical spine evaluation include those by the EAST group in the US.1 The same group have produced recommendations for thoracolumbar clearance.[4] However there remains a lack of level 1 evidence in both. In the UK there is currently no national guidance relying on expert opinion and consensus recommendations.[2,3,5] NICE has included guidance for the management of cervical spine injuries within their head injury guidelines.[6] They identify a number of risk factors for cervical spine injury, including GCS ≤ 13, intubated and ventilated patients, patients having other scans for polytrauma or traumatic brain injury, age greater than 65 years, or a suggestive mechanism of injury, e.g. fall from more than 1m height. A CT scan within an hour of any of these risk factors being identified is recommended, with a provisional written report available within an hour of the scan. Locally agreed guidelines tend to be based on available evidence, as described above, and best practice.

Suggested indicators

All patients admitted to intensive care with blunt multi-trauma.

Proposed standard or target for best practice

- All units should have in place local guidelines incorporating current best practice recommendations as above.
- Each patient should have a named consultant responsible for clearance and overall care.
- Appropriate management plan completed within 24hrs of presentation.
- Early CT imaging in unconscious patients.
- Spinal precautions should be continued until appropriate imaging obtained.
- Aim to remove unnecessary cervical collars, spinal extraction boards within 48-72 hrs.
- At least 95% compliance with all aspects of guidelines.

Suggested data to be collected

- Mechanism of injury.
- Injury sustained.
- Imaging performed in referring hospital or tertiary referral unit.
- Adequacy of imaging performed.
- Time of imaging reported.
- Personnel reporting imaging.
- Personnel involved with spinal management plan.
- Timing of intervention of management plan.
- Nursing management when turning patient before reporting of imaging.
- Nursing management when turning patient after reporting of imaging.
- Documentation of use of hard collar.
- Documentation of duration of use of hard collar.
- Duration of time in spinal immobilisation – hard collar, spinal board – before decision made.
- Additional imaging performed on patient (including MRI or repeat CT/X-ray).
- Spinal clearance signed off as per local unit guidelines.

Common reasons for failure to meet standard

- No local guidelines.
- Inadequate documentation.
- Limited access to imaging in hospital.
- Limited access to senior radiologists.

CPD and Curriculum mapping

CPD matrix codes: **2A02, 2F02, 2F03, 3F00**

Training curriculum competencies: **NA_IK_13, NA_IK_14**.

References

1 Como JJ et al. Practice Management Guidelines for identification of cervical spine injuries following trauma: Update from the Eastern Association for the Surgery of Trauma Practice Management Guidelines Committee. *J Trauma Acute Care Surg* 2009;**67**:651–659.

2 Morris CGT, McCoy E. Clearing the cervical spine in unconscious polytrauma victims, balancing risks and effective screening. *Anaesth* 2004;**59**:464–482.

3 Morris CG, McCoy EP, Lavery GG. Spinal immobilisation for unconscious patients with multiple injuries. *BMJ* 2004;**329**:495–499.

4 Sixta S et al. Screening for thoracolumbar spinal injuries in blunt trauma: An Eastern Association for the Surgery of Trauma practice management guideline. J *Trauma Acute Care Surg* 2012;**73(Suppl 4)**:5326–5332.

5 Scott TE et al. Clearing the spine in the unconscious trauma patient: an update. *JICS* 2012;**13**:227–231.

6 CG176 Head injury: Triage, assessment, investigation and early management of head injury in children, young people and adults. *NICE*, London 2014 (http://publications.nice.org.uk/head-injury-cg176/key-priorities-for-implementation) (accessed 4 April 2014).

14.7 Intra-arterial thrombectomy

Dr J Dinsmore, Dr R Campbell

Why do this audit?

Stroke is the third leading cause of death and the leading cause of disability in Europe. Intra-arterial interventions such as intra-arterial thrombectomy (IAT) are increasingly used for the treatment of acute ischaemic stroke. Anaesthesia may be required during this procedure to reduce pain during mechanical thrombectomy, minimise movement, maintain physiological stability and for airway management. Recent studies have reported an association between general anaesthesia for IAT and poor outcome.[1–3] Class 11a, level of evidence B.

Best practice: research evidence or authoritative opinion

Studies to date are retrospective, mostly without control for baseline neurological status and with little information on intraoperative management of patients. There appears to be an association between hypotension and poor outcome.[3] Time from stroke onset to successful reperfusion is crucially important. Delays in providing general anaesthesia or intraoperative hypotension may have contributed to poor outcome.[4] Consensus guidelines exist.[5] However, due to limited available data most recommendations are based on current expert opinion.

- These patients present as time critical emergencies.
- Avoid hypotension: Systolic blood pressure should be maintained within 10–15% of baseline with fluids and vasopressors.
- Local anaesthesia should be considered first line in patients who are cooperative and can protect their airway.
- General anaesthesia is recommended in patients with a reduced level of consciousness, uncooperative or agitated patients, those who cannot protect their airway or those already intubated.
- Patients receiving local anaesthesia with sedation should be monitored and provision made to enable rapid conversion to a general anaesthetic if necessary.
- Tracheal intubation is recommended for those patients with reduced level of consciousness, signs of brain stem dysfunction, those unable to protect their airway, with active nausea and vomiting before intervention and patients who become hypoxic or develop airway obstruction under sedation.
- All patients should be monitored with pulse oximetry and capnography.
- FiO_2 should be titrated to maintain SpO_2 > 94%. Ventilation should be adjusted to maintain normocapnia under anaesthesia. Hypercapnia should be avoided in patients undergoing sedation.
- Haemodynamic monitoring should include ECG and continuous blood pressure or, if non-invasively, measured at least once every 3 minutes.
- Continuous invasive arterial monitoring is recommended for all interventional procedures but should not delay intervention.
- Patient who have received general anaesthesia should be managed on the NICU or High dependency care/stroke unit postoperatively to continue invasive monitoring and neurological monitoring.

Suggested indicators

All patients admitted for Intra arterial thrombectomy..

Proposed standard or target for best practice

- All departments should have an anaesthetic lead for neuroradiology.
- Availability of departmental protocol/guideline for IAT meeting above recommended criteria.
- Time from admission to intervention.
- 100% of patients should have appropriate monitoring.
- Hypotension and hypoxia should be treated promptly.
- 100% of patients ASA ≥ 3 should have access to level 2/3 care.

Suggested data to be collected

- Time from presentation to start of anaesthesia and intervention.
- Patient age, ASA status, stroke severity by NIHSS score.
- Type of anaesthesia, agents used, airway management.
- Monitoring used.
- Strategies to treat intraoperative hypotension.
- Lowest peri-operative blood pressure.
- Conversion rate from local to general anaesthesia.
- Destination for postoperative care.
- Outcome.

Common reasons for failure to meet standard

- Lack of familiarity with procedure / departmental protocols.
- Delays in process of admitting patient.
- Lack of availability of emergency anaesthetic cover.
- Lack of HDU/ICU capacity.

CPD and Curriculum mapping

CPD matrix codes: **3F00**

Training curriculum competencies: **ND-1K_10, NA_HK_02**.

References

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2 Shuaib A. Results of the Sentis Ischemic Stroke Trial. *Int J Stroke* 2010;**5**:271–219.

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4 Avitsian R, Somal J. Anesthetic management for intra-arterial therapy in stroke. *Curr Opin Anaesthesiol* 2012;**25**:523–532.

5 Talke PO et al. Society for Neuroscience in Anesthesiology and Critical Care Expert Consensus Statement: Anesthetic Management of Endovascular Treatment for Acute Ischemic Stroke*: Endorsed by the Society of Neurointerventional Surgery and the Neurocritical Care Society. *J Neurosurg Anesthesiol* 2014;**26**:95–108.