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Abstracts From the Neuro Anaesthesia and Critical Care Society Annual Scientific Meeting: Glasgow, May 9 to 10, 2019

Your Patient has Vasospasm ... Use Spasm Six

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Introduction: Vasospasm is a major cause of death and disability following subarachnoid hemorrhage.[1] We surveyed Anaesthetic Trainees and FY2s to assess their confidence in the management of vasospasm on the wards and High Dependency Unit (HDU). To improve confidence we designed the "Spasm Six" Poster and HDU protocol.

Methods: All 12 anesthetics and 8 FY2 trainees working in HDU and neurosurgical wards of a tertiary neurosciences centre were invited to complete a prospective written Likert scale–based survey. The "Spasm Six" Poster and Vasospasm HDU Protocol were produced by a Neurosurgery Trainee (J.J.M.L.). The final version was produced following extensive collaboration with consultant Neuroanaesthetists, Neurosurgeons, and Neuroradiologists. The poster, aimed at Junior Doctors on the neurosurgical ward, has a clear 6 step bundle to be delivered within 1 hour of vasospasm diagnosis, including urgent computed tomography brain and HDU transfer. The HDU protocol has more information including blood pressure management, aimed at Anaesthetic Trainees who may have never treated a patient with vasospasm.

Results: Overall, 15 of the 20 trainees responded (12 anesthetics, 3 FY2s). On a scale of 1 to 10 confidence, trainees had mean confidence of 5.6 in assessing vasospasm and 6.7 in managing vasospasm. None of the FY2s had heard of vasospasm until their neurosurgical rotation. The Spasm Six poster is now displayed on all neurosurgical wards in Glasgow and the protocol is in HDU. Ward charge nurses have been informed and trainees will be made aware of the poster/protocol during their inductions.

Conclusions: The Spasm Six and associated HDU protocol is simple and easy to use bundle. Its use may be beneficial in other neurosurgical units. Regular flash teaching sessions and/or an e-learning module on vasospasm management may be an effective way of consolidating the information. A further survey to assess the efficacy of the Spasm Six poster and protocol will be conducted.

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Intraoperative Cell Salvage (ICS) in Spine Surgery—A Quality Improvement Survey in a Regional Neuroscience Centre

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Introduction: Intraoperative cell salvage (ICS) is a relatively simple and effective blood conservation technique.[1,2] It forms a key part of patient blood management strategy and reduces the requirement for and amount of allogeneic blood transfusion.[3]

Methods: We undertook an online survey to evaluate current local opinion regarding ICS in spine surgery. The impetus for this quality improvement survey was to update our existing ICS practices and effectively align them with the (Association of Anaesthetists) 2018 guidelines on perioperative blood conservation.[1] The survey questionnaire aimed to address—current attitudes towards ICS service provision, perceived benefits versus potential barriers and respondent awareness of any local/national guidelines. The 28 respondents surveyed included neuroanesthetists and neurosurgeons.

Results: The final response rate obtained was 54%. Of the respondents, 33% had never used cell salvage in spine surgery, although 88% said that they would consider the use of ICS when the expected blood loss was > 500 mL. The potential expected benefits from ICS as reported were—reduction of the likelihood of allogeneic blood transfusion, prevention of severe postoperative anemia and a blood conservation alternative in patients who have a religious objection to receiving allogeneic blood. Significant perceived barriers for ICS service provision reported were—lack of staffing, training in ICS, funding, ICS consumables, concerns with malignancy.

Conclusions: The results of our survey highlighted some of the inadequacies in the potential utilization of ICS in spine surgery. After identifying key priorities, we have implemented important policy updates such as regular training in ICS, nomination of a cell salvage lead, procurement of new cell salvage machines/appropriate kit and a future update of patient information leaflets. We plan to audit the results of the implementation of our updated ICS policy as part of ongoing quality improvement.

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Improving the Quality of Interhospital Transfer to a Tertiary Centre of Patients With Traumatic Brain Injury

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Introduction: Secondary brain injury, which occurs following primary traumatic brain injury (TBI), can be worsened by hypotension, hypoxia, hypocapnia or hypercapnia, and inadequate sedation, analgesia or paralysis.[1,2] The Anaesthetists of Great Britain and Ireland (AAGBI) Recommendations for the safe transfer of patients with brain injury sets these targets: $PaO_2 > 13$ kPa, $PaCO_2$ 4.5 to 5 kPa, mean arterial pressure (MAP) > 80 mm Hg.[3] Our large district general hospital transfers TBIs to a tertiary neurosurgical centre. We compared our practice against the AAGBI Recommendations, to identify areas requiring improvement.

DOI: 10.1097/ANA.0000000000000649

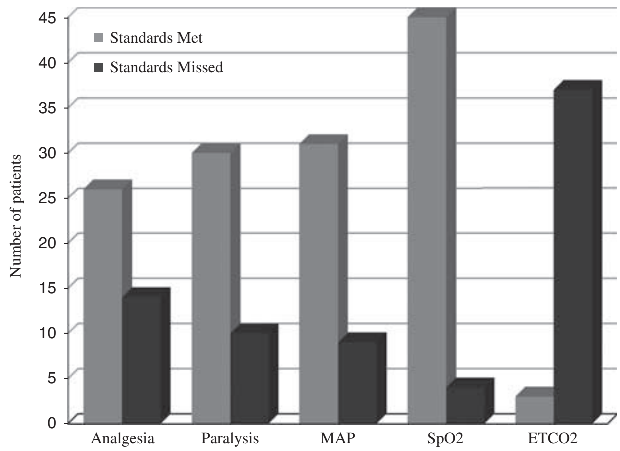

FIGURE 1. Number of patients meeting transfer standards.

Methods: The records of all patients with acute TBI transferred between September 2014 and September 2018 were examined and analyzed.
Results: A total of 49 patients met the criteria. In all, 28 were female (57%). Mean age was 51 years. In total, 40 were intubated; 9 were transferred unintubated.
Analgesia: All intubated patients received a propofol infusion. Overall, 26/40 (65%) also received an opiate infusion.
Paralysis: 30/40 (75%) were paralyzed; 10/40 (25%) were not paralyzed.
MAP: 9/49 (18%) missed the target MAP of > 80 mm Hg, with a mean of 74.1 mm Hg and a low of 67 mm Hg. No charts showed the administration of vasopressors or additional fluids.
SpO_2: 4/49 (8%) had SpO_2 fall below 95%, with a low of 92% in an unintubated patient.
$ETCO_2$: 37/40 (92.5%) had $ETCO_2$ outwith the target (4.5 to 5 kPa), with a range of 2.5 to 6.2 kPa. No charts showed ventilator adjustment.
Results are displayed in Figure 1. No difference was found between the grade of transferring doctor in any category.
Conclusions: Our practice fell below the AAGBI standards in several areas. We recommend more aggressively treating MAP with fluids and/or vasopressors, and SpO_2 and $ETCO_2$ by ventilator adjustment and adequate sedation, analgesia, and paralysis. An education session was added to our departmental teaching program. The AAGBI Recommendations checklist was affixed to our transfer trolley as an aide-mémoire. Our transfer paperwork was updated to include specific guidance for these patients to improve safety.

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Targeted Temperature Management in Subarachnoid Hemorrhage

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Introduction: In patients with subarachnoid hemorrhage (SAH), hyperthermia is a risk factor for poor outcomes.[1] It is widely recommended to treat fever and infection, and actively control temperature.[1–3] We assessed our current practice in patients with SAH in our neuro-intensive care unit (NICU).
Methods: Electronic records of all patients admitted to NICU with SAH in 2017 were extracted and analyzed.
Results: A total of 67 patients were included. In total, 51 (76%) were female. Mean age was 55 years. Overall, 35 became hyperthermic (≥ 38.0°C) in NICU, with a median duration of 19 hours (interquartile range [IQR]: 5 to 41.5) and a mean peak of 38.8°C.

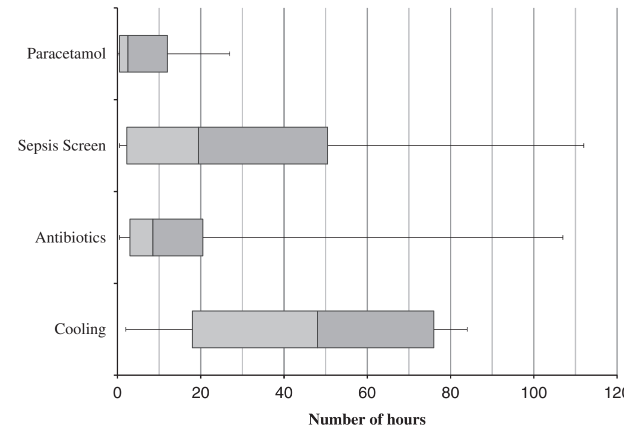

FIGURE 1. Time from hyperthermia to treatment.

Paracetamol: 14/35 (40%) were already receiving paracetamol. Overall, 16 (46%) were commenced (median delay 2.5 h, IQR: 0.5 to 12). One patient was contraindicated, and 4 not treated with no documented reason.
Sepsis screen: 22/35 (63%) had a sepsis screen (median delay 19.5 h, IQR: 2.25 to 50.5). Thirteen (37%) did not: 8 had a fever of 38.0°C for <1 hour and were not treated as sepsis, 2 had a known source, and 3 had no documented reason.
Antibiotics: 8/35 (23%) were already receiving antibiotics. Overall, 20 (57%) were commenced (median delay 8.5 h, IQR: 3 to 20.5). Seven (20%) had a fever of 38.0°C for <1 hour and were not treated as sepsis. Cooling: 13/35 (37%) were cooled (median delay 48 h, IQR: 18 to 76). One patient was treated with the Arctic Sun; 12 were treated with wet cloths, cooling blankets, fans and/or ice packs. Results are displayed in Figure 1.
Conclusions: These data show a substantial burden of hyperthermia. Overall, 63% of patients were not cooled, and there are delays in initiating treatment. We should cool more patients, use more aggressive cooling methods (eg, Arctic Sun), and reduce delays in sepsis screens and antibiotics. Documenting of reasons to deviate from guidelines could also be improved.

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Developing a 24/7 Mechanical Thrombectomy Service

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Introduction: Mechanical thrombectomy is a rapidly evolving treatment for acute ischemic stroke with improved efficacy when compared with thrombolysis.[1] NHS England has committed to commissioning this service in all 24 neuroscience centers in the United Kingdom.[1] Currently only 2 centers in the United Kingdom offer a 24/7 thrombectomy service. The Royal Victoria Hospital, Belfast is a tertiary stroke unit. Our current service for thrombectomy is "in hours" on weekdays. We were asked to expand this to 24 hours, 7 days a week. The recommendation from other

similar centers currently operating this service is that an anesthetist with neuroscience experience would be preferable.[2]
We wished to determine the impact on the emergency anesthesia service in our hospital and if it was either feasible or necessary to provide 24/7 cover with a dedicated neuroanesthetist for this service expansion.
Methods: We undertook retrospective data collection of all thrombectomy cases in a 12-month period from July 2017 to August 2018. A total of 100 patients were included. We collected data on the provision of local and general anesthesia, presence of an anesthetist, outcome of general anesthesia cases and referral to critical care.
Results: Three cases were performed under general anesthesia. Two cases were performed under local anesthesia with an anesthetist present. The other 95 patients required no anesthetic intervention. After general anesthesia, 2 patients required critical care admission. There were 3 other admissions to critical care following local anesthesia.
Conclusions: NICE guidance suggests that mechanical thrombectomy should be provided under local anesthesia with occasional need for general anaesthesia[3] and our data support this. The low numbers requiring general anesthesia or critical care suggest that separate neuroanesthesia cover in our hospital is not warranted. This has important economic implications when preparing for the expansion of regional service.

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Use of 3D Printing to Increase Immersion For In Situ Simulation of Neurosurgical Emergencies

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Introduction: Simulation for medical training provides realistic experience in rare scenarios without risk to patients. Evidence supports the role of multidisciplinary in situ simulation in improving real-life patient safety outcomes, clinical skills, and teamwork.[1] Cardiac arrest when a proned patient is in a Mayfield Clamp, is a rare, life-threatening event requiring complex team interactions. The simulation should be used to train for this critical event.[2] 3D printers allow easy production of lifelike body parts that can enhance the fidelity of simulations, deepening immersion.
Methods: A high fidelity scenario was developed for use in situ in a neurosurgical theater. A.STL file of a 3D cerebellum[3] was printed with a BigBox printer (BigBox3D Ltd, UK), painted, and attached to a Resusci Anne manikin (Laerdal, Norway). Theater was set up as standard for a posterior fossa craniotomy.
Presimulation versus postsimulation confidence on the Likert scale was recorded. Debrief was by an external trained facilitator. Participants provided written feedback.
A paired t test was used to analyze data, P-value ≤ 0.05, 95% confidence intervals.
Results: Five nurses, 1 surgeon, and 1 anesthetist took part. Mean confidence preintervention was 3.14 (SD: 0.69) and postintervention 4.71 (SD: 0.49), $P = 0.0019$ (95% CI: 0.84-2.30) (Fig. 1). Qualitative feedback included: "Realistic, practices teamwork"; "prepares us for what might happen in the future."
Conclusions: This was the first in situ simulation in our theaters. To achieve buy-in, we made the environment familiar. 3D printing of the cerebellum helped to achieve added realism and therefore deeper immersion, as reflected in the feedback. The training was successful, with a statistically significant increase in confidence in the management of unstable neurosurgical patients. We advocate the use of 3D printing to facilitate deep immersion in simulation. We are printing other body parts (eg, cervical spine) for future scenarios.

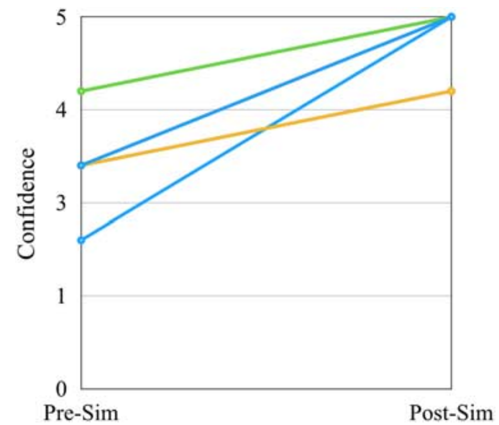

FIGURE 1. Confidence before and after simulation.

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DREAMing in Neurosurgery: An Evaluation of Perioperative Fluid Management and Enhanced Recovery Standards

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Introduction: Fluid therapy is a key aspect of enhanced recovery after surgery (ERAS) and perioperative care.[1] General guidelines exist but neurosurgery presents a unique challenge due to the need to maintain euvolemia and cerebral oxygenation whilst avoiding edema. The "CHEERS-DREAM" campaign aims to improve patient care by assessing adherence to ERAS principles following surgery.[2] We conducted an audit to establish adherence to the "DREAM" standards and current local practice of perioperative fluid management in elective supratentorial tumor surgery.
Methods: Prospective audit conducted over a 5-week period from August 2018. Data collected from patient records including demographics, anesthetic and surgical care, fluid therapy, time to mobilization and established oral intake, and length of postoperative stay.
Results: n = 35 (Table 1). Adherence to all DREAM standards on day 1 after surgery was 90%; 74% stopped IV fluids, 94% established oral intake, 86% mobilized and 86% urinary catheter removed. Mean (SD) nil by mouth time for solids and liquids was 14 (3.1) hours and 5 (3.4) hours respectively. All patients received compound sodium lactate (CSL), mean (SD) volume 1763 (609) mL, intraoperatively. Postoperative practice was varied (CSL 44% vs. 0.9% sodium chloride 33%). Fluids were continued after day 1 in patients with neurological complications of diabetes mellitus requiring control of blood glucose. Median (range) length of postoperative stay was 5 (2 to 30) days.
Conclusions: Adherence to DREAM standards were high but further improvement is required to decrease preoperative starvation time. CSL is the preferred perioperative fluid at our neurosciences centre despite the perceived risks associated with its hypotonicity. A recent study, however, demonstrated no difference in brain relaxation when comparing 0.9% saline with CSL for intracranial surgery.[3]

TABLE 1. Perioperative Fluid Management and Enhanced Recovery Standards in Elective Supratentorial Tumor Surgery

Patient demographics (N = 35)	
Male:female (n)	12:23
Age, mean (SD) (y)	53 (16.5)
Length of postoperative stay, median (range) (d)	5 (2-30)
Comorbidities present*, n (%)	10 (28.6)
Perioperative fluid management	
Volume, mean (SD) (mL)	
Surgery	1763 (609)
Day 1	1097 (301)
After day 1	2125 (2100)
Postoperative care, n (%)	
Intravenous fluids stopped day 1	26 (74.3)
Urinary catheter removed by day 1	30 (85.7)
DREAM standards day 1, n (%)	
Intravenous fluid stopped	26 (74.3)
Drinking and eating	33 (94.3)
Mobilizing	30 (85.7)

*Ischemic heart disease, congestive cardiac failure, diabetes mellitus, hypertension, chronic kidney disease.

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Glucose Control in Neurosurgical Patients

F. Saif, M. Galea, FRCA, FFICM. *University Hospital Southampton NHS Foundation Trust, Southampton, UK.*

Introduction: Neurosurgical patients are at high risk of hyperglycemia because of the use of steroids to manage intracranial edema and the frequent administration of dexamethasone. Current local guidelines state that all patients should have a glucose level (HbA1c or random blood glucose) preoperatively, and regular glucose monitoring if on steroids and/or diabetic.[1]

Methods: We carried out a prospective audit over a period of 8 weeks looking into glucose monitoring in patients undergoing elective neurosurgical procedures, using local guidelines, and Joint British Diabetic Society guidelines, as the gold standard.[1,2] Patients were identified from theater lists. Data was collated using electronic NHS systems and paper notes. Patients below 18 years old and those undergoing day surgery were excluded.

Results: A total of 83 patients were identified; 6 were excluded as per criteria, 10 because of incomplete/missing notes. A total of 67 patient notes were reviewed—41 had a cranial surgery, and 26 had spinal surgery.

In total, 23/67 patients had random blood glucose done preoperatively; none had serum HbA1c levels. In total, 20/41 cranial (48.8%) and 3/26 spinal patients (8.33%) had preoperative blood glucose done. Overall, 36 patients (38.9% cranial, 61.1% spinal) had no blood glucose measurements taken at any point.

In total, 58/67 patients received steroids perioperatively. Of these, 17 nondiabetic patients had glucose measured at least once daily, and 2/2 diabetic patients had regular measurements. Eight patients had at least 1 episode of elevated blood glucose, which was measured appropriately.

Conclusions: Management of blood glucose levels is meeting standards in patients with known diabetes, but improvements in monitoring would ensure all hyperglycaemic episodes are identified. The audit also suggests that the 2 main surgical groups are managed differently, possibly due to a longer duration of steroid therapy in cranial surgery patients, so reaudit would look into these separately.

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Regional Scalp Blockade Audit to Improve Postcraniotomy Analgesia

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Introduction: Regional scalp blockade (RSB) is a well-established technique for providing anesthesia and analgesia for the scalp.[1] In our institution, local anesthetic infiltration (LAI) of the craniotomy wound is standard practice for procedures under general anesthesia. With the advent of awake craniotomies being performed in our organization, there has been a rise in RSB for anesthesia of the scalp. We intended to audit pain scores and analgesic requirements between patients who received RSB versus those who received LAI.

Methods: With audit department approval, we obtained a list of patients who underwent elective craniotomy during January to July 2017. With an even gender split, we chose the first 12 patients in the list who underwent awake craniotomy (the RSB group) followed by the first 12 patients who had a craniotomy under general anesthesia (the LAI group). We gathered demographic data, pain scores postprocedure, and morphine consumption.

Results: We obtained data for 18 patients; 10 from RSB group (5 male and 6 female) and 8 from LAI group (5 male and 3 female). Six patients were excluded due to nonavailability of notes. Mean ages were 42 and 50 years for RSB and LAI group, respectively. All patients received an appropriate dose of local anesthetic and all blocks were performed pre-incision. Mean morphine administration intraoperatively was 1.8 mg for RSB group and 3.4 mg for LAI group. Mean morphine consumption in the recovery ward was 1.1 mg for RSB group and 4.4 mg for LAI group. Mean Visual Analogue Pain scores at 0.5, 1, 2, 4, and 6 hours post-procedure for the RSB group were 1.3, 1.7, 1.3, 3 and 6, compared with the LAI group's 2.5, 3.25, 3.125, 3, and 0.6.

Conclusions: Our audit reflects the evidence base, with RSB performing better than LAI for postoperative analgesia.[2] We plan to incorporate the RSB for all craniotomies as part of a wider analgesic protocol for neurosurgical patients undergoing craniotomy.

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Early β-Blocker Use in Traumatic Brain Injury: A Survey of UK Practice

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Introduction: Recent guidelines from the Eastern Association of Surgery for Trauma (EAST) conditionally recommend β-blockers in traumatic brain injury (TBI) on the basis of reduced in-hospital mortality. However, the evidence is weak, the ideal regimen unknown, and further research is recommended.[1] Early use is standard in some approaches to TBI management (eg, Lund concept)[2] but is not in Brain Trauma Foundation guidelines.[3] We aimed to evaluate UK practice with a view to developing collaborative research into the role of β-blockade in TBI.

Methods: Through NACCS linkmen we surveyed 22 UK adult neuro-intensive care units regarding β-blocker therapy in TBI. The questionnaire had 3 parts: the profile of the ICU, current β-blocker use in TBI, and opinion on research in this area. Details of drugs and dosing were not gathered.

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Results: Nineteen of 22 intensive care units responded (86% response rate). In total, 15/19 (78.9%) were Major Trauma Centres and 17/19 (89%) used protocols for TBI care. Only 5/19 unit protocols (26%) covered management of preexisting β-blocker therapy, and only 2/19 (10.5%) covered de novo β-blocker therapy post-TBI. Early and late phase therapy were reported as common by 3/19 units (15.8%). The lack of evidence for use was cited as a barrier by 2 units. The importance of further research was scored 5.7 of 10 (SD 2.1); 5 units scored importance at 8/10 or greater.
Conclusions: This represents a valid snapshot of UK TBI care. A minority of units incorporate β-blocker therapy into their protocols. There is a recognition of the need for and the importance of further research.

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Improving Postoperative Care of Neurosurgical Patients After Anterior Neck Surgery. The Implementation of the S.H.O.U.T Care Standard to Detect Postoperative Neck Hematoma

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Introduction: Following anterior cervical surgery patients may develop rare and devastating postoperative airway complications, secondary to neck hematoma; often detected late. After a Serious Incident we introduced a new care standard, S.H.O.U.T (Fig. 1) to aid early detection of this complication and to create a cognitive aid for staff when early symptoms may be subtle.
Methods: Staff involved in the care of patients postanterior neck surgery were taught about SHOUT symptoms and a SHOUT sticker was placed in the patient's postoperative notes. We retrospectively audited the files of patients who had anterior neck surgery over a 1-year period, analyzing compliance with our standard of care and assessing complications.

SHOUT AIRWAY RISK? This patient has had anterior neck surgery. The airway may be at risk.	
S	Swelling of neck
H	Hoarseness / voice changes
O	Oesophageal discomfort: swallowing difficulty / drooling
U	Unusual behaviour / agitation
T	Tachypnoea / difficulty breathing
If any SHOUT symptoms present within 24 hours post op contact the Neurosurgical SpR immediately	

FIGURE 1. SHOUT care sticker.

Results: In 1 year, a total of 157 patients had anterior neck surgery, 149 operations were elective and 8 urgent, 7 notes were unavailable. SHOUT postoperative care was commenced in 136 (87%) patients, by anesthetic or recovery staff. SHOUT symptoms were found in 21 (15%) cases. One patient developed a postoperative neck hematoma, which triggered SHOUT symptoms in recovery requiring a return to theater, within 5 hours. The most common postoperative SHOUT symptom was esophageal discomfort, 11 (7%) patients, with 5 (3%) of patients requiring speech and language review. Symptoms occurred in longer operations, mean 2.1 hours (SHOUT symptoms present), versus 1.8 hours (no SHOUT symptoms, $P=0.04$). Similarly, patients with symptoms had a higher mean BMI, 31 (SHOUT symptoms) versus 28, (no SHOUT symptoms, $P=0.03$).
Conclusions: Introduction of the SHOUT care standard is a useful measure to alert all clinicians to early postoperative symptoms following anterior neck surgery. This prompts early detection and intervention, reducing the incidence of life-threatening complications. SHOUT symptoms are more likely in patients with extended procedures and a raised BMI. A lack of SHOUT symptoms could offer a tool to screen patients for early discharge.

Bilateral Fixed Pupils Postcraniotomy. A Forgotten Complication of Papaverine?

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Introduction: We present a case of spontaneously resolving bilateral fixed dilated pupils following emergency clipping of a middle cerebral artery (MCA) aneurysm, not related to raised intracranial pressure (ICP).
Case History: A 51-year-old female with a background of hypertension and type 2 diabetes presented to our institution with a sudden onset occipital headache. Her World Federation of Neurosurgeons grade was 2, pupils were normal. A noncontrast computed tomography scan showed widespread subarachnoid hemorrhage and early hydrocephalus. Angiography confirmed an MCA aneurysm and coiling was attempted but failed as the neck was too wide. The patient went for open clipping immediately. The surgery was uneventful. From an anesthetic perspective, neuroprotective measures were maintained throughout. At the end of the procedure, the patient had bilateral fixed dilated pupils. Computed tomography angiography (CTA) showed improved hemorrhage and stable hydrocephalus. Despite this, given the clinical picture, an external ventricular drain (EVD) was sited, ICP was noted to be normal. By 4 hours postoperative, both pupils were 3 mm and reactive to light. On sedation hold the next morning, the patient was moving all 4 limbs.
Discussion: The possible pathologies causing the immediate postoperative signs were alarming, hence the CTA and EVD. But, given the lack of a structural cause, the team looked for alternative explanations. The surgical team applied topical papaverine, aiming to reduce vasospasm. A literature search identified a few cases of pupillary changes similar to those in our case.[1] Most commonly was ipsilateral mydriasis though. The mechanism is poorly understood, but some suggest it is due to weak local anesthetic effects on the parasympathetic fibers of the oculomotor nerve. Knowledge of these effects may have changed management in this case, however, given the clinical picture, the actions were no doubt justified.

Reference:
1. Zygourakis CC, Vasudeva V, Lai PMR, et al. Transient pupillary dilation following local papaverine application in intracranial aneurysm surgery. *J Clin Neurosci*. 2015;22:676–679.

Audit of the Management of Aneurysmal Subarachnoid Hemorrhages in Our Critical Care Unit

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Introduction: Queens Medical Centre, Nottingham is a tertiary neurosciences centre. To improve the care of patients with subarachnoid hemorrhage (SAH),

TABLE 1. Survey Questionnaire

Time spent by anaesthetist?	98%
Clear communication?	100%
Issues and complications to anaesthesia?	42%
Address concerns?	84%
Confident about anaesthetist?	93%
Friendly anaesthetist?	95%
Satisfaction with anaesthetist skill?	96%
Recommend to family/friend?	97%
Intraoperative awareness?	0%
Pain management?	None: 19%
	Mild: 26%
	Moderate: 28%
	Severe: 11%
	Extreme: 7%
Postoperative nausea and vomiting?	None: 58%
	Nausea only:19%
	Retching: 0%
	Vomited once: 0%
	Vomited > 1: 14%
	Unanswered: 9%

Patient perspective on quality of anesthetic care.

a multidisciplinary guideline[1] was implemented. This study audits compliance and highlights areas for review.

Methods: Thirty patients coded as SAH were identified from the Intensive Care National Audit and Research Centre (ICNARC) database in 2018. Outcome measures were: aneurysm secured in 48 hours, blood pressure control, 21 days of nimodipine, glucose control, sodium homeostasis, euvolemia. Data were collected after case note review.

Results: Seven patients were excluded due to coding error or case note availability.

Time to secure aneurysm: Attempts to secure aneurysms occurred within 48 hours for 22/23 patients. One patient exceeded this due to anatomic difficulties.

Blood pressure control: Controlled for all patients. Unsecured aneurysms remained systolic blood pressure <160 mm Hg; secured <220 mm Hg.

Nimodipine prescription: Should be commenced on admission for 21 days. One person was delayed until day 2. Three did not receive it due to perceived devastating outcome.

Glucose control: Should be controlled at 6 to 10 mmol/L. Only 5/23 achieved this target.

Sodium homeostasis: In total, 17/23 had concentrations outside 135 to 145 mmol/L. These were investigated and acted upon but paired urine and serum samples were often incomplete.

Volume status: Polyuria occurred in 20/23 for a variable duration and often with sodium derangement. It was hard to ascertain from daily charts the accurate fluid balance.

Conclusions: Aneurysmal SAH is a frequent presentation. This study highlights the challenge of normalizing physiology in the face of multisystem derangement. Adherence to the multidisciplinary guideline will improve this. Improvement measures being implemented include a sticker for the daily chart to highlight key guideline recommendations; multidisciplinary education to empower everyone to promptly investigate abnormalities; a single-order dataset for dysnatremia. Following this, further audit of the guideline (Table 1).

Reference:

1. Lyons I, De Beer T, Candler P. Guidelines for the management of patients with Aneurysmal Subarachnoid Haemorrhage in Adult Critical Care. *Nottingham University Hospitals*; 2017. Available at: www.nuh.nhs.uk/download.cfm?doc=docm93jijm4n3604.pdf&ver=6132. Accessed September 5, 2019.

Lack of Correlation Between Brain Parenchymal Oxygen Monitoring and Cerebral Arterial Flow Velocities in Aneurysmal Subarachnoid Hemorrhage

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Introduction: Multimodal monitoring of ICP, temperature, and brain tissue oxygenation ($PbtO_2$) is routinely performed on our neurosurgical intensive care unit to guide patient management following aneurysmal subarachnoid hemorrhage, with the aim of detecting delayed cerebral ischemia (DCI) and monitoring the effectiveness of any therapeutic interventions. Such patients also routinely undergo regular transcranial Doppler (TCD) to assess the flow velocities within the cerebral arteries

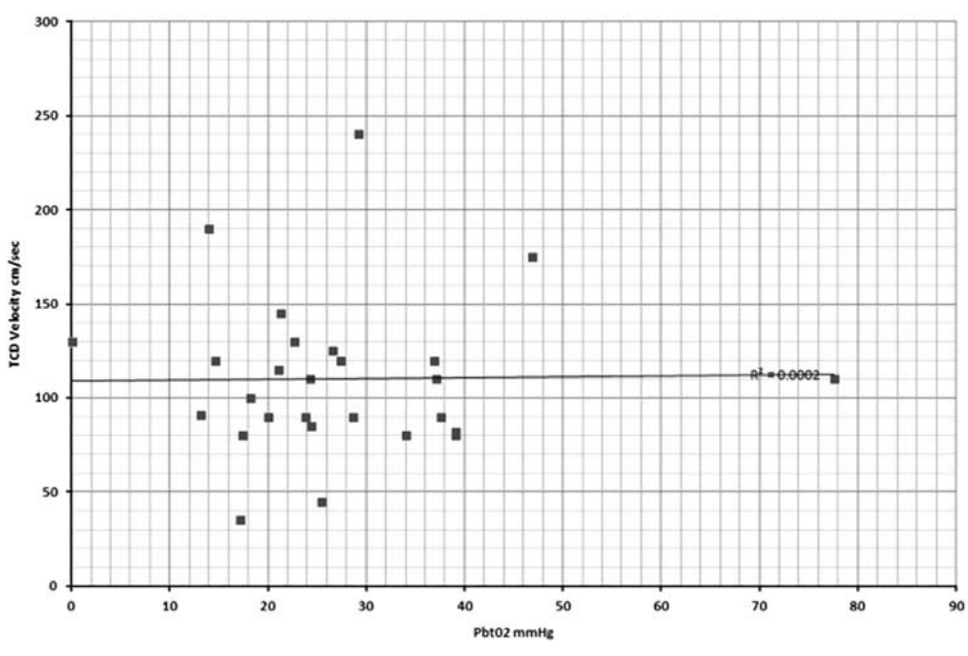

FIGURE 1. Relationship between transcranial Doppler (TCD) velocity and brain tissue oximetry ($PbtO_2$).

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and thereby screen for potential vasospasm. Transcranial Doppler is well-established for this use,[1] and is a noninvasive procedure which can be performed at the patient's bedside. We hypothesized there would be a correlation between a reduction in $PbtO_2$ and the presence of vasospasm as diagnosed by increased flow velocities on TCD.

Methods: Patients studied were those admitted with aneurysmal subarachnoid hemorrhage in whom clinical monitoring for DCI was difficult, for example, due to endotracheal intubation. $PbtO_2$ was obtained from Raumedic NEUROVENT-PTO probes, and the data downloaded into a Microsoft Excel spreadsheet. A low $PbtO_2$ was defined as <15 mm Hg. When TCD was performed on a patient with a probe in situ, the velocity obtained (cm/s) was plotted against the matched time-stamped value for $PbtO_2$ (mm Hg) (Fig. 1) and the Pearson correlation coefficient was calculated. For our hypothesis to be correct, we anticipated a value approaching −1.

Results: Fifteen patients with 36 matched results were analyzed. The Pearson correlation coefficient between $PbtO_2$ and TCD velocity was $P = 0.0002$.

Conclusions: The data from this small sample refute our hypothesis, and suggests that there is no correlation between TCD velocities and intraparenchymal brain tissue oxygenation. A larger observational study is planned to further investigate the relationship between cerebral arterial flow velocities, brain tissue oxygenation and DCI.

Reference:

1. Réza Behrouz DO. The rise and fall of transcranial Doppler ultrasonography for the diagnosis of vasospasm in aneurysmal subarachnoid hemorrhage. *J Neurosurg Anesthesiol*. 2019;31:79–80.

Brain Parenchymal Oxygen Monitoring for the Detection of Delayed Cerebral Ischemia in Aneurysmal Subarachnoid Hemorrhage

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Introduction: Delayed cerebral ischemia is the main cause of morbidity and mortality in aneurysmal subarachnoid hemorrhage (aSAH).[1] Direct brain tissue oxygen tension monitoring ($PbtO_2$) alerts clinicians to reduced cerebral oxygenation and blood flow.[2] Early detection of evolving ischemia allows more timely interventions, whether medical or angiographic. We outline our experience of $PbtO_2$ monitoring in aSAH and the relationship to Glasgow Outcome Scale, clinical symptoms of delayed cerebral ischemia, angioplasty (chemical and/or balloon), cerebrospinal fluid (CSF) diversion and blood transfusion.

Methods: Thirty-three patients had at least 24 hours of continuous $PbtO_2$ monitoring via a Raumedic NEUROVENT-PTO probe. Patients were those whose neurology was difficult to assess clinically, with a need for ICP bolt insertion. Data were analyzed in Microsoft Excel and cross-referenced to any relevant interventions documented in the electronic ICU record or theater/interventional radiology documentation. $PbtO_2$ <15 mm Hg was considered suboptimal.

Results: Analysis of the data recorded was suggestive of the following:

(1) $PbtO_2$ was associated with poor Glasgow Outcome Score (>4) at 3 months.

(2) Neurological deficits were associated with reduced $PbtO_2$.

(3) Increases in $PbtO_2$ were seen with intra-arterial verapamil, CSF diversion, and blood transfusion, as demonstrated by the examples in Figure 1.

Conclusions: In our study a $PbtO_2$ <15 mm Hg was predictive for development of a clinical deficit and for poor Glasgow Outcome Scale at 3 months. Intra-arterial chemical angioplasty results in a pronounced increase in $PbtO_2$, but this is not always maintained. CSF diversion results in a small but persistent increase in $PbtO_2$, with the added effect of lowering ICP. In 3 patients, blood transfusion was also noted to cause an increase in $PbtO_2$. Larger scale observation and analysis of $PbtO_2$ targeted management of aSAH is required to evaluate whether longer term morbidity and mortality outcomes are improved.

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1. Velderman M, Hollig A, Clusmann H, et al. Delayed cerebral ischaemia prevention and treatment after aneurysmal subarachnoid haemorrhage: a systematic review. *Br J Anaesth*. 2016;117:17–40.
2. Bohman LE, Pisapia JM, Sanborn MR, et al. Response of brain oxygen to therapy correlates with long-term outcome after subarachnoid haemorrhage. *Neurocrit Care*. 2013;19:320–328.

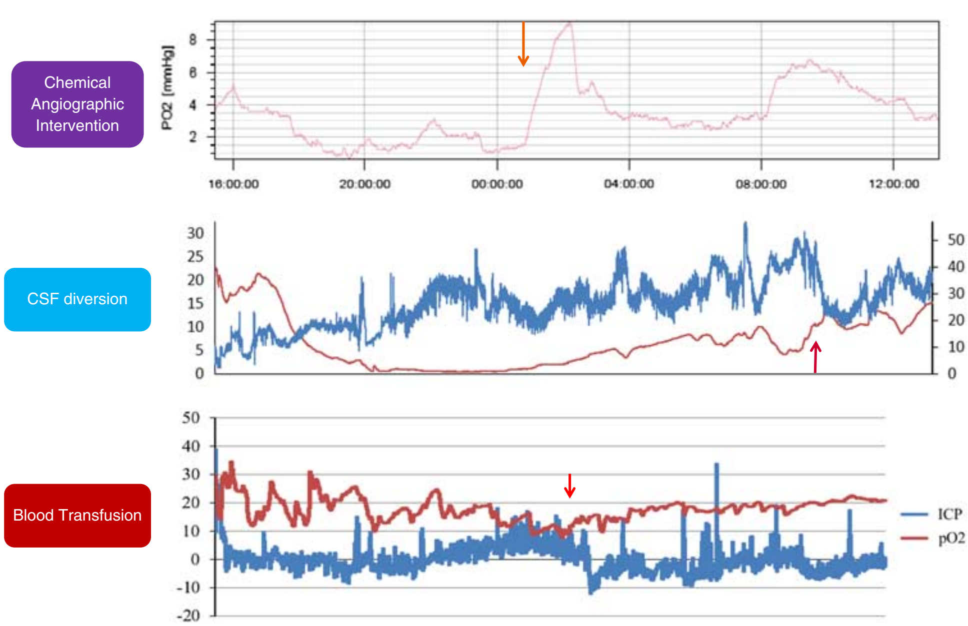

FIGURE 1. Response of brain tissue oximetry to interventions. Selected examples of response in $PbtO_2$ (red lines) ± ICP (blue lines) to therapeutic interventions of chemical angioplasty, CSF diversion, and blood transfusion. Time of intervention indicated by red arrow. *x*-axis = time, *y*-axis = mm Hg. CSF indicates cerebrospinal fluid; ICP, intracranial pressure; $PbtO_2$, brain tissue oxygenation.

Management of Anemia on Neurointensive Care

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Introduction: Anemia is common in intensive care unit (ICU) patients, affecting 60% to 80% patients.[1] Most patients will have normochromic, normocytic anemia secondary to chronic illness. Local guidelines state that patients with a hemoglobin (Hb) <100 g/L should have serum ferritin, iron, transferrin saturation, vitamin B_{12}, and folate levels done. Patients should only be transfused if Hb < 70 g/L unless they are bleeding, have had recent surgery or have evidence of impaired oxygen delivery.[2] The aims of this reaudit were to assess what proportion of neuro-ICU patients are anemic on admission, whether we are performing the right tests, transfusion rate, and transfusion threshold.

Methods: We carried out a retrospective audit over a 12-month period (November 2017 to October 2018). Data were collected using the ICU Metavision database, eQuest, and blood transfusion data from Blood Bank to cross-reference. The audit was registered with trust CE team.

Results: Five hundred five patients were admitted over a 12-month period. Admission Hb was as per Table 1. Of these, 46 had a Hb <100 g/L. Few of these patients had investigations done—ferritin 11/46; iron 3/46; transferrin 3/46; transferring saturation 3/46; vitamin B_{12} 9/46; folate 9/46.

We also looked at red blood cell transfusion over 10 months (January to October 18). A total of 54 U were transfused to 28 patients. Of these, 14 had ongoing bleeding. The average Hb pretransfusion in the remaining patients was 70 g/L (laboratory)/67 g/L (blood gas).

Conclusions: The results of this audit are very similar to those of the first audit. Compliance to transfusion threshold guidelines remains good, but there is still poor compliance to guidelines for the investigation of anemia. Teaching has been incorporated at induction of new junior doctors, but these change 6 monthly. We now need to think of either changing the wording of the guidelines and/or multidisciplinary teaching, empowering the nonmedical staff to prompt the junior doctors, before reauditing.

TABLE 1. Admission Hemoglobin (g/L)

Hemoglobin	n (%)
< 80	4 (0.8)
< 90	18 (3.6)
< 100	46 (9.1)
< 110	106 (21)
< 120	206 (40.8)
< 130	319 (63.2)

References:

1. Retter A, Wyncoll D, Pearse R, et al. Guidelines on the management of anaemia and red cell transfusion in adult critically ill patients. *Br J Haematol*. 2013;160:445–464
2. Wessex NICU Guidelines. Available at: www.neuroicu.org.uk. Accessed September 5, 2019.

Audit: Anesthesia For Endovascular Thrombectomy at Salford Royal

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Introduction: Stroke is a significant contributor to mortality and morbidity in the UK and worldwide.[1] Overall, 85% of strokes are ischemic, of which one third are caused by large artery occlusion and can be treated by mechanical thrombectomy, with good results.[2] Mechanical thrombectomy should be done as soon as possible after stroke onset.[3] Since NICE recommendations were published in 2015, staffing around the clock service has been a challenge many centers have faced in recent years.[3]

Methods: All thrombectomy cases at Salford Royal between 2012 and 2018 were retrospectively reviewed. Data collected included stroke onset time (SO), territory of infarct, whether thrombolysis had been administered, time of arrival in angiography suite, anesthetic technique, preintubation GCS, knife to groin time (KTG), highest and lowest intraoperative blood pressure, use of vasoactive substances and/or invasive blood pressure monitoring, postoperative destination and immediate and late complications.

Results: A total of 109 cases were identified in total. Overall, 92 cases underwent general anesthesia (GA), 7 cases were performed under conscious sedation (CS), and 10 cases were performed under local anesthesia (LA). Mean time from SO to KTG was 4 hours 45 minutes. Mean time from arrival in suite to KTG in cases undergoing GA was 25 minutes. This compares to 14 minutes for both CS and LA groups. In the GA group, 19 cases had an episode of hypotension (defined as systolic blood pressure <90). No cases undergoing CS or LA experienced hypotension. In total, 36 cases were admitted to ICU, 56 cases to High Dependency Unit, and 18 cases to the ward postoperatively.

Conclusions: Over 80% of cases were performed under GA. We found that GA prolonged time from arrival in suite to KTG and resulted in a greater incidence of periprocedural hypotension. Given our findings, we should consider the wider use of CS and LA only techniques in appropriate cases.

References:

1. Feigin V, Forouzanfar M, Krishnamurthi R, et al. Global and regional burden of stroke during 1990–2010: findings from the Global Burden of Disease Study 2010. *Lancet*. 2014;383:245–254.
2. White P, Bhalla A, Dinsmore J, et al. Standards for providing safe acute ischaemic stroke thrombectomy services (September 2015). *Clin Radiol*. 2017;72:175.e1–175.e9.
3. National Institute for Health and Care Excellence. Mechanical clot retrieval for treating acute ischaemic stroke. Interventional Procedures Guideline [IPG548]; 2016. Available at: www.nice.org.uk/ipg548. Accessed September 5, 2019.

The First Faculty of Intensive Care Recognized Advanced Critical Care Practitioner Trained in Neurointensive Care: A Future Model of Working?

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Introduction: The Advanced Critical Care Practitioner (ACCP) role has been successfully established in General Intensive Care units across the country, addressing growing concerns regarding medical staffing shortfalls.[1] A novel approach to the implementation of the Faculty of Intensive Care Medicine (FICM) curriculum[2] has seen the first FICM accredited ACCP for a standalone neuro-ICU in the United Kingdom. We outline the development of a clinical and academic training program, allowing ACCPs to work as part of a medical rota, undertaking clinical activities previously in the domain of the doctor.

Methods: The program includes a Master's level academic component, alongside a program of clinical supervision provided by neurointensive care consultants. Once relevant knowledge and competence are demonstrated trainees are signed off for each component of the FICM curriculum. After successful completion of the program, ACCPs are encouraged to apply for FICM accreditation. Data of advanced procedures undertaken by ACCPs was collected after a survey of individuals' logbooks.

Results: As a result of the successful implementation of an ACCP program we have the first FICM accredited ACCP for neuro-ICU, with a second trainee due to complete training in July 2019. During a 12-month period ACCPs have carried out 45 endotracheal intubations (first-pass success rate of 91%). Since the introduction of the role ACCPs have been involved in a total 81 central venous cannulations (success rate of 94%, complication rate of 6%) and 31 unsupervised intrahospital Level 3 transfers.

Conclusions: The results demonstrate a level of technical ability comparable to their ACCP peers.[3] The full impact of the ACCP role cannot be fully appreciated by technical ability alone, further work should focus on how the consistent presence and expertise of ACCPs has improved continuity of patient care and contributed to the education and clinical supervision for junior doctors.

References:

1. Department of Health. The national and competence framework for advanced critical care practitioners; 2008. Available at: www.ficm.ac.

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2. The Faculty of Intensive Care Medicine. Curriculum for training for Advanced Critical Care Practitioners; 2015. Available at: www.ficm.ac.uk/accps/curriculum. Accessed September 5, 2019
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Implementation of a Preoperative Anemia Care Pathway in Elective Spinal Surgery Patients

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Introduction: Anemia is common in preoperative patients with prevalence up to 30%. It is associated with increased 30-day surgical morbidity and mortality. Spinal surgery is associated with intraoperative blood loss and a tendency towards allogeneic blood transfusion administration.[1,2] Muñoz et al[3] suggest that treatment of preoperative anemia targets a hemoglobin ≥130 g/L, and have demonstrated improved clinical outcomes. We present data from our quality improvement initiative to (a) reduce blood transfusion in elective spine surgery, and (b) improve patient outcomes by introducing a multidisciplinary preoperative anemia pathway. The baseline audit conducted in 2014 found 16.3% of our patients were anemic preoperatively, of these, 23% had a blood transfusion. This was more common in complex spine surgery and associated with increased hospital length of stay (LOS) (9.2 [13.7] vs. 16.6 [11.8] d).

Methods: Retrospective interrogation of our 4-year preoperative anemia database and electronic patient record review was completed. We collected demographics, cause of anemia, blood transfusion rate, surgical LOS and complications. Results were compared with baseline data. Anemia was classified using World Health Organization (WHO) criteria and complications using the Clavien-Dindo system.

Results: A total of 285 patients included; 225 had a surgical procedure (Table 1). Incidence of blood transfusion was reduced from 23% to 8% ($P=0.0019$) and LOS decreased (mean [SD]: 10.4 [9.7] vs. 7.2 [7.0]; $P=0.003$). Introduction of consensus guidelines increased the number of patients reviewed with fewer requiring optimization.

Conclusions: Patient demographics vary each year but the implementation of our anemia care pathway has contributed to reducing blood transfusion and LOS at our institution. To ensure sustainability of our project, we have (a) engaged in continued staff and patient education, (b) held regular meetings to facilitate communication, highlight new and address continuing problems and (c) aligned our work with our Trust's strategic goals.

References:
1. Musallam KM, Tamim HM, Richards T, et al. Preoperative anaemia and postoperative outcomes in noncardiac surgery: a retrospective cohort study. *Lancet*. 2011;378:1396–1407.
2. Seicean A, Seicean S, Alan N, et al. Preoperative anaemia and perioperative outcomes in patients who undergo elective spine surgery. *Spine (Phil Pa 1976)*. 2013;38:1331–1341.
3. Muñoz M, Acheson AG, Auerbach M, et al. International consensus statement on the perioperative management of anaemia and iron deficiency. *Anaesthesia*. 2017;72:233–247.

TABLE 1. Impact of Preoperative Anemia Pathway

Anemic Patients	2014 (N = 66) (Baseline Data)	2015 (N = 47)	2016 (N = 67)	2017* (N = 47)	2018 (N = 124)
Demographics					
Age, median (range) (y)	65 (25-85)	69 (25-93)	67 (30-88)	63 (31-89)	65 (22-88)
Sex (% female)	62	47	43	43	61
Complex spine (%)	80	27	32	32	37
Preoperative anemia (% patients)					
Mild (Hb ≥ 110 g/L)	73	62	64	53	81
Moderate (Hb < 110 g/L)	27	38	36	47	19
Severe (Hb < 80 g/L)	0	0	0	0	0
Iron deficiency anemia (% patients)		64	40	49	39
Surgery delayed due to anemia (n)		3	5	12	9
Intravenous iron treatment (n)		1	2	6	8
Incidence of blood transfusion (% patients)	23	21.6	1.9	5.1	6.4
Hospital LOS, mean (SD) (d)	10.4 (9.7)	9.92 (8.3)	7.18 (7.27)	7.36 (6.71)	6.04 (6.21)
Incidence, postoperative complications (% patients)	27	23	12	19	10

*Publication of consensus statement.[3] Target Hb adjusted to Hb ≥ 130 g/L for all patients. Introduction of formal preoperative intravenous iron service by hematology team.

Hb indicates hemoglobin; LOS, length of stay.

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