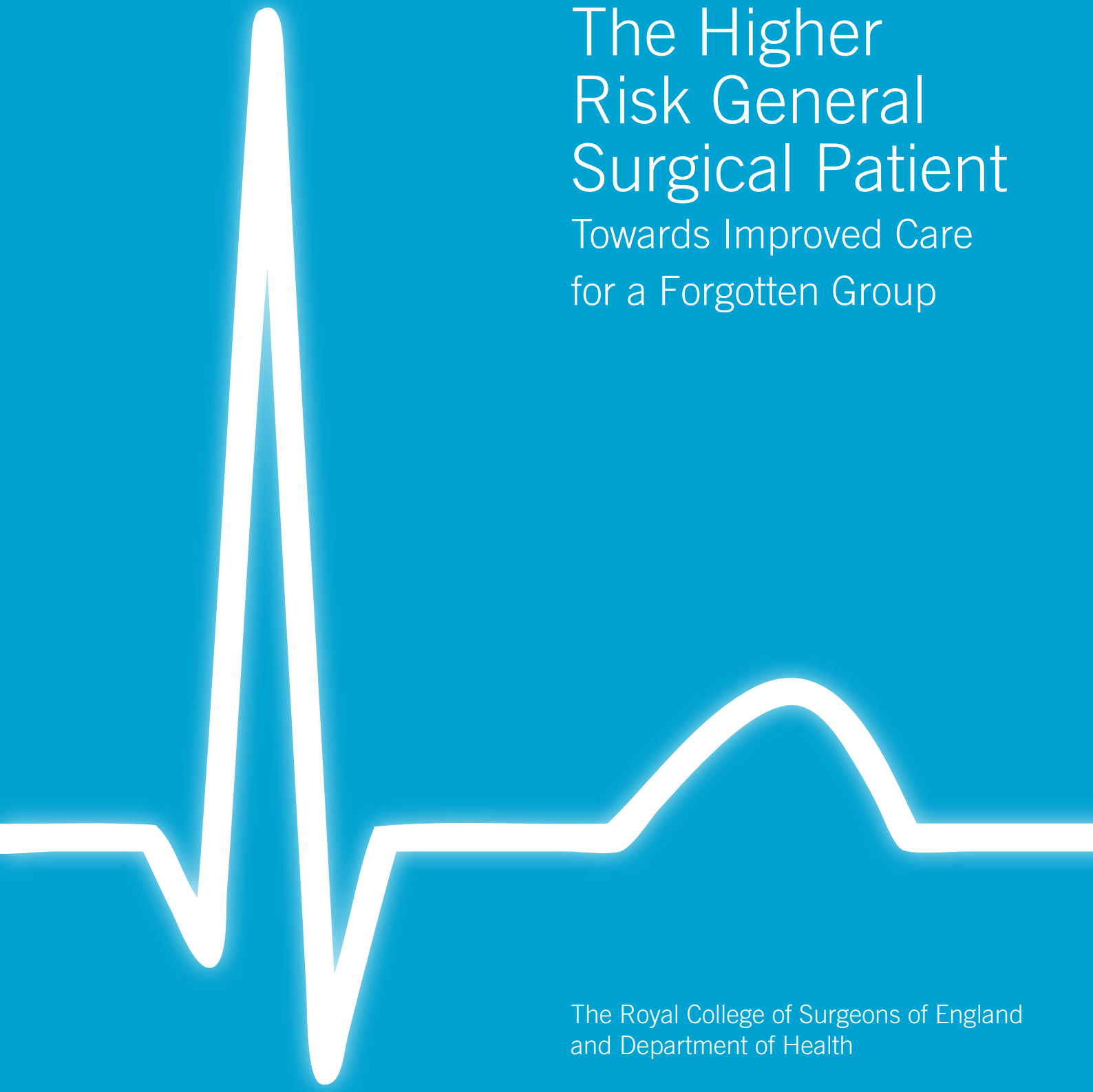

The Higher Risk General Surgical Patient

Towards Improved Care for a Forgotten Group

The Royal College of Surgeons of England
and Department of Health

Report on the Peri-operative Care of the Higher Risk General Surgical Patient
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Contents

Contributors

The Royal College of Surgeons of England and Department of Health Working Group on Peri-operative Care of the Higher Risk General Surgical Patient

ID Anderson	Consultant General and Colorectal Surgeon, Salford Royal Foundation NHS Trust Director of Emergency Surgery, ASGBI (Chair)
J Eddleston	Consultant Anaesthetist and Intensivist, Central Manchester Foundation NHS Trust (Adult Critical Care Advisor Department of Health)
M Grocott	Consultant Anaesthetist and Intensivist, Southampton, Director, NIAA Health Services Research Centre, The Royal College of Anaesthetists
NP Lees	Consultant General and Colorectal Surgeon, Salford Royal Foundation NHS Trust
D Lobo	Consultant General and Upper GI Surgeon, Queens Medical Centre, Nottingham
I Loftus	Consultant Vascular Surgeon, St George's Hospital, London
NI Markham	Consultant General Surgeon, North Devon District Hospital , Barnstaple
D Mitchell	Consultant Vascular and Renal Transplant Surgeon. Chair, Audit and Quality Improvement Committee. Vascular Society of Great Britain & Ireland
R Pearse	Senior Lecturer and Consultant in Intensive Care Medicine, Barts and The London School of Medicine and Dentistry
C Peden	Consultant Anaesthetist and Intensivist, Royal United Hospital, Bath
RD Sayers	Professor of Vascular Surgery, University of Leicester
J Wigfull	Consultant Anaesthetist and Intensivist, Sheffield Teaching Hospitals

Approving organisations

This document has been reviewed and supported by:

- Association of Anaesthetists of Great Britain and Ireland
- Association of Coloproctology of Great Britain and Ireland
- Association of Surgeons of Great Britain and Ireland
- Association of Upper Gastro-intestinal Surgeons
- Critical Care Networks
- Faculty of Intensive Care Medicine
- Intensive Care Society
- Royal College of Physicians
- Society of Academic and Research Surgeons
- Vascular Society of Great Britain and Ireland
- Royal College of Anaesthetists

Summary

Higher risk non-cardiac general surgery is undertaken in every acute hospital. By way of comparison, the mortality for this group, which includes most major gastro-intestinal and vascular procedures, exceeds that for cardiac surgery by two to three fold and complication rates of 50% are not uncommon. There may be a lack of awareness of the level of risk. Among these patients, emergency surgery and unscheduled management of complications is common and this group of patients are one of the largest consumers of critical care resources. The health and financial costs are considerable.

Evidence indicates that the peri-operative pathway followed by patients requiring emergency surgical management is frequently disjointed, protracted and not always patient centred. Outcomes are known to vary substantially and could be considerably improved. Trusts should formalise their clinical pathway for this group of patients, ensuring that risk of further deterioration is matched with urgency of diagnostic tests, seniority of clinician in decision making, timing of surgery and appropriate clinical location for immediate post-operative care.

This document describes key issues and standards. It is the opinion of this expert group that the recommendations contained within should be deliverable within two years in all acute hospitals undertaking unscheduled general surgery in adults and that doing so would make an appreciable difference to outcomes.

Key recommendations

1) Trusts should formalise their pathways for unscheduled adult general surgical care. All patients should have a clear diagnostic and monitoring plan documented on admission. The monitoring plan must be compliant with National Institute for Health and Clinical Excellence (NICE) CG50 guidance and match competency of the doctor to needs of the patient. The pathway should include the timing of diagnostic tests, timing of surgery and post-operative location for patients.

2) Prompt recognition and treatment of emergencies and complications is essential to improve outcomes and reduce costs. Surgical patients often require complex management and delay worsens outcomes. The adoption of an escalation strategy which incorporates defined time-points and the early involvement of senior staff when necessary are strongly advised. One such strategy is defined.

3) Trusts should ensure emergency theatre access matches need and ensure prioritisation of access is given to emergency surgical patients ahead of elective patients whenever necessary as signficant delays are common and affect outcomes. The necessary timescale of intervention is defined.

4) Each patient should have his or her expected risk of death estimated and documented prior to intervention and due adjustments made in urgency of care and seniority of staff involved.

5) High risk patients are defined by a predicted hospital mortality ≥5%: they should have active consultant input in the diagnostic, surgical, anaesthetic and critical care elements of their pathway.

6) Surgical procedures with a predicted mortality of ≥10% should be conducted under the direct supervision of a consultant surgeon and consultant anaesthetist unless the responsible consultants have satisfied themselves that their delegated staff have adequate competency, experience, manpower and are adequately free of competing responsibilities.

7) Each patient should have their risk of death re-assessed by the surgical and anaesthetic teams at the end of surgery, using an 'end of surgery bundle' to determine optimal location for immediate post-operative care.

8) All high risk patients should be considered for critical care and as a minimum, patients with an estimated risk of death of ≥10% should be admitted to a critical care location. Trusts should examine their spectrum of critical care provision and consider options for patients with lower risks of death which will further enhance surgical outcomes and limit costs overall.

9) A national audit of outcome should be conducted for adult patients undergoing unscheduled general surgery, utilising the standards proposed in the document and incorporating measures of cost effectiveness. Local assessment of outcome is fundamental in improving care and results should be shared appropriately.

Background

Introduction

The adult higher risk non-cardiac surgical population represents a major healthcare challenge to every acute hospital. Surgery remains a common and effective treatment option for a diverse range of diseases and far from being replaced by drug therapies, surgery is now more frequently deemed a viable option for elderly patients and those with co-morbidities or advanced disease. The standard of patient care during surgery itself can now be extremely high and even complex elective surgery can be made relatively safe.[1,2] However, successful surgery also depends on good peri-operative care and here lie challenges. While we may have made some progress towards improving surgical outcomes, the available evidence suggests that post-operative adverse events may be much more frequent than many appreciate and that the consequences of these complications are considerable.

In the UK, the focus has fallen previously on cardiac surgery where specialist units carry out a modest range of predominantly elective procedures with routine intensive care support. Audit now shows good results which continue to improve with 2–3% mortality typical.[3] The established and transparent measurement of outcomes in cardiac surgery facilitate improvement by identifying centres of good practice and centres where change may be required.

By contrast, major general surgery is carried out in every acute hospital, encompassing a wide range of conditions which are, hence, more difficult to audit and conducted with limited critical care support. The mortality of elective major gastro-intestinal or vascular surgery substantially exceeds that of cardiac surgery. A much higher proportion of non-cardiac surgical patients are treated on an emergency basis and at present the service for such patients lacks focus despite much higher mortality and complication rates.

There is growing concern that this group of higher risk general surgical patients receive sub-optimal care which has important implications for patients and the healthcare economy. In the UK, 170,000 patients undergo higher risk non-cardiac surgery each year.[4] Of these patients, 100,000 will develop significant complications resulting in over 25,000 deaths. General surgical emergency admissions are the largest group of all surgical admissions to UK hospitals and account for a large percentage of all surgical deaths.[5] Emergency cases alone presently account for 14,000 admissions to intensive care in England and Wales annually.[6] The mortality of these cases is over 25% and the intensive care unit (ICU) cost alone is at least £88 million.

Complications occur in as many as 50% of patients undergoing some common procedures, and these result in dramatic increases in length of stay and cost. Many of the patients undergoing this type of surgery are elderly with multiple co-morbidities[7–10] and indeed the over 80s are more likely to present for emergency surgery than elective,[11,12] where the risks multiply. Despite these findings, there is surprisingly little research into how to improve these patients outcomes but structures of care which facilitate attention to the detail of peri-operative care may help.[13]

Studies from the UK suggest that a readily identified higher risk sub-group accounts for over 80% of post-operative deaths but less than 15% of in-patient procedures.[4,7] Advanced age, co-morbid disease, and major and urgent surgery are the key factors associated with increased risk. Within this group, emergency major gastrointestinal (GI) surgery has one of the highest mortalities, which can reach 50% in the over 80s.[8] Presently, this type of surgery is carried out in every acute hospital, but not always with consultant staff present and not always with routine admission to a critical care bed after surgery. Many of these issues were highlighted in the most recent National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report.[14]

In the UK, fewer than one third of high risk non-cardiac surgical patients may be admitted to critical care following surgery.[4,7] In addition, those patients who do receive this level of care are discharged after a median stay of only 24 hours, despite going on to have prolonged hospital stays. Premature discharge from critical care has been identified as an important risk factor for post-operative death, as has delayed admission to critical care.[15] International comparisons suggest that critical care beds may run at 50% of comparable levels elsewhere and indeed rank amongst the lowest in the developed world.[16]

To identify and advise on how these patients could be better managed, a joint working group was set up between The Royal College of Surgeons of England and the Department of Health (DH) to address these issues as they relate to the peri-operative care of general and vascular surgery in the first instance.

The following document seeks to explain to the nature of the problem to commissioners, chief executives and medical directors, and to lay out logical steps which should be taken in order to achieve the greatest benefit in the most effective way.

Variation in current outcomes

There are several indicators that the outcomes from higher risk surgery in the UK are not as good as they should be. Review of 2008/9 hospital episode statistics (HES) data from Dr Foster reveal a greater than two-fold variation in relative risk of 30-day mortality (risk-adjusted) after non-elective lower GI procedures between trusts in the North West SHA (strategic health authority). It is known that the chance of a patient dying in a UK hospital is 10% higher if he or she is admitted at a weekend rather than during the week.[17] There are no evident reasons for these differences other than that care, at times, is of variable quality: a conclusion which fits with the available evidence and professional opinion. International studies have reached similar conclusions and local audit data confirm that outcomes deteriorate if patients are admitted towards the end of duty periods and at weekends . Two recent NCEPOD reports showed significant deficiencies in the active care of patients who ultimately died.[14, 18] These included delays in assessment, decision making and treatment. There were shortfalls in access to theatre, radiology and critical care; surgery was suboptimally supervised in 30% of cases and there was a failure for juniors to call for help in 21% of cases. Timely surgery was not carried out in 22% of patients who died. There was also the failure to reliably administer therapy known to be of benefit such as antibiotic and venous thrombo-embolism prophylaxis. There are few data which compare our outcomes in the UK to other countries but one study reported that risk-adjusted mortality rates were as much as four times higher in the UK than in the US.[19] A large percentage of the patients that survive have prolonged hospital stays with significant cost implications, both physical and emotional to the patient and their family, and financial to the hospital.[20]

Together, these data show that these higher risk patients are a significant clinical burden in every hospital, use substantial critical care facilities with corresponding high cost but have outcomes which vary considerably between sites and within sites at weekends. These observations represent a poorly defined care pathway with standards that are either not determined or not implemented. The consequent impact on both patient outcomes and use of NHS resources is considerable. The scope for improvement is difficult to document given the very limited nature of current audit methods and the diversity of procedures undertaken. However, the findings are well recognised by many working in the field and nor are they surprising. Provision of services, particularly of theatre access, critical care and interventional radiology, is often incomplete and the correct location of patients after surgery is often not given sufficient priority. Furthermore, the clinical response for patients who deteriorate is often poorly thought through and, at times, ad hoc. Aligning patients' needs and subsequent risk of deterioration to the most appropriate pre and post-operative clinical area requires active early assessment of risk of death and clear objectives for clinical care to be identified.

How do adverse outcomes occur for the higher risk general surgery patient?

While occasional patients die from haemorrhagic or cardiac complications during surgery, it is post-operative complications that account for the bulk of morbidity and mortality in general surgery. Some of these result from suboptimal surgical peri-operative care – perhaps on account of poor pre-operative preparation or inexpert or delayed surgery or anaesthesia. For others, post-operative complications are chance occurrences but nevertheless ones which can often be readily anticipated and mitigated through consideration of co-existent diseases and the surgery performed. In the elderly, frailty is a risk factor and should be formally assessed in addition to nutritional and mental state.[14] Complications can be greatly reduced by optimal peri-operative care.

There are opportunities to improve outcomes before, during and after surgery. Many of these higher risk patients are emergencies where the time for pre-operative assessment is less and surgery is often unavoidable. In these cases, optimal resuscitation is important but delay is detrimental. However, for those patients undergoing elective high-risk surgery, optimal multidisciplinary pre-operative planning is the ideal.

Complications are common and raise costs, often several-fold. Their development reduces survival (both short and long term) independently of pre-operative risk and complexity of surgery.[21] Those that occur are managed variably and adverse outcomes are estimated to be due to errors in the process of care or medical management, each in about 20% of cases.[22]

Minor complications are extremely common after complex procedures and slow or suboptimal management of these, particularly in patients with other medical diseases can trigger a subsequent cascade of more serious complications. Many of the life threatening problems involve systemic infection (sepsis). Once a patient develops major complications, they are at risk of major organ dysfunction or failure. Typically, patients at risk or with organ dysfunction are managed in high dependency units (level 2), where the mortality is at least 5%. Once organ failure develops, full intensive care (level 3) is required and the mortality rises to 30% or more, often after prolonged treatment. The health and financial advantages of managing complex patients with adequate critical care support from the time of surgery are self evident.

Complications may be inevitable after this magnitude of surgery but their number and severity can be mitigated by rapid and successful treatment. It is well established that this requires the following steps:

1) Rapid identification
2) Adequate resuscitation
3) Investigation to define the underlying problem
4) Rapid definitive treatment of that problem
5) Appropriate critical care provision to prevent further complications

Too often the whole process is slow or inaccurate as it is complex, requires multidisciplinary input, often occurs out of hours and is initiated by junior staff. Suboptimal care on general wards prior to critical care admission has been recognised as a cause of avoidable mortality[14] which has resulted in the publication of a clinical guideline document from NICE[23] and of a competency framework from DH.[24] These documents outline a graded response strategy that each acute hospital should establish to recognise and respond to the deteriorating patient. Escalation of care for those that require surgical intervention, including radiological intervention, has not been the subject of specific guidance to date. Certainly in the US, the ability of different hospitals to manage complications differed significantly and this (rather than the initial frequency of complications) accounted for large variations in outcomes.[25] Prompt intervention is fundamental to the successful treatment of the patient who deteriorates after surgery.

Sepsis

Sepsis (the body's generalised response to infection) requires special consideration because it is the principal reason for prolonged admission to critical care and death in these patients and because the existing guidelines do not take into account current understanding of the timeliness of intervention.

The process is time critical and two steps are of particular importance in surgical patients. The first, as defined in the Surviving Sepsis Campaign, is to administer broad-spectrum antimicrobials as early as possible, and always within the first hour of recognising severe sepsis and septic shock[26] together with other appropriate measures shown in Box 1.

Box 1. Early resuscitative measures in sepsis

Measure serum lactate.
Take blood cultures (preferably before antibiotic administration).
Administer broad spectrum antimicrobials within 1 hour.
Treat hypotension, hypovolaemia or elevated lactate with appropriate intravenous fluids.

The second is to deal with the source of sepsis which, in surgical practice, often means a complex operation or radiological drainage. Previous guidance with regard to the urgency of emergency surgery is too non-specific and does not take account of new evidence which suggests that patients with septic shock requiring source control have a progressive deterioration in outcome associated with increasing delay to source control.[27] Delay of more than twelve hours after the onset of septic shock may increase mortality by a factor of 2.5 times when compared with patients who received source control within three hours. Gathering data on these patients is difficult but this expert group believes there is enough evidence at present to establish pragmatic guidance consistent with NICE CG50. Namely, that a graded response be established that requires increasingly rapid intervention for patients with increasing severity of illness and that the degree of urgency should be considerably greater than that previously accepted.

It is anticipated that the effects of this will be to reduce severity of illness, the need for higher levels of critical care and its associated cost and improve outcomes.

Actions

Managing the critically ill surgical patient with sepsis

Surgical patients may become critically ill for two reasons. They may present as an emergency with an acute surgical illness or they may develop complications following surgery or during surgical illness. Some complications have well defined treatment protocols and others are so catastrophic that the need for immediate summoning of the cardiac arrest team is obvious. However, the graded response for identification and treatment of sepsis, the most frequent serious complication is not well defined. This deficit leads to avoidable adverse outcomes.

Escalation of care

Fundamental to prompt definitive treatment of sepsis and indeed, all complications, is the need to identify critically ill patients at an early stage. This escalation guideline is written with reference to existing documents; NICE CG50[23] and *Competencies for Recognising and Responding to Acutely Ill Patients in Hospital*.[24] The graded response to early warning scores will be described as a three point scale of response to low, medium and high scoring patients. Further explanation of the current status of early warning scores (EWS) is given in Appendix 1.

Surgical patients frequently differ from non-surgical ones in two ways. Firstly, the conditions which develop often demand greater urgency and secondly, they more often require complex operative interventions following advanced imaging. These differences bring opportunity for delay.

For a medium-score patient NICE CG50 requires: 'Urgent call to team with primary medical responsibility and simultaneous call to staff with core competencies in care of acute illness.' In the case of a surgical patient that has deteriorated on the ward the member of staff with 'core competencies' is a surgical trainee, who will usually have passed MRCS. A typical 'medium score' patient would be one that is developing severe sepsis or one with less severe acute pathology but with significant co-morbidities.

This trainee, here denoted MRCS, is the secondary responder in the chain of response described.[23] The MRCS plays a key role in diagnosis and communication between tertiary response groups; crucially the consultant surgeon although microbiologist, radiologist, anaesthetist and intensivist may all need to be involved within a short space of time. Staffing arrangements between hospitals will vary. Responsibility for ensuring that the MRCS is able to review a patient that triggers a medium score without delay is fundamental and will rest with individual departments.

For the escalation structure, below, to work for the patient's benefit, the MRCS must be competent in recognising whether a deteriorating patient has sepsis or not and whether the cause of sepsis is most appropriately treated with antibiotics alone or with source control. The MRCS must also be able to differentiate between the different levels of severity of sepsis. Successful attendance at a Care of the Critically Ill Surgical Patient® (CCrISP®) course[28] or equivalent would provide this, and this is a 'strongly recommended' facet of basic surgical training in the UK.

Suggested pathways for escalation are shown in Figure 1. The upper part of Figure 1 utilises the early stages of the generic pathway described in NICE CG50 up to the point of referral to the secondary responder. However, note that 12-hourly observations is too infrequent for this group: hourly observations would be more usual until medical review, and would likely be triggered by the EWS. There follows the recommended pathway for the surgical patient.

The summary timelines for assessment of the unstable patient and for intervention are shown below. For definitive treatment to occur within the recommended timeframe, it will be clear that each phase of treatment must be expeditious. These phases often include initial recognition, initial assessment, MRCS assessment, investigation (most commonly CT scan) and senior decision making. Hospitals should audit the stages of the pathway to minimise the avoidable delays which are currently recognised. When staff shifts change, effective handover at a sufficiently senior level is essential to maintain momentum.

Urgency of source control

Patients with sepsis require immediate broad-spectrum antibiotics with fluid resuscitation and source control.

a) Those with septic shock require immediate broad-spectrum antibiotics with fluid resuscitation and source control. Delay to source control of more than twelve hours after onset of hypotension when compared with a delay of less than three hours could be expected to increase mortality from 25% to more than 60%.[27] Rapid involvement of senior staff is important. Control of the source of sepsis by surgery or other means should be immediate and underway within three hours.

b) Patients with severe sepsis (sepsis with organ dysfunction) are at greatest risk of developing septic shock. There is no direct evidence to confirm that delayed source control worsens outcome but there are obvious advantages to operating before progression to septic shock occurs[29-31] given the associated 5 to 10-fold rise in mortality which occurs as the patient deteriorates. Surgery or equivalent (eg radiological drainage) should be carried out within six hours from the onset of deterioration. These patients require immediate broad-spectrum antibiotics with fluid resuscitation, urgent but not immediate surgery, frequent monitoring (as per NICE CG50) in an appropriate environment during the interim to promptly identify development of hypotension. Where it is elected to observe and resuscitate the patient for a few hours until morning, surgery should assume priority over elective procedures. Neither observation nor resuscitation should delay source control for more than six hours. Evidence suggests that further delays at this point are common.[14, 32]

c) Source control for patients with sepsis but without organ dysfunction should always be carried out within 18 hours. Immediate broad-spectrum antibiotics are required but surgery can be delayed overnight or until the next theatre becomes available. Source control is needed before progression to severe sepsis which carries a greater overall mortality and an increased frequency of observations is needed in the interim to identify any clinical deterioration which should trigger a revised management plan.

d) Patients that require source control but have not mounted a systemic inflammatory response are clinically appropriate for NCEPOD classification 'expedited'.

Doctors should be aware of these timescales when determining the urgency of assessment and intervention. As the acute management pathway for many of these patients is tortuous (assessment, senior assessment, investigation, anaesthetic review, critical care review, theatre scheduling, operation) the need for urgency at each stage is emphasised.

These timescales shown are the maximum. Some patients will have surgical considerations mandating more urgent intervention.

Hospitals should provide adequate emergency theatre access free from predictable obstruction or restriction caused by over-running elective work or manpower shortage. This is not infrequently seen at late afternoon / early evening.

Hospitals should also ensure that there are clear arrangements in place for interventional radiology, especially out of hours. For many, this will be via a network of cover across multiple hospitals.

Moving a patient to critical care does not treat the source of sepsis and the focus must remain on timely definitive care. This needs to be balanced with appropriate but rapid pre-operative resuscitation. If the patient becomes hypotensive, fails to respond to resuscitation or otherwise deteriorates then immediate treatment is necessary as in a).

Recent College standards, from a multi-professional group with lay input, define the need for consultant availability for emergency care 24-hours a day, 7-days a week, location of at-risk emergencies in a single site, genuine availability of emergency theatre and defined rotas for interventional radiology.[33] These principles are fundamental to modern, safe and reliable unscheduled care and are strongly supported. Many hospitals have moved substantially in this direction but remaining ones should follow and adjust job plans accordingly.[32]

Summary timelines

Surgical Response (level 2 / secondary)

EWS	Grade of staff	Time
Low	Foundation / ST 1–2	1 hour
Medium	MRCS	within 30 mins
High	MRCS and critical care / anaesthetic staff	immediate

If there is an incomplete response to resuscitation within one hour, particularly if the patient remains hypotensive or with organ dysfunction, then: inform/involve senior staff and move to critical care area or operating room as appropriate.

If MRCS is not available because he or she is operating, the ICU or anaesthetic special registrar (SpR) should be called directly to the patient according to a local tiered escalation policy and, typically, the consultant surgeon should be involved. At each stage, all members of the multidiscplinary team should be encouraged to involve more senior staff if there is a delayed or incomplete response by the medical team or the patient.

Intervention to control source of sepsis

Severity of sepsis	Time to intervention (maximum)
Septic shock	Immediate
Severe sepsis / organ dysfunction	as soon as possible and within 6 hours of onset
Sepsis	as soon as possible and within 18 hours (7am–10pm start)
Infected source, no SIRS	as soon as possible (7am–10pm start)

Figure 1, below, combines initial generic assessment taken from NICE CG50 (upper part of figure) with a surgery specific pathway (lower part of figure). Initial routine monitoring for this group of patients will be hourly.

Assessing and identifying risk

Why it should be done

Studies from the UK suggest that a readily identified higher risk sub-group accounts for over 80% of post-operative deaths but less than 15% of in-patient procedures.[4,7] Advanced age, co-morbid disease, major and urgent surgery, primary diagnosis and acute physiological deterioration are the key factors associated with increased risk. Routine identification of patients most at risk would permit care and resources to be better directed.

How should risk be assessed?

Presently, clinicians' assessment of peri-operative risk may be omitted, inaccurate or may not lead to an effective change in clinical management. Objective assessment of risk must become routine. Most importantly, identification of higher risk needs to trigger joint advance planning specific to that case.

1) We recommend that objective risk assessment become a mandatory part of the pre-operative checklist to be discussed between surgeon and anaesthetist for all patients. This must be more detailed than simply noting the American Society of Anesthesiologists (ASA) score.

2) For elective patients, risk should be assessed at pre-operative assessment and those at high risk should ideally see the anaesthetist who will anaesthetise them. Being seen by a colleague with appropriate competencies from a specialist team that adopts common accepted protocols would be acceptable. A range of risk scores and tests of exercise capacity are available and should be adopted. Close working arrangements, advance communication and sub-specialisation are advocated for higher risk cases that should be optimised according to current local and national guidelines prior to surgery. The reliability of this process should be audited.

Patients with a predicted mortality ≥5% should be managed as 'high risk'. Most major general surgical emergency laparotomy procedures fall in this category, together with complex elective GI and vascular procedures, in comorbid patients.

There are a number of methods with which to predict hospital mortality risk. Some methods are described below. Each method has strengths and weaknesses so for patients to be safely defined as low risk they should not obviously enter the high risk group by any method.

Note that the average mortality of a defined group can be expected to be approximately 2–4 times the threshold and it is anticipated that teams may wish to set the threshold lower in time.

a) P-POSSUM, freely available on the internet,[34] is possibly the simplest and best validated method and a good place to start. Its scoring includes operative details so these have to be estimated for pre-operative use and can be updated at the end of surgery.

b) Alternatively, the criteria below are taken from an expert clinical trial in this population and also fit with expert opinion, Box 2. These will define a group with a predicted mortality ≥5% and an overall mortality of 10–12%.

c) A third way of identifying the higher risk surgical patient is by reference to HES procedure groups. While this approach shows considerable concordance with the methods above for populations of patients, its failure to include acute illness or chronic co-morbid disease means it should be used alongside a consideration of patient physiology for individual patient assessment. With that caveat, HES data analysis shows that the following emergency cases have an average mortality of ≥10% in the UK; laparotomy for peritonitis, resection of colon or rectum, therapeutic

operations on small bowel, therapeutic upper GI endoscopy, peptic ulcer surgery, gastrectomy and splenectomy. In such cases patients are likely to be 'higher risk' unless they are unusually fit.

d) Other physiological derangements, disease states and procedures may also define high and medium risk patients, including urgent surgery in patient with ASA >3 plus at least one acute organ dysfunction/failure, ASA 4 or 5, dialysis-dependent patients or patients with elevated lactate.

Box 2. Patients undergoing major gastro-intestinal or vascular surgery who are either:

1. Aged >50 years;
   and undergoing urgent, emergency or re-do surgery
   or have acute or chronic renal impairment (serum creatinine >130 μmol/l)
   or have diabetes mellitus (even if only diet controlled)
   or have or are strongly suspected clinically to have any significant risk factor for cardiac or respiratory disease.

2. Aged >65 years.

3. Have shock of any cause, any age group.

The identification of higher risk status should lead to certain levels of care. Staff involved should be sufficient in seniority and number to permit care to proceed expeditiously. It is recognised that, while some more senior trainees may have many of the skills necessary, this is less so than previously. Furthermore, the presence of a consultant can remove organisational barriers and assist in prompt decision making. For the surgical team, this practical assistance is essential given modern day on call arrangements. Anaesthetic juniors may similarly lack experience and have to manage calls about other patients simultaneously, causing further delays.

Consequently, each higher risk case (predicted mortality ≥5%) should have the active input of consultant surgeon and consultant anaesthetist. Surgical procedures with a predicted mortality of ≥10% should be conducted under the direct supervision of a consultant surgeon and a consultant anaesthetist unless the responsible consultants have actively satisfied themselves that junior staff have adequate experience and manpower and are adequately free of competing responsibilities.

Occasional cases may be appropriately managed by unsupervised juniors but this should be an active and audited senior decision. Calling senior staff at a later stage once problems have developed will usually be associated with worse outcomes and this event should also be audited. It is also recognised that the systemic impact of sepsis on patients undergoing major procedures is not always identified initially and seniors should be cautious about leaving before the case is finished. It is very important that rotas permit trainees to work with consultants who are delivering care, in order to ensure training of future consultants.

Formal identification of risk can help identify when surgery for frail and critically ill patients may be futile and where end of life care may be more appropriate. The wishes of patient and family and senior input are important. As the population ages, the issue of futile care will increase. Better working relationships with services providing care for the elderly and primary care, although currently difficult in emergency settings, can only be an advantage.[14]

Peri-operative fluid and vasoactive drug therapies

Fluid resuscitation of the emergency patient is essential.[26] It should occur in a location appropriate to the degree of illness and interventions necessary. It may often require senior input. The importance of urgent source control has been indicated above and location and protocols should take account of that as well, especially in the sickest patients where deferring source control for prolonged fluid resuscitation could be detrimental.

The optimal approach to intra-operative fluid and vasoactive drug therapies remains uncertain but evidence from a number of small trials suggests that the use of cardiac output monitoring, typically via oesophageal Doppler, to guide fluid therapy during major gastro-intestinal surgery may reduce complication rates and duration of hospital stay. For this reason, the technology has been recommended in a recent guideline issued by the NICE as being clinically and financially effective when invasive monitoring is required.[35] Several larger trials of this treatment are under way and will inform future practice recommendations.

Both excessive and inadequate intravenous fluid administered in the peri-operative and post-operative period can be harmful, particularly in the elderly.[14,36] A fluid plan should be agreed between the anaesthetic team and senior surgeon, bearing in mind current evidence and the risks of both excessive and inadequate fluid therapy. This should include blood loss and replacement.

End of surgery bundle

The post-operative pathway must be determined by the risk of death and complications and receiving areas must possess the competencies to deal with surgical patients.

A key decision point occurs towards the end of higher risk surgery, much of which is emergency in nature and thus less than perfectly planned. At this point, decisions need to be made concerning the disposition of the patient following surgery. Underestimating the degree of existing physiological upset or of the likely evolution of organ dysfunction can be catastrophic: late admission to critical care carries a much higher mortality than a planned admission from the operating room. Staff may be relatively inexperienced, tired or dealing with unfamiliar circumstances and it seems logical to conduct a structured assessment of risk towards the end of surgery. One method would be to use the Apgar score for surgery.[37] An alternative would be to use the bundle described below[38] within the last 30 minutes of surgery in all cases identified by the pre-operative assessment as having mortality risk ≥5% and in those who deteriorate during surgery.

1) Risk score patient (≥5% mortality defines high risk)
2) Check arterial blood gases to assess lactate, acid-base status and the ratio of arterial oxygen concentration to the fraction of inspired oxygen (P:F ratio)
3) Summarise fluids given and draft ongoing fluid requirements.
4) Reverse muscle relaxant; use of nerve stimulator is mandatory.
5) Check and document temperature, plan further correction as necessary.

Based on the bundle criteria, the surgeon and anaesthetist should decide jointly the preferred destination of the patient after surgery. All patients with predicted mortality ≥10% should be admitted to the appropriate (level 2/3) critical care unit with surgical competencies. This decision will be influenced by adverse events during surgery or a high likelihood of deterioration in the short to medium term. The bundle should be used to supplement rather than replace existing indicators of the need for critical care. Details of the criteria are given in Appendix 3.

The use of 'bundles' has been shown to increase the reliability of key steps of care.[39] The concept of using a bundle at the end of high risk surgery should be tested in individual institutions, if necessary adjusted for context, and if found to increase the reliability of key step delivery, incorporated into routine anaesthetic paperwork. Joint early discussion with the critical care team is fundamental.

Postoperative care

Access to critical care is an essential aspect of adequate peri-operative care for the high-risk group in order to identify complications early and minimise their impact. All patients should be managed after surgery in a location determined by risk and staff competence. Hospitals should plan their critical care resource to match need in order to avoid shortages and define critical care areas accordingly. Patients should move up and down through a spectrum of levels of care. Levels of care are described[40, 41] as shown in Table 1.

Table 1. Levels of care

Level	Description	Patient characteristics
0	Ward	Basic observations
1	Enhanced ward	At risk of deterioration, more frequent observations, basic resuscitation
2	High dependency	Needs detailed observation, intervention or single organ support
3	Intensive care	Multiple organ support, complexity

All patients with a predicted mortality of ≥10% should be admitted to a level 2 or 3 critical care area after surgery and all patients should have an updated management plan which incorporates haemodynamic and blood gas parameters, on-going antibiotics, nutrition and thromboembolic prophylaxis.

Importantly, trusts may wish to examine their existing provision particularly around levels 1 and 2. When compared to level 0 care, the impact of level 1 or 2 care is likely to be much greater in the unscheduled surgical population than the elective population due to the dynamic nature of the acute illness and its influence on organ function. Recognition of any deterioration in organ function and timely intervention is essential to optimise patient benefit. Provision of this level of monitoring is frequently difficult to deliver in a standard ward environment with a staffing ratio which is frequently <0.20 nurse-to-patient.[42] Defining and auditing pathways for such patients affords organisations an opportunity to address competencies of staff and staffing ratios to deliver a reliable tiered pathway of care.

Considerable gains in outcome are likely with improved level 1 and 2 care and some organisations have developed bespoke solutions such as the development of post-anaesthesia care unit (PACUs) or co-locating medium risk patients in pre-defined clinical areas.

Structured care on the PACU

A patient inappropriate for the ward could be admitted to PACU for continued monitoring. Formal joint assessment should occur after four hours. If the patient is alert and has a normal temperature, mean arterial pressure, pH, lactate and gas exchange, and the previous three consecutive hourly urine volumes were all >0.5 ml/kg, transfer to the ward is acceptable unless there is specific clinical concern to the contrary.

If the above criteria are not met after four hours in PACU, care should be formally taken over by the critical care team who will continue to care for the patient in PACU until transfer to a critical care bed can be arranged or the patient is considered ready for transfer to the ward by a senior critical care specialist.

To do this, hospitals will need to ensure that there is a 24/7 PACU service and that a consultant from anaesthesia/critical care/surgery is identified to take responsibility for this provision and to work with the PACU manager to ensure delivery of appropriate care.

Ongoing audit will allow assessment of impact of PACU on elective and emergency surgery. Hospitals will wish to make the difference between PACU and theatre recovery explicit as inadequate staffing may result in loss of ability to undertake further emergency surgery if a patient is 'blocking' recovery. These events should be audited and classified as an adverse incident.

Co-location of medium risk patients

Existing systems of critical care can leave a large step between high dependency unit (HDU) and ward care. In cost-limited times, the co-location of medium risk patients in special wards or ward-areas (level 1) could be expected to lead to immediate improvement in standards even if staffed near general surgical ward levels and without significant investment in additional monitoring.

Immediate benefits would be promoted, providing trusts:

- establish local protocols drawn up jointly between surgical and critical care departments to define parameters of care and to ensure seamless transition of patients between units
- establish co-operative education programmes with critical care for nursing and medical staff
- establish improved daily communication between units
- recommend geographical proximity to critical care where possible
- name a critical care consultant with responsibility for basic education and support for nursing and junior medical staff.

Audit and outcomes

The relative paucity of data in this field needs to be addressed urgently, preferably on a national basis. Given the mortality and morbidity associated with this group, comparative risk-adjusted outcomes should be monitored for each hospital and would be completely in line with national policy. At the moment, HES data may be the best available. The adoption of a defined basket of healthcare resource group (HRG) codes would facilitate this. International comparisons would provide the greatest re-assurance that care for this group is optimal.

Local audit of outcomes is an important driver for change. The processes advocated in this report should be audited in each hospital and key indicators include:

- outcomes (death, length of stay) from higher risk general surgery
- frequency of observations in higher risk group
- accuracy of risk estimate prior to surgery
- accuracy of risk estimate at end of surgery
- time to CT from emergency admission or deterioration
- time from deterioration to operation for higher risk group
- compliance with the standard for intra-operative surgical team seniority
- compliance with post-surgery pathway for higher risk patients.
- unplanned surgical readmissions to critical care within 48 hours of discharge back to the ward.

Emergency laparotomy is a clearly defined point in the pathway of a significant proportion of these patients and in this group, many of the factors discussed in this report come together. The laparotomy network audit (http://www.networks.nhs.uk/nhs-networks/emergency-laparotomy-network) is beginning to look at these patients on a voluntary basis and this study should be supported and expanded.

Conclusions

Peri-operative care of higher risk general surgical patients in the UK appears to have significant deficiencies. Outcomes are variable, appear worse than other countries and generate a large health cost through prolonged hospital stay and use of intensive care.

While there are several specific initiatives (eg hospital-acquired thrombosis) and patient pathways for single operations (eg aortic aneurysm), there is a lack of overall recognition and strategy for the care of all patients at higher risk of death and complications.

This higher risk group comprises 12–15% of cases but contributes 80% or more of postoperative deaths and complications. This group can be identified at an early point and differential management pathways applied. Identification of these at risk patients should become a formal part of patient assessment and included in the pre-operative checklist.

Standards of care are described in this document. Trusts should develop pathways in order to achieve these. The clinical pathway should identify risk of death for an individual patient, match the needs of the patient, based on risk of death with timing and choice of diagnostic tests, seniority of clinician in decision making, timing of surgery and post-operative location of care.

In particular, attention could be better focussed on elective cases who develop complications and on major emergency cases. A defined and escalating pathway of management, which complements existing guidance for acute care, should be adopted. The described pathways match urgency to patient need and include guidance on senior involvement and time to treatment.

An estimated mortality of ≥5% defines a high risk patient.

High risk procedures should be managed by consultant staff. Active input will always be required and consultants should usually be present for procedures and anaesthesia when the risk of mortality exceeds 10%.

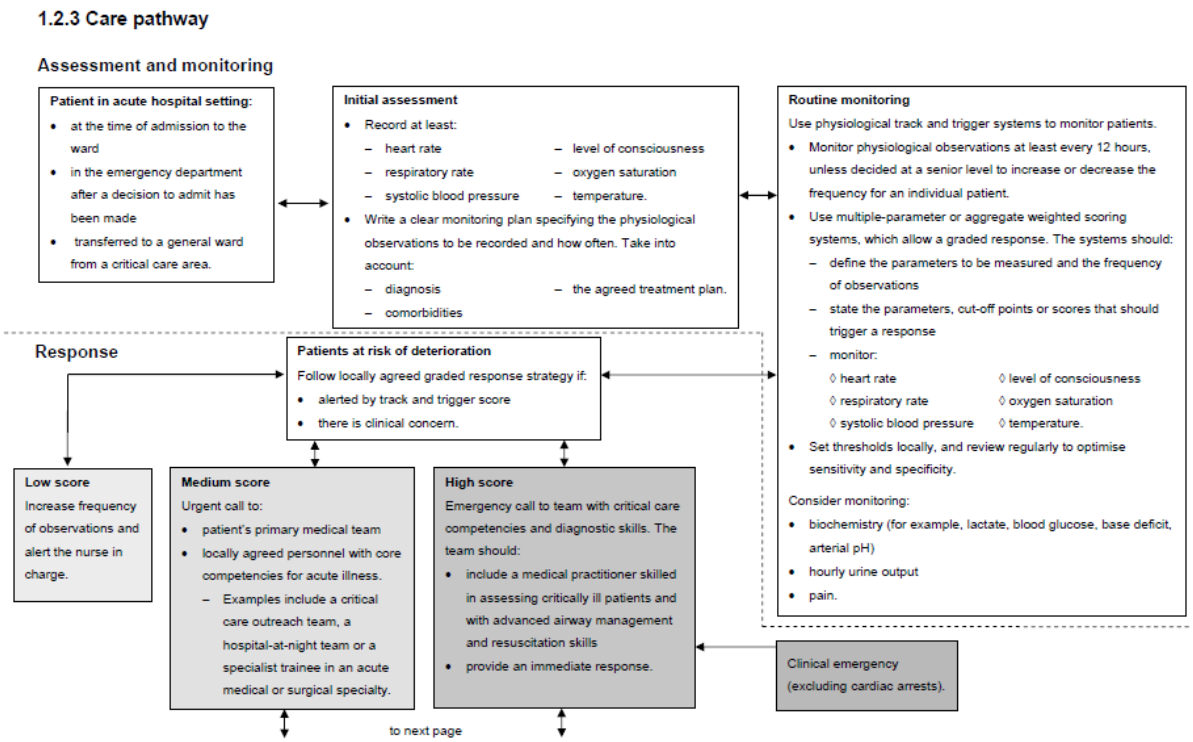
There should be a brief but structured review of risks towards the end of higher risk operations, conducted jointly between surgeon and anaesthetist. This end of surgery bundle should guide the location of post-operative care.

Higher risk patients should be managed after surgery in a location capable of meeting their need for higher levels of care. Trusts should look critically at their provision of enhanced levels of care as investment in better perioperative care would realise benefits for both cost and outcomes.

The principal life threatening complication is the development of severe sepsis. Patients from this group account for the greatest use of ICU beds. Improved assessment and treatment would likely improve outcomes and reduce ICU utilisation.

Outcomes from emergency surgery are difficult to compare due to the range of diagnoses and operations. A national audit of higher risk emergency surgery is essential. A basket of HES codes is proposed and should be agreed for ongoing comparison.

Figure 1. Care pathway



MRCS to attend patient and to coordinate response.
MRCS will immediately leave less urgent tasks such as clinics and ward rounds and will delegate to an appropriately competent colleague if currently operating or attending another medium-high score case.

MEDICAL

Continue to follow NICE CG50

SURGICAL

Immediate life, limb or organ saving surgery is indicated. Resuscitation is simultaneous with intervention. Example; the exsanguinating patient. MRCS to liaise with consultant surgeon, anaesthetist and theatre staff. The patient should be transferred to theatre within minutes of the decision to operate.	**The patient is septic** The need for source control must be established rapidly. Urgency of surgery depends on severity of sepsis. **The patient has sepsis** but no organ impairment or low score risk. Establish source control urgently and always within 18 hours. Patient should be monitored hourly and reassessed by MRCS every 6 hours to check for progression to severe sepsis/septic shock. **The patient has severe sepsis** or medium-high score risk without hypotension. Establish source control as soon as possible and within 6 hours maximum. Reassess hourly for progression to septic shock and provide appropriate interim critical care. **The patient has septic shock**. The patient's chance of survival progressively deteriorates with increasing delay to source control. Establish source control as soon as possible. Transfer to theatre must not be delayed for resuscitation which should be continued in the anaesthetic room.	**The patient is NOT septic and does not require immediate intervention** Organise initial treatment and investigations, liaise with consultant surgeon and plan definitive treatment.

Appendix 1: Early warning score (EWS)

This is a scoring system used to track abnormal physiology and trigger clinical response. The score is based on routinely recorded physiological observations such as blood pressure and heart rate. Each observation is given a score of zero if it is normal, increasing to (typically) three as the observation deviates further from the normal range. The sum of all parameter scores gives a total EWS. There is currently no national system in use. Different hospitals use scoring systems that differ in the methodology for generating the final EWS and in the response. Until a national scoring system (expected to be available in autumn 2011) is established (and audited) the only generally applicable guidance comes from NICE CG50 which stipulates that hospitals should establish a graded response system according to the following system:

Low-score group: increase frequency of observations and inform nurse in charge.

Medium-score group: urgent call to team with primary medical responsibility and simultaneous call to personnel with core competencies for acute illness.

High-score group: emergency call to team with critical care competencies and diagnostic skills.

Septic Shock is defined as severe sepsis complicated by persistent hypotension (systolic less than 90mmHg or >40% decrease from baseline) that is not reversed by fluid resuscitation. An adequate volume of fluid is considered to be 20ml/kg of crystalloid or an equivalent volume of colloid. In this document hypotension in the context of severe sepsis is taken to be persistent hypotension that is not fluid responsive.

Appendix 2: End of surgery bundle

1) The POSSUM score is the most validated risk prediction method for general and vascular patients that takes into account pre-operative and peri-operative factors. P-POSSUM may be used for all patients.[43] A predicted mortality risk ≥10% indicates need for critical care admission, except for patients on end-of-life pathways with appropriate palliative care facilities available at ward level.

2) Hyperlactataemia (>4 mmol/l) and significant metabolic acidosis indicate unresolved physiological impairment that requires ongoing invasive monitoring +/- physiological support.[26] Serum lactate levels may also be used to guide fluid therapy and levels >2 mmol/l indicate the need for closer monitoring.[44] P:F ratio <40kPa is consistent with an acute lung injury. A senior critical care specialist should be involved in the decision to extubate. A P:F ratio <26kPa is consistent with a diagnosis of acute respiratory distress syndrome (ARDS): the patient should be transferred to ICU intubated.

3) Both excessive and inadequate intravenous fluid administered in the peri-operative and post-operative period can be harmful particularly in the elderly.[14] A fluid plan should be agreed between the anaesthetic team and senior surgeon, bearing in mind current evidence and the risks of both excessive and inadequate fluid therapy.[36] This should include blood loss and replacement.

4) Partial reversal of muscle relaxation is common and poorly recognised. It is a risk factor for post-operative respiratory failure and aspiration. Nerve stimulation and reversal is mandatory if a neuromuscular blocker has been given regardless of time interval. A train-of-four (TOF) ratio of 0.9 is required for airway protection. Unfortunately TOF ratio is difficult to assess accurately by observation alone.[45] To be confidant of airway protection, neostigmine should not be given if the TOF count is less than two and at least nine minutes should elapse after neostigmine bolus before extubation is attempted.

5) Hypothermia (core temperature <36°C) increases the incidence of post-operative myocardial events[46] and wound infections. Drug metabolism is reduced such that duration of neuromuscular blockers can be doubled[47] and neostigmine can take 20% longer to take effect.[48] NICE clinical guidance (*Management of Inadvertent Perioperative Hypothermia*, 2008) should be followed.[49]

Appendix 3: Unscheduled adult general surgical pathway

This pathway has four identifiable components: Clinical Assessment, Diagnostics, Intra-Operative, and Post-Operative phases. It was developed by clinical staff from surgery, anaesthesia, intensive care medicine, radiology and emergency medicine in Central Manchester University Hospitals NHS Foundation Trust. The pathway will assist colleagues in matching an individual patient's risk of death to seniority of staff in decision making and identifying the timing of key interventions. These include the timing and choice of diagnostic tests and location of post-operative care. The pathway describes measurable standards based on the report.

	Clinical assessment	Diagnostics	Intra-operative phase	Post-operative care
FEATURES	Decision based on: clinical history, clinical examination, bedside observations, EWS and laboratory tests.	Laboratory: assessment of organ function; microbiology assessment. Radiology: choice determined by clinical examination and history. Minimise secondary renal morbidity.	Assessment of risk associated with anaesthesia and surgery calculated and documented in notes. The surgical risk will be calculated using P-POSSUM. The risk associated with anaesthesia will be undertaken using the ASA grade. Antibiotics within 30mins prior to skin incision. Optimisation of peri-operative fluid administration, cardiovascular and respiratory function. Monitoring of other organ function	Patients will be located in a clinical area dependent on end of surgery bundle assessment. Principles of care: » Post-operative plan determined by diagnosis/surgery/ clinical condition. » Early detection of new onset acute organ dysfunction. » Mobilisation at the earliest opportunity.
DECISION MAKING	MRCS and senior help as indicated by condition.	MRCS.	MRCS and FRCAnaes.	MRCS for low and medium risk populations.

	Clinical assessment	Diagnostics	Intraoperative phase	Postoperative care
INTERVENTIONS	Monitoring EWS plan set. Minimum of 4 hrly observations. Graded response based on EWS and clinical progress. Diagnostic plan identified. Senior review within 12hrs (Consultant or MRCS trainee should not be moved from ESU or nor should they be handed off to another team until review has occurred). If referred to another surgical team senior review within 12hrs. Organ dysfunction quantified. Antibiotics as per Trust Surviving Sepsis guidelines.	USS CT; selection of contrast determined by renal function. CT with angiography. Discussion about need for interventional / other procedures before leaving the radiology dept.	Intra-operative: » Invasive monitoring to optimise intravascular fluid therapy and organ perfusion. » Measurement of arterial blood gases and lactate. » Minimise risk of secondary organ dysfunction eg atrial fibrillation, basal atelectasis, renal dysfunction. End of Surgery: » Assessment of postsurgery organ support needs, based on operative findings, clinical state and risk of further deterioration. » Development of Bundle to identify low, medium and High Risk Groups and determine postsurgery pathways	Maintain minimum of 1hrly observations following surgery until senior review. Antibiotic regime dependent on surgical diagnosis. Chest physiotherapy and Mobilisation regime. Nutritional regime. DVT prophylaxis. Use of continuous fluid balance monitoring. Daily biochemistry and Haematology until stepped down in frequency by senior review. Post-operative pain relief regime according to protocolised care.

	Clinical assessment	Diagnostics	Intraoperative phase	Postoperative care
HIGH RISK CRITERIA	Patients with a predicted mortality >10% (using P-POSSUM or other scoring system). 2 SIRS criteria + l acute organ dysfunction. Age>65. Dialysis dependent patients. ASA>3 + 1 organ dysfunction ASA4 & 5. Ptients who are immunosuppressed e.g. transplant patients, IVDA. IDDM patients. Patients on long term steroids or Beta blockade.	Evidence of luminal perforation. Suspected ischaemia/ infarction/intra-abdominal bleeding.	Pre-Surgery: » ASA3 + at least 1 acute organ dysfunction/failure. » ASA 4 or 5. » Dialysis dependent patients. » Patients with elevated lactate > 4mmol/L. End of Surgery: » Elevated Lactate >4mmol/L. » Patients with P/F ratio<40kPa. » Patients at risk of intra-abdominal hypertension and abdominal compartment syndrome. » Patients with massive transfusion: risk of TRALI. » Hypothermia (core temp <36°C at end of procedure).	Patients within critical care. Patients with new onset organ dysfunction / failure admission to critical care based on current EWS protocol.
DECISION MAKING FOR HIGH RISK GROUP	Consultant-led process – identified and communicated to general consultant on call within hour	Consultant-level decision making: surgery and radiology.	Consultant anaesthetist, surgeon and critical care discussion.	Consultant surgeon and consultant in critical care.

	Clinical assessment	Diagnostics	Intraoperative phase	Postoperative care
INTERVENTIONS	Arterial blood gases. Expedited diagnostic investigations (CT within 6hrs). Goal directed resuscitation. Communication of results of investigations to consultant surgeon and general anaesthetic team (FRCAnaes) including emergency theatre within 1 hour.	Definitive surgery within 2hrs to operate. Critical care needs discussed with anaesthesia and critical care. Avoid further organ dysfunction by adoption of supporting clinical initiatives, eg Acute Kidney Injury protocol.	Intra-operative period: » Targeted optimisation of cardiovascular and respiratory function using invasive techniques. » Anaesthesia to expand. End of Surgery: » Consultant surgeon and anaesthetist to assess risk of further deterioration and ultimate mortality: using bundle, clinical findings (ischaemia, evidence of perforation, ongoing bleeding, new onset rhythm, need for vasoactive drugs, evidence of ALI, elevated lactate, renal dysfunction). » High risk group will require level 2 or 3 critical care post-surgery and should be admitted to critical care at the end of surgery. » Patients requiring level 1 critical care should return to a ward area with increased monitoring frequency (initial monitoring every 30mins for 2hrs followed by hourly until next senior review (MRCS)). » Consultant in critical care involved in post-surgery pathway for level 2 and 3 patients.	Time to admission to critical care within 4hrs of decision to admit to critical care.

	Clinical assessment	Diagnostics	Intraoperative phase	Postoperative care
CLINICAL STANDARDS	Consultant Surgeon involved in decision making for high risk group within 1hr of identification as high risk. Definitive diagnostic CT as early as possible but should be within 4hrs of identification as high risk. Patients admitted with septic shock should have an operation to treat the source of sepsis within 3hrs of admission. Patients with an intraabdominal pathology and organ dysfunction should be operated on within 6hrs of onset of organ dysfunction. Consultant review within 12hrs of emergency admission for all other patients. CT for non-high risk group within 24hrs of decision to undertake a CT.	Consultant decision making for high risk group. Time to operate within 2hrs of decision to operate for high risk group. For non-high-risk group definitive operation within same working day from time of decision to operate.	Use of end of surgery bundle. Decision making team for high risk patients involves consultant surgeon, intensivist and anaesthetist.	All high risk patients admitted to critical care within 4hrs of decision to admit. No unplanned readmissions to critical care within 48hrs of discharge back to the ward.
AUDIT	CT within 4hrs for high risk Group. Definitive decision within 1 hour of CT.	Time to operate for both high and non-high-risk groups.	Compliance with documenting the risk of surgery and anaesthesia using P-POSSUM and ASA grading. Compliance with end of surgery bundle.	Unplanned surgical readmissions to critical care within 48hrs of discharge back to the ward. Time of admission to critical care for high risk group.

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