



Royal Australasian College of Surgeons
Australian and New Zealand
Audits of Surgical Mortality

National Case Note Review Booklet

LESSONS FROM
THE AUDIT

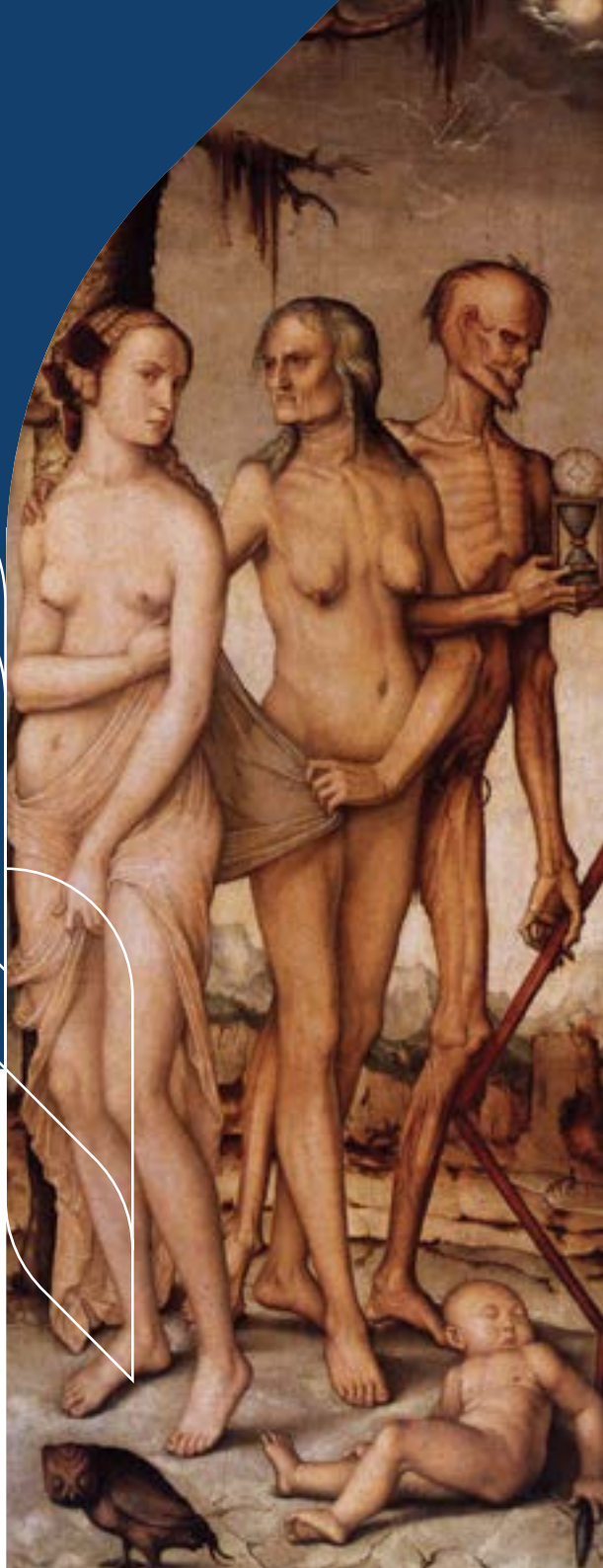
VOLUME 29
JULY 2024



Royal Australasian
College of Surgeons



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Cover image: 'The Ages of Woman and Death' by Hans Baldung

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Guest Chair's Report

This collection of deaths highlights the importance of rescue. Complications can always occur after surgery and they are encountered by all surgeons. The management of these complications and the risks that contribute to them have a major impact on the outcome of surgery.

Surgeons intuitively understand that delays in managing complex life-threatening problems will lead to poor outcomes and contribute to death. Early recognition of complications facilitates earlier intervention, and this is what is required to avoid a poor outcome. As complications will occur from time to time, it is the successful rescue of a patient with a complication versus the failure to rescue that patient, that determines the ultimate outcome.

Early intervention and rescue can't occur without early recognition of the problem. Successful rescue indicates a high functioning team. It requires an environment with staff—medical, nursing and allied health—who are all familiar with what the expected normal recovery looks like. These staff are then better able to realise when things are not going well, and they are more likely to call for help sooner. As surgeons, we depend on others to help us care for the patients we have operated on. We need an environment that supports us to deliver best outcomes.

What does this environment look like? Familiarity of the whole team with what is considered normal versus not normal after a particular type of surgery, requires sufficient hospital volume. This is especially true for complex and higher-risk procedures. Higher hospital volume delivers this familiarity. This has been well demonstrated for complex higher-risk procedures such as oesophagectomy, abdominal aortic aneurysm surgery and cardiac surgery. It likely is also true for the full spectrum of procedures we undertake.

The collection of deaths in this volume highlights the importance of undertaking complex and higher-risk procedures in an environment that delivers best outcomes, not where these scenarios are rarely encountered or where the facilities required to manage postoperative complications are not present. Complications will occur after surgery. We need to recognise them early, and then rescue without delay.

Professor David Watson
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Case Studies

Case 1: Private hospital emergency case transfer delays surgical care

General Surgery

CASE SUMMARY

A 78-year-old male with significant comorbidities including chronic lymphoma, was admitted to a major private hospital with an intensive care unit (ICU) for a total hip replacement for avascular necrosis. The hip replacement was complicated by a posterior fracture of the acetabulum. Care was shared by the orthopaedic surgeon and a rehabilitation physician.

On postoperative day 3, the patient developed low-grade fever and tachycardia to 130 beats per minute (bpm). An abdominal examination was unremarkable; bloods were unremarkable. The notes contain no nursing observations over the next 2 days.

On postoperative day 5, the patient developed further abdominal pain. The white cell count (WCC) was $13 \times 10^9/\text{L}$ (neutrophils $4.5 \times 10^9/\text{L}$, lymphocytes $8.1 \times 10^9/\text{L}$); C-reactive protein (CRP) was 434 mg/L. A repeat computed tomography (CT) scan showed free gas and fluid, reportedly from a small bowel perforation. The report states that the physician was called at 16:30. At 17:15, transfer to a tertiary hospital was arranged. The ambulance was called at 17:19 and arrived 10 minutes later, arriving at the receiving hospital at 18:30.

On arrival, the WCC was $31 \times 10^9/\text{L}$. A National Emergency Laparotomy Audit (NELA) score was not calculated at the time, but retrospectively determined to be 73% expected mortality. The patient arrived in theatre at 21:30. At laparotomy, 4-quadrant faecal peritonitis was found, secondary to perforated diverticulitis. A sigmoid resection was performed and the abdomen left open with an AbThera dressing. The procedure finished at 22:50 and the patient was transferred to ICU and ventilated.

Two days later, the patient was returned to theatre for a wash out, stoma formation and abdominal closure. Over the next 2 weeks he slowly deteriorated, despite maximum and appropriate therapy. Goals of care were discussed and it was decided not to offer another return to theatre. With increasing sepsis, the patient became more confused, and the family elected for palliation and withdrawal of active treatment. The patient died 25 days after the emergency laparotomy. The final pathology report suggested rupture of a single diverticulum.

DISCUSSION

Without access to the observations in the private hospital, it is difficult to determine exactly when the perforation happened. Clinical review occurred daily and the blood tests did not change markedly until the day of the emergency laparotomy. There seemed to be no delay in the initial diagnosis. The radiologist reported the scan promptly to the referring physician.

It seems there was no attempt to contact the private hospital for the emergency laparotomy to be undertaken there, despite the presence of an ICU and general surgeons operating.

Although the tertiary hospital receiving team was aware a patient with known sepsis from a perforated viscus was arriving, there was a 3-hour delay before the patient went to theatre, making a 5-hour interval from the CT report to surgery. During this time, the WCC went from $13 \times 10^9/L$ to $31 \times 10^9/L$. That stated, earlier surgery, while ideal, may not have changed the outcome.

The initial surgical admission notes were written retrospectively (presumably the admitting team was busy), but there is no documentation of a mortality score, discussion of care goals, or consultant opinion regarding possible futility. The first documentation of goals of care was 8 days after the initial laparotomy. Nursing observation charts from the private hospital for the final 2 days are missing.

The electronic PDF files from the public hospital are 662 pages long and in no chronological order or any other order. Medical notes are mixed with observations and blood tests. This is completely unacceptable. While one believes they have been examined fully, it is impossible to dismiss the notion that something could have been missed.

CLINICAL LESSON

This case is an example of how insidious the onset of sepsis can be.

In light of the reviewer's comments, nursing observation charts at the private hospital were recalled and reviewed. Until the late evening of the fourth day there was nothing to suggest the patient was developing a major problem. Overnight, the oxygen requirements increased, pyrexia $\rightarrow 38^\circ C$ developed and the total Adult Deterioration Detection System (ADDS) increased during the day. So, while it is possible that the deterioration could have been noted earlier, this is an interpretation made with the advantage of hindsight and would not have been obvious at the time.

ANZASM COMMENT

While the ANZASM process focuses on management during the terminal admission, there were missed opportunities during this patient's care prior to transfer.

Life-threatening abdominal complications (e.g. cholecystitis and colonic pseudo-obstruction) are recognised following hip surgery; however, they are rare and—as in this case—there is often a delay to diagnosis.

Review of the private hospital notes indicates the patient's deterioration should have been investigated earlier, perhaps with a CT scan on the evening of day 4. This potentially avoidable delay to diagnosis of 18–24 hours was a key determinant of the outcome.

Consultant-to-consultant discussion in these complex circumstances can facilitate decision-making. Reasons for the transfer were likely multifactorial but these were not documented. The delay was also potentially preventable as the private hospital has facilities to perform emergency laparotomy, including an ICU. Given how promptly the patient underwent surgery, the delay to treatment was likely less significant, as pointed out by the reviewer.

Perioperative risk calculators may help when discussing the futility of surgery. However, even a one in four chance of survival—following what began as an elective quality-of-life operation—may be seen as a reasonable chance, given the alternative.

Abdominal symptoms following orthopaedic surgery should be investigated so as not to miss rare but life-threatening complications.

Case 2: Lower limb and bowel ischaemia following open abdominal aortic aneurysm repair at a hospital unable to manage complex vascular cases

Vascular Surgery

CASE SUMMARY

A 74-year-old woman was admitted to a peripheral public/private hospital for elective repair of a juxtarenal abdominal aortic aneurysm. The size was not recorded. The patient underwent an open bifurcated interposition graft (on a Friday afternoon) to both common iliac arteries. No adverse intraoperative events were noted. It is unclear at what level the aorta was clamped.

Postoperatively, the patient was transferred to ICU at 17:26 extubated. No abnormal postoperative findings were recorded. The next entry—by the ICU registrar at 19:30—reported a complete foot drop on the right. There is no mention of any distal pulse status or foot temperature. Discussion occurred, perhaps with the ICU consultant on call (name and designation unreadable). A personal consultant review did not take place and it seems the surgeon was not informed. It was decided that the complete foot drop was a result of aortic clamping and an epidural catheter. The decision was to observe.

The findings were confirmed at the next ICU round at 23:00. Again, no pulse status was documented.

During the ICU round at 08:00 the next day, the issue was not identified as a vascular problem. One entry mentions that the operating surgeon was informed at this time. It is unclear whether this was a routine call or specifically about the adverse finding.

Thereafter, the notes are incomplete and the timeline unclear. At some stage, the vascular surgeon attended the patient and decided to return to theatre for exploratory laparotomy for suspected severe right leg ischaemia. Retrospective notes state that on the surgeon's inspection the leg was mottled up to the umbilicus.

It is unclear at what time the patient actually went to theatre. The next entry in the notes states that the patient returned from theatre at 15:00. During the revision surgery, the thrombosed limb was successfully thrombectomised. However, signs of mesenteric ischaemia were identified, and a general surgeon was called. A hemicolectomy was performed. The patient returned to ICU intubated.

In ICU the patient continued to deteriorate, with increasing inotropic requirements. At a family meeting with the vascular surgeon, it was decided that further surgical intervention would be futile. The patient passed away at 18:10.

DISCUSSION

This death could possibly have been prevented in a different setting. Central to what happened postoperatively was that a major vascular operation was performed in a peripheral hospital without a tertiary vascular unit. There was no 24-hour on-site vascular cover, only off-site consultants available. It seems clear that the ICU team was inexperienced in the management of complex vascular patients.

It is more than reasonable to assume that the foot drop was an early sign of acute limb ischaemia. The examination was inadequate—or at least inadequately documented. An appropriate vascular examination comprising feeling pulses, and simple vascular investigations such as dopplers, would have flagged the developing vascular complication quite early. Neither the operating surgeon nor the ICU consultant attended the patient personally to address the key clinical finding.

The aetiology of the bowel ischaemia is difficult to determine. Whether it was a result of metabolic changes secondary to profound untreated limb ischaemia, loss of right internal iliac and inferior mesenteric circulation, or any other cause, remains subject to speculation.

There was a concerning lack of communication. The operating surgeon was not informed of the arising postoperative issue. By the time of surgical review, the patient was already showing signs of severe advanced ischaemia. It is unclear whether this review was routine or emergent.

CLINICAL LESSONS

Timely surgical review would most certainly have led to an early identification of the right limb occlusion, and most likely would have changed this patient's outcome.

Major vascular cases, especially aortic surgery, should be reserved for tertiary centres with experience in these operations: a fact that is extensively documented throughout the world literature.¹⁻³

ANZASM COMMENT

The point raised by the second-line reviewer is well made: as far as possible, major vascular surgery should be undertaken in centres experienced in this area of medicine. This has been widely recognised with open aortic surgery. The first 2 groups referenced by the reviewer propose minimum caseloads: 32 in the UK paper and 30 in a later iteration of the German study. However, setting minimum caseloads in Australia is a complex issue. According to AVA (Australasian Vascular Audit) data, no Australian centres currently meet these thresholds. In 2021, 2 hospitals met these thresholds; in 2010, 5 did.

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Case 3: Attempted open repair of failed complex endoluminal grafting of abdominal aortic aneurysm performed at a hospital unsuitable for complex vascular cases

Vascular Surgery

CASE SUMMARY

A 77-year-old man was admitted to a private hospital for explanting of a previous endoluminal graft and open repair of an abdominal aortic aneurysm (AAA).

The patient had a complex history involving repair of the AAA with an endoluminal graft some 5 years earlier. He continued to have increasing sac size post-graft and had a further open repair with banding of the neck and endoluminally placed endoanchors, presumably to control a proximal leak. Coiling of lumbar vessels had also been performed, presumably to prevent a past type II leak. Despite this, the patient continued to have increasing sac size, so it was decided to perform a further intervention. A multidisciplinary team discussion with the patient and family agreed to proceed with explanting the graft and open repair of the aneurysm.

The patient was admitted to a private hospital and had a coronary CT scan, which determined that his coronary status was stable. It was expected that he would have significant adhesions due to the previous surgeries, so a general surgeon was also involved in the operation to perform adhesiolysis prior to the aneurysm repair. Surgery commenced at 14:00.

After a prolonged adhesiolysis, the vascular component of the surgery commenced at 21:00. A supra-coeliac clamp was placed and the graft was explanted, retaining the supra-renal struts, which is usually the case when supra-renal fixation is involved. The proximal anastomosis was performed. On release of the clamp, the patient became significantly hypotensive, presumably because of reperfusion syndrome with a 45-minute supra-coeliac clamp time.

Despite aggressive resuscitation, including open cardiac massage, and the anaesthetist obtaining a second assistant, the attempt was unsuccessful and the patient died.

DISCUSSION

This was a very difficult case. The decision to proceed with open surgery and attempted explanting of the graft was not unreasonable, as long as the family and patient were aware of the potential consequences. After looking at the notes, the reviewer believes that they were. However, there are concerns regarding various decisions made along the care pathway for this patient.

Major concerns relate to ‘administrative’ decisions. The operation should have been performed in a tertiary institution. This was a case known to be very complex. There was a need for a general surgeon and the necessity for high-level anaesthetic input and high-level intensive care input postoperatively. The vascular assistant was not a consultant surgeon, whereas great benefit would have been derived from having 2 vascular consultant surgeons.

Although previous banding, endoanchors and coiling of lumbar arteries had been performed, the CT scan just prior to surgery showed a fairly poor distal landing zone on the right common iliac artery of the graft with minimal contact, thus potentially a cause of endoleak. The proximal component of the graft had fairly short contact as well, which may have compromised the seal, leading to a possible type 1 endoleak. It is unclear whether a fenestrated endoluminal repair was considered to try to deal with a possible proximal endoleak and also extension down the right side beyond the internal iliac to deal with the poor contact on the right limb of the graft, which may have been the source of the expanding aneurysm.

The timing of the surgery, commencing at 14:00, was inappropriate for a prolonged complex operation that would inevitably extend into the evening.

Intraoperatively, the surgeon found an unexpected, contained rupture of the aneurysm, which could have been quite old. In a situation such as this—where it is unclear where the actual endoleak or endo-tension is occurring—a more appropriate intraoperative approach would have been to gain supra-coeliac access to the aorta but not to clamp, and then open the sac to try to determine whether it was a type II endoleak, which could have been dealt with by under-running of the lumbar or inferior mesenteric artery vessels. However, if it was truly a type I leak the clamp could be applied and the procedure continued safely. This has the potential to prevent the need for any supra-coeliac clamping with the associated risk of reperfusion that subsequently occurred.

The clamp time of 45 minutes for the proximal anastomosis is reasonable, although quite prolonged, which may have contributed significantly to the outcome. If there were 2 consultant vascular surgeons present, this time may have been significantly reduced.

Finally, there was a known thoracic aneurysm of 4.5 cm, which is believed to be in the distal thoracic aorta. There was no imaging to look at the more proximal thoracic aorta, which may have shown an even bigger aneurysm that may have actually contributed to the patient's demise with prolonged clamping at the supra-coeliac level.

CLINICAL LESSONS

This case highlights the difficulty and complexity with patients who have had previous endoluminal repair and continue to have expanding sacs, especially when no obvious endoleak is determined. Transferring the care of these patients to a tertiary centre that does high-volume open aortic work is essential.

Case 4: Importance of preoperative workup and consent for operation in patient with multiple meningiomas

Neurosurgery

CASE SUMMARY

A public hospital patient in her 70s with multiple meningiomas, including cortical, temporal pole and medial sphenoidal wing, was transferred to a private hospital for surgery. Significant comorbidities included past deep vein thrombosis (DVT) on aspirin, hypertension, hypothyroidism, asthma, palpitations and aphasia. The patient's consent for surgery was done on the day of surgery and did not state which meningiomas were to be excised.

The first operation—a stealth-guided, left frontal-temporal-parietal craniotomy for removal of the large medial sphenoid wing and a smaller convexity meningioma—was abandoned due to brain swelling. At the frontal-temporal-parietal skin incision with scalp reflection the patient was noted to be moving and her blood pressure was >200 mm Hg for a transient period. The procedure was paused, and with anaesthetic intervention the blood pressure was controlled. The craniotomy was performed. The brain was noted to be tense, and once the dura was opened the brain swelled. The patient was given mannitol and the procedure was abandoned. However, the posterior temporal meningioma self-delivered and was removed as it was pushed out by the bulging brain. The case was abandoned because brain swelling continued.

The patient was sent for a CT scan, which confirmed diffuse brain swelling and subarachnoid haemorrhage. No aneurysm was seen.

The patient returned to theatre for external ventricular drainage (EVD) and was then transferred to ICU with an appropriate increased intracranial pressure management strategy initiated. The patient's left pupil was dilated, and a repeat CT scan confirmed a large hemispheric haemorrhage with significant midline shift and absent basal cisterns.

The patient returned to theatre for clot evacuation, partial temporal lobectomy and diffuse bleeding from a sylvian vessel, which was clipped. Bone was left out.

The patient returned to ICU but did not make any meaningful recovery. Her pupils were unreactive. Palliative care was provided after multiple family and clinical meetings.

DISCUSSION

This was a public hospital patient transferred to a private hospital for surgery, so scant information of the preoperative workup is available. There was no thorough preoperative history nor examination detailing the patient's neurology, the reasoning for the surgery, or a detailed consenting process (not just on the day of admission for surgery). A nurse form states that the patient had aphasia, which may be the reason for the operation. Given her age and multiple comorbidities, an anaesthetic review would have been ideal.

Perhaps all this was done in the public hospital but not transferred over to the private hospital? It would have been beneficial to include the preoperative magnetic resonance imaging in the chart. Meningiomas that have marked cerebral oedema have a higher risk profile and may need a different preoperative approach. Preoperative dexamethasone and antiepileptics should have been discussed, along with the possible requirement for preoperative embolisation. Again, this may have occurred, but it was not documented in the chart given to the private hospital.

This was a complex case with multiple tumours. On review, it is likely that the ictus occurred at the time of surgery when the patient became hypertensive (>200 mm Hg) and bradycardic. The dura was already tense on performing the first craniotomy, so the subarachnoid haemorrhage (SAH) had most likely occurred. Consideration should have been given at that time to abandoning the operation before opening the dura and going to scan. If the brain was tense, the ability to access the medial sphenoid meningioma in the presence of brain swelling would have been difficult. Opening the dura releases the tamponade, making swelling and bleeding worse. No aneurysm was discovered on subsequent CT angiography, but the description of the pattern of SAH is a concern for an aneurysm or dissection.

The operative management followed standard protocol, that is, ceasing the operation, going to CT scanning, inserting an EVD, then reimaging when the pupils change. The evacuation of the haematoma and the craniectomy as an attempt at salvage, were appropriate, but did not change the ultimate outcome. ICU management was consistent with established procedures. Appropriate family meetings were documented. The radiology reports are as expected and sufficiently detailed for assessment.

CLINICAL LESSONS

This case highlights the importance of robust preoperative workup, management and documentation. Such cases are more complex and concerning in patients with multiple comorbidities. There are reports of SAH occurring pre- and postoperatively with meningioma. These haemorrhages can be spontaneous, from

concurrent aneurysms, from dissections, or from invasion by the tumour itself into the middle cerebral artery.¹⁻³

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Case 5: Denied inter-hospital transfer impacts patient care

General Surgery

CASE SUMMARY

A woman in her 80s arrived in the emergency department (ED) with septic shock. She initially needed intraosseous noradrenaline. She had obstructive liver function tests and bilirubin of 90 $\mu\text{mol/L}$.

CT scanning demonstrated gallstones in the gallbladder and possibly a stone at the ampulla. The correct diagnosis of ascending cholangitis was promptly made. Antibiotics and fluids were prescribed. The patient had a troponin level of 12,000 ng/ml.

Appropriately, the surgical team attempted to transfer the patient for endoscopic retrograde cholangiopancreatography (ERCP). This transfer request was denied by every hospital in the region.

The surgeon—in desperation—performed a laparoscopic cholecystostomy that night.

The patient continued to deteriorate and died the next day.

DISCUSSION

The surgeon performed the cholecystostomy—knowing it was not ideal—because no other options were available. The patient may have survived if ERCP could have been performed at the admitting hospital at the time of presentation. There was no documentation that the decision to operate had been discussed with a hepatopancreato-biliary surgeon.

The patient died due to myocardial infarction and cholangitis. If the patient had been transferred for ERCP, the outcome may have remained the same.

CLINICAL LESSONS

Once gallstones had been confirmed on CT and the diagnosis of cholangitis established with liver function tests, an ultrasound scan was unnecessary and may have delayed treatment.

Cholecystostomy for cholangitis has been described but it is not the standard of care. The surgeon felt abandoned by the health system and had no other options.

ANZASM COMMENT

There are quite a few lessons to be learned here, all of them of great relevance. Obstructive jaundice, particularly with ascending cholangitis, is not uncommon, has grave consequences and is relatively easily correctable.

In dealing with referrals: as a rule, when a colleague asks for help this must not be denied, particularly when the help needed has a strong basis, like in this case.

Referring patients from a peripheral hospital to a tertiary centre can be very difficult. The referring team may struggle to find a tertiary centre that accepts the patient, or the patient may be accepted but blocked by the 'no beds' issue.

There are several things that can improve the acceptance of a patient, including talking to the correct team (e.g. hepatobiliary instead of general surgery or gastroenterology), consultant-to-consultant referrals and early involvement of state transfer services.

A national initiative is needed that enforces the accepting hospital to receive the referral in ED and deal with the patient from there.

Case 6: Complications following malignant large bowel obstruction

General Surgery

CASE SUMMARY

A 67-year-old man presented to hospital with a short history of abdominal pain. He spoke no English, so his medical history was mainly obtained during his stay from family/friends and interpretive services.

On presentation, he appeared well but had a soft distended abdomen. His bowels were unopened for 2–3 days. He was anaemic (haemoglobin 97 g/L). CT scanning demonstrated a large bowel obstruction, with a descending colon mass and proximal colonic dilatation. The CT result came late in the evening, so a surgical review was requested from the ED for the following morning.

The patient was seen in the morning (day 2) by the surgical registrar, who noted a soft but mildly distended abdomen and considered a malignant large bowel obstruction. A liver lesion was visible on the CT scan—thought to be possibly a cyst—but there was no comment of definite metastatic disease. A plan was made for intravenous (IV) antibiotics (no clear indication), tumour markers, a ‘decompressive laparotomy’, and a nasogastric tube (NGT) if the patient vomited. No sense of urgency for the problem was apparent from the notes, presumably as the patient appeared well.

Later that day there was an extensive discussion with the patient via an interpreter, with a recommendation for flexible sigmoidoscopy then a laparotomy/Hartmann’s procedure. The patient wanted to await his son’s arrival the following day before deciding to proceed. He was warned of the risk of perforation by delaying this decision, which he accepted.

On day 3, the patient’s bowels opened. He still had a distended abdomen with normal observations. Consent was obtained via an interpreter for a flexible sigmoidoscopy and a laparotomy/bowel resection/stoma. There was no documentation of urgency for surgery and no time allocated for theatre the following day. That afternoon, the patient had 3 vomits.

On the morning of day 4, the patient had another large vomit. He consented to NGT placement (the plan was for NGT placement only if further vomits). Surgical review planned for sips only, IV fluids, and a scheduled flexible sigmoidoscopy the following day. No further imaging was obtained.

The patient had no further vomiting and was stable on the morning of day 5 with normal observations. It was planned to proceed to theatre for a flexible sigmoidoscopy and NGT placement.

No flexible sigmoidoscopy report is provided in the notes. The procedure was performed under propofol and Hudson mask, without airway protection. No surgical notes are entered in the records from this point onwards. Photos in the notes show presumably an obstructing descending colon cancer. The patient appears to have desaturated; he became febrile immediately after the procedure.

He was transferred to ICU (an initial plan for a CT scan was aborted due to instability). His oxygen saturation levels were 85–90% and this was unable to be elevated despite increased oxygen flow via a Hudson mask. He rapidly deteriorated with agitation, hypoxia and increasing tachycardia to 150 bpm. He was noted to have a very distended abdomen. It was decided to transfer him directly to theatre, where he underwent a laparotomy and Hartmann's operation. Comment is made of aspiration of gastric/faecal matter peri-intubation, and a prolonged period of hypoxia. No bowel perforation was identified at surgery.

Postoperatively, the patient was transferred back to ICU intubated. There were extreme difficulties with oxygenation, and chest X-ray demonstrated near white-out of the left lung. Worsening hypoxia followed despite maximal ventilation, with deterioration and asystolic arrest the following morning.

DISCUSSION

This 67-year-old man presented with a malignant large bowel obstruction. The surgical team made this diagnosis promptly based on the CT scan.

Malignant large bowel obstruction is considered a surgical emergency, usually mandating surgical intervention within 24 hours. In some cases, a competent ileocaecal valve can lead to colonic compromise/perforation within hours. In others, the obstruction decompresses to the small bowel, with patients continuing to appear relatively well until vomiting occurs. Even with a large bowel obstruction, the abdomen may appear only mildly distended, as in this case.

There appears to be a lack of clinical urgency in the management of this patient, perhaps contributed to by the patient seeming to be well and probably also to the fact that his bowels opened, leading to documentation of a 'partial obstruction'. 'Bowels opening' does not exclude a complete obstruction. Further imaging—either a plain abdominal X-ray or repeat CT—would likely have demonstrated the progression of the bowel obstruction to one involving the large and small bowel, hence warning the treating team to the danger of performing the endoscopic procedure without airway protection. The fact that he vomited was also a sure

sign of this development. The decision not to protect the airway during the procedure led to the aspiration to which the patient succumbed.

The rationale for a flexible sigmoidoscopy was presumably to confirm the diagnosis and exclude a more distal lesion. However, in clear, established, mechanical large bowel obstruction, a flexible sigmoidoscopy is best avoided because the additional insufflation only worsens the colonic distension and risk of perforation. A contrast enema study can confirm a mechanical obstruction and exclude a more distal lesion. The reviewer feels that a flexible sigmoidoscopy was not required in this case. The patient should have proceeded directly to surgery for management of his large bowel obstruction.

Difficulties with the language barrier in this case were well negotiated, with good documentation of the consent process. These difficulties did not contribute to the patient's poor outcome, which was due to the decision to perform a flexible sigmoidoscopy when an exploratory laparotomy was required.

The surgeon completing the case form states that the patient succumbed to an infection acquired preoperatively. The reviewer disagrees with this comment. It is more likely that the patient succumbed to respiratory failure from aspiration pneumonitis as a consequence of the flexible sigmoidoscopy.

The postmortem examination notes an ascending colon perforation. This was not identified at the time of the Hartmann's operation and presumably occurred in the postoperative phase, perhaps due to ischaemia. The postmortem examination confirmed the diagnosis of a localised, low-grade descending colon cancer without metastatic disease. Advanced malignancy did not contribute to this man's death.

Thus, this was likely to have been a preventable death.

CLINICAL LESSONS

A mechanical large bowel obstruction is a surgical emergency that requires intervention (endoscopic stent or surgery) with an amount of clinical urgency. In some cases, decompression to the small intestine occurs. Clinicians should be aware of this possibility, particularly if the patient develops vomiting. This represents a clear airway risk, and any intervention requires airway protection in this scenario.

In general, up-front surgery is required for patients with acute mechanical large bowel obstruction. Flexible sigmoidoscopy/colonoscopy should be avoided due to the risks of additional insufflation and aspiration.

Case 7: Postoperative over-sedation in a deteriorating patient

Cardiothoracic Surgery

CASE SUMMARY

A 71-year-old man underwent coronary artery bypass grafting with a saphenous vein graft to the left anterior descending (LAD) artery and an aortic valve replacement. The procedure occurred on a non-elective basis after he presented to an outpatient clinic with ischaemic changes and chest pain. There was deepening ST depression in V5 and V6 on one electrocardiogram (ECG), which was labelled as 'chest pain'. He had also experienced a recent chest infection.

The patient's surgical history included stenting 10 years previously, bilateral cataract surgery and a laparotomy. His comorbidities included type 2 diabetes (on insulin), hypertension, hypercholesterolaemia, asthma/chronic obstructive pulmonary disease (treated with puffers), gastroesophageal reflux disease and hypothyroidism. He had ceased smoking 5 years previously. Preoperative work-up demonstrated severe aortic stenosis and diastolic dysfunction. An angiogram reported severe proximal LAD disease, a 60–70% lesion in the circumflex system, and mild to moderate disease in the right coronary system.

The operation was performed and appeared to be routine, with no major intraoperative technical issues. A ventricular pacing wire was placed onto the epicardium. Blood was noted on withdrawal of the transoesophageal echocardiography (TOE) device but not involving the endotracheal tube (ETT). The gastrointestinal bleed was treated with product transfusion.

Following the procedure, the patient was transferred to ICU, where the main concern of nursing and medical staff over the first 24–48 hours was drowsiness and potential over-sedation due to the analgesia. Physiotherapy on day one also noted he was extremely drowsy and unable to sit out of bed nor make a satisfactory cough effort. Analgesia was altered but not ceased.

On postoperative day 2, the patient was noted to have bilateral coarse crepitations and pitting oedema. He was mottled peripherally and cool. His urine output deteriorated and he required low dose noradrenaline. He became febrile, with a temperature $>39^{\circ}\text{C}$ early in the postoperative period. His Glasgow coma score dropped as he developed a state of shock. He was reintubated.

The patient commenced on dobutamine and was given fluid loading. TOE was performed, which demonstrated good left ventricular (LV) function with a hyperdynamic state. He developed heart block and was subsequently paced in

a VVI mode,¹ which increased to 110 bpm for a period of time. The dobutamine was replaced with vasopressin after it was determined that the patient was predominantly in a vasodilatory state. Following this, the patient was ‘filtered’. He had elevated lactate levels and escalating inotropic requirements. It is unclear on the ECG if there were associated dynamic ECG changes at this time.

The patient’s inotropic support was capped, and he passed away on postoperative day 3.

DISCUSSION

There appear to be no intraoperative technical issues.

The postmortem report notes there was an acute infarct in the lateral wall. It is difficult to ascertain the timeline for this event or to determine if this was the precipitating factor that led the patient into an acute pulmonary oedema-type state early in the postoperative course, or whether this occurred in the later hypoperfused state.

There was a gastrointestinal bleed associated with the TOE, despite there being no clear contraindication to TOE insertion in the preoperative notes. Heyde’s syndrome was mentioned but no oesophageal pathology.

The patient had gastrointestinal bleeding perioperatively. He had blood around the TOE upon removal but no blood in the ETT. He also had low platelets in the postoperative period. Despite this, he was administered 300 mg of aspirin daily. The autopsy findings report that a polyp in the upper gastrointestinal tract was responsible for the bleeding.

On postoperative findings the patient also had melaena. The aspirin dosage could have been reconsidered in this context. It was also difficult to decipher in the notes the course of events and medications on the ICU chart. It was unclear what the central venous pressure was, which could have given a better indication as to the cause of deterioration. The deterioration into shock may have been:

- ‘Septic’, as a result of possible early aspiration, given an ‘over-sedated’ state secondary to analgesia. The patient had also had a recent lower respiratory tract infection, which may have played a role.
- ‘Cardiogenic’, given that an acute lateral wall infarct was found. However, this is incompatible with the finding of a hyperdynamic normal LV function on TOE after deterioration. The circumflex disease was noted to be moderate. It is difficult to comment upon the severity or ‘graftability’ of the lateral wall (circumflex) disease without viewing the angiogram. The autopsy demonstrates minor thrombus in the LAD; however, the anastomosis was patent.

Both nursing and medical staff noticed ‘over-sedation’, such that the patient was unable to cough appropriately nor partake in physiotherapy as expected.

CLINICAL LESSONS

Earlier recognition of deterioration may have altered the course for this patient. Signs that he was deteriorating were present early in the postoperative stay, with decreased urine output, crackles and pitting oedema. He had quite a large product transfusion for his gastrointestinal bleeding and a further fluid challenge in the postoperative course. Diuresis did not appear to be a main feature of treatment in the early deterioration phases.

ANZASM COMMENT

Over-sedation in the perioperative period can mask a variety of conditions. In addition to delaying extubation, the clinical status can be masked. It can cloud assessment of a patient with a deteriorating circulatory and/or metabolic state, in addition to the need for escalation in the use of vasopressor agents. Goals, guidelines and expectations must be discussed with the ICU care team in a collaborative manner to avoid over-sedation of patients.

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Case 8: Unexpected death after surgery, likely due to pulmonary embolus

Orthopaedic Surgery

CASE SUMMARY

An 86-year-old man was admitted to hospital A after falling from his tricycle, sustaining a stable lumbar fracture and a fracture of his left acetabulum. Six days later, he was transferred to hospital B for surgical fixation of the left hip fracture and total hip replacement.

The patient lived alone at home and was independent in all daily activities. He was under the care of a general practitioner and a geriatrician. His medical history included non-insulin dependent diabetes, mild dementia, hypertension and gastroesophageal reflux disease. He was a non-smoker and occasional drinker. His usual medications were gliclazide, metformin, donepezil, irbesartan and esomeprazole.

The surgical procedure was planned for the day after transfer, but was postponed on the day, then deferred until day 5 of admission at hospital B (11 days after initial presentation). The delay was apparently due to unavailability of the surgeon. The patient was seen each day by the orthopaedic and orthogeriatric ward rounds. He was noted to be confused at night, but his vital signs remained stable. He remained resting in bed. An in-dwelling catheter was inserted; enoxaparin 20 mg was commenced for DVT prophylaxis. His blood sugar levels remained below 12 mmol/L. Elevated WCC prompted a urine culture, which showed normal values and no growth. A chest X-ray was clear. Despite this, he was commenced on IV cefazolin.

On the day of surgery, the patient's resuscitation plan was confirmed with his daughter, requesting cardiopulmonary resuscitation (CPR), intubation and ICU care if required. The procedure commenced at 12:41 under general anaesthesia, commencing with open reduction of the acetabular fracture through an anterior approach, then repositioning and total hip replacement through a lateral approach. Blood gas indicated acidosis, and elevated blood glucose and ketones. He was commenced on an insulin infusion.

The patient was returned to the ward postoperatively. Observations at 17:35 recorded that he was awake, alert and without pain. His blood pressure was 113/63 mm Hg, his blood glucose level was 10.5 mmol/L, and he was afebrile.

Observations at 23:27 were: rousable and oriented; without pain; blood pressure 105/59 mm Hg; heart rate 85 bpm; temperature 36.9 °C. These were his last recorded observations.

At the next observation round, at 03:15, the nurse found him cold and unconscious. The nurse called a medical emergency team (MET). Despite CPR and defibrillation attempts for 20 minutes the patient remained in asystolic arrest. He was declared deceased at 03:47. His family was informed and his death was reported to the coroner.

DISCUSSION

The surgical case form raised an area for consideration in that the reporting surgeon felt that the patient was in diabetic ketoacidosis (DKA) perioperatively, and this may have contributed to his death. The first-line assessor was concerned by the information supporting death from DKA. The medical records do not suggest he had life-threatening DKA. Prior to anaesthesia, he was noted to be mildly acidotic (pH 7.27, HCO₃⁻ 19 mmol/L), with a blood glucose level of 11.7 mmol/L and mildly elevated ketones (1.6 mmol/L).

The patient died from an unexpected cardiac arrest. The possible cause of death was acute cardiac arrest secondary to a pulmonary embolus, either thrombotic (despite chemoprophylaxis for DVT) or marrow fat from the hip replacement.

CLINICAL LESSONS

The first question to be asked for an 86-year-old with an acetabular fracture is: Should this patient have surgery at all?

Secondly, the patient waited 11 days for surgery. It is well recognised that the longer that elderly patients with fractures remain bed-bound, the more likely they are to die. Given that the surgery was difficult, and it is likely that relatively few surgeons would have been happy to perform it, delays were invariably created. However, 11 days seems excessive, nevertheless.

Management of this patient's diabetes is the final issue of concern. The team looking after him had 11 days to perfect his diabetes management. Instead, he presented to theatre acidotic and ketotic.

It is debatable whether the clinical management was optimal in this complex scenario. What is not debatable, is that this patient would have stood a greater chance of survival if his surgery was performed in a timely manner with his medical conditions properly optimised.

Case 9: Redo lung transplantation for chronic lung allograft dysfunction

Cardiothoracic Surgery

CASE SUMMARY

A 58-year-old man was admitted for a redo lung transplant for chronic lung allograft dysfunction (CLAD). He had a background history of ischaemic heart disease requiring stent insertion 6 years previously, then coronary artery bypass grafting (CABG) 3 years later. He also had limited cutaneous scleroderma, prompting a Nissen fundoplication for oesophagitis 4 years before his current admission.

The patient's progressive interstitial lung disease led to a bilateral sequential lung transplant 2 years ago. This was complicated by chronic allograft failure. Despite repeated pulses of methylprednisolone and plasmapheresis, he deteriorated and returned to the lung transplantation waitlist.

The transplant was complicated by severe haemorrhage. The left lung was removed first and the left donor lung implanted. Attention then turned to the right side. At dissection, the right pulmonary vein tore in the region of the previous anastomosis. Cardiopulmonary bypass (CPB) (femoral cannulation) was instituted and the transplant was completed.

The patient required a significant blood transfusion. There was a period of hypoxia (60–80%) and hypotension (systolic blood pressure 60–80 mm Hg) for approximately 1 hour. Due to poor saturations on lung reperfusion and patient instability, venous-venous extracorporeal membrane oxygenation (ECMO) commenced.

The patient was returned to ICU, where ongoing high-volume blood losses from chest drains required further blood products. Neurological examination the next day revealed fixed dilated pupils and no gag/cough reflex. A brain CT scan showed diffuse cerebral hypoperfusion and hypoxic ischaemic encephalopathy with cerebral oedema. The patient was declared brain dead.

DISCUSSION

This was a high-risk redo lung transplant. The operation was technically challenging due to the previous surgery and adhesions, and also the previous CABG surgery creating a 'fixed' and relatively immobile mediastinum. This translates into a hilar region often difficult to retract, to mobilise and to visualise the anatomy. It is not unusual to enter vessels or chambers of the heart and create

a ‘bleeding mess’. These technical challenges, in combination with an already immune-suppressed (older) patient, lead to poorer outcomes compared with first-time lung transplantation.

The technical events at the time of transplant were undesirable, but not unusual in redo lung transplant patients. Transitioning onto femoral CPB is the correct strategy. This can take time, especially if the groin was previously cannulated during the first surgery or if the patient is overweight with peripheral vascular disease (common in interstitial lung disease patients with pre-existing vasculopathy).

The use of venous-venous ECMO for primary graft dysfunction at the conclusion of the transplant was also correct. Unfortunately, lung primary graft dysfunction (PGD) is not uncommon in the setting of a long operation, CPB, massive haemorrhage and blood transfusion. From the patient notes, it is difficult to assess time intervals for instituting CPB and ECMO. Perfusion and anaesthetic notes from the operation do not show dramatically reduced saturations/arterial pressure for any significant time periods. No doubt, some time was spent cannulating vessels, heparinising, acquiring CPB lines and starting the bypass circuit, but this does not appear unreasonable from the medical notes provided.

In conclusion, this operation was technically very challenging in a high-risk lung transplant patient. From the medical notes review, all teams appear to have been appropriate in their practice and efforts to succeed in the operation.

CLINICAL LESSONS

CLAD retransplanted patients present additional perioperative complications such as severe PGD, increased need for perioperative ECMO and increased risk of bleeding.¹ Early postoperative mortality in these patients can be due to a combination of the complexity of the surgical procedure, the increased risk of bleeding in patients with extensive pleural adhesions, and the fact that such patients are in a worse condition prior to transplantation due to severe hypoxic respiratory failure.²

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Case 10: Overwhelming sepsis secondary to ascending cholangitis

General Surgery

CASE SUMMARY

An 80-year-old man living independently with his wife in a retirement village—still able to drive and ride a motor bike—presented to a regional hospital with a 3-day history of abdominal pain. He had history of diabetes and mild renal impairment. He had also had several strokes and was on clopidogrel.

The patient was noted to be acidotic with metabolic acidosis and a lactate of 8 mmol/L. He had a raised WCC of $15.4 \times 10^9/L$ with neutrophilia and CRP of 208 mg/L. CT scanning showed intra- and extrahepatic duct dilatation with calculi in the common bile duct (CBD). The CBD diameter was 11 mm. He also had left basal lung consolidation. Cholangitis was diagnosed and the patient was given IV antibiotics at the regional hospital. A referral was made to a metropolitan hospital for management of sepsis and for ERCP to relieve the obstruction.

Upon arrival at the metropolitan hospital that night, the patient was assessed as being haemodynamically stable, afebrile and not unwell. Antibiotics continued and ERCP was planned for the following afternoon. The patient was admitted to a general surgical ward. During the night he was noted to be stable, but increasingly oliguric.

By the next morning, the patient was anuric. His respiratory rate had increased from 20 breaths per minute on admission, to 30 breaths per minute. The surgical team reviewed the patient in the morning; the plan for the ERCP remained for that afternoon. However, the patient deteriorated during the morning. A MET call was initiated by the nursing staff due to tachypnoea and oliguria. Despite aggressive resuscitation and intensive care input, the patient continued to deteriorate. It was decided to palliate rather than proceed with ERCP. The patient died that afternoon.

DISCUSSION

This case reflects the failure to adequately manage a patient with worsening sepsis. There were several signs of deterioration that went unrecognised, and management was not escalated. Medical note-keeping was quite poor, making it difficult to accurately consider the medical assessment of the patient once he was admitted to the metropolitan hospital. There is no evidence of awareness of the fact that the patient had severe metabolic acidosis with a very raised WCC and CRP. There was also associated significant renal impairment. The patient was left

on a general ward overnight with worsening urine output. Tachypnoea is a sign of worsening acidosis, but this was not acted upon.

Nursing notes show that medical review was sought for the oliguria. There are no medical notes from the overnight doctor. The surgical unit reviewed the patient in the morning and stated that he was stable, observations were stable, and ERCP was planned for that afternoon. There is no awareness that the patient had almost no urine output for the previous 8 hours and was significantly tachypnoeic. It seems that a normal blood pressure and temperature, and the fact that the patient was on antibiotics, provided false reassurance.

The concern here, is that the patient was seen by a surgical registrar at 20:00 on the day prior to his death. There was awareness that the patient had cholangitis, was jaundiced, had significantly elevated liver function tests, WCC of $15.4 \times 10^9/L$ and CRP of 208 mg/L. It was noted there was minimal urine in the bag. No note is made that the admission electrolytes and renal function showed a creatinine of 357 mmol/L, urea of 4.5 mmol/L, HCO_3^- of <10 mmol/L and an elevated anion gap. This reflects a patient in acute renal failure with significant sepsis who—at the very least—requires intensive care review, if not admission.

It was acknowledged by the treating team that there was a delay in performing the ERCP. The question in this case, is whether the ERCP should have been done on the evening of admission after intensive care input and adequate resuscitation. If this had occurred, it is likely the patient would have survived. By the following morning, when a MET call was instituted at 10:15, the patient had a pH of 6.94, HCO_3^- of 3 mmol/L and lactate of 11 mmol/L on venous gases. This is inconsistent with survival.

CLINICAL LESSONS

This case raises issues regarding the management of sepsis and escalation of care beyond junior staff. While antibiotics are important in sepsis, treating the underlying cause in an expeditious fashion is also vital.

Management of the acutely unwell patient after hours is the other issue. When such management is left to a junior doctor overnight, who may not recognise the significance of the patient's condition or the significance of a deterioration in several parameters, the opportunity for escalation of management and appropriate care can be lost. Initial awareness of the seriousness of a patient's condition, and admission to an appropriate area of the hospital for care, is vital.

Case 11: Poor decision-making in a patient with metastatic oesophagogastric cancer

General Surgery

CASE SUMMARY

A 48-year-old man was admitted for a percutaneous endoscopic gastrostomy (PEG). He had been diagnosed with metastatic oesophagogastric cancer a few months earlier and had undergone chemo- and immunotherapy with some response, but had subsequently deteriorated with dysphagia and increasing malnourishment.

Unfortunately, the transverse colon was transfixed, leading to a delayed faecal fistula and peritonitis. The patient underwent a laparotomy and the colotomies and gastrostomy were repaired and the PEG removed. Multiple liver and omental metastases were noted. The patient developed a postoperative ileus. He was treated with total parenteral nutrition and an oesophageal stent was considered. Following stent insertion, the patient developed aspiration pneumonia. Multiple MET calls for hypoxia occurred. A CT scan indicated persistent ileus and the disease appeared to be rapidly progressive. In view of the likely poor outcome the patient was provided with palliative care.

DISCUSSION

There were a few issues of note in the management of this case.

PEG is absolutely contraindicated if a patient is potentially resectable because it can ruin the gastric conduit. In the presence of metastatic disease, it is relatively contraindicated for the following reasons:

- other organs (e.g. transverse colon) can become fixed to the anterior abdominal wall and be damaged
- ascites, if present, is more likely to leak around the tube (gastrostomy site)
- a seal may not be obtained with regards to gastric content
- in the presence of extensive disease, seeding may occur at the entry site.

Insertion of an oesophageal stent may have been a reasonable option as a first step, but in the presence of an ileus or potential mechanical obstruction (due to disseminated malignancy) the risk of aspiration is markedly increased.

CLINICAL LESSONS

Decision-making in the terminally ill patient can be difficult. Ideally, it leads to good palliation. However, there is a risk that intervention can precipitate sudden deterioration.

It is unclear whether a single surgical team was making all the decisions related to this patient. Where multiple teams are involved, clear communication between teams is necessary to achieve a satisfactory outcome.

Case 12: Delay in seeking vascular opinion following neuroradiological intervention

Vascular Surgery

CASE SUMMARY

A 68-year-old woman presented to the ED 2 hours after the onset of right hemispheric stroke. Her medical history included type 1 diabetes, end-stage renal failure and cardiomyopathy. Left hemiparesis was noted on admission at 16:47. Movements of the right upper and lower extremities were unaffected. Radial pulses were present bilaterally, but no comment was made on lower limb pulses.

After urgent medical imaging (CT brain), the patient was transferred to the radiology department without delay. Successful catheter-based clot retrieval was performed from the right middle cerebral artery. The right common femoral artery access site was closed with an Angioseal closure device. Following the procedure, the patient was able to move all 4 extremities, with noticeable improvement on the left side. According to the notes, pedal pulses were bilaterally present. She was transferred to the neurology ward at 22:52.

At approximately 02:00—3 hours after the neurovascular intervention—she had 2 episodes of asystolic cardiac arrest requiring CPR. Most likely, this was initiated by a severe respiratory complication caused by aspiration. She was intubated and transferred to ICU at 03:27.

As early as 03:50, and then again at 07:09, a cold pulseless right foot was noticed. No comment was made on foot/leg movements, pain or calf tenderness. By this time, the patient was on a respirator and sedated. Contradictory entries appear in the medical record regarding the time of onset of right lower limb ischaemia. The ischaemia may have been clinically obvious well before the cardiac arrest. There was a late, retrospective entry citing a cold, pulseless right foot and mottled appearance of the skin after transfer from radiology to the neurology ward.

Later in the morning at approximately 07:00—without consulting the vascular team—a duplex scan study of the lower limb arteries was requested. After several hours of delay, only a limited, targeted examination was performed on the common femoral artery, confirming femoral artery occlusion at the puncture site where the closure device was deployed.

The vascular team was finally consulted in the afternoon at 17:00 and the need for immediate surgery was determined. The misplaced closure device was removed, a femoral thrombo-endarterectomy and patch-plasty were performed,

and 2-compartment fasciotomies concluded the procedure. Postoperative improvement of lower limb circulation was noted, although the right pedal pulses did not reappear. When the fasciotomy wounds were closed 3 days later, viability of the calf muscles was observed.

The patient remained on a ventilator in ICU and received ongoing renal replacement therapy and cardiac support; however, her neurological progress diminished. Eventually all active treatment was withdrawn. She died on day 10 of hospitalisation.

DISCUSSION

This is a complex case of a 68-year-old stroke patient with significant comorbidities. She underwent successful clot retrieval from the right middle cerebral artery, but subsequently died as a result of multiple complications.

From the scanty progress notes it is clear that the patient harboured a severely ischaemic right leg for about 20 hours after the neurovascular intervention. The severity and clinical significance of the ischaemic leg was not clearly appreciated, with neurology prepared to wait an additional 10 hours for an arterial duplex scan study before seeking vascular surgical opinion.

It seems that the underlying, initially untreated lower limb ischaemia and its metabolic consequences potentially contributed to the patient's demise.

CLINICAL LESSONS

Complex patients are at risk of siloed care, which can be countered by exemplary communication and handover. This patient may have been better served by being admitted to a high dependency unit. When acute arterial ischaemia is suspected, urgent referral to vascular surgery should be undertaken without delay while waiting for diagnostic imaging.

Abbreviations

AAA	abdominal aortic aneurysm
ADDS	Adult Deterioration Detection System
BPM	beats per minute
CABG	coronary artery bypass grafting
CBD	common bile duct
CLAD	chronic lung allograft dysfunction
CPB	cardiopulmonary bypass
CPR	cardiopulmonary resuscitation
CRP	C-reactive protein
CT	computed tomography
DKA	diabetic ketoacidosis
DVT	deep vein thrombosis
ECG	electrocardiogram
ECMO	extracorporeal membrane oxygenation
ED	emergency department
ETT	endotracheal tube
EVD	external ventricular drainage
ICU	intensive care unit
IV	intravenous
LAD	left anterior descending
LV	left ventricular
MET	medical emergency team
NELA	National Emergency Laparotomy Audit
NGT	nasogastric tube
PEG	percutaneous endoscopic gastronomy
PGD	primary graft dysfunction
SAH	subarachnoid haemorrhage
TOE	transoesophageal echocardiography
WCC	white cell count

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