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Abdominal aortic aneurysm repair in the United Kingdom: an exemplar for the role of anaesthetists in perioperative medicine

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Abstract

The past two decades have seen an increasing recognition that the delivery of safe surgery with low complication rates and good long-term outcomes is a team endeavour embracing the whole patient care pathway. The key role of the anaesthetist in managing the patient through the surgical process is widely understood and has driven the emergence of perioperative medicine. In parallel with these developments there has been a sea change in the organisation of the care of patients presenting for elective abdominal aortic aneurysm (AAA) repair. Data from the 2008 report of the VASCUNET vascular registry suggested that the UK had the highest mortality for elective open AAA repair in Europe (7.9%). In response, a national quality improvement programme (AAAQIP) spanning the disciplines of surgery, anaesthesia, radiology and nursing was put in place. This led to significant changes in all aspects of AAA repair including the role of the anaesthetist. Preoperative assessment by an anaesthetist with a vascular practice was mandated and the role of the anaesthetist in the vascular multidisciplinary team meeting (MDT) established. Anaesthetic data were included in the national data collection system for vascular surgery, the National Vascular Registry. These changes paralleled and in some cases led the wider evolution of the role of the anaesthetist in perioperative medicine. The mortality from infrarenal AAA repair in the UK decreased to 2.4% by 2012. This improvement reflects changes in perioperative care supported and in some cases led by anaesthetists.

Key words: Abdominal aortic aneurysm; quality improvement

> *'I have always looked upon extensive disease of the heart as a contra-indication, to a certain extent, of inhalation, and have expressed opinions to that effect.'*
>
> John Snow 1848

John Snow, as one of the founding fathers of anaesthesia, recognised the impact of co-existing disease on surgical outcome.[1] In the century and a half since Snow wrote on cardiac disease the role of the anaesthetist has been transformed and is now understood to be integral to the delivery of high-quality safe surgical care. The development of anaesthesia has seen the expansion of the work of the anaesthetist beyond the confines of the operating theatre to the pre-assessment clinic, the ward and the critical care unit. This change has accelerated in the past 15 yr with the advent of Enhanced Recovery After Surgery (ERAS) programmes and the recognition of the discipline of perioperative medicine.

In many ways the evolution of perioperative care in non-cardiac surgery has been led by changes in the care of patients undergoing cardiac surgery, where the *Fast Track* approach of bundling perioperative treatments produced significant differences in postoperative intensive care unit length of stay.[2] Effective quality improvement rests on the systematic implementation of change and the measurement of effect of this change. A bundle is a set of evidence-based practices

(usually three to five) that are implemented together to support systematic rather than haphazard change in care.[3] This strategy was applied to colorectal surgery and found to reduce postoperative morbidity and length of stay.[2 4 5] The success of these initial studies led to the development of ERAS programmes.

An integrated approach to perioperative care lies at the core of ERAS. It is a package of care that begins before admission and encompasses preoperative, intraoperative and postoperative care. There is evidence to support 24 elements of ERAS.[5] Many of these fall into the sphere of anaesthetic care including preoperative assessment and optimisation, preoperative fasting and nutrition, perioperative fluid management, and multimodal pain control.

Whilst enhanced recovery has ushered in the delivery of standardized evidence based perioperative care there remains much work to be done on the implementation of ERAS. Uptake is variable and has to be tailored to individual systems and settings.[6] Nevertheless, the next logical steps in the evolution of perioperative care are being taken. Standardized care improves outcomes so long as it is recognised that people are individuals and may vary in their needs. Surgical care systems should be able to deliver management that eliminates inappropriate variation whilst at the same time modifying care where necessary. This may involve prehospital interventions to address comorbidities and frailty, modifications to the surgical and anaesthetic plans to manage comorbidity (e.g. use of carbon dioxide rather than contrast angiography in renal impairment), modifying the planned level of postoperative care in higher risk patients, and early discharge planning for frail or vulnerable patients.[7 8]

Anaesthetists are uniquely equipped to coordinate the delivery of sophisticated individualised care. It is essential for patients that the specialty of anaesthesia evolves to embrace the whole surgical care pathway. In 2012 Grocott and Pearse[9] made a strong case for formal recognition of the role of anaesthesia in preoperative and postoperative care both for the good of the specialty and, most importantly, for the good of patients.[9] They emphasised the importance of integrated care across the whole surgical episode and the role of the anaesthetist in delivering it stating:

> *'The aim of perioperative medicine is to deliver the best possible pre-, intra- and postoperative care to meet the needs of patients undergoing major surgery.[1 2] This will be achieved through refining existing care pathways and by developing new pathways where current approaches are not fit for purpose.'*

In 2015 the Royal College of Anaesthetists launched its Perioperative Medicine Programme. Again this focuses on the delivery of integrated care across the journey taken by the surgical patient. It recognizes the key role of the anaesthetist in improving perioperative care.[10]

The concept of the Perioperative Surgical Home (PSH) has brought a similar focus on the whole surgical episode to practice in the USA. As with the model of care promulgated by the Royal College of Anaesthetists, the PSH model reaches beyond enhanced recovery and emphasises co-ordination of care from the decision to operate until 30 days after discharge.[11]

The challenge of mortality in abdominal aortic aneurysm repair

Elective abdominal aortic aneurysm (AAA) repair is a prophylactic operation performed to prevent death from aneurysm rupture and catastrophic haemorrhage. Because of the risks of operating on the aorta and the burden of comorbidity in this group, patients with AAA are at particular risk of intraoperative and postoperative complications. Options for AAA repair include open surgery and endovascular aortic stenting (EVAR). Open repair is associated with a significant immediate risk of death and major complications. EVAR carries a lesser but still significant risk of complications and may not achieve definitive aneurysm repair, with a significant proportion of patients developing a leak around the aortic stent (endoleak).[12 13] The risk of aortic rupture increases with increasing aortic diameter and the decision to offer aneurysm repair is informed by the risk benefit balance of intervention *vs* conservative management.[14]

Ten years ago most United Kingdom (UK) doctors working in vascular surgery believed that the care provided in the UK for AAA patients was as good as any in the world. Ljungquist and colleagues[5] suggest that health care professionals tend to believe that their outcomes are better than is really the case. There is no doubt that in a low volume high risk service it can be difficult to recognise fluctuations in the quality of care.[15] In 2008 a report prompted questions regarding the quality of care of AAA patients across the UK.[16] After an initial response of shock and disbelief the response to this report was a model of quality improvement in healthcare. One of pillars of this was a systematic approach supporting changes in the patient pathway from referral to discharge in individual vascular units that is an exemplar of the application of the principles of perioperative medicine.

In 2008, VASCUNET, the international audit run by the European Society for Vascular Surgery, reported outcomes from vascular surgery across eight European Countries, Australia and New Zealand. This showed mortality from open aortic aneurysm repair in the UK in the period 1994 to 2006 to be the highest in Europe at 7.9% as against an international average of 3.5%.[16] These data were supported by a number of studies including the Vascular Anaesthesia Society of Great Britain and Ireland (VASGBI) audit of outcome from elective abdominal aortic aneurysm repair in the UK and Ireland. This reported an overall mortality of 7.3% in a population of 933 patients drawn from 177 hospitals over three months.[17] A subsequent analysis of VASCUNET data for nine countries for the period 2005–2009 demonstrates the differences between nations in more detail. Table 1 details differences in mortality rates between countries for intact and ruptured AAA.[18] During the period studied, which differed from that of the VASCUNET report, the overall mortality across all countries for elective repair of AAA (intact AAA) was 2.8% (95% CI 2.6–3.0%) as compared with 4.0 (3.6–4.4%) in the UK. This analysis also identified an increase in the use of EVAR over the period studied. The overall rate of EVAR across all countries increased from 27.5% (25.9–29.1%) in 2005 to 53.4% (52.3–54.6%) in 2009. A similar trend was seen in the UK with an increase from 20.2% (16.6 –24.4%) to 48.5% (46.7–50.3%). Perioperative mortality rates (30 day mortality in some countries and in-hospital mortality in others) were lower with EVAR than open repair with sex differences in outcome for both modalities of repair. In the full dataset for all countries mortality after EVAR was 1.3% (1.1–1.5%) for men and 2.4% (1.7–3.3%) for women. For open repair the mortality for the same period was 3.4% (3.1–3.7%) for men and 4.5% (3.8–5.4%) for women. This analysis also presents comparative data for outcome from ruptured AAA. Overall there was a statistically significant decrease in mortality from ruptured AAA over time from 32.8% (30.0–35.7%) in 2005 to 28.6% (26.4–30.9%) in 2009. The data for the UK were encouraging, with a decrease in mortality from 42.5% (34.9–50.4%) in 2005 to 28.6% (25.2–32.0%) in 2009. It is suggested that this improvement in mortality reflects the increased

Table 1 Rate of perioperative mortality by country and over time for intact and ruptured AAA repair. (Reproduced with permission from reference)[18] *In-hospital mortality. †30-day mortality

		2005	2006	2007	2008	2009	2005–2009	P-value for trend
Intact AAA Repair								
	Overall	3.4 (2.8;4.1)	3.0 (2.4;3.6)	2.5 (2.2;2.9)	2.9 (2.6;3.3)	2.5 (2.2;2.9)	2.8 (2.6;3.0)	0.064
	Australia*	2.4 (1.3;4.4)	2.6 (1.4;4.8)	3.5 (2.0;6.2)	1.6 (0.8;3.3)	2.0 (1.0;4.2)	2.4 (1.8;3.2)	0.507
	Denmark†	3.1 (1.9;5.2)	3.9 (2.6;6.0)	2.8 (1.7;4.7)	3.0 (1.8;4.9)	3.6 (2.3;5.5)	3.3 (2.7;4.1)	0.974
	Finland†	–	–	3.3 (1.1;9.3)	3.9 (1.5;9.7)	5.0 (2.1;11.1)	4.1 (2.4;7.0)	0.571
	Hungary*	–	–	–	1.2 (0.3;4.4)	4.7 (2.0;10.5)	2.6 (1.3;5.3)	0.084
	Italy†	–	–	1.4 (1.1;1.9)	1.5 (1.2;2.0)	1.8 (1.3;2.3)	1.6 (1.3;1.8)	0.295
	Norway*	2.6 (1.7;4.1)	1.7 (0.9;2.9)	2.7 (1.7;4.2)	3.0 (1.9;4.7)	–	2.5 (1.9;3.1)	0.421
	Sweden†	3.6 (2.5;5.2)	2.3 (1.4;3.6)	2.0 (1.2;3.2)	3.0 (2.0;4.3)	2.4 (1.6;3.6)	2.6 (2.2;3.2)	0.436
	Switzerland*	2.0 (0.9;4.4)	2.1 (1.0;4.2)	5.7 (3.4;9.4)	3.6 (2.1;6.2)	–	3.2 (2.4;4.4)	0.086
	United Kingdom*	5.5 (3.9;7.7)	5.4 (3.8;7.5)	4.4 (3.4;5.6)	4.3 (3.7;5.1)	3.0 (2.4;3.6)	4.0 (3.6;4.4)	<0.001
Ruptured AAA Repair								
	Overall	32.8 (30.0;35.7)	35.5 (32.4;38.6)	31.4 (29.2;33.8)	31.9 (29.8;34.0)	28.6 (26.4;30.9)	31.6 (30.6;32.8)	0.004
	Australia*	30.7 (21.4;41.8)	29.7 (20.5;40.9)	35.7 (24.5;48.8)	30.9 (21.9;41.6)	35.4 (23.4;49.6)	32.0 (27.3;37.2)	0.608
	Denmark†	36.3 (30.6;42.4)	39.6 (33.2;46.4)	34.9 (28.5;41.8)	32.5 (26.3;39.3)	32.7 (26.0;40.2)	35.4 (32.5;38.4)	0.197
	Finland†	–	–	28.6 (17.8;42.4)	25.0 (14.2;40.2)	31.7 (19.6;47.0)	29.0 (21.9;37.3)	0.982
	Hungary*	–	–	–	42.9 (24.5;63.5)	33.3 (17.2;54.6)	38.1 (25.0;53.2)	0.525
	Italy†	–	–	27.0 (22.7;31.8)	26.1 (21.8;30.9)	29.4 (24.4;35.0)	27.4 (24.7;30.2)	0.529
	Norway*	18.2 (13.2;24.7)	30.0 (21.9;39.6)	33.0 (27.0;39.6)	38.8 (28.0;50.8)	–	28.6 (24.9;32.5)	<0.001
	Sweden†	30.0 (25.0;35.4)	33.8 (28.8;39.2)	25.7 (21.1;30.9)	28.3 (23.5;33.7)	23.9 (19.4;28.9)	28.3 (26.1;30.7)	0.029
	Switzerland*	47.2 (36.1;58.6)	34.9 (24.3;47.2)	44.2 (31.6;57.7)	30.2 (20.2;42.4)	–	39.2 (33.4;45.4)	0.101
	United Kingdom*	42.5 (34.9;50.4)	39.4 (32.4;46.9)	36.4 (31.3;41.9)	35.5 (32.2;39.0)	28.5 (25.2;32.0)	34.2 (32.2;36.2)	<0.001

use of EVAR for rupture. However, this is not consistent with the results of the IMPROVE trial, which was published after this work and which showed no difference in mortality between open and endovascular repair in ruptured AAA.[19]

The VASCUNET findings were published at a time when the UK was implementing a national screening programme for AAA.[20] The programme aims to screen males over 65 yr. Men with small aneurysms (3–5.4 cm diameter) are offered regular surveillance. Those with aneurysms 5.5 cm or greater in diameter are referred to a vascular surgeon for consideration for AAA repair. The statistical and population modeling justifying the programme assumes the safe treatment of screen detected aneurysms. Alongside the over-riding concerns about excess mortality, the findings of VASCUNET had the potential to invalidate the National Screening Programme. One of the key pillars supporting the UK abdominal aortic aneurysm screening programme is the UK Multicentre Aneurysm Screening Study (MASS).[21] This demonstrated a hazard ratio for the benefit to be gained from screening of 0.52 (0.43–0.63). The 30 day postoperative mortality rate in the screened and control groups was 4% and 6%, respectively. An overall mortality rate of 7.9% would have the potential to obviate much of the population benefit from screening.

The national abdominal aortic aneurysm quality improvement programme

The response to the VASCUNET finding was a National Quality Improvement Programme led by the Vascular Society.

Grant funding for a national quality improvement programme (AAA-QIP) with the objective of reducing UK elective AAA mortality was obtained from the Health Foundation. A collaboration was established that encompassed the Vascular Society, the Vascular Anaesthesia Society of Great Britain and Ireland, the British Society of Interventional Radiology, the Society of Vascular Nurses, and local Cardiac and Stroke Networks.[22] The primary aims of the programme were: to reduce the elective mortality for infrarenal AAA repair in the UK to 3.5% by 2013, to increase data contribution onto the National Vascular Database, and to standardize and improve patient care through the AAA care pathway. A quality improvement framework was agreed which provided standards for the development of best practice protocols. Care bundles were developed to underpin the measurement of consistency in care delivery. It was initially planned to develop a national care pathway for AAA management. Early work established that a regional approach would be more effective. Quality improvement meetings based around the Institute for Healthcare Improvement (IHI) model for achieving breakthrough change were held in each region.[23] These covered the IHI methodology, the use of best practice packages, local challenges, and data collection through the National Vascular Database. It also became clear at an early stage that modifying the whole AAA care pathway at once would pose considerable challenges to hospital trusts and clinicians alike. To address this the pathway was broken down into a series of steps. Clinicians were encouraged to make changes to one component of the pathway at a time, focusing first on what were perceived to be the most important issues locally. This was supported by the dissemination nationally of examples of successful approaches in individual units.

Whilst anaesthetists were involved with all aspects of the work, the components of the programme relating to preoperative assessment and intraoperative care are of particular relevance to anaesthetists and are examined further below.

Preoperative assessment and the multidisciplinary team meeting

Components of preoperative assessment within the AAA-QIP included a formal initial risk assessment and preoperative assessment by an anaesthetist. The initial 'safe for surgery' assessment was designed as a checklist of co-morbidities taken from the EVAR1 study protocol and associated with increased perioperative risk (e.g. significant valvular heart disease, dyspnoea on exertion, renal impairment).[24] On the basis of these questions individual patient risk is classified as either: red (requiring specialist review if an aortic intervention is to be considered), amber (significant co-morbidity requiring preoperative optimisation, or green (fit to proceed to further assessment). There was variation in the implementation of this assessment across different units and clarification was issued that this 'traffic light' system is not intended to provide a definitive risk assessment but to identify patients in whom consideration should be given to improving their medical fitness before they are brought forward for aortic surgery.

The importance of preoperative assessment by an anaesthetist with a regular vascular practice was recognised.[22 25] This assessment should precede the decision to operate and it is essential that there is a mechanism whereby the information from the anaesthetic assessment can feed into the decision making process. Whilst this may seem logical and indeed self-evident it required significant redesign of the patient pathway. The AAA-QIP process supported this with example pathways developed in a number for centres.[25]

A central component of the AAA-QIP is the recognition of the key role of the Multidisciplinary Team Meeting (MDT) in the management of patients presenting for aortic surgery. The model of bringing together the different disciplines involved in the care of complex patients is well established in cancer. In the UK the Department of Health mandates the role of the MDT in cancer decision making.[26] In the case of AAA patients the minimum standard set by the quality improvement process was that management decision should be made by an MDT that includes surgeons, anaesthetists, radiologists and vascular nurses working in pre-hospital care. This proved challenging to implement in some centres as a result of completing work pressures for all the specialties involved but vascular consultant anaesthetist attendance at the MDT is now established practice in many centres. Where an anaesthetist cannot attend the MDT meeting it is essential that there is clear process by which the preoperative anaesthetic assessment is communicated to the vascular MDT meeting and that this is documented.

The MDT decision making process has been extensively researched, and is an established way of working with evidence from individual specialties of improved outcome.[27] The process in cancer MDTs is not perfect. It has been noted that not all decisions made by cancer MDTs can be implemented in practice.[28] A recurring theme is that MDT meetings tend to be skewed towards the technical aspects of care with less consideration of patient preferences and limited input from non-medical staff.[29–31] Set against this is the observation that meetings are generally chaired by a senior clinician and the work of chairing the meeting can reduce the ability of that individual to contribute to the discussion.[32] These considerations reflect ongoing research and translational work on the cancer MDT. The author is aware of only one ongoing study into the working of vascular MDTs. Targeted studies to identify the extent to which vascular MDT decisions can be implemented and the role of different disciplines in the decision making process for AAA patients would be of value.

Risk stratification

Patients and clinicians alike want to know the risks of surgery including the likelihood of death and major complications. The AAA-QIP process noted that formal calculation of risk was inconsistent in both its application and the methods used. Improving the use of risk scoring was incorporated into the objective of improving the decision to treat element of the patient pathway in the AAA-QIP. Progress in developing robust models to predict 30-day mortality after aortic surgery has been mixed. A recent systematic review identified 13 risk prediction models for mortality prediction after endovascular and open AAA repair.[33] The development of the models was often methodologically weak and performance variable across different populations. Matching case-mix correction to the population of interest was noted to be more likely to improve performance than developing new models.

Much of the work on preoperative risk prediction focuses on 30-day mortality. As noted by Carlisle, patients do not submit to surgery in order to gain one month of life.[34] The focus on long-term outcome is important for all types of surgery but is especially pertinent to elective AAA repair, where surgery is undertaken not to cure a disease but as a prophylactic procedure to prevent aneurysm rupture. A proportion of patients

subjected to the risks of surgery would, if left untreated, never face the life-threatening crisis of AAA rupture and would ultimately die of some other condition. With this stark thought in view a number of groups have undertaken work to predict long-term survival in AAA patients with and without elective AAA repair.[35 36] This approach to risk modelling, which mirrors the long-term focus of decision making in cancer, is an exciting and promising innovation in the management of AAA patients.

Long-term outcomes

Progress in the care of patients with AAA has been marked by an increasing recognition that outcomes beyond mortality are important. A meta-analysis of studies of patient reported quality of life after AAA repair demonstrated that both physical and mental health related quality of life are substantially reduced in the first three to six months after intervention.[37] Perhaps surprisingly the impact of open repair and EVAR on quality of life was not significantly different. Population data for both procedures indicates that quality of life recovers beyond six months after intervention. However, the limited data available on individual patient trajectories suggest that some patients never fully recover from surgery. Focus group studies from the AAA-QIP programme indicated that this was an issue of concern to patients and that clinicians should look beyond mortality when discussing the risk of AAA repair. This is congruent with the results of the 2014–15 Anaesthetic and Perioperative Care Research Priority Setting Partnership. One of the 10 key priorities that emerged from the Partnership's priority setting process is the identification of appropriate measures of the success of anaesthesia and perioperative care.[23] The challenge that we face in the case of AAA is to identify before surgery those patients most at risk of suffering a significant adverse outcome from what is a prophylactic operation.

A recent review of the clinical and ethical aspects of consent for aortic surgery reflects the use of standardized consent and lists the complications associated with a procedure together with their frequency. This approach has been challenged in some jurisdictions. It is proposed that informed consent should be tailored to the risks and benefits of the individual patient and should include discussion of quality of life outcomes and mortality and complications.[38] There is evidence that anaesthetists may by particularly well placed to add value to this aspect of care. The AAA-QIP process emphasized patient involvement. Regional focus groups were held and explored all aspects of the patient pathway. The role of the anaesthetist featured strongly in patient reflections on preoperative assessment and preparation for surgery. Patients valued being able to talk to all members of the vascular team and were noted to especially value explanations given by anaesthetists and nurses.

Intraoperative care

The expectation, reinforced by the AAA-QIP process, is that intraoperative care should be delivered by an anaesthetist with a regular practice in vascular anaesthesia. There is evidence for both vascular surgery in general and aortic surgery in particular that specialist care is associated with better outcomes.[39] This recognition of the impact of specialist expert care on outcome has been one of the drivers for the centralisation of vascular services in the UK. It is likely that the benefits of expert care include expertise in managing the multiple co-morbidities to which this group of patients is prone. The presence of other cardiovascular disease is a particular issue for this group of patients.

Perioperative myocardial injury

In 1984 Hertzer[40] reported that 31% of coronary angiograms in a series of 264 patients presenting for AAA repair showed severe coronary artery disease. Concerns regarding perioperative myocardial infarction and its prevention are an ever present anxiety for the vascular anaesthetist, which have been magnified by studies of perioperative cardiac troponin release over the past decade. A multicentre study of perioperative troponin release in vascular surgery patients conducted under the auspices of the VASGBI and published in 2006 demonstrated that, even using the relatively low sensitivity troponin assays available at that time, cardiac biomarker release, indicative of perioperative myocardial injury is common in the vascular surgery population.[24] In this study across six centres 40% of patients had cardiac troponin release at one or more postoperative time points. Only a third of these patients had clinical evidence of a cardiac event. The VISION study examined perioperative troponin release and myocardial injury in a group of over 15,000 patients aged over 45 yr who underwent non-cardiac surgery. This study demonstrated that perioperative cardiac biomarker release is common in high-risk patients undergoing non-cardiac surgery and has significant implications for long-term outcome.[41] A recent analysis of a subset of 502 patients included in the VISION study who underwent vascular surgery reported an incidence of myocardial injury after non-cardiac surgery (MINS) of 19.1%.[42] The best strategies to prevent such injury remain unclear. It has previously been suggested that in the case of myocardial injury caused by coronary artery flow/demand imbalance, reducing the heart rate or blood pressure with sympatholytic therapies such as beta-blockers or alpha-2 agonists may improve outcome. Similarly, it has been suggested that antiplatelet therapy may offer benefit in instances where cardiac injury is as a result of coronary artery plaque rupture and coronary artery occlusion because of thrombosis. However, the evidence base around both sympatholytic therapies and antiplatelet agents is becoming increasingly uncertain.

Cardioprotective therapies

For three decades perioperative beta-blockade seemed to hold out the promise of reducing or preventing perioperative myocardial injury. Early studies by Prys-Roberts and colleagues[43] suggested a reduction in perioperative myocardial ischaemia. This was followed by trials by Mangano and colleagues[44] and by Poldermans and colleagues[45] suggesting improvements in mortality with perioperative beta-blockade. However, the data were not entirely consistent. Some studies suggested a reduction in perioperative myocardial ischaemia whilst others, including a study of 453 patients, showed no such effect.[46] The methodology underpinning the initially positive clinical trials of beta-blockade was increasingly questioned. The POISE study published in 2012 demonstrated that whilst perioperative beta-blockade with metoprolol did reduce the incidence of cardiac events it was actually associated with an increased perioperative mortality rate.[47] The absence of protective effects of beta-blockers in vascular and endovascular surgery is supported by a recent meta-analysis.[48]

Studies of the use of anti-platelet agents in the perioperative setting have also defied expectations of benefit from these

drugs. The POISE-2 study demonstrated no benefit from the use of aspirin in patients at risk of perioperative cardiac complications undergoing surgery.[49] This trial, which had a factorial design, also indicated that perioperative sympatholysis with clonidine did not reduce perioperative risk.[50]

Anaesthetic technique

Whilst the evidence base for some cardioprotective strategies has weakened, there is evidence that the choice of anaesthesia in endovascular AAA repair may have a significant impact on outcome. A systematic review of anaesthesia for elective EVAR suggested reduced length of stay and reduce postoperative morbidity with regional anaesthesia.[51] The authors suggest in the introduction to their analysis that locoregional anaesthesia might reduce the physiological effects of surgery. However, they also note that it cannot be excluded that more challenging and higher risk patients received general anaesthesia, therefore confounding an apparent benefit from regional anaesthesia. The IMPROVE trial compared open and endovascular repair of ruptured AAA. The study found no difference in survival between the two techniques.[19] However, secondary analyses suggested a substantial survival benefit from regional anaesthesia.[52] The data collection tool used in IMPROVE did not distinguish between local infiltration of local anaesthetic to the groins and the use of neuraxial blockade. It is certainly possible to posit benefit from the use of infiltration anaesthesia. In endovascular repair of AAA rupture there can be a period of up to an hour or more between the start of the procedure and the aneurysm being excluded from the circulation. Thus, the risk of catastrophic cardiovascular decompensation remains for a significant period after surgery has started. The use of local anaesthetic infiltration that avoids the cardiovascular effects of general anaesthesia or neuraxial block might make this less likely to occur.

Monitoring performance and demonstrating improvement

Measurement tools are key to an effective quality improvement strategy. Without them it is impossible to provide evidence that a change is an improvement. At the beginning of the AAA-QIP process UK data on vascular surgery were collected in the National Vascular Database (NVD). Participation was voluntary. The information collected included co-morbidities, details of anaesthetic and surgical care, outcome data, and the name of the surgeon. Whilst the NVD had the potential to support the AAA-QIP process, data entry was far from complete. A comparison between the number of AAA operations performed in NHS Trusts gleaned from NHS administrative data and the number of AAA repairs recorded in the NVD indicated that only 65% of cases were being entered into the database. A target was set of increasing this to 90% by April 2012. NHS Hospital Episode Statistic data were sent to NHS Trust Vascular Leads and Clinical Governance Leads and Trusts were asked to validate the two datasets. After this initiative NVD reporting had improved to 84% of cases by the time of the AAA-QIP final report in 2012. Whilst short of the 90% target this was a very substantial change. It was accompanied by an improvement in the timeliness of reporting with records being entered into the database close to the time of the procedure rather than weeks or even months later. The initiative also saw an improvement in anaesthetic participation in the NVD. The NVD has now been superseded by the National Vascular Registry (NVR), a national clinical audit commissioned by the Health Quality Improvement Partnership (HQIP).[53] The NVR was developed by the United Kingdom Vascular Society, in collaboration with a number of partners and includes a detailed dataset on anaesthetic management and perioperative care developed in collaboration with the VASGBI. Individual consultant anaesthetists with a practice in vascular anaesthesia are encouraged by both the VASGBI and the Royal College of Anaesthetists to register with the NVR and to access their individual data in the registry.

Organisation of vascular services

A major consequence of this work was the centralisation of vascular services. The volume-outcome relationship for surgery is now well established in a number of specialities. Put simply, centres with higher levels of activity have better outcomes.[54] It is notable that the VASGBI audit of open AAA repair included data from 177 centres. The findings of the VASCUNET report were one of a number of drivers supporting steady progress to the centralisation of UK vascular services into fewer centres with larger catchment areas.[55]

Conclusions

The UK elective infrarenal AAA repair mortality rate decreased to 2.4% by 2012.[25] It is difficult to attribute this change to anything other than the major changes in AAA care in the UK between 2008 and 2012. Many if not most of these changes related to perioperative rather than intraoperative care. The evolving management of AAA repair is an exemplar of the evolution of perioperative medicine. The importance of the organisation of services in determining outcome from AAA repair has been recognised. The role of the anaesthetist in the care of AAA patients has shifted from intraoperative service provider to being integral to the operative decision making process. The high incidence of cardiac disease and the risk of cardiac complications in this group has made them central to the evolution of the management of cardiac risk in non-cardiac surgery. The past decade has seen a significant reduction in mortality amongst patients undergoing AAA repair in the UK. Anaesthetists have played a key part in this achievement.

Declaration of interest

British Journal of Anaesthesia Director and Editorial Board Member.

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