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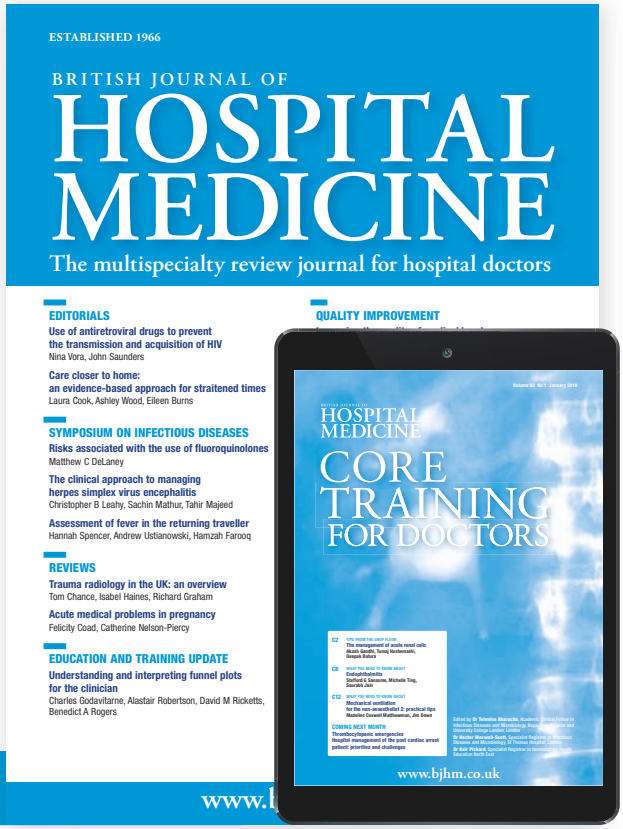

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Give doctors the regulatory regime they deserve

A radical overhaul of the regulatory regime for health professionals is both necessary and long overdue, so it is important to seize this chance to get it right and get it done.

Catherine Wills[1]

Author details can be found at the end of this article

Correspondence to:
Catherine Wills;
media@themdu.com

After waiting many years for the government to grasp this nettle, it felt like a significant step when the Department of Health and Social Care (2021) published proposals and a timetable for reforming the regulation of doctors and other healthcare professionals.

The Medical Defence Union has long encouraged the General Medical Council to make its fitness to practise procedures faster, fairer, less adversarial and more proportionate, but the General Medical Council itself has been constrained by outdated legislation. *Regulating healthcare professionals, protecting the public* (Department of Health and Social Care, 2021) proposes a new approach which aims to give the regulators greater autonomy to set out their operating processes within a framework of rules, guidance and safeguards. In its own words, it seeks to 'modernise the regulators' fitness to practise processes, which will enable the safe and quick conclusion of many cases without the need for expensive and lengthy panel hearings.'

The Medical Defence Union agrees with these principles and there is much in the consultation that they broadly support, such as the creation of a three-tier fitness to practise process covering initial assessment, case examiner stage and panel hearing. The Medical Defence Union believes that this should allow more cases to be appropriately resolved at an earlier stage, minimising the stress for doctors.

But the devil will be in the detail. With greater autonomy, regulators also need to ensure greater transparency and accountability. It is important to ensure that these much-anticipated reforms lead to a regulatory regime which protects patients and which investigates concerns about doctors in a fair, proportionate and timely way. There is much to applaud but the Medical Defence Union is concerned about two proposals which have the potential to undermine this objective.

Doctors with health concerns

The government proposes to remove health as a category of impairment in fitness to practise cases. Instead, it proposes two grounds for action: lack of competence and misconduct. The motives for this, which the Medical Defence Union support, are that such concerns should usually be dealt with outside a fitness to practise process. However, there will inevitably be some cases where health concerns lead to a formal process and removing this route is a retrograde step, resulting in cases falling under the 'lack of competence' ground for action.

In recent years, the General Medical Council (2021a) has established measures for sensitively managing these concerns, such as ensuring details about a doctor's health are separated from other publicly available content about fitness to practise matters.

Removing the health category for fitness to practise cases risks undoing the many advances the General Medical Council has made in establishing separate and supportive procedures for dealing with unwell doctors. And the terminology will surely add to the distress for any doctor who is struggling with their physical or mental health under the strain of an investigation. The practical effect of this will be to penalise the most vulnerable doctors.

Investigating allegations more than 5 years old

The government proposes the removal of policies on investigating allegations that are more than 5 years old. Under the current 5-year rule applied by some regulators, including the General Medical Council, allegations cannot be investigated if they happened more than 5 years ago 'unless the Registrar considers that it is in the public interest for it to proceed'.

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However, the government suggests changing this because it means regulators 'cannot currently consider fitness to practise concerns which are more than 5 years old'. This is not the case. If a concern or complaint is older than 5 years but corresponds with a potential current impairment or risk to patient safety, the General Medical Council can still investigate.

The General Medical Council has produced detailed guidance (General Medical Council, 2021b) on applying the 5-year rule for its decision makers which considers factors such as the gravity of the allegation, the extent of any continuing unwarranted risk to the public and/or to public confidence and the potential for a fair hearing based on the available evidence.

Seen in this context, the 5-year rule is a useful filter which ensures the fitness to practise process is focused on whether a doctor's practice is currently impaired and whether conditions are required on their registration to protect patients.

Without the 5-year rule, there is a risk that doctors will be routinely and needlessly subjected to fitness to practise proceedings for historic complaints where there is no question of current impairment or risk to patients.

More flexible regulation

The welcome intention behind these proposals is to give the General Medical Council greater flexibility, particularly in the management of fitness to practise procedures. It would be ironic if plans to remove health as a category of impairment and abandon the 5-year rule went ahead because these are two areas where the General Medical Council has been able to exercise its limited flexibility to date.

The Medical Defence Union hopes that the government will address these concerns when it brings forward draft legislation later this year, with a view to the General Medical Council having its new powers in spring 2022. This consultation moves closer to the promise of a regulator which protects the public while dealing with doctors fairly and humanely. There is still work to do to ensure this promise is fully realised.

Author details

[1]Medical Defence Union, London, UK

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Key points

- The government is intending to reform regulation for doctors and other healthcare professionals.
- It should lead to fitness to practise procedures which are faster, fairer, less adversarial and more proportionate.
- A three-tier fitness to practise process covering initial assessment, case examiner stage and panel hearing is proposed.
- A separate category for dealing with doctors with health concerns must remain.
- Investigations into complaints that date back beyond 5 years should only take place if they are in the public interest.

Emphasising compassion for co-workers in medical training and healthcare organisations to address bullying

The over-representation of bullying in healthcare is incongruent with the compassion of healthcare professionals. This issue needs to be addressed at the levels of medical training and organisation by extending the emphasis on compassionate patient care to include care for co-workers.

Tamara Simpson[1]

Ace V Simpson[2]

Author details can be found at the end of this article

Correspondence to:
Ace V Simpson;
ace.simpson@brunel.ac.uk

Introduction

Despite the inclination towards compassion in healthcare professionals (Eley et al, 2010), bullying and harassment is over-represented in healthcare work (Eurofound, 2017). Bullying in healthcare is not limited to a single geographical location or healthcare system – it is a global problem at both vertical (top-down) and horizontal (peer-to-peer) levels. In the NHS, 18.7% of healthcare workers report having been bullied by their colleagues and 12.4% report having been bullied by managers (NHS, 2021). That people who are so compassionate and caring towards patients can be so harsh with each other is a puzzle and a serious problem. This article discusses this issue as a problem, not of character, but in the application of training received in medical school, and of how the healthcare system is organised.

Negative effects of bullying

Bullying in healthcare is a concern not just because it is wrong that people feel unsafe at work, it also undermines the integrity of the healthcare system, along with the quality of care provided to patients (Carter et al, 2013; Kline and Lewis, 2019). Bullying precipitates higher levels of employee absenteeism, sick leave, compensation claims and turnover. A workforce such as the UK healthcare sector, already struggling with an undersupply of quality recruits and vacancies waiting to be filled, cannot afford such high levels of workforce attrition. Bullying also erodes the quality of patient care. When healthcare professionals do not feel safe to question diagnoses or care plans, report mistakes, or seek advice when in doubt because of a culture of competition, judgement and putdowns, this affects patient care.

Traditional approaches to countering bullying

The issue of bullying in healthcare is generally addressed with a combination of proactive and reactive strategies. Internal staff training and guidance on the problem of bullying in healthcare is one proactive–reactive approach, but one that staff may resent being mandated to undertake. Another is having clear organisational policies in place, so people are aware of the consequences of bullying behaviour. Such policies inform reactive strategies of having processes in place for reporting problem cases, investigating allegations and providing victim support, including through counselling and compensation. Studies have found that, overall, antibullying measures have limited or unclear efficacy (Bambi et al, 2017). More recently, there has been a growing interest in staff training in resilience, mindfulness and self-compassion that supports emotional and physical health (Egan et al, 2017; King et al, 2019). Training managers in these skills has been suggested for compassionate leadership training (de Zulueta, 2016). As a researcher in management and organisation studies with a focus on workplace compassion (AVS), and as a current medical student (TS), the authors feel that these initiatives are not sufficient, something their limited success to date makes obvious.

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Colleagues also need compassion and care

To address the problem of bullying in healthcare at a more fundamental level the question must be asked, if healthcare staff are compassionate by inclination, why do they lack compassion in their dealings with colleagues? One response to this question is that healthcare organisations are set up to provide compassionate patient-centred care, rather than care for colleagues (Decety (2020) and Shah (2021) are examples of how compassion is most commonly discussed in healthcare). In other words, healthcare needs a definition of compassion that sees fellow caregivers as legitimate recipients of care and compassion.

In organisational compassion studies, by contrast, workplace compassion is defined with an emphasis on supporting co-workers as (NEAR): Noticing the suffering of colleagues, Empathising with it, Appraising to understand its causes and circumstances, and Responding to address a colleague's distress (Simpson et al, 2020). Two decades of research into workplace compassion suggests some additional levers such as promoting compassionate routines (for example, those related to organisational recruitment and promotion), including compassion for colleagues in role descriptions, a social architecture promoting frequent staff interactions, creating a culture that supports robust but psychosocially safe communication, and compassionate leadership.

Healthcare is an intense workplace environment. Long shifts are coupled with many tense moments in dealing with patient concerns. As a result, healthcare professionals experience a lot of stress and fatigue. This being the nature of the job, or at least how it is currently configured, can lead healthcare professionals to overlook a colleague's signs of personal struggle. Colleagues are not the patient, the patient is the person who is sick. Colleagues' issues are generally not seen to warrant compassion. If the healthcare sector were to make an effort to adopt this broader definition and these organisational levers, compassion could be woven systemically into the very fabric of the organisation.

Generalising patient-centred care skills to colleagues

Another answer to the problem of a lack of compassion for co-workers in healthcare relates to the training received in medical school. Medical school teaches compassion skills, including how to listen to patients, the language to adopt to express empathy for patient concerns and how to summarise what patients report to clarify and confirm proper understanding of patient conditions (Phillips and Dalgarno, 2017; Patel et al, 2019). In other words, healthcare professionals are trained in NEAR capabilities. Unfortunately, medical students are taught to see these skills as patient specific and are not encouraged to generalise them in compassionate dealings with one another. Overlooking signs of struggle in colleagues and experiencing constant tiredness may also begin in medical school. Medical students are constantly under pressure to perform and deliver in frequent exams, in front of doctors providing training and in front of patients receiving care. These struggles are accepted as par for the course and not viewed as legitimate reasons for receiving compassion. Hence, compassion for peer concerns is desensitised and an important learning opportunity is lost. Listening to notice indications of suffering, empathising to provide emotional care and clarifying to confirm understanding are practices of compassion relevant for both patient care and co-worker support. However, healthcare professionals are not taught to make that connection, and too often it is not made.

Conclusions

Caregivers are known for their compassion. The desire to help others is a primary motivation for many caregivers entering the profession. It takes years of study to qualify, and involves long hours in difficult situations, often with life and death implications, but for healthcare professionals the idea of making a positive difference in people's lives makes up for these challenges. The problem of workplace bullying in healthcare can be solved. Compassion for colleagues can prevail if there is a will to address these concerns in medical schools and healthcare organisations.

Key points

- Despite the compassionate inclinations of healthcare workers, bullying is over-represented in healthcare.
- Bullying among healthcare workers is an occupational hazard that undermines the integrity of the healthcare system, including patient care.
- Current approaches to addressing workplace bullying emphasise policy compliance, training, reporting and redress, with limited effectiveness.
- Healthcare educators and providers need to broaden the scope of how compassionate care is defined from an emphasis on patient care to include caring for co-workers.
- The cultivation of compassion also needs to go beyond psychological approaches to include organisational mechanisms that can be attuned to promote compassion among colleagues.

Author details

[1]St George's University of London MBBS Programme, University of Nicosia Medical School, London, UK

[2]Brunel Business School, Brunel University London, London, UK

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Day case shoulder arthroplasty: needed now more than ever

Abstract

The demand for total shoulder arthroplasty has grown over the years and is set to continue in a similar trend because of the ageing population. Following a global reduction in elective orthopaedic treatment and an exponential rise in surgical waiting times, innovative strategies are desperately needed to mitigate against the harmful effects of delaying vital operations on both patients and the wider society. Day case shoulder arthroplasty is a safe alternative to a traditional inpatient approach, with evidence supporting substantial cost savings, improved outcomes and fewer complications. Rigorous patient selection and a multidisciplinary team approach are paramount when adopting a day case service to deliver joint replacement surgery. This review outlines the principles of day case total shoulder arthroplasty and highlights key considerations when transitioning to this approach.

Key words: Cost-effectiveness; Day case surgery; Inpatient surgery; Total shoulder arthroplasty

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Tanujan Thangarajah[1]

Author details can be found at the end of this article

Correspondence to:
Tanujan Thangarajah;
tanujan1@hotmail.com

Introduction

The annual growth rate of shoulder arthroplasty surgeries has been estimated to be greater than that of hip and knee replacement surgery (Day et al, 2010). Owing to the ageing population, it has been projected that between 2011 and 2030 this demand will increase by 755% in those over the age of 55 years (Padegimas et al, 2015). As healthcare policy has evolved, a greater emphasis has been placed on providing safe, high-quality care in both an efficient and cost-effective manner. Total shoulder arthroplasty has conventionally been delivered as an inpatient service despite some patients not having complex medical comorbidities and wishing to be discharged quickly. Ancillary costs arising from this can be considerable and are predominantly a result of additional laboratory studies, overnight bed occupancy and staffing (nursing, physiotherapy and occupational therapy). These variables contribute to the length of stay following surgery, which ranges from 2 to 6 days (Brolin and Throckmorton, 2018; Borakati et al, 2020).

The COVID-19 pandemic has led to a substantial reduction in the provision of elective orthopaedic care with an estimated 28 404 603 operations being cancelled worldwide during a peak 12-week window (COVIDSurg Collaborative, 2020). In November 2020 the orthopaedic elective waiting list in England was estimated to be as high as 1.4 million (Oussedik et al, 2021). Even with a 20% increase in normal surgical volume it would take up to 46 months to clear the backlog resulting from the disruption (Oussedik et al, 2021). Many patients experience severe pain and disability and so it vital that the healthcare system develops methods to deal with this unprecedented caseload that has the potential to overwhelm clinical services in the months to come.

Given the progressive nature of arthritis and its ability to distort normal anatomy, the complexity of surgical cases may increase with time, and so strategies are desperately needed to optimise theatre efficiency and increase output. It is no surprise that the desire to pursue day case shoulder arthroplasty has grown, with 16 articles on the subject published in 2020 in PubMed, compared to three in 2019. Not only does day case shoulder arthroplasty result in substantial cost savings, it is associated with high levels of patient satisfaction and favourable complication and readmission rates when compared to inpatient procedures (Basques et al, 2017; Brolin et al, 2017; Charles et al, 2019; Borakati et al, 2020).

This article outlines the principles of day case total shoulder arthroplasty and highlights key considerations when transitioning to this approach.

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Safety of a day case shoulder arthroplasty service

Compared to hip and knee surgery, shoulder arthroplasty is associated with a lower mortality rate, fewer complications, shorter hospitalisation and fewer readmissions (Fehringer et al, 2010). Given the successful transition of lower limb arthroplasty to a day case service, it is plausible that a similar approach may be suitable for a subset of patients traditionally offered hospital admission for their shoulder replacement (Brolin et al, 2017). Critics cite inadequate pain control, excessive blood loss and the possibility of complications as reasons for not changing to a day case service (Brolin and Throckmorton, 2018). However, the complication rate following total shoulder arthroplasty ranges from 2.8% to 9.4%, with inpatient surgery being associated with a significantly increased risk of 30-day and 90-day hospital readmission, acute kidney injury, thromboembolic events, surgical site infections and the need for a blood transfusion (Basques et al, 2017; Brolin et al, 2017).

Several large centres in North America have described their experience with day case shoulder arthroplasty, providing a degree of optimism for those in the UK wishing to adopt a similar policy. In a database study of 123 347 shoulder replacements over a 7-year period, 3493 (2.8%) were treated as a day case (Basques et al, 2017). A significant proportion of those undergoing inpatient surgery had a greater incidence of medical comorbidities such as diabetes, ischaemic heart disease and chronic kidney disease. Accordingly, readmission rates were significantly higher for the inpatient group at both 30 and 90 days, as were complications such as thromboembolic events and surgical site infections. While this may appear to be a result of selection bias, the results were no different after controlling for age and medical comorbidities (Erickson et al, 2020). To further evaluate the safety profile of day case surgery, Brolin et al (2017) compared the outcomes between 30 day case total shoulder arthroplasties and an inpatient group of 30 patients matched for age and comorbidities. No significant differences were found between cohorts regarding age, American Society of Anesthesiologists (ASA) score, operative indications or body mass index. They found no significant differences between rates of complications and hospital readmissions. Additionally, in a retrospective case-control study of 241 day case total shoulder arthroplasties and 373 inpatient procedures, no difference in clinical outcomes were found between groups despite significantly fewer complications occurring in the day case cohort (7% vs 13%, P=0.023) (Erickson et al, 2020).

Falls are one of the most commonly reported safety incidents in hospitals and lead to physical injury in up to 30% of cases, prolonged inpatient stays and increased healthcare costs (Sridharan et al, 2020). An analysis of all inpatient falls that occurred over nearly a decade in a tertiary referral hospital found that 0.9% of patients admitted for elective orthopaedic procedures experience a fall during their stay, of which 5.5% underwent an upper limb procedure (Mandl et al, 2013). In the only study to specifically review this complication following both inpatient and day case shoulder arthroplasty, the total prevalence of postoperative falls was 11.1%, noted to be significantly higher in those undergoing day case surgery (Sridharan et al, 2020). Independent risk factors associated with this included female sex and a history of a movement disorder. Interestingly, age was not a contributing factor.

Cost-effectiveness of day case shoulder arthroplasty

During the COVID-19 pandemic, the NHS has been stretched more than ever before. With a strong desire to return to pre-pandemic activity levels, methods of decreasing costs without jeopardising patient safety and clinical outcomes should be explored. In the private sector, the transition to day case hip arthroplasty has been associated with an overall saving of approximately £5000 per patient (Aynardi et al, 2014). Using a day case approach in the USA, up to $3500 (~ £2500) can be saved per patient undergoing shoulder arthroplasty. In the UK the figure has been suggested to be £529, although this is likely to be a gross underestimation since limited cost analyses were undertaken to derive this (Cancienne et al, 2017; Borakati et al, 2020). According to the National Joint Registry (2020), 7655 primary shoulder replacements were carried out in the UK during 2019, and so with a day case service there is scope to make substantial savings that can be redistributed to other areas across the NHS.

Patient selection

The main concerns with day case arthroplasty are potential complications leading to increased morbidity and hospital readmission. In a large population-based study of approximately 34 000 patients, the postoperative complication rates for total shoulder arthroplasty, total hip arthroplasty and total knee arthroplasty were 7.6%, 6.8% and 2.8% respectively. The 30-day mortality rates followed a similar trend, at 1.2%, 1.1% and 0.4% for total hip arthroplasties, total knee arthroplasties and total shoulder arthroplasties respectively (Fehringer et al, 2010).

The favourable adverse event profile of total shoulder arthroplasty highlights its suitability as a day case procedure but a comprehensive understanding of which patients are most vulnerable to complications is essential to selecting those that will undergo a benign postoperative course. Risk factors for complications within the first 30 days following surgery include chronic steroid use, a preoperative haematocrit of less than 38%, ASA class 4, and an operative time longer than 2 hours (Anthony et al, 2015). Intraoperative bleeding requiring transfusion occurs in 4% of cases and has been identified as the most common complication following total shoulder arthroplasty (Anthony et al, 2015). Fortunately, cardiac sequelae following blood loss during total shoulder arthroplasty occur infrequently, but predictors of a postoperative transfusion (preoperative haematocrit less than 40% and post-traumatic arthritis) should be considered when selecting patients for day case surgery (Abildgaard et al, 2016).

Patients with an increasing number of medical comorbidities should intuitively be at a greater risk of complications and hospital readmission following surgery, but reliance on such 'medical dogma' may disadvantage patients with stable chronic conditions that seldom pose a risk to inpatient total shoulder arthroplasty. An algorithm exclusively based on patient age, body mass index, cardiopulmonary comorbidities and preoperative haematocrit has been proposed. While this resulted in a low rate of perioperative complications and no readmissions, it did not consider other medical problems or encompass a comparative scale for risk stratification (Fournier et al, 2019).

A more discriminative tool that may assist with patient stratification is the Day case Arthroplasty Risk Assessment score (Meneghini et al, 2017). This was initially developed to help determine a patient's likelihood of safely undergoing lower limb arthroplasty and subsequently being discharged within 24 hours of surgery. The Day case Arthroplasty Risk Assessment score assesses nine categories of comorbidity (general medical, haematological, cardiac, endocrine, gastrointestinal, neurological, renal, pulmonary and infectious) based on their presence, severity and extent to which they are controlled. A total of 54 binary questions (yes or no) are answered to calculate the score with a result less than 59 having a positive predictive value of 82% for early discharge and a 90-day readmission rate of 2.9% (Meneghini et al, 2017). The only study examining the Day case Arthroplasty Risk Assessment score for total shoulder arthroplasty found a much higher threshold score of 110 accurately identified patients suitable for same day discharge. Additionally, patients with a score of ≤110 were 2.5 times less likely to visit the emergency department for an acute medical or surgical complaint related to their surgery (Polisetty et al, 2020). It is unsurprising that the cut-off score was lower for surgery involving the shoulder compared to the lower limb given the lower complication rate associate with total shoulder arthroplasty (Fehringer et al, 2010). The Day case Arthroplasty Risk Assessment scoring tool is a promising development in the quest to provide day case shoulder arthroplasty, but the mandatory subscription fee and its failure to consider non-medical factors influencing a patient's ability to stay overnight (eg lack of home support and distance from the hospital) presents some distinct challenges.

Key steps in the transition to day case shoulder arthroplasty

The care of patients undergoing total shoulder arthroplasty has evolved over the years as a result of improvements in surgical technique, implant design, pain management and perioperative care. Cumulatively, these have led to an overall reduction in length of stay and form the foundation of a potential day case approach. While several factors need to be considered when delivering a day case-based service, the most important ones include partnership and coordination with the anaesthetic department, patient education, pain management, limiting intraoperative blood loss and medical risk stratification (**Figure 1**).

The decision to include a patient into a day case pathway should be taken by both the surgeon and anaesthetist. Irrespective of whether a formal scoring system or a more generalised algorithm is used, certain factors must be considered and include severity of any cardiopulmonary disease, presence of obstructive sleep apnoea, ASA score, opiate dependence, mobility, degree of social support at home and motivation for the day case process. With the exception of revision surgery, post-traumatic and oncology cases, the majority of patients may be suitable (Bean et al, 2018).

Before surgery, a comprehensive anaesthetic evaluation should be carried out and the operation scheduled as either the first or second case to allow sufficient recovery time. Regional anaesthetic block is conventionally given but concerns have been raised regarding severe rebound pain. To mitigate against this, novel local anaesthetic agents have been advocated as a useful adjunct to standard postoperative analgesic regimens. Liposomal bupivacaine consists of bupivacaine stored in multivesicular liposomes that allow its slow release and thus prolongs its action (Chahar and Cummings, 2012). Additional pharmacological treatments may include perioperative tranexamic acid (1 g intravenous) since this decreased the need for blood transfusion following total shoulder arthroplasty in patients with a haematocrit under 38% (Clay et al, 2020).

Multimodal pain relief uses a combination of analgesic medications that act on different sites of the pain pathway. It may include a combination of opiate and non-opiate analgesia and is a fundamental part of day case arthroplasty surgery because adequate pain control is essential for any postoperative discharge plan, and in preventing unplanned hospital readmission. For discharge on the day of surgery, plans should be made to phone the patient on the following day in order to ensure satisfactory clinical progress. If an unexpected problem is identified, such as an exacerbation of pain or bleeding through the dressing, a clear policy needs to be in place to facilitate an immediate surgical assessment without the need to attend the emergency department. Essential criteria that need to be fulfilled to safely discharge a patient on the day of surgery include review of formal postoperative X-rays taken in the radiology department, dry surgical dressings, adequate pain relief, passage of urine and the ability to independently mobilise (Figure 2).

Important considerations during implementation

Successful introduction of day case shoulder arthroplasty is predicated upon a robust protocol that should be developed in collaboration with the anaesthetic department, day surgery unit and theatre team. This is vital since defined lines of communication and staff engagement are arguably two of the most important factors influencing the outcome. Patient education and motivation are critical, and these should be provided and evaluated respectively preoperatively. If for any reason the patient does not consent for same-day discharge, then the procedure should be performed as an inpatient.

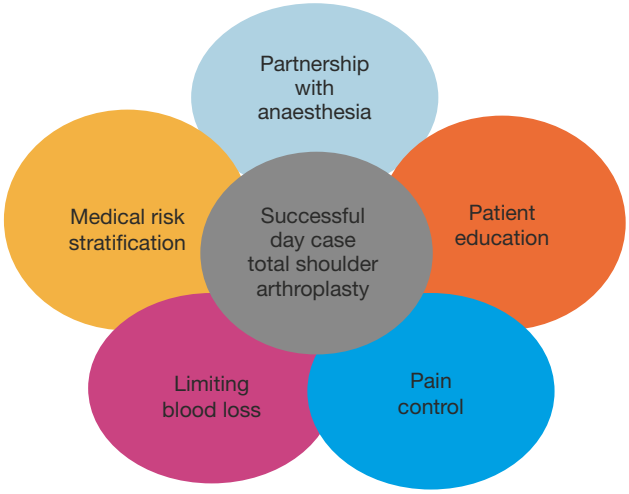

Figure 1. Principles of successful day case total shoulder arthroplasty.

Potential barriers to implementation

Before performing total shoulder arthroplasty as a day case procedure, it is essential that the surgeon possesses a degree of technical proficiency because prolonged operating time increases complication rates (Anthony et al, 2015). Similarly, surgical volume influences the decision to pursue day case arthroplasty, with those that engage with the approach performing higher numbers; a factor that likely reflects their comfort with the procedure (Brolin et al, 2018).

Transitioning to day case shoulder arthroplasty may be seen as a relatively novel change in policy, and so it is important to identify not only potential barriers to its implementation, but also the views of clinicians who have experience with it. In a survey of members

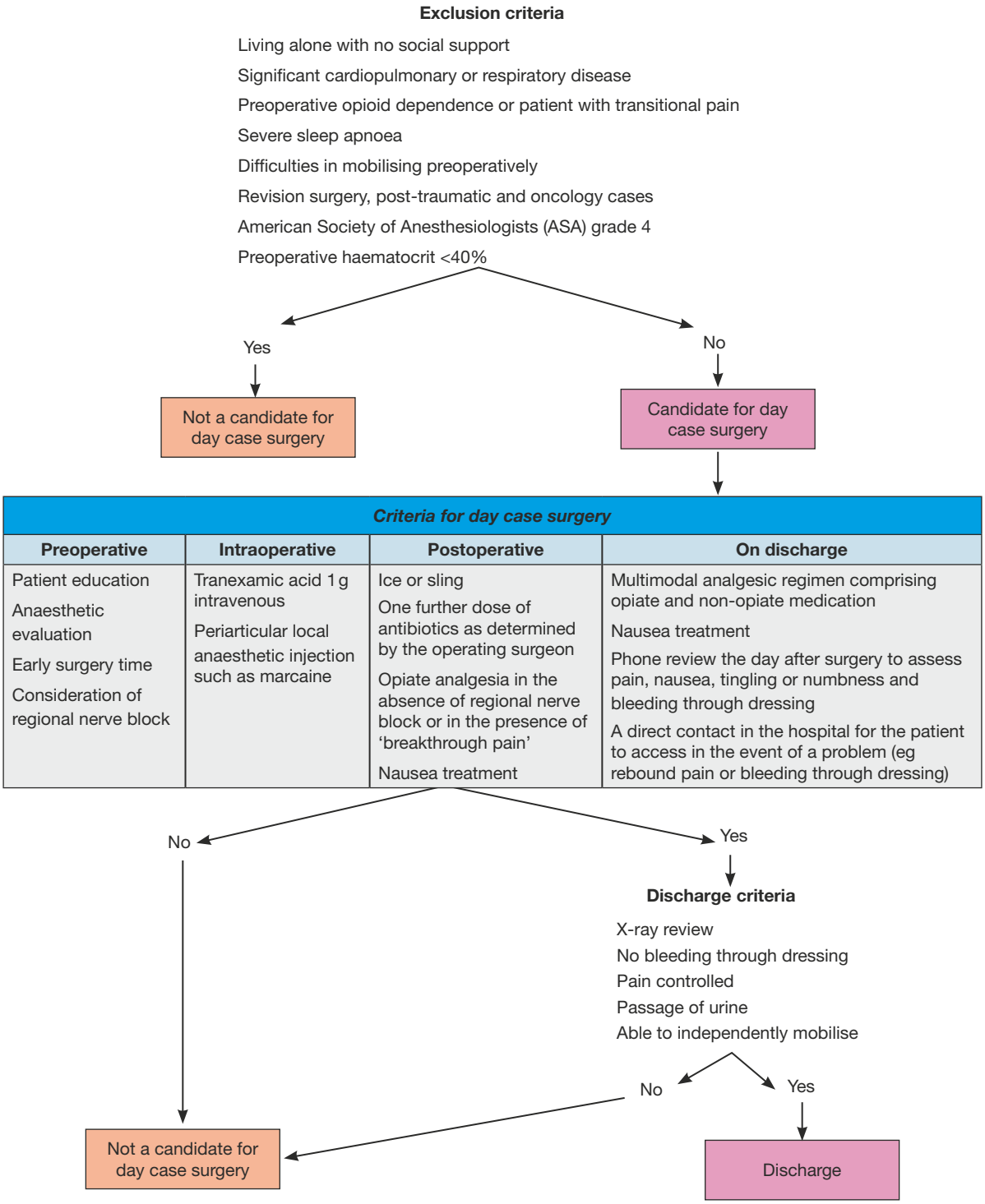

Figure 2. Algorithm guiding patient selection for day case shoulder arthroplasty.

Key points

- Compared to a day case approach, inpatient shoulder arthroplasty is associated with higher rates of hospital readmissions and complications such as thromboembolic events and surgical site infections.
- Using a day case approach for shoulder arthroplasty in the USA, up to $3500 (~£2500) can be saved per patient, giving scope for substantial savings to the NHS.
- Risk factors for complications within the first 30 days following shoulder arthroplasty include chronic steroid use, a preoperative haematocrit of less than 38%, American Society of Anesthesiologists class 4 and an operative time longer than 2 hours.
- Key factors that need to be considered when delivering a day case service include partnership and coordination with the anaesthetic department, patient education, pain management, limiting intraoperative blood loss and medical risk stratification.

belonging to the American Shoulder and Elbow Surgeons society, reasons for surgeons not performing day case arthroplasty included patient comorbidities, patient social support, complications occurring in an unmonitored home environment, readmission risk and patient age (Brolin et al, 2018). Unforeseen overnight stays or unplanned hospital admissions increase episode-of-care-costs, decrease patient satisfaction and may compromise patient safety. Nonetheless, surgeons performing day case total shoulder arthroplasty reported high levels of satisfaction with nearly 80% reporting an excellent experience (Brolin et al, 2018).

Conclusions

Providing high-quality musculoskeletal healthcare in an overstretched NHS has always been challenging because of the numerous financial and logistical challenges that need to be overcome. The COVID-19 pandemic has placed an increased strain on all medical services with soaring waiting lists and limited capacity. Strategies will be needed to cope with the increased demand for elective orthopaedic care as a result of an ageing population and the cessation of non-emergency surgery. Evidence supports the use of day case shoulder arthroplasty with results demonstrating excellent clinical outcomes, high patient satisfaction and few complications. Careful patient selection and partnership with the anaesthetic department are crucial components of a potential day case pathway. This is an exciting opportunity for the health service to keep up with demand, while limiting bed occupancy rates and making substantial savings that can be redirected into other vital services.

Author details

[1]Department of Trauma and Orthopaedic Surgery, Faculty of Medicine, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada

Conflicts of interest

The author declares that there are no conflicts of interest.

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How to interpret and manage abnormal liver blood test results in older people

Mohsan Subhani[1,2]

Abhishek Sheth[1,2]

Bilal Ahmad[3]

Stephen Ryder[1,2]

Author details can be found at the end of this article

Correspondence to:
Mohsan Subhani; mohsan.subhani@nottingham.ac.uk

Abstract

Ageing impairs liver function and reduces the liver's regenerative capacity. With the predicted increase in the older population, the burden of liver disease will proportionally rise in this age group. Elevated levels of liver enzymes in an otherwise asymptomatic older individual (≥65 years) are a common observation and positively associated with the metabolic syndrome, whereas a decline in albumin levels is linked with a rise in all-cause and liver-specific mortality. Deranged liver function tests do not always indicate liver disease, nor do normal liver function tests exclude liver disease. Therefore, clinicians need to consider individual patient risk factors during the assessment of abnormal liver function tests. This article discusses various liver function tests, their pathophysiology, and the approach to interpret and manage common abnormalities in liver function test results and liver disease in the older population.

Key words: LFT; Liver enzymes; Liver function tests; Older people; Review

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Introduction

Deranged liver function test results in older people is a frequently encountered clinical problem, and the prevalence is twice (16%) that of the younger population (8%) (Fleming et al, 2011; Lala et al, 2020). Liver function tests are part of routine clinical assessment and the third most commonly requested blood test in primary care; over 10 years, 25% of the resident population of Tayside Scotland had liver function tests (Donnan et al, 2007). Asymptomatic liver function test measurement, alongside a 6% predicted rise in the UK ageing population by 2038 (Office for National Statistics, 2019), is likely to have a significant impact on clinical practice.

As the liver ages, its total blood volume reduces by 35% compared to that in people younger than 40 years (Kim et al, 2015). This causes a reduction in functional cell mass, translating into a lower regenerative capacity (Kim et al, 2015; Cieslak et al, 2016). The liver is central to systemic lipid and glucose metabolism, steroid biosynthesis, homeostasis and insulin signalling (Hunt et al, 2019). Hence the risk of metabolic liver diseases demonstrates a positive linear association with age (Liu et al, 2018). The effect of this change may be mediated by ageing physiology, promoting the development of fibrosis. Age-related changes in the liver include dysregulation of hepatic energy metabolic pathways, lipofuscin accumulation, dysfunction of hepatic endothelial cells and increased oxidative stress, increased susceptibility to age-related diseases, insulin resistance, diabetes, non-alcohol fatty liver disease and the harmful effects of alcohol (Kim et al, 2015). Consequently, modern lifestyle choices promoting obesity and increased alcohol consumption (Williams et al, 2014) have led to an increase in non-viral liver disease in western populations. Over the last decade, there has been a worrying trend of increasing alcohol misuse among older people, with an exponential rise (>90%) in alcohol-related hospital admissions in people aged 65 years and over (Rao et al, 2016). Older people with at-risk drinking behaviours are increasingly prone to liver disease, which may progress rapidly as a result of associated age-related changes in liver physiology.

What are the liver function tests?

Liver function tests have been used in clinical practice since the 1950s to diagnose and treat liver disease. The standard liver function test panel includes liver enzymes (alanine

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aminotransferase, aspartate aminotransferase, alkaline phosphatase and gamma-glutamyl transferase) and markers of liver function (bilirubin and albumin). In the setting of acute liver failure, prothrombin time can be a useful marker.

Aspartate aminotransferase and alanine aminotransferase transfer amino groups from aspartate and alanine to ketoglutaric acid and are markers of hepatocellular liver injury, but in reality, can be non-specific (Karmen et al, 1955). Alanine aminotransferase is more liver-specific whereas aspartate aminotransferase is present in cardiac and skeletal muscles, kidney, pancreas, lung and brain, as well as in the liver. An isolated rise in aspartate aminotransferase levels can be the result of cardiac or skeletal muscle disease (Kwo et al, 2017). Gamma-glutamyl transferase is a marker of oxidative stress and subclinical inflammation (Liu et al, 2018). The primary source of gamma-glutamyl transferase is the liver, although tissues such as the intestine, prostate and pancreas produce gamma-glutamyl transferase albeit at low levels, it is not present in bone (Newsome et al, 2018). Alkaline phosphatase is mainly present in the hepatocytes' canalicular membrane and is involved in hydrolysis of phosphate esters (Kwo et al, 2017). Other tissues that secrete alkaline phosphatase are bone, intestines, kidneys and white blood cells. However, a concomitant rise in gamma-glutamyl transferase supports the idea that an elevated alkaline phosphatase level is hepatic in origin. Aminotransferases (alanine aminotransferase and aspartate aminotransferase) usually remain within the reference range, whereas gamma-glutamyl transferase and alkaline phosphatase can rise with age. Serum bilirubin levels may gradually decline as a result of reduced muscle mass and haemoglobin (Tajiri and Shimizu, 2013; Kim et al, 2015). In patients who have hepatocellular liver injury, elevation of transaminase levels (alanine aminotransferase, alanine aminotransferase) is the predominant finding, whereas gamma-glutamyl transferase and alkaline phosphatase levels are elevated in patients with cholestatic liver injury.

It is essential to emphasise that because of the indolent nature of liver disease, especially in apoptotic conditions such as non-alcoholic fatty liver disease and alcohol-related liver disease, a patient can have advanced liver disease but still have normal results of liver function tests (Newsome et al, 2018). This review discusses the observed derangement of liver function tests in the older population (≥65 years), the clinical implications, including management, and briefly describes the common causes of liver disease in this cohort.

Liver function tests in asymptomatic older people in community settings

Despite liver function being the third most commonly requested blood test in primary care, data on the true prevalence of impaired liver function test results in the otherwise asymptomatic population is lacking. Mild elevation of liver enzyme levels in healthy patients is a commonly reported incidental abnormality. One in six older adults (≥75 years) is said to have at least one abnormal liver function test (aspartate aminotransferase, alanine aminotransferase or bilirubin) (Fleming et al, 2011) (**Table 1**).

A population-based study from the USA reported 8.9% and 4.9% of healthy individuals had an elevated alanine aminotransferase or aspartate aminotransferase level respectively; high body mass index, waist circumference and alcohol intake were common causes (Ioannou et al, 2006). Donnan et al (2007) conducted a population-based cohort study (ALFIE) to determine the natural history of impaired liver function test results. They showed that 21.7% of participants reported having at least one deranged liver function test result and, of these, only 1.14% developed liver disease (median follow up of 3.7 years). Those with mild elevations of aspartate aminotransferase, alanine aminotransferase or gamma-glutamyl transferase levels had up to four times the risk (hazard ratio 4.23, 95% confidence interval 3.55–5.04) of developing liver disease over 5 years. This risk was 13 times higher when severe elevations of both alanine aminotransferase or aspartate aminotransferase and gamma-glutamyl transferase levels were observed. The Birmingham and Lambeth Liver Evaluation Testing Strategies study highlighted similar findings: fewer than 5% of cases with abnormal liver test results had an acute or chronic liver condition, and only 1.3% of patients had a severe liver problem (Lilford et al, 2013). A caveat of these studies is a lack of long-term follow up, which is essential to predict the natural history of chronic liver disease.

Table 1. Distribution of impaired liver function test results among older people (≥75 years) in the community

Liver function test	Sample size (*n*)	% abnormal test results (95% confidence interval)
Aspartate aminotransferase	*n*=12826	3.3 (3.0–3.7)
≤2 upper normal limit		2.9 (2.6–3.2)
≥2 upper normal limit		0.5 (0.4–0.6)
Alkaline phosphatase	*n*=13499	9.2 (8.7–9.7)
≤2 upper normal limit		8.3 (7.8–8.8)
≥2 upper normal limit		0.9 (0.8–1.1)
Bilirubin	*n*=12690	5.4 (5.0–5.8)
≤2 upper normal limit		5.1 (5.0–5.8)
≥2 upper normal limit		0.3 (0.2–0.5)
Aspartate aminotransferase and alkaline phosphatase	*n*=12794	0.7 (0.6–0.9)
Aspartate aminotransferase and bilirubin	*n*=12021	0.3 (0.2–0.5)
Alkaline phosphatase and bilirubin	*n*=12648	0.5 (0.4–0.7)
Aspartate aminotransferase, alkaline phosphatase and bilirubin	*n*=11994	0.07 (0.03–0.14)
Any (aspartate aminotransferase, alkaline phosphatase or bilirubin)	*n*=13546	16.1 (15.4–16.7)

From Fleming et al (2011)

Multimorbidity is expected after the age of 65 years and becomes almost universal in people aged 90 years or over. Most of the reported increase in morbidity and mortality linked to abnormal liver enzyme levels in older people relates to systemic diseases rather than the liver. Donnan et al (2007) found low albumin levels to be a strong predictor of all-cause mortality in their study (mean age of 62 years; ratio 2.65, 95% confidence interval 2.47–2.85) and the decline in albumin levels with increasing age is correlated with an increased risk of all-cause and cardiovascular mortality (Schalk et al, 2006).

Up to 50% of people with cirrhosis first present with decompensated liver disease and may not have deranged liver enzymes (Williams et al, 2014). A diagnosis of cirrhosis confers an increased risk of liver-related morbidity and mortality (Sharma et al, 2014). There is little evidence to help the physician decide on further diagnostic workup for abnormal liver function test results in older people (Oh and Hustead, 2011) and the diagnostic accuracy of liver function tests in isolation is questionable. Adding non-invasive investigations and diagnostic tools, such as identifying risk factors for liver disease, may increase the yield of diagnosing liver disease and minimise the risk of harm (Donnan et al, 2007; Aragon and Younossi, 2010). Extensive undue investigation in otherwise healthy individuals can provoke anxiety, result in unnecessary exposure to invasive procedures like liver biopsy or endoscopy and has cost implications for healthcare services (Aragon and Younossi, 2010).

Historically, liver biopsy was considered the gold standard to establish aetiology and severity of liver disease (Berger et al, 2019), but recently more reliable non-invasive markers of liver fibrosis, such as enhanced liver fibrosis tests and fibroscan, have become available (Loomba and Adams, 2020). Although the evidence on non-invasive assessment of liver fibrosis in cohorts of older people is limited, it does show promising results and should be considered as part of routine clinical assessment for patients with impaired liver function test results in the presence of relevant risk factors (Salles et al, 2009; Dong et al, 2016). Early diagnosis of liver fibrosis provides an opportunity to intervene and is the most effective way of preventing progression of liver disease (Roberts et al, 2019). Common causes of impaired liver function test results in otherwise asymptomatic older individuals and a brief guide to management is given in Tables 2 and 3.

Table 2. Common causes of deranged liver function test results in otherwise asymptomatic older people	
■ Non-alcoholic fatty liver disease ■ Alcohol-related liver disease ■ Drug-induced liver injury ■ Autoimmune hepatitis	
Isolated rise in alkaline phosphatase levels	■ Vitamin D deficiency ■ Paget disease ■ Osteomalacia
Isolated rise in gamma-glutamyl transferase levels	■ Obesity ■ Smoking ■ Alcohol excess ■ Diabetes

Table 3. Management of deranged liver function test results in otherwise asymptomatic older people	
Clinical history	Take a history of ■ Alcohol intake ■ Baseline body mass index ■ Recent change in weight ■ Type 2 diabetes ■ Recent change in medication ■ History of over the counter medications, illicit drugs, herbal medications ■ History of intravenous drug use
Features of metabolic syndrome	Identify the common features of metabolic syndrome ■ Central obesity ■ Hypertension ■ Diabetes ■ Insulin resistance ■ Dyslipidaemia ■ Obstructive sleep apnoea
Further investigations	Based on individual risk factors ■ Request investigations to establish aetiology ■ Non-invasive tests to stratify stage of liver disease (fibroscan, enhanced liver fibrosis test)

Liver function tests in hospitalised older people

In 2017, 22.2% of all hospital admissions in England were of people older than 75 years. Of these, 81% had a single hospital admission, and 96% had one emergency visit in the last year of their life. Cancer, dementia, chronic obstructive pulmonary disease, acute heart disease and liver disease were the most common indications for hospitalisation and mortality (Public Health England, 2020). Hospitalised older adults often have a low functional reserve, increased risk of recurrent hospital admissions and mortality. The prevalence of chronic liver disease rises with age and significantly impacts functional status, quality of life, risk of multimorbidity and mortality in older age (Klausen et al, 2017).

Shah et al (2010) found that 16% (n=2172) of hospitalised patients (≥75 years) had at least one elevated liver function test result (aspartate aminotransferase 3.3%, alkaline phosphatase 9.2%, bilirubin 5.4%). A history of diabetes or dementia was associated with elevated aspartate aminotransferase and alkaline phosphatase levels, while a history of heart attack was related to an elevated alkaline phosphatase level. Sepsis (32.5%) was the most common cause of impaired liver function test results, followed by alcohol-related

liver disease (22%), malignancy (10%), congestive heart failure (5%) and drug-induced liver injury (4.7%) (Shah et al, 2010).

Hospitalised older people (mean age 78 years) with serum albumin level <33 g/litre had 3.2-fold (odds ratio 3.23) increased risk of inpatient mortality (Silva et al, 2009). In a cohort of patients with COVID-19 (mean age 66 years±15 years) those with at least one elevated liver function test result were 3.5 times more likely to die or be transferred to intensive care than those with normal liver function test results (Piano et al, 2020).

The management of patients with deranged liver function test results in hospital settings involves treating the underlying cause, which is often a systemic disease like sepsis. It is vital to consider the presenting and past medical history, risk factors for liver disease and clinical signs while requesting further workup. The early involvement of specialist geriatric teams in managing older patients who are hospitalised as a result of any cause improves the outcome and facilitates early discharge (Totten et al, 2011).

Chronic liver disease in old age

The prevalence of chronic liver disease in older age is rising in line with an increasing life expectancy favouring an ageing population. Unfortunately, these patients often present at a late stage because of the paucity of symptoms in early disease. Alcohol-related liver disease and non-alcoholic fatty liver disease are the commonest aetiologies in developed nations influenced by western lifestyles (Frith et al, 2008).

Alcohol-related liver disease

In the UK, 53% of men and 38% of women over the age of 60 years are current alcohol drinkers and, of all patients diagnosed with alcohol-related liver disease, 28% are older than 60 years (Frith et al, 2008). The risk of liver disease rises in proportion with an increase in alcohol intake and doubles for any given alcohol intake once body mass index is >35 kg/m^2 (Newsome et al, 2018). Excess alcohol consumption is on the rise in older people, but alcohol metabolism reduces because of the decline in activity of the enzymes which metabolise alcohol, which increases the risk of alcohol-related liver disease (Kim et al, 2015). Alcohol is associated with acceleration of liver fibrosis in concomitant hepatitis C virus infection and increases adverse events as a result of polypharmacy (Tajiri and Shimizu, 2013). The most common abnormalities observed are elevated levels of aspartate aminotransferase, alkaline phosphatase and bilirubin, and increased mean corpuscular volume (Frith et al, 2008). Mortality in over 60-year-olds is 34%, management is supportive, and abstinence from alcohol is the mainstay of treatment (Frith et al, 2008).

Non-alcoholic fatty liver disease

Ageing is associated with an increase in central obesity, excessive visceral fat, and increased blood levels of cholesterol and high-density lipoprotein, resulting in enhanced insulin resistance, which is a major pathophysiological trigger for metabolic liver disease (Kim et al, 2015). The overall prevalence of non-alcoholic fatty liver disease is as high as 35% in people older than 65 years and is significantly higher than in younger counterparts (Kim et al, 2015). The current mainstay of treatment is lifestyle modification, including exercise and Mediterranean diets, which improves non-alcoholic fatty liver disease outcomes and those of other metabolic diseases (Kim et al, 2015).

Drug-induced liver injury

Drug-induced liver injury is on the rise among the general population and more so in older people; the precise prevalence in older population is unknown but estimates range from 23% to 45% (Danjuma et al, 2020). Multimorbidity along with polypharmacy make older people more vulnerable to drug-induced liver injury (Kullak-Ublick et al, 2017). A prospective study looking at polypharmacy in old age (mean age 82 years) showed 73% took at least four or more prescription medications (Tajiri and Shimizu, 2013). This makes it challenging to establish causality and identify a single culprit drug; a test system called MetaHeps can be useful in this scenario (Kullak-Ublick et al, 2017). The international expert group for drug-induced liver injury proposed the following thresholds for diagnosis: alanine

aminotransferase value ≥5 × upper limit normal, alkaline phosphatase value ≥2 × upper limit normal or alanine aminotransferase value ≥3 × upper limit normal and bilirubin ≥2 × upper limit normal. Danjuma et al (2020) found that over 30% of drug-induced liver injury in old age is avoidable with rational decision making, avoiding medications and interactions associated with increased risk of drug-induced liver injury. Management involves prompt recognition and discontinuation of the offending drug, close monitoring and, in cases of drug-induced liver injury with autoimmune features, consideration of corticosteroids after liver specialist advice (Kullak-Ublick et al, 2017).

Autoimmune hepatitis

Autoimmune hepatitis is an immune-mediated inflammatory condition of the liver and can present as acute hepatitis, liver failure or chronic liver disease. Although it is typically considered a disease of younger age, the incidence is rising in older people (Durazzo et al, 2019). The clinical presentation largely remains the same in all age groups, but above the age of 60 years can be with a relatively higher alkaline phosphatase and gamma-glutamyl transferase level than younger patients (Peng et al, 2014). The workup includes testing for the presence of liver autoantibodies and serum immunoglobulins, specifically IgG, with liver biopsy to confirm the diagnosis (Newsome et al, 2018). It is worth noting that seronegative autoimmune hepatitis is more common in older patients. Other comorbidities, polypharmacy and increased risk of side effects make management particularly challenging in this age group. Treatment with steroids alone or in combination with azathioprine is the most commonly used and well-tolerated immunosuppressive regimen (Durazzo et al, 2019).

Viral hepatitis (A, B, C, E)

Hepatitis E virus infection is significantly ($P \leq 0.05$) more common in older people (median age 64 years) than hepatitis A, hepatitis B and hepatitis C virus (Kokki et al, 2016). The typical route of hepatitis B virus and hepatitis C virus transmission in the older generation is blood transfusion or surgery before the 1990s (Kim et al, 2015), whereas hepatitis E virus and hepatitis A virus are mainly transmitted via the faeco-oral route. All people with acute and chronic elevated levels of liver transaminases should be risk assessed and tested for viral hepatitis. Hepatitis A virus is usually self-limiting but can cause significant hepatocellular dysfunction and rise in liver enzyme levels, with mortality demonstrably higher in people age 75 years or over (Tajiri and Shimizu, 2013). A vaccine is available for hepatitis A virus and hepatitis B virus worldwide.

Conclusions

The prevalence of chronic liver disease in the ageing population is rising in proportion with advancing life expectancy. Deranged liver function test results are commonly reported in older patients, both in community and hospital settings. Although liver function testing is part of routine clinical practice and is a frequently requested blood test, a significant proportion of patients continue to be diagnosed at an advanced stage of liver disease whereby the scope of any intervention is minimal. Normal liver function test results do not exclude liver disease, and at the same time, impaired liver function test results are not always indicative of liver disease. A targeted history to identify liver disease-specific risk factors and the integration of recently available non-invasive liver disease diagnostic investigations in clinical practice can enhance early diagnosis of liver disease and thus help to reduce the morbidity and mortality associated with advanced disease. Further research is needed to establish the true prevalence and natural history of impaired liver function in the older population.

Author details

[1]Nottingham Digestive Diseases Biomedical Research Centre, School of Medicine, University of Nottingham, Nottingham, UK

[2]NIHR Nottingham Biomedical Research Centre, Nottingham University Hospitals NHS Trust and the University of Nottingham, Nottingham, UK

[3]Department of Gastroenterology, Wrexham Maelor Hospital, Wrexham, UK

Key points

- Deranged liver function test results are a common finding in older people.
- Common causes include non-alcoholic fatty liver disease, alcohol-related liver disease and drug-induced liver injury.
- Deranged liver function test results do not always indicate liver disease, nor does normal liver function test results exclude liver disease.
- Clinicians need to consider individual patient risk factors during the assessment and request further investigation to establish aetiology with caution and only where indicated.
- Assessment of patients with abnormal liver function tests should include non-invasive tests to stage liver disease.

Conflicts of interest
The authors declare that they have no conflicts of interest.

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Common haemostatic techniques used in surgical practice

Georgina H Frew[1]

Lachlan Dick[1]

Jamie Young[1]

Author details can be found at the end of this article

Correspondence to:
Lachlan Dick;
lachlan.dick3@nhs.scot

Abstract

Intraoperative bleeding can be difficult to manage and is associated with worse patient outcomes. Good intraoperative haemostasis by the surgeon is a key factor in ensuring a bloodless field and reducing intraoperative blood loss. There is a myriad of mechanical, thermal and energy-based techniques available to use, each of which has their own benefits and drawbacks. The decision of which to use will depend on patient and procedural factors as well as the surgeon's preference. This article reviews techniques commonly used in surgical practice to maintain intraoperative haemostasis.

Key words: Bleeding; Blood loss; Coagulation; Diathermy; Electrosurgery; Haemostasis

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Introduction

Bleeding can occur during any surgical procedure, and large intraoperative blood loss is associated with worse patient outcomes and increased cost and length of admission (Karkouti et al, 2004; Stokes et al, 2011). Intraoperative bleeding also makes surgery technically challenging; not only can blood obscure the operative field, but during laparoscopic and endoscopic surgery haemoglobin absorbs the light needed to visualise visceral structures (Bosschaart et al, 2014) further hindering the operator. Bleeding may be minor and arise from small, dermal vessels, but it can originate from larger vessels resulting in significant and rapid blood loss. In either case, it is important for those performing operations to have a solid understanding of the factors that contribute to bleeding. These can manifest preoperatively or intraoperatively and can be further exacerbated during the immediate postoperative period. A range of techniques is available to manage bleeding when it occurs, and each has its own associated strengths and weaknesses.

This article focuses on minimising blood loss through effective intraoperative haemostasis and the available mechanical, thermal and energy-based techniques used to achieve this. The advantages and disadvantages of the techniques are discussed and procedures that frequently use them are highlighted.

General principles

Intraoperative blood loss can be attributed to a range of factors, many of which present during the perioperative period. A key element is in the management of patients with acquired and congenital coagulopathies (Kozek-Langenecker et al, 2017). Correction of coagulopathy by withholding anticoagulants is common practice and in certain cases reversal agents are indicated. In major trauma, correction of acidosis and hypothermia helps to reduce the acquired coagulopathic state (Mitra et al, 2012). However, while coagulopathies contribute to blood loss, more often the main cause of bleeding is the surgical intervention itself (Curnow et al, 2016).

While minimally invasive surgical approaches reduce blood loss (Simillis et al, 2019), it is still important that good use of anatomically avascular planes is achieved. For example, during percutaneous renal surgery, use of the plane between the anterior and posterior renal artery branches (Brödel's line) helps to prevent bleeding that would otherwise be difficult to control (Macchi et al, 2018). Furthermore, knowledge of regional vascular anatomy is important as potential sites of bleeding can be anticipated and managed appropriately. This is particularly pertinent for procedures involving the scalp as it has a rich blood supply (Cormia, 1963).

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In addition to good use of anatomy, physiological techniques, such as permissive hypotension, are effective at minimising blood loss (Kudo et al, 2017). Pharmacological methods can also be used, with tranexamic acid administration during major surgery minimising the need for transfusion (Shah et al, 2020) and subcutaneous adrenaline use during skin graft surgery reducing intraoperative bleeding as well as the operative time (Gacto et al, 2009).

Mechanical

A surgeon's initial action on encountering bleeding is often to apply direct pressure to the area. This is for two reasons: first, direct pressure maintained for 15–20 seconds may be sufficient to control the bleed (Samudrala, 2008) and second, it minimises blood loss while gathering the instruments for a more definitive haemostatic technique. Pressure dressings are also commonly used, particularly following varicose vein surgery. Direct pressure alone carries the risk of rebleed if the clot is displaced and will not control bleeding from larger vessels, which will require the cut ends to be ligated (Table 1).

Sutures

Sutures date back to neolithic times when they are thought to have been used for wound approximation (Mackenzie, 1973). In clinical practice, catgut and silk were the first widely used suture materials (Holder, 1949) and remained popular until the late 1960s when synthetic suture materials became available. Sutures can be described according to their absorbability (absorbable vs non-absorbable), filament type (monofilament vs multifilament), material and size. Sutures are available mounted onto a variety of needles or as ties. The myriad types of suture reflect their versatility and widespread use for tissue approximation and haemostasis in both open and laparoscopic surgery.

Prolene, a polypropylene suture, was developed in 1969 (Figure 1); it is a non-absorbable suture that exerts minimal tissue trauma while providing long-term durability. These properties are useful in vascular anastomoses and vessel repair, making it popular in cardiac and vascular surgery (Calhoun and Kitten, 1986) where it is associated with a lower incidence of false aneurysms (Gaspar et al, 1983).

Shortly after, Vicryl (polyglactin 910 suture) was developed (Figure 1); this is a multifilament synthetic suture which is absorbable and easier to handle and tie securely than monofilament sutures.

It is widely used to ligate small, subcutaneous vessels and in general surgery to ligate mesenteric vessels during bowel resections. For larger vessels (for example, the ileocolic artery) Vicryl can be used on a needle (rather than as a tie) to ensure adequate tissue is secured, to help reduce the risk of knot slipping. For control of bleeding following large calibre venous access removal, Vicryl has a superior time to haemostasis, ambulation and discharge as well as fewer complications compared with manual compression alone (Kumar et al, 2019). The ready availability and accessibility of suture materials and individuals competent to use them is one of the main benefits of suture control of bleeding. It is also cost effective when compared to other vessel sealing devices (Cheng et al, 2018). The main drawbacks are that it can be time consuming to perform, particularly intracorporeally, and there is a risk of technical failure.

Table 1. Comparison of common mechanical techniques

Method	Advantages	Disadvantages
Direct pressure	Easy, can achieve immediate short-term control	May not provide long-term control
Sutures	Versatile, many different varieties with differing properties, cheap	Risk of technical failure, may not be adequate for larger vessels
Clips	Easy to use, come in a range of sizes and materials	May become dislodged, risk of secondary thermal injury
Staplers	Quick and easy to use	More expensive, bleeding may result if wrong size used

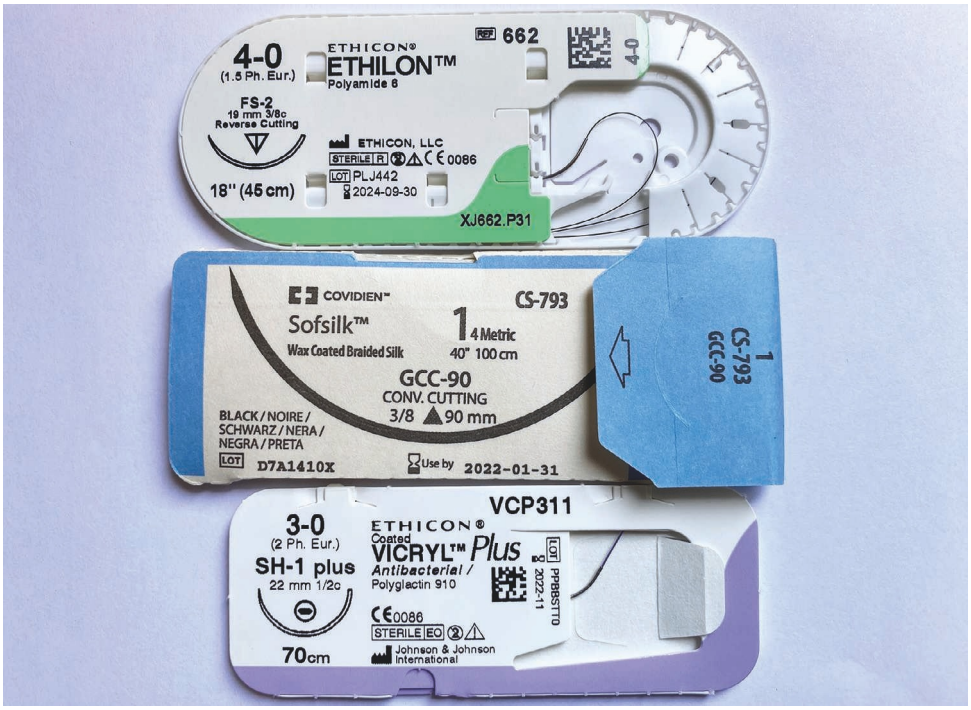

Figure 1. Examples of polypropylene, polyglactin and silk sutures.

Clips

Clips are u-shaped metal or polymer devices which, using an applicator, can be flattened around a vessel or small tubular structure to occlude the lumen. Clips are used in both open and laparoscopic surgery; in the latter metal clips are made from titanium rather than stainless steel so they do not magnetise and become difficult to handle (Gould, 2011). Clips are comparable to other vessel ligation methods in vessels with diameters <5 mm and are easier to use intracorporeally than sutures (Rajbabu et al, 2007).

As clipping is a 'cold' method of haemostasis there is no risk of thermal damage to surrounding tissue when applying a clip device, but care must be taken to prevent subsequent injury when using energy devices nearby. However, clips can be dislodged from the vessel during further dissection or as a result of arterial pulsation; this risk is greater in larger vessels or if the clip is not applied at 90° to the vessel (Gould, 2011). The vessel also needs to be dissected away from surrounding structures to enable adequate margins and prevent collateral damage from the clip. In 1999, Hem-o-Lok clips (non-absorbable polymer clips with a locking mechanism) were introduced; these can be used to secure larger vessels and are better than staplers at preserving vessel length, which is beneficial during renal artery ligation for donor nephrectomy (Liu et al, 2018). Clips have also been modified for use during craniotomy surgery to maintain scalp haemostasis (Langford et al, 2009).

Staplers

Surgical staplers seal structures by compressing the tissue and delivering multiple rows of small staples (typically four or six) before dividing the tissue in the middle (Gould, 2011) (Figure 2). Staplers are commonly used on gastrointestinal tissue for bowel resection and/or anastomoses but this article focuses on the role of vascular staplers in sealing vessels and achieving haemostasis. When compared with clips and hand tied sutures, vascular staplers have similar performance under physiological conditions in vitro and vivo (Joseph et al, 2004; Liu et al, 2018). The main drawback for staple devices is the cost – a meta-analysis of renal pedicle ligation methods found that staplers cost on average $400 more than Hem-o-lok clips with no difference in clinical outcomes (Liu et al, 2018). Additionally, if the wrong size staples are selected, whether too short or too long, then there is a risk of bleeding as the staples will not interlock properly or will inadequately compress the tissue.

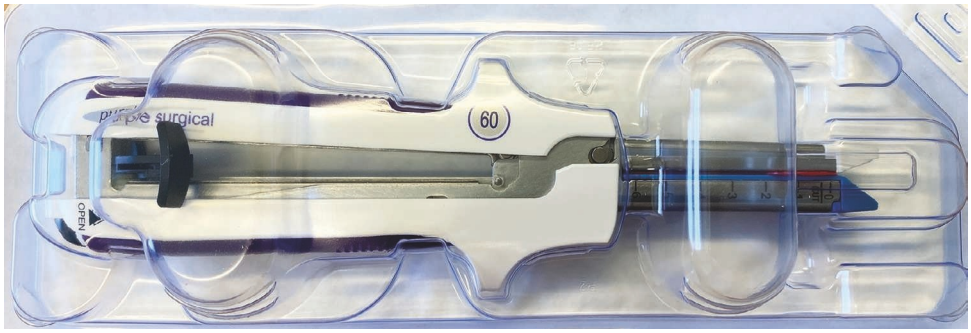

Figure 2. An example of a linear stapler.

Energy based

Electrosurgery

Electrosurgery relies on the principle of using high frequency electricity alternating at different currents to generate heat within tissues (El-Sayed et al, 2020). Differences in voltage allow for varied functions, such as cutting and coagulation (El-Sayed et al, 2020). By delivering a continuous waveform at a high power, the cutting function results in tissue vaporisation. This is in contrast to coagulation, which relies on a pulsed waveform that generates less heat and thus allows formation of a coagulum (Palanker et al, 2008). Electrosurgery can be further classified as either monopolar or bipolar depending on the method of delivery. In monopolar electrosurgery, the current is delivered via an active device and travels through the tissues to a return plate, which is usually placed on the patient's upper thigh or back. In contrast, bipolar electrosurgery has both the input and output confined to the instrument (El-Sayed et al, 2020). Electrosurgery technology has developed over the years and now encompasses electrothermal bipolar vessel-sealing devices; these devices combine pressure and electrical energy to seal vessels and have in-built sensors that alert the surgeon when the tissue is adequately sealed (Janssen et al, 2012).

Electrosurgery, in particular monopolar and bipolar devices, is used in all surgical specialties as a result of its widespread availability, versatility and lower cost compared with newer haemostatic devices (Sutton and Abbott, 2013). Bipolar vessel-sealing devices have superior sealing times and burst pressures when compared with ultrasonic devices (Lamberton et al, 2008) and comparable surgical outcomes to endoscopic staplers (Fathi et al, 2020). The main disadvantages of electrosurgery, particularly with monopolar devices, are thermal damage to surrounding tissues, inadvertent burns and interference with cardiac resynchronisation devices. The latter can occur as a result of stimulation of the atria, heat production and subsequent myocardial injury or in the case of implantable cardioverter-defibrillators, inadvertent activation (Apfelbaum et al, 2020). Thermal damage occurs as a result of transmission of energy beyond the intended structure and is increased by using monopolar devices, higher voltages, continuous currents and longer application times (El-Sayed et al, 2020). As a result of the risk of thermal damage, alternative haemostatic devices are preferred when in close proximity to delicate structures such as nerves and bowel. With regards to bipolar devices, care should be taken to avoid excessive tissue tension as this can result in avulsion before adequate haemostasis is achieved (Table 2).

Argon plasma coagulation

Argon plasma coagulation is a variant of monopolar electrosurgery that delivers 'non-contact' coagulation. Initially used in open hepatic surgery, it was later adapted for endoscopic surgery in the 1990s. The instrument emits a stream of argon gas that displaces the air around the target tissue. The device ionises the gas by passing an alternating current through it; once ionised the gas becomes argon plasma, which conducts the electrical current and causes coagulation in the tissue it is applied to (Zenker, 2008). As the tissue coagulates and desiccates, its impedance increases, shifting the focus of the plasma and limiting the depth of action to a few millimetres (Zenker, 2008). Consequently, collateral thermal

Table 2. Comparison of common energy-based techniques

Method	Advantages	Disadvantages
Electrosurgery	Versatile, widely accessible, cheap	Risk of thermal injury
Argon plasma	Lower risk of thermal injury	May not control large vessels
Ultrasonic	Minimal risk of thermal injury, wide range of models	More expensive
Laser	Can deliver precise coagulation	Risk to operator if inappropriately used

Figure 3. An example of an ultrasonic sealing device.

damage from the device is minimised but this also means argon plasma coagulation devices cannot cut tissue or control bleeding from larger vessels. The main uses of argon plasma coagulation are superficial haemostasis and tissue ablation, particularly during endoscopic procedures, for example gastrointestinal endoscopy, hysteroscopy and cystoscopy. While argon is an inert gas, there are complications associated with its use: argon gas emboli have been reported in patients undergoing liver resections using argon plasma coagulation and when used during laparoscopic surgery the stream of argon gas can further increase intra-abdominal pressure (Gould, 2011).

Ultrasonic devices

Ultrasonic devices work by using vibration to both cut and cauterise tissue (Figure 3). Using high frequencies (in the region of 55 000 Hz) these devices generate friction between molecules, resulting in heat production and protein denaturation (Fitzgerald et al, 2012). With most being able to seal vessels up to 7 mm, they are frequently used during colonic mobilisation to minimise small vessel bleeding. In addition, given there is minimal damage to surrounding tissue (Dutta and Dutta, 2016), these devices are frequently used to minimise blood loss during thyroid surgery where careful protection of surrounding nerves is essential (Foreman et al, 2009). Newer devices incorporate both ultrasonic and bipolar principles to seal vessels although there appears to be no difference in outcome when compared with standard ultrasonic devices (Suhardja et al, 2018). One of the main disadvantages is the cost of the device at the point of use. However, a meta-analysis has shown that this is offset by reduced operating times and so their use overall reduces costs in a range of different procedures (Cheng et al, 2018).

Lasers

Lasers are devices that produce a powerful narrow beam of electromagnetic radiation in a single wavelength; depending on the wavelength and pulse duration, lasers can be used to cut, coagulate or ablate tissue (Gould, 2011). The name laser is an acronym for the method by which the wavelength is produced – 'light amplification by stimulated emission of radiation'. The device consists of an external energy source that excites the

atoms in the laser medium; these atoms, when they return to their low-energy state, emit photons that are reflected within the resonance chamber to produce an electromagnetic beam with a specific wavelength (Colt, 2011). Laser wavelength is selected according to the target molecule, for example oxyhaemoglobin, which absorbs the light and then dissipates the energy as thermal or chemical energy (Colt, 2011). The versatility of lasers means they are used in a range of medical and surgical specialties, most commonly in ophthalmology and dermatology. Lasers can also be delivered via fibreoptic cables making them useful in endoscopic and laparoscopic procedures. Unlike other methods of haemostasis discussed here, lasers provide very precise coagulation; the CO_2 lasers used in otorhinolaryngology can seal blood vessels up to 0.5 mm diameter (Betka et al, 2013). Laser radiation can damage the eyes and skin of users and patients so appropriate training and safety equipment is required for theatre staff and surgeons (Samudrala, 2008; Colt, 2011).

Topical agents

If, as a result of the location or the presence of friable tissue, haemostasis cannot be achieved using other methods, then topical agents can be used. Topical agents are classified as passive, promoting platelet aggregation but reliant on an intact coagulation cascade, or active, containing fibrinogen and/or thrombin and triggering clot formation (Samudrala, 2008; Huang et al, 2020). As many topical agents are derived from biological sources (human, shellfish, bovine or equine), there is a risk of immune reaction and it is important to consider any patient allergies. In clinical practice, fibrin sealants have a higher success rate of haemostasis compared with conventional methods in patients undergoing aortic aneurysm surgery (Weltert et al, 2016). While traditionally used for wound management, in vitro studies have shown that alginate dressings may also have haemostatic properties (Rembe et al, 2015). Passive agents can absorb large volumes of blood and swell, so caution should be exercised when using them in enclosed spaces to prevent compression of neurovascular structures (Samudrala, 2008; Huang et al, 2020).

Conclusions

Techniques for maintaining intraoperative haemostasis are varied and encompass many different principles. Although they all have broadly similar effectiveness, each has unique properties that make them preferred for particular operations. Undoubtedly surgeon preference will also influence which methods are used. It is important for those involved in the operating environment to be aware of the potential drawbacks of each to reduce and prevent negative outcomes.

Author details

[1]Department of General Surgery, Borders General Hospital, Melrose, UK

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Key points

- Intraoperative blood loss is associated with worse patient outcomes and increased costs of care.
- Mechanical techniques to prevent bleeding (such as pressure, suture ligation, clips, staplers) are cost effective although there is a risk of technical failure.
- Energy-based devices are most commonly used because of their versatility, but care should be taken to prevent damage to surrounding tissue.
- Topical agents are useful for friable tissues but carry a risk of immune reactions.
- Patient and procedural factors, as well as the surgeon's preference, need to be considered when choosing a haemostatic technique.

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D-dimers: a most misunderstood test

Luke Carter-Brzezinski[1]

Scott Houston[1,2]

Jecko Thachil[1,2]

Author details can be found at the end of this article

Correspondence to:
Luke Carter-Brzezinski;
lukecarter@nhs.net

Abstract

The role of D-dimers in the management of venous thromboembolism is well established and testing for D-dimers has become common in most acute settings. Although it has been validated for the purpose of excluding venous thromboembolism, the test is increasingly ordered to 'diagnose' venous thromboembolism. Furthermore, in the COVID-19 pandemic, heavy reliance has been put on this test with the inclusion of D-dimers to guide treatment pathways. This review summarises the appropriateness of D-dimer tests in these different clinical settings.

Key words: Anticoagulation; COVID-19; D-dimer; Fibrinogen; Thromboembolism

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Introduction

D-dimer measurement has become one of the most common blood tests ordered in an acute medical setting. It is an extremely valuable test to exclude venous thromboembolism in patients who have a low clinical probability for this diagnosis (Adam et al, 2009). It may also be helpful in patients who develop the complication of disseminated intravascular coagulation and in the diagnostic algorithm for an aortic aneurysm (Weitz et al, 2017). It has been thrust into the limelight during the COVID-19 pandemic where it is (purported) to predict venous thromboembolism and also mortality (Lippi and Favaloro, 2020). Despite this varied usefulness, this laboratory test is often inappropriately requested as a marker of clot formation, despite it never being intended for this purpose.

What is D-dimer?

To understand more about the test, it is important to understand how D-dimer is created in the body (Figure 1). During the coagulation process, thrombin, generated from prothrombin with the action of various clotting factors, acts on fibrinogen (which consists of two D domains and one E domain) to form fibrin monomers, where the D domains come together (Thachil et al, 2017). The fibrin monomers then polymerise into an insoluble network which gives the tensile strength to a clot. To ensure the clot is limited to the site of vessel injury and does not completely occlude the blood vessel, fibrinolytic proteins break down the cross-linked fibrin (Adam et al, 2009; Thachil et al, 2017). This process creates various fragments including D-dimers. So, D-dimers are the product of the proteolytic breakdown of cross-linked fibrin created by the action of thrombin. The commonly used D-dimer tests are monoclonal antibodies specific for these D domains (Dempfle, 2005).

What makes D-dimer levels increase?

As already discussed, the presence of D-dimers signifies clot breakdown. The coagulation system is always on the look-out for vessel injury to facilitate the rapid sealing of wounds, and limit loss of blood. As such, D-dimer levels can be elevated in any condition where there may be tissue injury (minor and major trauma, surgeries and interventional procedures) (Lippi et al, 2008). It may also be noted that the normal D-dimer result is never zero, but a numerical value that varies between laboratories based on the methodology used (for example <500 ng/ml) (Longstaff et al, 2016). This minimal amount of D-dimer is created by the fibrinolytic system as a result of constant breakdown of thrombi formed anywhere in the body to maintain uninterrupted blood flow.

However, the formation of clots is not limited to inside blood vessels. A fibrin mesh can form a scaffold that the various inflammatory proteins can use as a foundation to

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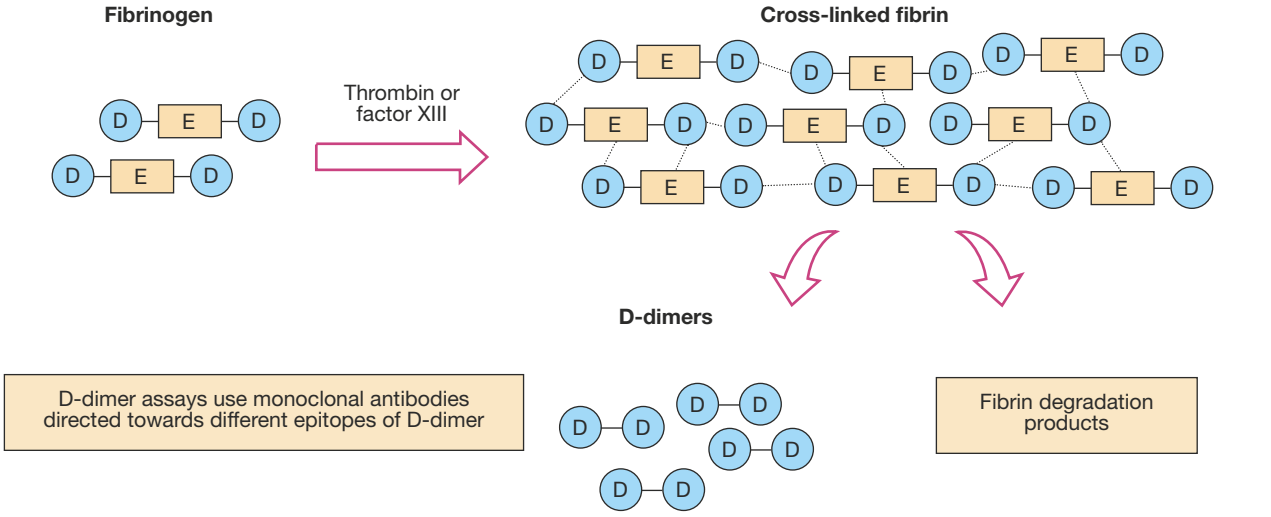

Figure 1. Cross-linked fibrin is created from fibrinogen by the action of thrombin and then factor XIII. The cross-linked fibrin is broken down into D-dimers and fibrin degradation products by fibrinolytic enzymes. Monoclonal antibodies that recognise D-dimer domains in the blood are commercially available as D-dimer assays.

perform their pro-inflammatory function (Wagers et al, 2004). This is typical of situations where inflammatory proteins leak into the extravascular space, ie inflammatory disorders. In these clinical situations, the coagulation proteins 'escape' the blood vessel and form a clot in the extravascular space (Thachil et al, 2021). These clots are broken down in a similar fashion to those formed as a result of endothelial injury at the sites of vessel damage and thus create 'extravascular D-dimers' (Thachil et al, 2021). These D-dimers are then absorbed into the blood and are readily detectable by blood tests. This explains the elevated D-dimer levels seen in patients with inflammatory conditions where no clots are identifiable by the imaging techniques used to detect venous thromboembolism. In a similar way to inflammatory states, extravascular fibrinolysis in the cancer stromal spaces has been suggested as a reason for increased D-dimer levels in patients with malignancies (Thachil et al, 2021).

Why do inappropriate D-dimer requests happen?

Requests for D-dimer measurement have become routine despite the appropriateness of this being questionable in many scenarios. Acute physicians and haematologists are commonly approached to deal with a positive D-dimer result despite no evidence of thrombosis in a patient. A key reason for this erroneous requesting is the widespread belief that a positive D-dimer signifies a high likelihood of venous thromboembolism, although the test was never meant for this purpose. On the contrary, D-dimers are most helpful in excluding venous thromboembolism in those with low clinical probability for this condition (Di Nisio et al, 2007). This is clearly included in several guidelines for the diagnosis of venous thromboembolism including the National Institute of Health and Care Excellence guidance (Lim et al, 2018; National Institute of Health and Care Excellence, 2020). It is paramount that, in a patient with a high probability of venous thromboembolism based on a clinical prediction model like the Well's score, a D-dimer assay is not requested unless there is a delay in appropriate imaging. D-dimer tests should never be considered a substitute for a good clinical assessment in these settings. On the other hand, for those patients who have a low clinical probability for venous thromboembolism, a negative D-dimer result (values within normal range) would give added confidence in excluding a thrombus.

D-dimer epidemic during the COVID-19 pandemic

In the biggest pandemic for over a century, D-dimers have become one of the most examined laboratory tests (a search on PubMed using keywords D-dimer and COVID-19 identified

1496 articles in March 2021). In the first months of the pandemic, several investigators were considering differing doses of anticoagulation based on the D-dimer values; prophylactic anticoagulation for those with modestly elevated D-dimer values and higher doses including therapeutic anticoagulation for those who have markedly elevated D-dimer levels (discussed in a debate by Gomez et al, 2021). This practice probably stemmed from the belief that high levels of D-dimers equate to high rates of venous thromboembolism, although such a concept was never established pre-COVID-19 and has not been demonstrated conclusively during the pandemic either. In support of this lack of efficacy in predicting venous thromboembolism, guidelines now recommend against the use of D-dimers for anticoagulant intensification (Moores et al, 2020; Cuker et al, 2021). So, if increased D-dimer levels are not indicating clot burden in patients with severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection, why are they so elevated? COVID-19 is associated with an intense inflammatory response to the virus, usually manifesting as acute lung injury in severe cases (Grasselli et al, 2020). As described above, the intense inflammation that accompanies this infection stimulates extravascular fibrinolysis and thus production of large amounts of D-dimers (Thachil et al, 2021). It is therefore not surprising that D-dimer levels correlate with mortality in these patients since they are a marker of intense inflammation which is causing organ damage, especially acute lung injury (Yao et al, 2020; Zhang et al, 2020).

D-dimer measurement has also been rapidly assimilated into the World Health Organization diagnostic criteria for paediatric multisystem inflammatory disorder with COVID-19 (World Health Organization, 2020), and is recommended as one of the initial investigations in a new presentation. The raised D-dimer level may again be secondary to significant extravascular fibrinolysis. While knowledge is rapidly expanding in this area, without a lack of robust evidence, caution should be applied to interpreting D-dimer levels in this setting. There is a paucity of evidence demonstrating that serial D-dimer measurements provide useful and clinically significant data for management or outcomes.

D-dimer levels as a guide to the duration of therapy

Three D-dimer based prediction scores – The DASH Prediction Score, the Vienna Prediction Model and the HERDOO2 model – have been proposed to guide duration of anticoagulation in patients with unprovoked venous thromboembolism. As an example, the DASH score uses age, gender, hormone use (at onset of venous thromboembolism) and crucially D-dimer level, 1 month after cessation of anticoagulation (Tosetto et al, 2012). It is suggested that a score of 1 or fewer makes a patient 'low risk' and cessation of anticoagulation can be contemplated. Common consensus suggests that a venous thromboembolism recurrence rate of less than 5% per annum is an acceptable level at which cessation of anticoagulation can be considered (Kearon et al, 2010). However, some data suggest that the annual incidence in this 'low risk' group exceeds 5% (Tosetto et al, 2017; MacDonald et al, 2019). Therefore, it is reasonable to conclude that venous thromboembolism recurrence using D-dimer measurement, and subsequent cessation of anticoagulation, should be used with caution, as incidence even in the low risk groups may be unacceptably high.

Might there be benefits from non-specific D-dimer testing?

In the new test-oriented clinical world, D-dimer tests are often requested even before a clinical assessment is made, especially in patients with cardiorespiratory symptoms. This is supposed to make things 'easier' for the patient by avoiding repeat phlebotomy, but this needs reexamination. Since the practice of non-specific requests for D-dimer tests has already become widespread, might there be a silver lining among the dark clouds? In a patient who does have pulmonary embolism as their diagnosis, D-dimer levels correlate with disease severity (Keller et al, 2018). In a study of approximately 160 patients, elevated D-dimer levels correlated with thrombus burden and were predictive for right ventricular dysfunction in normotensive patients (Keller et al, 2018). Another study looked at the predictive value of D-dimer levels for disease severity and survival and found a correlation for higher D-dimer levels with clinical (pulse rate, blood pressure and oxygen saturations

Key points

- D-dimer is a clinically useful measurement, but is often inappropriately sent to investigate 'clot formation'.
- D-dimer levels can increase as a result of intravascular clot fibrinolysis, but also extravascular fibrinolysis.
- Despite D-dimers being a commonly requested test in patients with COVID-19, guidelines now suggest against using this as a measurement to intensify anticoagulation.
- D-dimer levels correlate with clinical severity markers of pulmonary embolism, suggesting there may be some additional benefits to D-dimer testing.

and the need for thrombolysis) and imaging (right-to-left ventricle diameter ratios ≥1), but not with long-term mortality (possibly because of aggressive treatment) (Geissenberger et al, 2019). In patients who do not have venous thromboembolism, a markedly elevated D-dimer level has been suggested to be specific for an underlying malignancy even if a venous thromboembolism had been diagnosed in an otherwise clinically stable patient (Schutte et al, 2016). In this Dutch retrospective cohort study of adult patients with markedly elevated D-dimer levels (>5000 µg/litre), cancer was diagnosed in almost a third of patients if a primary diagnosis of venous thromboembolism was excluded, and the patients had not undergone surgery and did not have trauma or sepsis.

Conclusions

D-dimer tests should only be requested in patients who have a low clinical probability for venous thromboembolism and not in those who have a high likelihood of venous thromboembolism. Elevated levels of this laboratory marker in patients with COVID-19 may be the result of intense inflammation triggered by the virus, in addition to clot breakdown which occurs from the high incidence of venous thromboembolism. D-dimer quantification may be beneficial in patients with pulmonary embolism as a marker of disease severity while its serial testing may prove helpful in monitoring critically ill patients who may run the risk of acute lung injury. Markedly elevated D-dimer levels may suggest the possibility of underlying cancer in those with or without venous thromboembolism. Nicolo Machiavelli once stated: 'All courses of action are risky, so prudence is not in avoiding danger (it's impossible), but calculating risk and acting decisively'. Perhaps this is the mantra we should adopt when deliberating over the utility of the D-dimer measurement.

Author details

[1]Department of Haematology, Manchester University Hospitals, Manchester, UK

[2]Department of Intensive Care Medicine, Manchester University Hospitals, Manchester, UK

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Management of the deteriorating adult patient: does simulation-based education improve patient safety?

Abstract

Failure to recognise the deteriorating patient can cause severe harm and is related to preventable death. Human factors are often identified as contributing factors. Simulation-based education is used to develop clinicians' human factors skills. This article discusses the evidence concerning the efficacy of simulation-based education for improving the recognition and management of the acutely deteriorating adult patient, and the limitations of simulation-based education. Findings demonstrated simulation-based education was the most effective educational method identified for training staff in recognising unwell patients. The evidence demonstrating the impact of simulation-based education on patient outcomes was equivocal. The quality of the evidence was low grade regarding the efficacy of simulation-based education on human factors. Further research is required to confirm the efficacy of simulation-based education for human factors and patient outcomes.

Key words: Education; Healthcare; Preventable incidents; Simulation-based education; Simulation

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Jacqueline Bennion[1]

Stephanie K Mansell[1]

Author details can be found at the end of this article

Correspondence to:
Jacqueline Bennion;
Jacqueline.Bennion@nhs.net

Introduction and background

The World Health Organization (2019) defined patient safety as the prevention of errors and adverse effects to patients. The Healthcare Safety Investigative Branch (2019) reported that failure to recognise the acutely deteriorating patient can cause severe harm and at times preventable death. The increased complexity of care and patient populations presenting with multiple morbidities, as well as the associated economic burden on healthcare systems, have resulted in encumbered health environments. Consequently, healthcare professionals are required to make increasingly complex decisions (World Health Organization, 2019). The National Institute for Health and Care Excellence (2007) developed guidelines to address concerns relating to the acutely deteriorating patient. Furthermore, preventable deaths have been widely investigated and this has been suggested as a measure of rating hospital performance in the UK (Panagioti et al, 2017; Manaseki-Holland et al, 2019).

Between January and March 2020 there were 566 647 patient-related incidents reported in the NHS in England (NHS England and NHS Improvement, 2020). The four main categories highlighted were implementation of care or monitoring (19.2%), patient accident (12.9%), admission, transfer or discharge (11.8%) and medication (9.9%). The majority of incidents occurred in the acute or general hospital setting (72.5%). A systematic review and meta-analysis reported that almost one in 20 patients experienced preventable harm (Panagioti et al, 2017), although the quality of the evidence was low to moderate. Furthermore, the incidencts of preventable deaths have been broadly reported as a result of inconsistencies of definitions, a lack of reporting and a diversity of measures for patient safety (Hogan et al, 2013, 2014; Healthcare Safety Investigative Branch, 2019). In 2005 investigations were carried out over 1 year to identify potential causes and contributing factors of preventable deaths (National Patient Safety Agency, 2007). Findings suggested ineffective non-technical skills (currently termed human factors) such as teamwork, leadership and poor communication, as well as a lack of training and implementation of protocols, were contributing and causal factors (National Patient Safety Agency, 2007).

Since then, multiple partnerships between the Royal College of Physicians, Health Education England, and NHS England and NHS Improvement have prioritised the

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improvement of interprofessional recognition and management of the acutely deteriorating patient. The partnerships have advocated the interprofessional and systemic incorporation of the National Early Warning Score monitoring tool and the situation background assessment and recommendations communication tool (NHS England, 2016; Royal College of Physicians, 2017a).

Simulation-based education is a training modality used to develop clinicians' human factors skills to improve the quality and safety of patient care (Association of Simulated Practice in Healthcare, 2016; Uramatsu et al, 2017). Furthermore, it provides a safe learning environment for participants to explore complex situations and promote healthy reflective practice regarding the making and exploring of errors (Gough et al, 2013). Perceived cost, inconsistencies of outcome measures used, diversity of uni-professional and interprofessional approaches and the quality of evidence may limit the implementation of simulation-based education in training programmes.

Educational strategies such as simulation-based education have been on the healthcare agenda internationally for many years. Early accounts of simulation-based education date back to the 1800s in midwifery education in France and in the 1900s in cardiopulmonary resuscitation training in Norway (Alinier and Platt, 2014). The Association of Simulated Practice in Healthcare (2016) defines simulation-based education as an activity involving any or a combination of role play, full body manikins, task trainers or simulated patients to replicate a specific complex environment. Simulation-based education has been delivered in preregistration training and post-registration training within universities and healthcare trusts. Simulation-based education has also been termed high, moderate or low fidelity simulation throughout the literature. The term fidelity refers to the different dimensions of simulation described such as physical, conceptual, psychological and emotional (Gu et al, 2017). The Association of Simulated Practice in Healthcare (2016) developed the National Standards Framework and Guidance for Simulation-Based Education in Healthcare across the UK. Although these guidelines have been developed to inform quality assurance processes of simulation-based education, they are not obligatory but currently function as a tool to facilitate innovation as highlighted within the framework.

A mixed-methods systematic review analysed the evidence of educational effectiveness in recognition and management of the deteriorating patient as well as the outcome measures used. The results demonstrated simulation-based education was the most effective educational method compared to interactive focus groups, tutorials, lectures, grand rounds, e-learning, seminars, slide presentations, theoretical training days and a 1-hour interactive situation background assessment and recommendations and Modified Early Warning Score training (Connell et al, 2016).

Simulation-based education and human factors training

Teamwork and leadership

There is an association between interprofessional teamwork and quality of patient care (Motola et al, 2013). The Royal College of Physicians (2017b) highlighted that the increasing complexity of healthcare potentially limits effective communication. Following a report on team communication they recommended an interprofessional approach to healthcare and education to maximise resources, performance, job satisfaction and coordination of care. A multiprofessional academic project comprising 95 healthcare students explored whether interprofessional simulation training using scenarios improved healthcare students' knowledge of other healthcare disciplinary roles and skills using simulation-based education (Alinier et al, 2008). Self-reported questionnaires were completed pre-simulation-based education by the control group (45) and post-simulation-based education by the experimental group (50). Findings suggested students' knowledge of the multi-professional roles improved and they were better prepared to enter the healthcare workforce.

Briggs et al (2015) investigated the human factors of 20 interprofessional trauma teams using a crisis resource management model of simulation-based education within a retrospective cohort design study. Performance was measured using the surgeons' framework for non-technical skills and the modified non-technical skills scale. Findings showed a

statistically significant correlation between the team leaders' decision making and critical task (insertion of an endotracheal tube and chest tube placement) completion (r=0.351, *P*=0.039) as well as the team leaders' situational awareness and critical task completion (r=0.412, *P*=0.014). Team performance demonstrated similar findings. Decision making of the team and critical task completion were correlated (r=0.478, *P*=0.004) and a correlation between situational awareness and team performance was identified (r=0.438, *P*=0.008). However, there were no statistically significant relationships between communication, teamwork and leaderships skills and the team leader's completion of critical tasks. Results were similar for these skills and the team's completion of critical tasks. An interesting finding was the statistically significant correlations identified between the team leader and team's situational awareness (r=0.775, *P*=0.001), decision making (r=0.785, *P*=0.001), communication and teamwork (r=0.602, *P*=0.001) and leadership skills (r=0.657, *P*=0.001). However, the interpretation of these findings may be limited by the small sample size in the study. Furthermore, neither of these studies controlled for variables allowing for risk of bias and confounding factors. Nevertheless, these findings do support recommendations for an interprofessional rather than uniprofessional approach. They also provide insight into the potential relationships between the team leader and the team to work together during high stress environments.

Communication and confidence

The Healthcare Safety Investigation Branch (2019) produced an independent report about recognising and responding to critically unwell patients. The report discussed the findings of 31 investigations, 65% of which reported failure to escalate the deteriorating patient. This included failure to initiate appropriate treatment and poor communication. A prospective cohort study compared performance pre vs post-simulation-based education training (Steinemann et al, 2011). This involved groups of interprofessional trauma emergency teams. There was a significant (76%) increase of near-perfect task completion and resuscitation time decreased by 16%. Moreover, results demonstrated a subsequent change in clinical practice, 6 months following training.

A survey study exploring the clinical application of teamwork skills in interprofessional trauma simulation-based education, identified communication and decision making were barriers to teamwork skills (Murphy et al, 2019). Communicating task completion to the team lead was inconsistent and team members often escalated issues to members of the team they knew instead of the appropriate member role. This may be partly explained by the 51.2% of participants who did not feel confident to escalate issues during resuscitation. Although these findings may highlight human factors to include in training programmes, the response rate (37%) was low which may limit the generalisability of results. The Association of Simulated Practice in Healthcare (2016) standards framework and guidance for simulation-based education requires training to result in a significant increase in participants' confidence. However, pre- vs post-simulation-based education clinical application of communication skills and confidence were not measured.

A mixed-methods cohort study investigated the impact of simulation-based education on confidence and human factors of non-respiratory physiotherapists within a local on-call respiratory physiotherapy service (Mansell et al, 2019). Self-reported confidence levels pre- and post-simulation-based education demonstrated a statistically significant difference (*P*=0.034) and large effect size (r=0.57). Although the study was carried out uniprofessionally, thematic analysis demonstrated simulation-based education provided coping strategies for emergency on-call scenarios using cognitive tools such as the situation background assessment and recommendations tool which is used across medical and nursing professions. The interpretation of the quantitative findings is limited to descriptive analysis without a conclusive cause and effect. However, the mixed-methods design incorporating focus groups, provided further meaning to the data collected using thematic analysis. This demonstrated that simulation-based education may support the dissemination of communication tools and protocols into clinical practice to improve the recognition and management of the deteriorating patient.

The evidence suggests there is the potential for simulation-based education to support clinicians to deliver best practice in difficult environments as well as aid the transfer

of knowledge into daily clinical practice. However, generalisability of the evidence is limited because of the variety of approaches, methodologies and diversity of outcome measures used. Nonetheless, these findings provide an awareness of the potential impact of communication skills and confidence upon clinicians' performance in delivering best practice in unpredictable and high stress environments.

Efficacy of simulation-based education and patient outcomes

Gjeraa et al (2014) carried out a systematic review investigating the efficacy of simulation-based education on interprofessional human factors for reaction, learning, behaviour and patient outcomes in trauma team training. They identified that simulation-based education significantly increased team performance but did not improve patient outcomes. The patient outcomes identified included the time taken from arrival in the emergency department to time of assessment, duration of time spent in the emergency department, complication and mortality rates and duration of stay in the intensive care unit and/or in hospital. However, only two out of the 13 included studies measured patient outcomes. All 13 studies were observational design studies. These included two retrospective studies and 11 prospective studies demonstrating a moderate to high risk of bias and none included randomisation. Therefore, the authors suggested the efficacy for simulation-based education improving patient outcomes remains unknown.

Cook et al (2011) completed a systematic review with meta-analysis to summarise the outcomes of simulation-based education for health professionals' education compared with no intervention. Pooled effect sizes demonstrated large effect sizes for knowledge (1.20, 95% confidence interval 1.03–1.16), time skills (1.14, 95% confidence interval 1.03–1.25) and other behaviours (0.81, 95% confidence interval 0.66–0.96). Moderate effect sizes were demonstrated for patient-related outcomes (0.50, 95% confidence interval 0.34–0.66). However, the heterogeneity of the research measured was large (>50%). This may be a result of the diversity of study designs, lack of randomisation and outcome measures.

Connell et al (2016) found the main patient-focused outcome measures used to evaluate the effectiveness of education in recognising and managing the deteriorating patient were patient mortality, intensive care unit admission rates and hospital length of stay. The authors speculated that the effectiveness of these outcome measures specifically related to education were difficult to measure because of the extent of uncontrolled variables. The authors recommended the use of quality patient assessment and documentation as patient outcome measures. Further research is needed to explore the validity of patient-focused outcome measures concerning the effectiveness of simulation-based education.

Limitations of simulation-based education

Faculty and quality of simulation-based education

A multicentre cross-sectional survey explored the implementation of simulation-based education in emergency medicine (Takahashi et al, 2019). Results showed a significant association between the number of faculty members and the quality of implementation for simulation-based education following adjustment of confounding factors (odds ratio 1.33, 95% confidence interval 1.10–1.60). Lack of faculty time (85%), payment (35%) and shortage of faculty members (29%) were identified as perceived barriers for the incorporation of simulation-based education. The authors suggested that a faculty programme was important to ensure the quality of simulation-based education. These findings are in agreement with reflections of faculty members delivering interprofessional simulation-based education for healthcare providers (Watts et al, 2020). The authors suggested that faculty development, an overall needs assessment, curriculum integration, logistical plans, a structured pre-brief and debrief plan and a process evaluation were vital factors for effective implementation of interprofessional simulation-based education. However, the cost to support protected time of faculty members with the relevant expertise is the largest contributed cost of implementing simulation-based education (Watts et al, 2020).

Costs

Reporting of costs has been inconsistent throughout the evidence. A systematic review found that only 6.1% of 967 studies reported any costs concerning simulation-based education (Zendejas et al, 2013). The majority (71%) of studies only reported costs of the mannequin itself. Ten potential cost components such as staff training and facility costs were not reported by the included studies.

A randomised controlled trial compared high and low fidelity simulation and the effect on human factors teaching for medical doctors. Results suggested there were no significant differences between the types of simulator and the outcomes on human factors (Gu et al, 2017). Therefore, this study suggests educators may consider lower cost methods for delivering simulation-based education. However, the study was not double-blinded so observer bias may have occurred. Furthermore, many of the participants had previously completed simulation-based education before the trial which may have influenced outcomes.

The Association of Simulated Practice in Healthcare (2016) emphasised that support for funding by both academic and health organisations is important to ensure the quality of simulation-based education delivery and therefore clinical education. Moreover, the guidance highlights the significance of programme planning to ensure efficient use of resources such as time (Association of Simulated Practice in Healthcare, 2016). However, the guidance does not provide parameters of time for implementation of simulation-based education in clinical training.

Time

Connell et al (2016) completed a systematic review evaluating the effectiveness of a variety of education methods in recognising the deteriorating patient. More than 87% of education methods used simulation-based education. The duration of simulation-based education sessions varied from 44 hours to 40 minutes with a mean of 8 hours. The most effective simulation-based education identified lasted 40 minutes. The 40-minute simulation-based education session was investigated in a UK comparative randomised prospective interventional study (Crofts et al, 2007). Randomisation reduced the risk of bias and the observational design limits inferring causal findings. Therefore, understanding the effectiveness of the 40-minute programme for services to implement simulation-based education in clinical training is unclear. However, controlling for the diverse variables within simulation-based education training challenges the methodological design of this area for research. Moreover, the identified discrepancies for the duration of simulation-based education training sessions may limit service implementation and prioritisation by clinicians who are regularly short of time. Further evidence is required to understand the optimal time commitment for clinicians and educators to improve the implementation of simulation-based education.

Discussion

Appropriate use of human factors such as leadership, teamwork and communication is challenging. This may be a result of the growing demands placed-upon the current health system and increasingly complex decision making required of health professionals. However, continuous professional development of human factors should be a priority, because evidence suggests poor human factors are causal and contributing factors to preventable incidents and deaths concerning the recognition and management of the deteriorating adult hospitalised patient. Evidence has shown simulation-based education is the most effective educational training tool for improving human factors as well as confidence, task performance, adherence to protocols and appropriate team referrals. Furthermore, the most effective simulation-based education demonstrated the shortest implementation time (40 minutes). Simulation-based education provides a safe environment for health professionals to make mistakes at no risk to the patient. Therefore, simulation-based education may contribute to supporting and developing clinicians' human factors for complex decision making in emergency environments. Subsequently, simulation-based education may ensure safer quality care for patients in difficult circumstances. However, the evidence demonstrating the effectiveness of simulation-based education for developing human factors is low grade and

Key points

- Failure to recognise the acutely deteriorating patient can cause severe harm and at times preventable death.
- The highest percentage of reported patient incidents in the NHS occur during implementation of care and monitoring patients in acute general hospitals.
- Human factors are contributory and causal factors for patient-related incidents concerning the recognition and management of the acutely deteriorating patient.
- The evidence suggests there is an association between simulation-based education and the improvement of clinicians' human factors as well as confidence and performance.
- However, the quality of studies identifying the efficacy of simulation-based education and human factors is limited.
- Evidence establishing the effectiveness of simulation-based education and patient outcomes is unclear.
- Future research comprising of generalisable methodologies and validated outcome measures is required to provide conclusive findings of the efficacy of simulation-based education for human factors and patient-focused outcomes.

the impact on patient outcomes and service costs is currently unknown. Varied reporting of time taken for implementation as well as discrepancies between quality assurance standards could explain the inconsistent implementation of simulation-based education across the NHS. Currently there is no conclusive standardisation of simulation-based education. This may be because of the diversity of research methodologies and complexity of knowledge translation into practice.

Conclusions

Further research comprising of robust methodologies is needed to confirm the efficacy of simulation-based education on human factors and patient outcomes. A mixed-methods approach may facilitate an efficient implementation strategy of simulation-based education and determine its value in the training of services and clinicians.

Author details

[1]Therapy Services, Royal Free London NHS Foundation Trust, London, UK

Conflicts of interest

The authors declare that there are no conflicts of interest.

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Efficiency changes in orthopaedic trauma surgery and implications for resource allocation

Abstract

Background/Aims The trauma and orthopaedic surgery department needed to modify practices as a result of the COVID-19 pandemic. This study quantitatively assessed the effects of changes in resource allocation on the efficiency of trauma, specifically the number of operations performed per defined trauma session.

Methods Trauma lists were reviewed pre-COVID, at the peak and at the tail of the first wave of COVID-19 infections at a hospital in the UK. Efficiency was calculated before and after the reallocation of resources and this was defined as the number of cases per trauma session as well as turnaround times for each part of the surgical patient journey.

Results The mean trauma list efficiency was 1.73 cases per session in February 2020 compared to 1.89 in February 2019. It reduced to 1.21 during the COVID peak in April 2020 compared to 1.90 in April 2019 and improved to 1.48 per session in June 2020 vs 1.82 in June 2019.

Conclusions Measures introduced at the start of the pandemic are likely to continue for the foreseeable future. Increased allocation of resources would be needed to allow urgent trauma surgery to provide a timely and efficient service.

Key words: Efficiency; Resource allocation; Trauma lists; Trauma surgery

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Siddharth Virani[1]

Giles Faria[1]

Philip Housden[1]

Author details can be found at the end of this article

Correspondence to:
Siddharth Virani;
siddharth.virani@nhs.net

Introduction

The COVID-19 pandemic has placed unprecedented demand on the entire healthcare system (Haffer et al, 2020). While the majority of elective orthopaedic surgery was halted, urgent orthopaedic trauma procedures continued (Casiraghi et al, 2020). Multiple challenges were encountered, such as reduced operative theatre time and space and reduced staff numbers as a result of symptoms of COVID-19, isolation periods or redeployment to other areas such as the intensive therapy unit.

This quality improvement project measured the trauma activity at the authors' centre throughout the first wave of the COVID-19 pandemic and compared it to previous seasonal activity. It also quantitatively assessed the efficiency of changes to resource allocation for trauma and orthopaedic surgery lists during this period and evaluated the potential impact of these changes going forward.

Methods

This quality improvement project took place at a UK district general hospital. The relevant factors recorded included the mean number of cases per session (4 hours or 240 minutes) and the gross time per case including anaesthetic and turnover time, the number of anaesthetic consultants supporting the lists and theatre space allocation. Trauma cases were subdivided into upper limb, lower limb and spinal cases.

Trauma lists for February (representing pre-COVID-19), April (first peak of COVID-19) and June 2020 (the tail of the first wave of COVID-19) were reviewed. The intervention took place in May 2020 and therefore February and April 2020 were considered as the first cycle and June 2020 was considered as the second cycle of the quality improvement project. Additional trauma lists carried out at nearby independent hospitals under the expanded NHS capacity were also included (UK Government, 2020a), as well as any operations performed on the hospital's emergency list.

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The intervention was centred around changes in resource allocation, specifically, extra anaesthetic consultant support in trauma theatre and extra theatre space provided to increase efficiency. The figures were compared to those from corresponding months for the previous year (2019) to account for seasonal variation.

All data was tabulated in Excel (Microsoft Corp. Redmond WA) and a statistical analysis was performed to determine significance. The project was approved as a quality improvement project by the Trust Clinical Audit Service.

Results

There were 57 trauma surgery sessions in February 2020 which increased to 66 in April 2020 and to 99 in June 2020 as the lockdown was relaxed. The number of sessions in the corresponding periods in 2019 were 55, 61 and 63 respectively (Figure 1).

The mean trauma list efficiency calculated on a case per session basis was 1.73 per session in February 2020 compared to 1.89 in February 2019 which was not statistically significant (P=0.010 assuming 99% confidence intervals) (Student's t-test). It reduced to 1.21 during the COVID peak in April 2020 compared to 1.90 in April 2019 (P<0.001). The mean efficiency improved to 1.48 per session in June 2020 against 1.82 in June 2019 (P<0.001). There was a rebound increase in the number of operations performed in June 2020 which was most pronounced for upper limb fractures (Figures 2 and 3).

About half of all lists in April 2020 were supported by two anaesthetic consultants which was increased to 75% of lists in June 2020 (Figure 4). In the pre-COVID period, almost all trauma was performed in a single theatre with a dedicated team. However, extra theatre space was used in about 20% of sessions during the COVID-19 peak, which was further

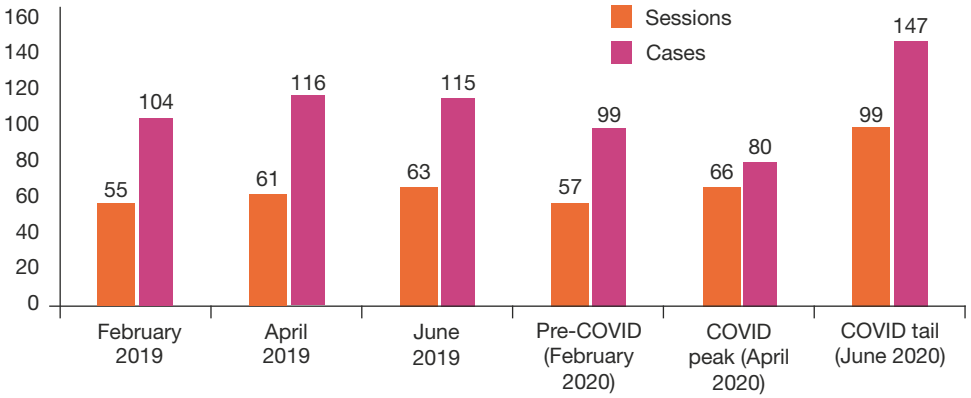

Figure 1. Volume of orthopaedic trauma surgery and the number of sessions required.

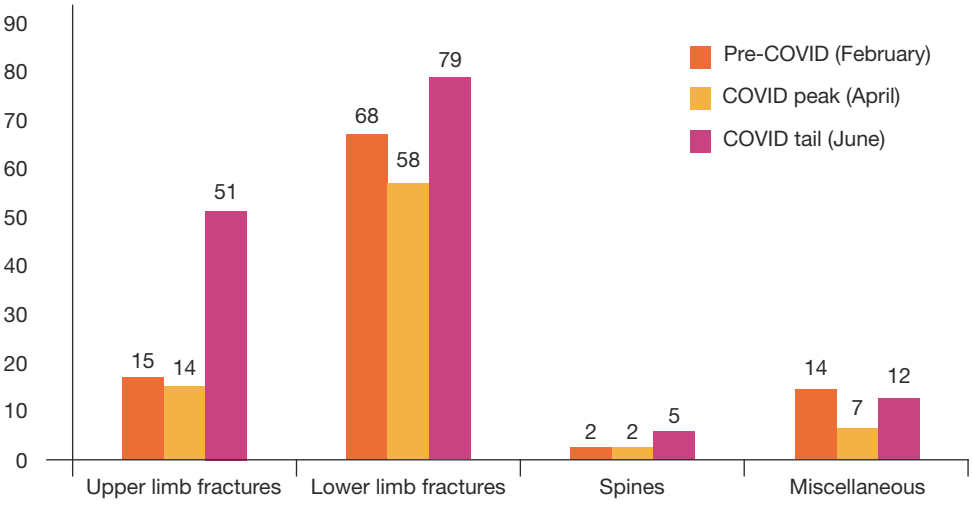

Figure 2. Distribution of trauma cases during the COVID-19 pandemic.

increased to 35% in June 2020 to ensure faster turnover (Figure 5). The mean gross time per case increased by more than 40% during the COVID peak (April 2020) compared to the pre-COVID averages (Figure 6).

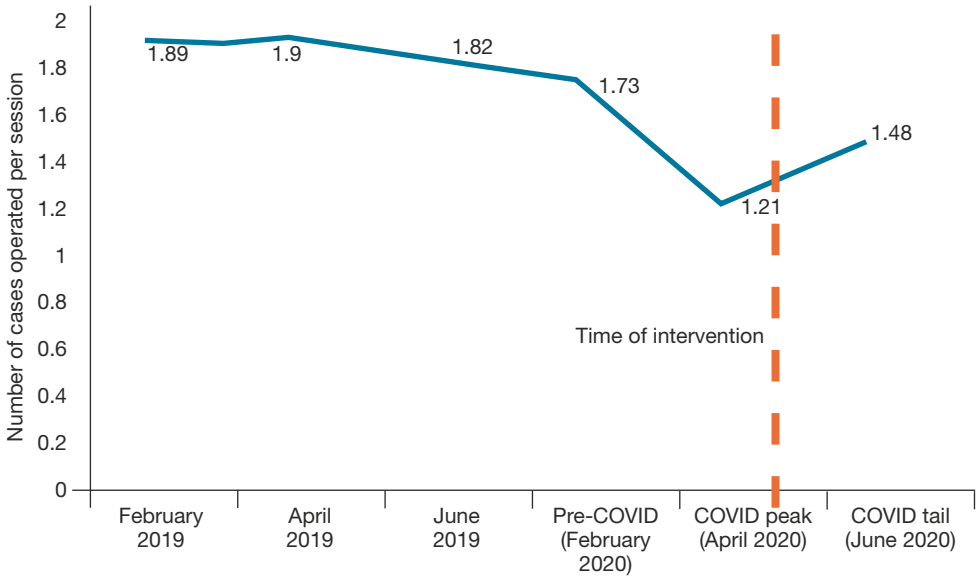

Figure 3. Trauma theatre efficiency quantified as number of cases operated per session.

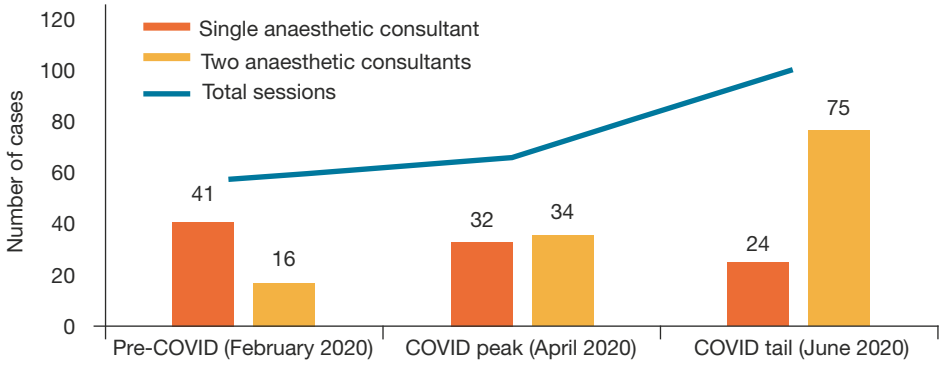

Figure 4. Anaesthetic consultant support to trauma lists.

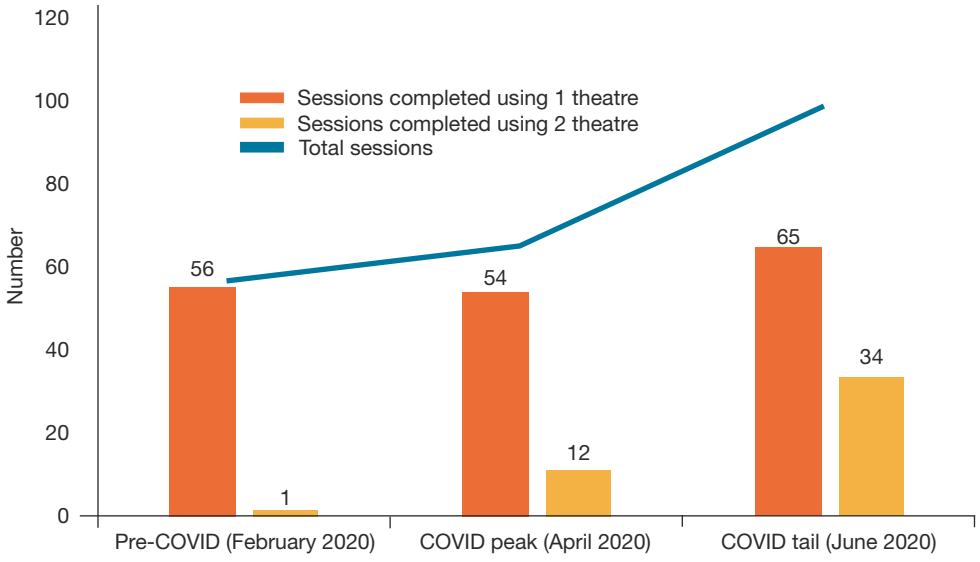

Figure 5. Distribution of the number of operating rooms used for trauma surgery sessions.

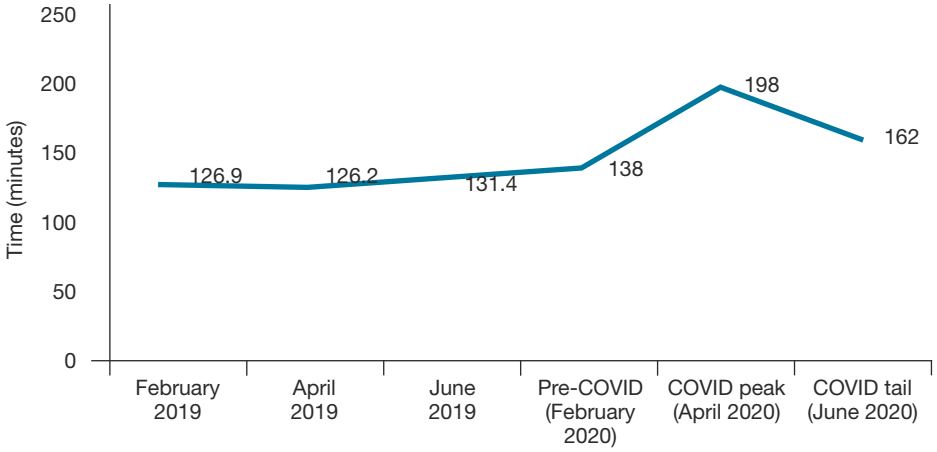

Figure 6. Gross time per operation, including surgical, anaesthetic and turnover time.

Discussion

A total of 335 trauma operations were performed from February–April 2019 while 326 were performed in the same months in 2020 (P=0.48; not statistically significant). Despite the trauma burden reducing during the peak of the pandemic, the efficiency of the remaining lists reduced by about 35%. The authors' trust implemented additional safety protocols based on national guidance (Wielogórska and Ekwobi, 2020) such as a deep clean after every procedure, a lockout period following an aerosol-generating procedure and use of enhanced personal protective equipment. This came with a learning curve for staff. The usual staff and equipment flow into and out of theatre was disrupted with minimum theatre equipment (such as surgical machines and orthopaedic implants) inside the theatre space. Instead they were kept in a 'clean space' outside the theatre, leading to delays when anything unexpected was required during surgery. Moreover, patients were routinely recovered in the operating theatre rather than recovery areas, which led to theatre lists becoming highly inefficient.

The introduction of the interventions led to efficiency increasing to within 80% of pre-COVID levels (Figure 7). The first measure included making a second theatre space available that the surgical, anaesthetic and scrub team could move into while the previous patient was recovered in the first theatre. This reduced delays while only using one team at a time when staffing levels were stretched. The second measure was to deploy a second anaesthetic consultant in about 75% of the lists. This increased efficiency by reducing the turnover time further, allowing the extra theatre space to be used to prepare the next patient as the previous surgery was concluding. If these changes (including extra theatre space and staff) were continued (Figure 8) (Ng et al, 2020), this would likely have an effect on the resumption of elective lists as the extra staff and space are currently drawn from the dormant elective capacity.

In 2015, the financial cost of an operating team in the NHS was calculated as about £800 per session (Chen et al, 2015). The cost of building and equipping an operating room is approximately £1.6 million (UK Government, 2010). The 10-year bond yields in the UK are at historic lows with the government borrowing via GILTS from the Bank of England at rates slashed to 0.1% per annum (UK Government, 2020b; 2020c). Extrapolating this expenditure to the building of an operating room, it would cost a hospital or government about £1600 to finance this loan for a year. This would provide a valuable asset at a very reasonable price. This could provide extra emergency theatre capacity for further COVID-19 peaks or any other extraordinary events that could impact the healthcare system. In times of austerity, it would mean less wear and tear and thereby a longer productive lifespan of these material assets.

The limitations of this quality improvement project include it being performed at a single centre (involvement of multiple centres would better validate the results), retrospective design and small time periods which may limit the generalisability of the outcomes. However, the authors believe that these measures can be adapted for use by other services as well such as emergency general surgery in order to provide extra operating capacity at a time of high demand.

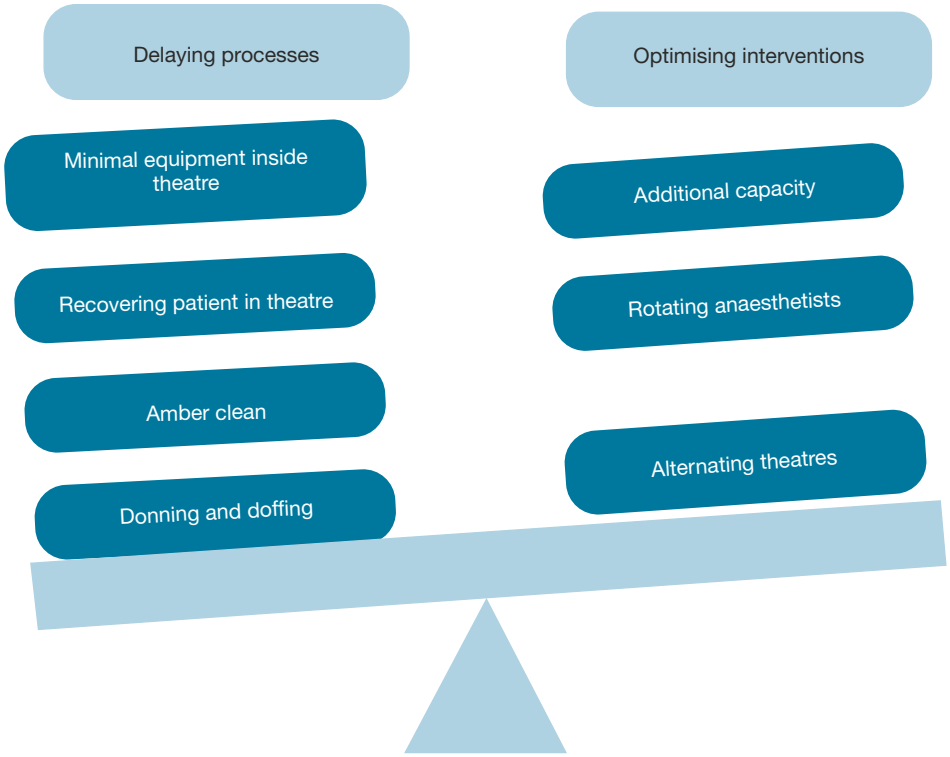

Figure 7. Processes affecting theatre efficiency as a result of the COVID-19 pandemic.

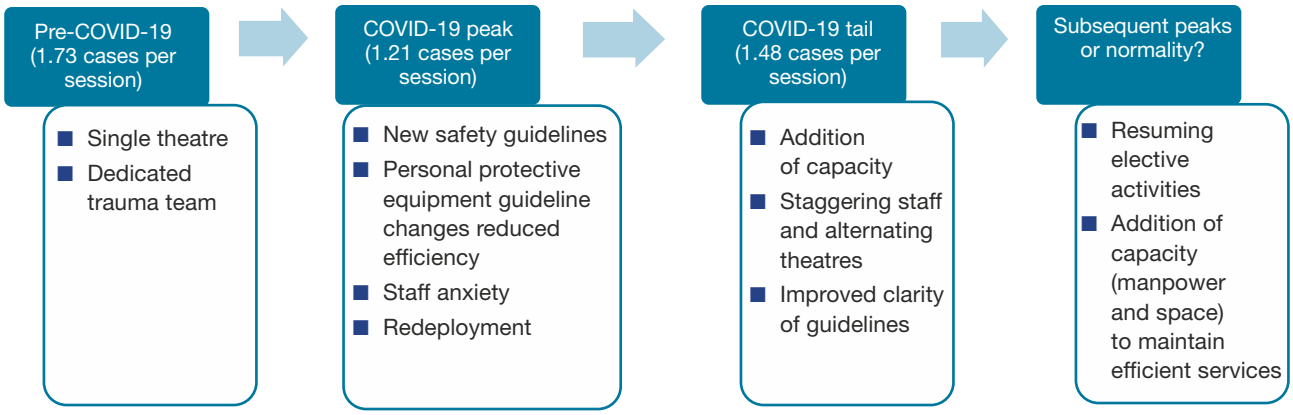

Figure 8. Flow of trauma surgery during the first wave of the COVID-19 pandemic and possible implications for future practice.

Conclusions

Urgent trauma surgery is a vital part of the provision of NHS healthcare. The measures introduced as a result of the COVID-19 pandemic are likely to continue in the foreseeable future, hence for timely trauma surgery to be maintained would require additional time, theatre space and anaesthetic staff. If additional theatre space is not made available, it is likely to impact on the volume of emergency and elective surgery undertaken. The capital cost of building additional theatre capacity is currently low and could represent an area for further exploration.

Author details

[1]Trauma and Orthopaedics, East Kent Hospitals University NHS Foundation Trust, Ashford, UK

Conflicts of interest

The authors declare that they have no conflicts of interest.

Key points

- It has been important for centres to maintain an emergency orthopaedic service during the COVID-19 pandemic to treat urgent cases such as hip fractures and septic joints.
- There have been many challenges to this, such as a reduction in staff and theatre time, as well as disruption to normal operating practices, which have significantly reduced the orthopaedic operating capacity and efficiency during this time.
- This quality improvement project suggests that additional theatre time, theatre space and anaesthetic support would be needed to not only maintain efficiency of trauma lists, but also to allow efficient elective surgery to be undertaken.

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A rare case of isolated laryngeal metastasis 23 years after nephrectomy for clear cell renal carcinoma

Michael J Eastwood[1]
Syed F Ahsan[1]
Richard Harris[1]
Author details can be found at the end of this article
Correspondence to:
Michael J Eastwood;
michael.eastwood@nhs.net

Introduction

Renal cell carcinoma accounts for up to 3% of adult malignancies, with clear cell carcinoma being the most common subtype (Suh et al, 2009). These tumours have a propensity for metastases which may present over two decades after resection of the primary tumour (Babar et al, 2019). Metastasis can present unpredictably, or in unexpected sites. This article presents a rare case of isolated laryngeal metastases 23 years after nephrectomy for clear cell carcinoma.

Discussion

Head and neck metastases occur in up to 15% of renal cell carcinomas, most commonly involving the paranasal sinuses, nose and oral cavity (Pritchyk et al, 2002). The larynx is a rare site of metastases for any cancer, being responsible for just 0.4% of laryngeal tumours (Nicolai et al, 1996).

Literature surrounding metachronous renal cell carcinoma metastases to the larynx is limited to case reports, with dysphagia and dysphonia being the most common presenting symptoms (Miyamoto and Helmus, 1973; Rossini et al, 2004; Mehdi et al, 2012). Previously

Case report

An 84-year-old man presented to the head and neck clinic with a 6-month history of dysphagia to solids and increasingly frequent episodes of choking on food. There was no odynophagia, dysphonia, haemoptysis or weight loss. His past medical history was significant for a benign thyroid cyst, hypertension, glaucoma and ischaemic heart disease that was well controlled despite requiring a coronary artery bypass graft in 2000 and subsequent coronary stenting in 2003. He had also undergone a left nephrectomy for clear cell renal carcinoma in 1997.

Examination of the oropharynx was unremarkable and neck examination identified only a small left thyroid nodule, unchanged from previous reviews. However, fibreoptic nasoendoscopy showed a mass lesion involving the posterior aspect of the right supraglottis and posterior commissure, although the vocal cords appeared healthy and mobile (Figure 1).

Computed tomography and magnetic resonance imaging of the neck confirmed an 18x15 mm soft tissue mass overlying the right arytaenoid cartilage, abutting the posteromedial aspect of the thyroid cartilage with no significant cervical lymphadenopathy (Figure 2).

Panendoscopy was performed identifying only the right supraglottic lesion, which was biopsied. Histology reported a highly vascular tumour with no involvement of overlying squamous mucosa. Cells demonstrated small nuclei and plentiful clear cytoplasm with immunohistochemistry positive for broad spectrum cytokeratin, PAX8 and CD10 and negative for CK7, CK20, p16, s100 and Melan-A. The appearance and immunohistochemistry profile were deemed to be in keeping with a diagnosis of clear cell renal carcinoma metastasis.

As histology identified a metastatic process, a computed tomography scan of the abdomen and pelvis was performed which excluded any intra-abdominal recurrence of renal carcinoma, and subsequent whole-body positron emission tomography–computed tomography identified only the isolated laryngeal metastasis (Figure 3).

Owing to the unusual nature of the tumour, the case was discussed at both the urological and head and neck multidisciplinary team meetings. Given the patient's age and comorbidities, treatment with high dose radiotherapy was initiated.

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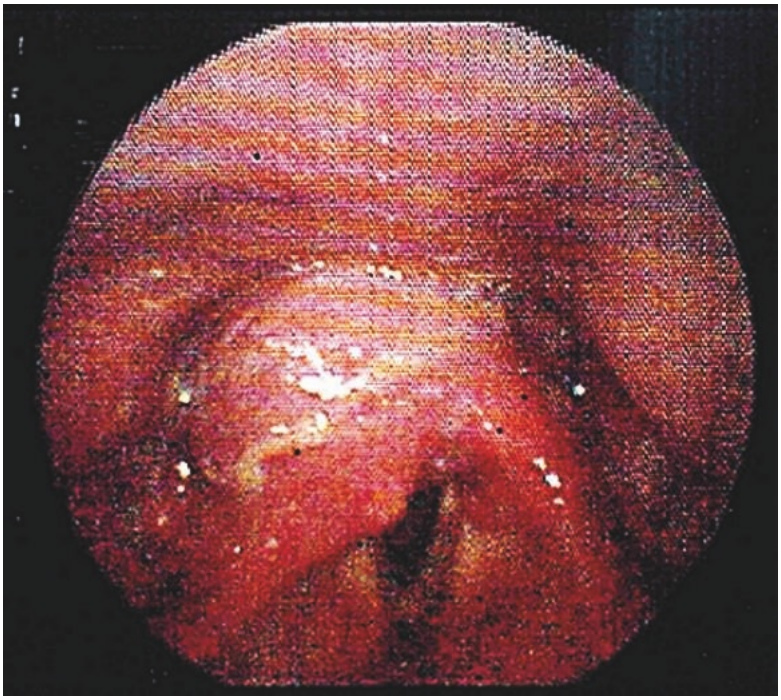

Figure 1. Endoscopic photograph demonstrating lesion of the right posterior supraglottis.

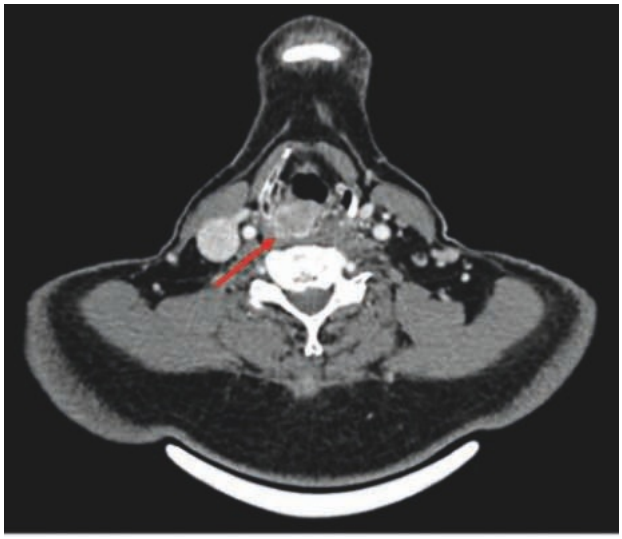

Figure 2. Axial view computed tomography scan demonstrating soft tissue mass overlying the right arytaenoid cartilage (red arrow) abutting thyroid cartilage.

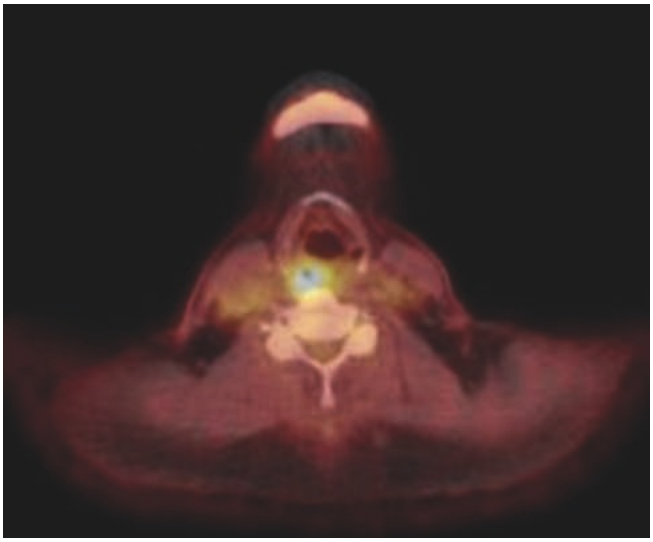

Figure 3. Axial view positron emission tomography–computed tomography demonstrating positron emission tomography-avid soft tissue lesion overlying the right arytaenoid cartilage.

the longest reported interval from nephrectomy to laryngeal metastasis was 17 years (Miyamoto and Helmus, 1973). Management of these patients is often surgical, with local excision favoured in smaller lesions of the vocal cords (Miyamoto and Helmus, 1973; Rossini et al, 2004; Sarkis et al, 2012). Radiotherapy has also been reported in cases where surgery is unsuitable with stable disease or remission reported at 14 months (Demir et al, 2012; Mehdi et al, 2012). This indicates that radiotherapy may be beneficial in selected cases despite renal cell carcinoma being notoriously radioresistant.

The literature does not provide sufficient evidence on the efficacy of these treatments because of the limited numbers and follow up. However, Takagi et al (2020) found that patients undergoing metastasectomy for renal cell carcinoma metastases had a 5-year cancer-specific survival of 82%, indicating that excision of localised disease has positive long-term outcomes.

Learning points

- Renal cell carcinoma may metastasise to rare and unexpected sites.
- Metastases may occur over two decades after nephrectomy.
- Patients with previous renal cell carcinoma who have upper aerodigestive symptoms should undergo prompt endoscopy and imaging regardless of the time interval.

To the authors' knowledge this case represents the longest interval between nephrectomy for renal cell carcinoma and development of laryngeal metastases, highlighting that these lesions may present significantly later than previously documented. As such, clinicians must have a low threshold for endoscopic assessment and imaging in patients with upper aerodigestive tract symptoms with previous renal cell carcinoma to exclude metachronous metastases. Management is complex, but excision of localised disease or radiotherapy in selected cases may be suitable options for disease control.

Author details

[1]Department of Ear Nose and Throat Surgery, Shrewsbury and Telford Hospital NHS Trust, Telford, UK

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Charles Bonnet syndrome in a young adult with diabetic retinopathy

Naashoma Pereira Carvalho[1]

Olajide Fasanya[1]

Sara McNally[1]

Author details can be found at the end of this article

Correspondence to:
Naashoma Pereira Carvalho;
naashoma@gmail.com

Introduction

Charles Bonnet syndrome is defined as complex persistent visual hallucinations occurring in patients with visual pathway pathology in the absence of a mental disorder. The patient has insight and is aware of the unrealistic visions. Charles Bonnet syndrome can occur with lesions located anywhere along the central visual pathway, from the eye to the calcarine fissure (Brucki et al, 2009). This rare condition was first studied by Charles Bonnet, a Swiss clinician, in 1760. Although it can affect people of any age, it is more frequent among older people. This article presents the case of a young adult aged 27 years with a diagnosis of type 1 diabetes and diabetic retinopathy who was referred to the mental health liaison team at the acute general hospital with visual hallucinations. It highlights the importance of considering Charles Bonnet syndrome in any age group with visual pathway pathology.

Discussion

Charles Bonnet syndrome is usually seen in older people, aged 78–85 years (Siddiqui et al, 2016). About 11–15% of people with impaired sight have visual hallucinations. Fewer case reports have described Charles Bonnet syndrome in younger people (Jones and Moosajee, 2020). This may be a result of a lack of awareness among clinicians and difficulty in diagnosis, for example, it may be investigated as schizophrenia or schizoaffective disorder.

Case report

A 27-year-old woman with type 1 diabetes was admitted to the acute hospital with diabetic ketoacidosis which had resolved. She had multiple diabetic complications including diabetic retinopathy. She was blind in the left eye and had 20% vision in the right eye for the last 8 months. Other complications included chronic kidney disease on dialysis, gastroparesis, two previous admissions to the intensive treatment unit for diabetic ketoacidosis and multiorgan failure, and infective endocarditis of the tricuspid valve.

During her admission the patient was noted to be responding to unseen stimuli in the late evenings and was referred to the mental health liaison team. Initially, she was reluctant to disclose her symptoms with the fear that she would be admitted to the mental health unit as she believed she was not mentally unwell.

On further reassurance she reported that she had seen vivid images of young children in Victorian outfits playing around her feet on most evenings for the past 6–8 months. This occurred when she sat in dim light watching television. She was aware they were unreal, and they did not scare her but occasionally irritated her. On other occasions she saw images in keeping with her surroundings, for example she saw street lights and cars on the hospital door which she mistook to be a window. She was not frightened or threatened by the images. She spent most of her time with her partner who talked a lot about cars and her partner's mother who worked with children. The patient wondered if there was a correlation between the images and her conversations.

On examination, she did not have any other psychopathology and had full insight into the visual hallucinations. Her cognition was intact. A computed tomography scan of her head was normal.

Charles Bonnet syndrome was explained to her in detail and she felt reassured. She was advised to do eye exercises, to increase retinal impulses by increasing ambient light and to avoid social isolation.

Unfortunately, she died some months later from medical complications.

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Table 1. Diagnostic criteria for Charles Bonnet syndrome
At least one complex visual hallucination within the past 4 weeks
A period between the first and last hallucination exceeding 4 weeks
Full or partial retention of insight into the unreal nature of the hallucinations
Absence of hallucinations in other sensory modalities
Absence of delusions

adapted from Jan and Del Castillo (2012)

Learning points

- Charles Bonnet syndrome should be considered as a diagnosis in any age group in a person with visual pathway pathology presenting with visual hallucinations.
- Patients with Charles Bonnet syndrome are often reluctant to disclose their symptoms and require reassurance.
- Increased awareness among professionals is important for the diagnosis of Charles Bonnet syndrome.
- Patient education can reduce the psychological burden and improve their ability to cope with the symptoms.

The diagnosis is made when the hallucinations occur in patients with vision loss in the absence of psychosis, delirium or other causes (Table 1).

It was initially thought that the hallucinations resolve within 12–18 months, but hallucinations have been present for 5 years after the onset (Siddiqui et al, 2016).

Charles Bonnet syndrome frequently goes unrecognised in clinical practice as patients fear being labelled 'mentally unstable' and are reluctant to admit their hallucinatory experience. Reassurance and explanation that the hallucinations are benign and do not signify mental illness will have a powerful therapeutic effect (Siddiqui et al, 2016).

Author details

[1]Mental Health Liaison Team, Hertfordshire Partnership NHS University Foundation Trust, Hatfield, UK

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Cerebral salt wasting: a forgotten diagnosis in district general hospitals?

Mohammed K Qayum[1]
Tavlene Banwaith[1]
Ghulam Nawaz[1]
Jayashekara Acharya[1]
Veena Sudarshan[2]

Author details can be found at the end of this article

Correspondence to:
Mohammed K Qayum;
mohammed.qayum@nhs.net

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Introduction

Hyponatraemia is an electrolyte disorder with an incidence of between 4% and 15% among hospitalised patients. In older patients, the most common cause of hyponatraemia is the syndrome of inappropriate antidiuretic hormone secretion. However, cerebral salt wasting is a rare cause of hyponatraemia, accompanied with hypovolaemia and increased urine sodium levels, that is often overlooked in district general hospitals. Cerebral salt wasting is most commonly diagnosed after injury to the CNS so, when making a diagnosis of

Case report

An 81-year-old man presented with a fall and trauma to the head following a syncopal episode. His past medical history consisted of atrial fibrillation, hypothyroidism and prostate cancer (treated 18 years ago with brachytherapy). His drug regimen consisted of rivaroxaban and levothyroxine. Following the fall, new onset confusion and escalating right hip pain led to his admission to the district general hospital via ambulance.

Upon examination, the patient's right leg was externally rotated and shortened. Auscultation of the chest revealed left-sided coarse crepitations. Blood work revealed low sodium level (131 mmol/litre; normal range 135–145 mmol/litre), elevated white cell count (15.7×10^9/litre; normal range $4.0–11.0\times10^9$/litre), raised C-reactive protein level (199 mg/litre; normal range <10 mg/litre) and normal renal function (estimated glomerular filtration rate >90 ml/min/1.73m^2). Chest X-ray was unremarkable. Pelvic X-ray indicated an intertrochanteric fracture of the right femur, while a computed tomography scan of his head showed an 18 mm right cerebellar haemorrhagic focus with adjacent oedema (Figure 1). An electrocardiogram confirmed the previous diagnosis of atrial fibrillation with normal ventricular rate. His blood pressure was stable at 115/95 mmHg. The patient was commenced on intravenous co-amoxiclav to treat a lower respiratory tract infection as inferred by his chest examination findings, and elevated white cell count and C-reactive protein level. He subsequently tested positive for COVID-19. Orthopaedic review was sought for the fracture and external neurosurgical advice suggested withholding rivaroxaban, alongside conservative management of his cerebellar haemorrhage.

On day nine of admission, following a right dynamic hip screw fixation, his blood work deranged with his postoperative sodium level reduced to 128 mmol/litre. His sodium levels decreased further to a low of 124 mmol/litre by day eleven of admission. A postural hypotension-induced syncopal episode led to the initiation of midodrine. Following a geriatric review, a working diagnosis of hyponatraemia secondary to syndrome of inappropriate antidiuretic hormone secretion was proposed, which saw the patient placed on a 1.5 litre/day fluid restriction and commenced on demeclocycline. Despite 8 days of fluid restriction, his sodium levels did not improve and remained at 125 mmol/litre. A specialist opinion from an endocrinologist was sought and the patient's biochemical markers were reviewed with the following results: serum osmolality 261 mOsm/kg, urine osmolality 776 mOsm/kg, urine sodium >60 mmol/litre, thyroid-stimulating hormone 0.8 mU/litre, cortisol levels 640 nmol/litre. In view of his recent intracranial bleed, low sodium of 124 mmol/litre, hypovolaemia and clinical dehydration, the endocrinologist suggested cerebral salt wasting as a likely diagnosis. At this point, intravenous normal saline (0.9% solution) was administered (>3 litres/day), demeclocycline was stopped and the patient was encouraged to eat and drink as normal.

After 2 days of intravenous fluids, the patient's sodium levels increased to 131 mmol/litre. An increase in blood pressure alleviated his postural hypotension, allowing him to undergo physiotherapy and regain his mobility. After 27 days in hospital, the patient was discharged with normal sodium levels and recommended to undergo monthly sodium monitoring by his GP. At follow up, his sodium levels were maintained and magnetic resonance imaging of his head revealed resolution of his cerebral haematoma.

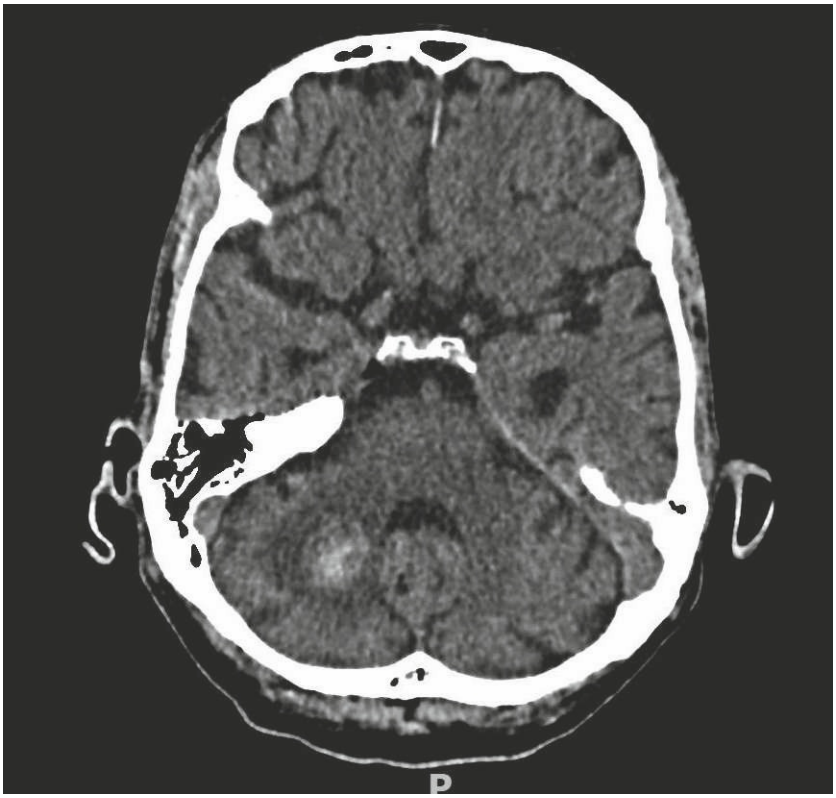

Figure 1. 18 mm right cerebellar haemorrhagic focus with adjacent oedema.

hyponatraemia, it is important to consider whether a patient has experienced a traumatic brain injury, an intracranial bleed or recent neurosurgery. Despite having somewhat similar laboratory results, the management of cerebral salt wasting is in direct contrast to that for syndrome of inappropriate antidiuretic hormone secretion, so reaching the correct diagnosis before treatment is started is essential. This article describes the case of a patient initially diagnosed with syndrome of inappropriate antidiuretic hormone secretion and then correctly diagnosed and treated for cerebral salt wasting with intravenous fluids.

Discussion

Cerebral salt wasting is the result of an insult to the CNS (Tenny and Thorell, 2020). The incidence of cerebral salt wasting is inconsistently reported, but appears rare among the general population (Orlik et al, 2019). The condition is most commonly diagnosed in those experiencing a traumatic brain injury, with a review estimating an incidence ranging from 0.8% to 34.6% within this cohort of patients (Tenny and Thorell, 2020).

Cerebral salt wasting presents with hypovolaemia, low blood sodium levels and normal renal function (Orlik et al, 2019). The correct diagnosis of cerebral salt wasting lies in being able to differentiate it from syndrome of inappropriate antidiuretic hormone secretion (Tenny and Thorell, 2020). The difficulty for physicians is that both conditions cause hyponatraemia, with similar biochemical and physical manifestations (Nakajima et al, 2017), but treatment regimens for these conditions are contradictory as a result of the differing aetiologies. For syndrome of inappropriate antidiuretic hormone secretion, treatment includes fluid restriction, while for cerebral salt wasting, because patients are hypovolaemic, the exact opposite is required (Tenny and Thorell, 2020). Once fluids have been administered, it is essential that the underlying causes of cerebral salt wasting are not exacerbated by this (Tenny and Thorell, 2020).

Centres offering neurosurgery report that cerebral salt wasting is a common occurrence following surgery. A 2015 review of the literature related to cerebral salt wasting found that approximately half of published papers were in neurology or neurosurgery-focused journals (Leonard et al, 2015). The condition is infrequently diagnosed within the district

Learning points

- While cerebral salt wasting is rarely seen in district general hospitals, it is imperative to consider it as a differential diagnosis and to not rule all cases of hyponatraemia as syndrome of inappropriate antidiuretic hormone secretion.
- Given the differing treatment regimens for cerebral salt wasting and syndrome of inappropriate antidiuretic hormone secretion, healthcare workers must be able to accurately diagnose and treat each condition.
- In cases of worsening hyponatraemia, especially after a traumatic brain injury, early endocrine review is key to ensuring appropriate treatment.

general hospital setting and, consequently, is often overlooked as a case of syndrome of inappropriate antidiuretic hormone secretion, as occurred in this case.

To improve the treatment of cerebral salt wasting and subsequent patient outcomes, it imperative that awareness of the condition is increased among healthcare professionals. This is particularly important in district general hospitals where the condition is more likely to be incorrectly diagnosed as syndrome of inappropriate antidiuretic hormone secretion, as a result of its rare nature. Understanding the fundamental difference between cerebral salt wasting and syndrome of inappropriate antidiuretic hormone secretion allows timely diagnosis and appropriate management of patients with each condition.

Author details

[1]Department of Endocrinology, Hereford County Hospital, Hereford, UK

[2]University of Buckingham Medical School, Buckingham, UK

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Interstitial granulomatous dermatitis associated with myelofibrosis

Derrick Phillips[1]
Erma Qazi[1]
Su Enn Low[2]
Nitin Khirwadkar[3]
Kok Ngan[4]

Author details can be found at the end of this article

Correspondence to:
Derrick Phillips;
derrickphillips@nhs.net

A 61-year-old woman presented with an 18-month history of weight loss, night sweats and a non-pruritic rash affecting her face, arms and torso (Figure 1). Her medical history included eczema and psoriasis localised to the hands, valve replacement surgery, hypertension and gastro-oesophageal reflux.

Blood tests revealed mild anaemia, significant lymphopenia and a negative autoimmune panel. A computed tomography scan identified hepatosplenomegaly and mesenteric lymphadenopathy. Haematological investigations confirmed a diagnosis of myelofibrosis, and skin biopsies revealed features consistent with interstitial granulomatous dermatitis (Figure 2).

Interstitial granulomatous dermatitis is a rare inflammatory eruption associated with autoimmune diseases (particularly rheumatoid arthritis), as well as haematological and solid organ malignancies (Cases-Merida et al, 2018). It presents with erythematous, indurated papules and plaques that are symmetrically distributed on the trunk and proximal limbs. The 'rope sign' is characterised by linear cord-like plaques affecting the lateral trunk and is pathognomonic (Kim et al, 2017; Takahashi et al, 2017). To the authors' knowledge, this is the first reported case of interstitial granulomatous dermatitis associated with myelofibrosis in the UK.

Author details

[1]Department of Dermatology, Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK

[2]Department of Histopathology, Whiston Hospital, Rainhill, Prescot, UK

[3]Department of Histopathology, Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK

[4]Department of Dermatology, Whiston Hospital, Rainhill, Prescot, UK

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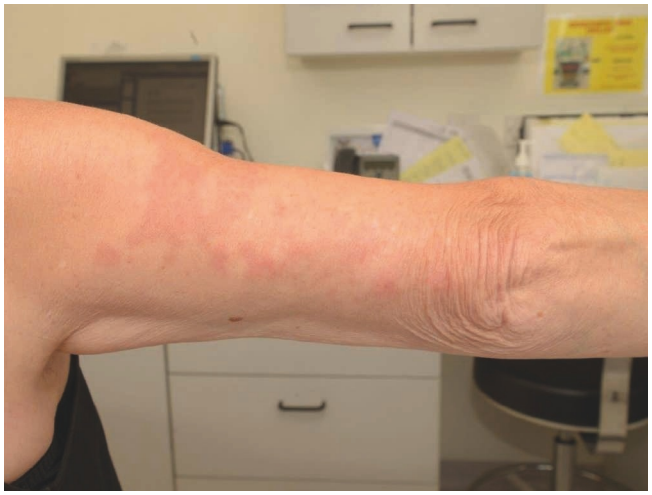

Figure 1. Annular and discoid-looking infiltrative, erythematous plaques suspicious for discoid lupus or Jessner's lymphocytic infiltrate.

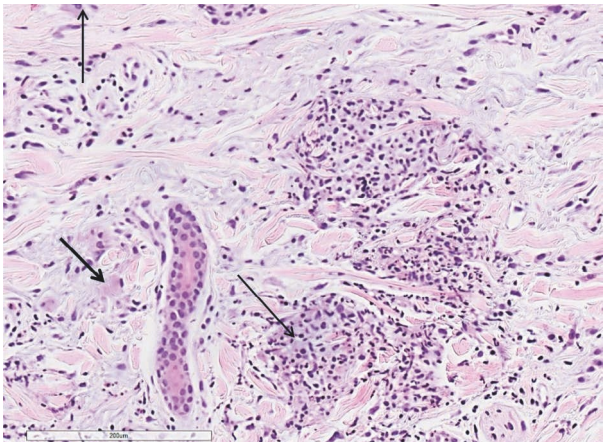

Figure 2. Light microscope image; haematoxylin and eosin stained skin specimen from arm, ×40 magnification. Interstitial histiocytes (black arrows) with admixed polymorphs and focal leukocytoclastic vasculitis, in keeping with interstitial granulomatous dermatitis.

Sir Felix Semon (1849–1921): distinguished laryngologist

This year marks the 100th anniversary of the death of Sir Felix Semon, one of the fathers of modern laryngology.

Harold Ellis[1]

Author details can be found at the end of this article

Correspondence to:
bjhm@markallengroup.com

Felix Semon was born in 1849 in Danzig, Germany, the elder son of Simon Semon, a stockbroker of Berlin. He became a medical student at the University of Heidelberg, but his studies were interrupted by the outbreak of the Franco-Prussian War in 1870. He served as a volunteer infantryman in the Prussian Guard and was awarded the war medal with five clasps.

After the war, he transferred to the Berlin Medical School, where he continued his studies and qualified Doctor of Medicine in 1873. Semon left Berlin because of the persecution he faced as a Jewish man. He was sickened by the anti-Semitism he encountered in Germany and he knew that he had little, if any, chance of promotion if he stayed.

Semon carried out postgraduate surgical studies in Vienna and Paris and then travelled to London at the age of 25 years, with a letter of introduction to the leading laryngologist of the time, Sir Morell Mackenzie, who received him with kindness, and in 1875 appointed him as clinical assistant at the Hospital for Diseases of the Throat at Golden Square, London. Two years later, in 1877, young Semon was elected to the honorary staff of the hospital.

Semon translated Morell Mackenzie's *Diseases of the Throat and Nose* into German and added his own footnotes. He was soon appointed to the consultant staff at St Thomas's Hospital, London, as physician to the throat department; the first laryngologist in the country to be appointed to a general hospital. He was not permitted to operate externally on the throat, and only allowed to operate via the mouth.

For the external approach, the initial experience of laryngo-fissure for carcinoma of the larynx (splitting the larynx and removing the tumour from within the larynx) was disappointing, but better selection of patients (choosing those cases of tumour confined to the vocal cord) led to improved results.

In 1887, Semon was appointed laryngologist to the National Hospital for Nervous Diseases Queen's Square, where Victor Horsley had been appointed surgeon a year earlier. Semon shared with him an interest in the thyroid gland and they proposed that cretinism, myxoedema and post-thyroidectomy cachexia were all the consequences of thyroid gland deficiency.

Semon put this concept forward at a meeting of the Clinical Society of London in November 1883. At the time his thesis was the subject of ridicule. However, the following month the Clinical Society appointed a committee to investigate this problem. Semon's colleague, Victor Horsley, was co-opted to this group. He carried out experimental thyroidectomies in monkeys and other animals and demonstrated that the clinical conditions could be reproduced in experimental animals. Felix Semon did much to disseminate knowledge on the science and art of laryngology. In 1893, he helped found the Laryngological Society of London and served as its President from 1894 to 1896. He founded *The International Journal for Laryngology and Rhinology* in 1894 and served as its editor for no less than 25 years.

Semon received numerous decorations during his career. At Queen Victoria's Diamond Jubilee in 1897 he was knighted. In 1901 he was appointed Physician to King Edward VII and, in the same year, became a naturalised British subject. This was followed, in 1905, by his being appointed Knight Commander of the Victorian Order.

Semon was a man with quite exceptional social gifts; he seemed to excel at anything he turned his hand to. He was a fine pianist and composer; at the end of the Franco-Prussian

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War, his regiment entered Berlin to the strains of the Victory March he had composed when encamped with his regiment outside Paris.

In 1911, at the zenith of his professional career, Semon retired. He spent his time writing his autobiography. The years of the First Great War, 1914–18, were especially unhappy and difficult for him. He was eventually more or less forced to publish a condemnation of his country of birth in *The Times*. He died of heart failure at his home and was buried in Golder's Green cemetery.

A truly remarkable man.

Author details

[1]c/o British Journal of Hospital Medicine, London, UK

Is DrEaMing (drinking, eating and mobilising) the dream?

The idea of patients drinking, eating and mobilising (DrEaMing) at 24 hours postoperatively is being used as a marker of functional recovery. This marker of recovery and quality is explored in this article.

Arun Sahni[1,2]

Author details can be found at the end of this article

Correspondence to:
Arun Sahni;
ArunSahni@nhs.net

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The traditional model of postoperative recovery has been characterised by intravenous fluids, catheters, bed rest and immobility for patients, in turn leading to prolonged hospital stays and associated adverse events, such as venous thromboembolism.

Enhanced recovery after surgery is a multidisciplinary, multimodal approach to the perioperative care of patients. When first described in 1995, it reduced the length of stay after major colonic surgery from 5 days to between 2 and 3 days (Bardram et al, 1995). Over the last 26 years enhanced recovery after surgery pathways have been adopted for a multitude of different surgical procedures, generally resulting in reduced length of stay, reduced postoperative complications and a lower cost of delivery of care (Kehlet, 2020). However, these programmes tend to focus on surgical outcomes such as length of stay rather than recovery from the patient's own point of view. In part, this has led to the focus on postoperative drinking, eating and mobilising (DrEaMing) as a measure of functional recovery.

What is the DrEaM?

The idea of DrEaMing was first introduced by an international initiative as part of 'The CHEERS-DREAM' campaign with the aim of restoring a fluid and nutritional state to assist in a functional recovery (Levy et al, 2016). If a patient is drinking, eating and mobilising after major surgery it means that they are likely to have adequate analgesia, hydration and cardiorespiratory function, thereby they are on the road to functional recovery.

DrEaMing is a patient-centred measure of outcome, which has led to its adoption as a marker of quality by the American Society for Enhanced Recovery and Perioperative Quality Initiative (Moonesinghe et al, 2017). Furthermore in the UK, the Perioperative Quality Improvement Programme (2018) had patients DrEaMing at 24 hours postoperatively as one of its top five improvement opportunities. The Perioperative Quality Improvement Programme found that, in 2018, 53% of the patients enrolled in the programme were DrEaMing (Perioperative Quality Improvement Programme, 2018) at 24 hours. This improved in 2019 within all recruiting surgical specialties except head and neck surgery (Perioperative Quality Improvement Programme, 2019).

When does DrEaMing not work?

Despite DrEaMing appearing to be a good marker of quality, there are still some important points which should be taken into consideration. First, DrEaMing does not fully indicate functional recovery; for example it does not necessarily indicate recovery of neurocognitive function. Postoperative cognitive decline is associated with increased morbidity and mortality (White et al, 2019). Second, DrEaMing at 24 hours postoperatively is not always feasible after certain surgical procedures, such as oesophagectomies. In patients undergoing major upper gastrointestinal surgery the Perioperative Quality Improvement Programme (2019) found that less than 20% of those recruited were DrEaMing at 24 hours. Third, there is the hypothesis that patients DrEaMing at postoperative hour 24 is a good marker of quality and good enhanced recovery (Moonesinghe et al, 2017). However, the result of studies examining if early DrEaMing is beneficial are yet to be published. If it is the case that

early (operative procedure-specific) DrEaMing is beneficial perioperative care pathways will need to change to encourage early DrEaMing.

Conclusions

DrEaMing is currently being used as a patient-centred marker of quality in the perioperative period, on the presumption that the ability to drink, eat and mobilise is an indicator of functional recovery. However DrEaMing at postoperative hour 24 has not yet been validated as either a marker of quality or recovery. As such it is not currently able to replace other validated systems.

Author details

[1]Department of Anaesthesia, Royal Marsden Hospital, London, UK

[2]Barts & The London School of Anaesthesia, London, UK

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Should central venous catheters be routinely replaced in adults?

Central venous catheters are sited for a variety of reasons in the adult critically ill patient. There is clear guidance for indications and maintenance of central venous catheters, but there is no clear guidance on how long a central venous catheter should remain in situ. This article looks at evidence to answer this question.

Priti Morzaria[1]

Coralie Carle[1]

Author details can be found at the end of this article

Correspondence to:
Priti Morzaria;
priti.morzaria@nhs.net

Central venous catheters are sited in the critically ill patient for a variety of reasons, including invasive monitoring, administration of drugs requiring a central vein, total parental nutrition, and difficult peripheral venous access. Central venous access can be achieved either by inserting a catheter directly into a central vein or via a peripherally inserted central catheter. Current National Institute for Health and Care Excellence (2002) recommendations state that the central venous catheter should be reviewed daily for both signs of infection and for the ongoing need of central venous access. However, there is no clear guidance on how long a central venous catheter should remain in situ. It is unclear whether these should be routinely replaced or replaced only when clinically indicated.

Indications for removal of central venous catheters

Clear indications that a central venous catheter needs to be removed or replaced include blocked lumen, suspected or confirmed sepsis related to the catheter, evidence of infection or inflammation at the insertion site, thrombosis, or that central access is no longer required (Smith and Nolan, 2013).

Central venous catheter-related infections arise from different mechanisms: infection at the insertion site and migration of the microbe on the external surface of the catheter, infection of the catheter port causing intraluminal catheter colonisation, and seeding of the catheter from systemic infections. Catheter-related bloodstream infections are associated with increased morbidity and mortality, as well as a prolonged length of critical care and hospital stay (Smith and Nolan, 2013).

Meticulous insertion and care of the central venous catheter is essential to reduce the risk of infection. Techniques used include strict asepsis during insertion, avoiding the femoral route of insertion, daily inspection of the catheter and insertion site, daily dressing changes, and daily re-determining of the clinical indication for the central venous catheter (Bion et al, 2013).

A central venous catheter can be replaced via guidewire exchange or use of a different site. If a site is infected, a new site must be selected. If a patient has a systemic infection and the risk of mechanical complication is high, then changing the central venous catheter over a guidewire may be considered.

Central venous catheters should be routinely replaced

Central venous catheters may be routinely replaced in an attempt to prevent associated infectious complications. The longer a central venous catheter is in place, the higher the risk of colonisation and the associated risk of catheter-related bloodstream infections. A study by Ullman et al (1990) recommended routine replacement of central venous catheter at 7 days. They revealed a sequential relationship between colonisation of the central venous catheter and the onset of sepsis. Sepsis had been caused by the same organism(s) that were cultured from the central venous catheter lumen and tips in the preceding days. Catheter-related bloodstream infections remain low in the first 3–4 days after insertion,

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but after this time it is probable that the risk remains the same, although cumulatively the incidence rises over time (Fletcher, 2005). This suggests that early replacement would likely avoid catheter-related bloodstream infections.

Central venous catheters should not be routinely replaced

The risks associated with central venous catheter insertion must be considered when replacing them purely based upon the duration since insertion. The risks of central venous catheter insertion include arterial puncture and/or inadvertent intra-arterial placement of catheter, pneumothorax, arrhythmias from malposition of the catheter tip, thoracic duct injury, cardiac tamponade, air embolism and wire embolism (Smith and Nolan, 2013). Some of these risks, particularly inadvertent arterial puncture or intra-arterial placement of the catheter, can be mitigated by using ultrasound for insertion. Failure rates for central venous catheter insertion are as high as 35% using the landmark technique (National Institute for Health and Care Excellence, 2002). Using safety checklists for insertion can also reduce complications like wire embolisation by ensuring the wire has been removed. One indication for removing a central venous catheter is a suspected catheter-related bloodstream infection in the sick patient. However, 80% of catheters removed on the basis of fever with or without a leucocytosis alone will be sterile. Therefore, routinely changing central venous catheters for this reason increases the risk of mechanical and thromboembolic complications (Fletcher, 2005) and reduces the number of available sites for future central venous catheters, as well as being unpleasant for the unsedated patient, who is fully awake for this procedure. Routinely replacing central venous catheters also has resource implications (both staffing and equipment) for the critical care unit.

Conclusions

The decision to routinely replace central venous catheters comes down to a balance between the risk of the mechanical and thromboembolic complications of insertion vs the increasing risk of infection with the longer duration of insertion. Having reviewed the evidence, the authors recommend that central venous catheters should be changed based on clinical need, rather than after a predetermined number of days. This requires a meticulous approach to both the insertion and the ongoing care of the catheter, highlighting the importance of central venous catheter care bundles. It may also be worth considering use of a peripherally inserted central catheter line in certain patients, which gives access to a central vein but with fewer mechanical complications.

Author details

[1]Department of Anaesthesia and Critical Care Medicine, Peterborough City Hospital, North West Anglia NHS Foundation Trust, Peterborough, Cambridgeshire, UK

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