How and why do we measure surgical risk?

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Surgical decision-making has evolved over time, and what was once an intuitive matter for surgeons has now become a multi-faceted decision with increased expectations from medical staff and patients, making the decision-making process itself often as challenging as the technical procedure.

When planning the most appropriate treatment for a patient, it is important to distinguish what we aim to achieve with regards to treating the pathology from what can be realistically expected from the patient physiologically. In other words, has the patient the potential to withstand the insult of the treatment itself and what are the risks involved? By quantifying this risk and making it a key part of surgical decision-making, we can arrive at the safest modality of treatment for an individual patient. This allows realistic expectations for the patient, helping them to make an informed decision.

This article aims to highlight some of the important aspects of surgical risk and the impact they have on patients.

INTRODUCTION

Risk has always followed surgery but its prediction has been more recent. Whenever surgery is offered as a potential treatment, it conjures up ideas of risk, particularly when compared with other options. This is reflected in the term 'conservative', used to mean non-surgical management.

Surgical decision-making has evolved over time from what was once little more than personal experience and intuition. However, in some situations this may become so complex that the decision-making process itself can be as challenging as the technical aspects of the surgery. All surgical procedures have complications, which may be considered to be a necessary occupational risk for surgeons. By surgical risk, we mean the risk of major morbidity and mortality to the patient in the perioperative period. Yet risk to both the patient and surgeon is relative. For instance, the risk of 5% mortality may be unacceptably high for a patient undergoing a fundoplication, whereas 50% operative

mortality may seem acceptable to a patient with a ruptured aneurysm.

We discuss some of the aspects of surgical risk and its effect on decision-making. The classical view is that this is an issue which is primarily the realm of the surgeon and the anaesthetist. However, we believe that appreciating the complexities of such a process is in the interests of all clinicians.

METHODS

We conducted a MEDLINE search using the following terms: 'surgical risk', 'perioperative risk', 'risk stratification' and 'risk prediction'. Articles considered for evidence included meta-analyses, review articles, large single-centre studies and non-randomized controlled trials.

THE EVOLUTION OF RISK PREDICTION AND SCORING SYSTEMS

Before the widespread introduction of scoring systems to predict postoperative outcomes, many surgical decisions were based upon the 'gut feeling' of the operating surgeon. Although the accuracy of such an assessment would invariably rely on the experience of the surgeon, there is some evidence that simple measurements can be equally as effective in predicting medical risk as more complex systems.¹ Furthermore, with the current drive towards protocol-led medical practice, it is important not to forget these traditional skills of clinical judgement. In fact, compared with an objective scoring system it has been demonstrated that surgical intuition is particularly effective in identifying patients with a poor prognosis.²

The development of objective risk prediction perhaps reflects the shift towards outcome measurement as part of the evolution of clinical governance in the National Health Service. Though there may be little difference between traditional approaches towards risk assessment and objective scoring systems, the requirement of a measurable evidence-based practice suggests subjective tools are less valued. Part of a modern and dynamic health-care system is accountability and safe-guarding of good practice, which is difficult to achieve in the absence of objectivity.

A number of objective systems have been developed over the last quarter of a century. Many early scoring tools seemed to be confined to intensive care settings; the software was often expensive to purchase and inputting the

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copious data from each patient was labour intensive. Now many of the prediction tools are simple to complete and easily accessible in the hospital via free internet resources, for example www.riskprediction.org.uk.

As prediction tools have developed, so has the patient interaction with doctors' decisions regarding whether to operate. Rather than the clinician simply dictating treatment plans, the involvement of the patient is integral in the consent process; the so-called 'doctor is always correct' ethos is rapidly losing ground. The estimation of risk should ideally be conveyed at the time of consultation by considering the patient as an individual rather than simply recounting the standard procedural risks.

POPULAR PATIENT-ASSESSMENT AND RISK-PREDICTION SYSTEMS

Before addressing the clinical impact and consequences of accurate risk prediction, it is important to appreciate some of the common systems used by clinicians in making these potentially difficult decisions. Although an exhaustive review is beyond the scope of this article, we aim to highlight some of the important points of such tools. Each has its own merits; however, they rely on different information in their estimation of risk, making direct comparisons difficult.

ASA (American Society of Anesthesiologists)

This widely used system can be measured simply by history-taking and clinical examination (Table 1). Originally described by Saklad³ for the use of statistical data management and later revised by the ASA,⁴ it does not include physiological variables and classifies patients into one of six categories of increasing severity. It was initially intended to provide a preoperative assessment but is rather subjective. One study showed that when over 300 anaesthetists attempted to grade 10 patients, on average only 5.9 patients were given the same rating by the anaesthetists and the author of the study.⁵ However, the system may allow anaesthetists to identify patients who require escalated perioperative care, thus ensuring these facilities are available if required. Perhaps the popularity of the ASA classification is due to its simplicity and suitability

for all surgical patients and its avoidance of quantitative data input.

There are many examples of retrospective studies correlating ASA grading and postoperative mortality.^{6–8} The ASA classification has subsequently been successfully used to predict the risk of adverse surgical outcomes such as cardiorespiratory complications, intraoperative blood loss and duration of intensive-care stay.⁹

APACHE (Acute Physiology and Chronic Health Evaluation)

First described over a quarter of a century ago, this system has been much revised (Table 2). The original system included an exhaustive 34 physiological variables and required values to be entered at different stages of a patient's admission to hospital.¹⁰ Perhaps partly because of its complexity, it was primarily used in intensive care settings, but has evolved over the years to be more applicable to a surgical setting. Version III—although not as widespread as the more popular APACHE II—allows clinicians to enter ongoing data and thus provide a dynamic assessment of the patient's condition.

The APACHE score is a total of the physiological variables, age points and chronic health scores.

POSSUM (Physiological and Severity Score for the Enumeration of Mortality and Morbidity)

The POSSUM system (Table 3) was developed in 1991 to address the concerns, relevance and application of the principles of audit in surgical practice.¹¹ It aimed to provide estimates of morbidity, as most scoring systems were based on mortality. POSSUM has become an increasingly popular tool in outcome measures and individual appraisals. Although originally described as a scoring system for surgical procedures generally, it has been modified for use in specific areas of surgery, including colorectal surgery (CR-POSSUM) and vascular surgery (V-POSSUM).

It compares favourably to other popular scoring systems such as APACHE, albeit the latter is often reserved for critically ill patients rather than all surgical patients. However, there have been accuracy problems with this system—hence the continual search for better tools. The main concern has been an over-estimate of mortality (and morbidity) by up to a factor of 10 in the lowest risk groups.¹² Newer models based on POSSUM, such as P-POSSUM, have sought to find a more accurate predictor.¹³

Further risk-predicting tools

There are now dozens of risk-predicting systems, many including certain facets of the patient's fitness, often focusing on cardiorespiratory function but ignoring other relevant factors (e.g. obesity, which is an independent risk

Table 1 ASA Physical Status Classification System

P1	Normal and healthy
P2	Mild systemic disease
P3	Severe systemic disease
P4	Severe systemic disease that is a constant threat to life
P5	Moribund and not expected to survive without operation
P6	Brain dead, whose organs are being removed for donation

Table 2 APACHE II (Acute Physiology and Chronic Health Evaluation)

Total Acute Physiology Score									
	4	3	2	1	0	1	2	3	4
Physiological variable									
Temperature – rectal (°C)	≥ 41	39–40.9		38.5–38.9	36–38.4	34–35.9	32–33.9	30–31.9	≤ 29.9
Mean arterial pressure (mmHg)	≥ 160	130–159	110–129		70–109		50–69		≤ 49
Heart rate	≥ 180	140–179	110–139		70–109		55–69	40–54	≤ 39
Respiratory rate	≥ 50	35–49		25–34	12–24	10–11	6–9		≤ 5
Oxygenation (aDO ₂ or PaO ₂)	≥ 500	350–499	200–349		≤ 200				
					pO ₂ > 70	pO ₂ 61–70	pO ₂ < 55–60		pO ₂ < 55
Arterial pH	≥ 7.7	7.6–7.69		7.5–7.59	7.33–7.49		7.25–7.32	7.15–7.24	< 7.15
Serum sodium (mEq/l)	≥ 180	160–179	155–159	150–154	130–149		120–129	111–119	≤ 110
Serum potassium (mEq/l)	≥ 7	6–6.9		5.5–5.9	3.5–5.4	3–3.4	2.5–2.9		< 2.5
Serum creatinine (mg/dl)									
[double score for acute renal failure]	≥ 3.5	2–3.4	1.5–1.9		0.6–1.4		< 0.6		
Haemocrit (%)	≥ 60		50–59.9	46–49.9	30–45.9		20–29.9		< 20
White blood count (total/mm ³)	≥ 40		20–39.9	15–19.9	3–14.9		1–2.9		< 1
Glasgow Coma Scale = 15 minus actual GCS									
Age points									
Age (years)	0	1	2	3	4	5	6		
	≤ 44		45–54	55–64		65–74	≥ 75		
Chronic health score. The following points are assigned for severe organ system insufficiency or immunocompromise (10):									
Points	Patients								
2	Elective								
5	Emergency								

factor for surgery).¹⁴ In fact, a tool encompassing every relevant factor in predicting every risk is difficult to imagine. Where available, a more objective and accurate estimate of the physiological reserve of a patient can be obtained by preoperative cardiopulmonary exercise testing (exercise ECHOs/VO₂ levels). Such tests aim to give a measured idea of risk from co-morbidity but are complex and are not yet widely used. In the future, it is proposed that risk prediction may even include genetic testing, thus predicting patients' response to sepsis,¹⁵ for example.

HOW RISK PREDICTION AFFECTS PATIENT MANAGEMENT

Figure 1 provides a graphic representation of the relationship between risk prediction and patient management.

Patient selection

Risk prediction can help in making the decision whether to adopt an operative or nonoperative management strategy. In many different fields, there has been an increasing involvement of the so-called multidisciplinary team (MDT). This allows several specialists with different areas of expertise to input management plans, with the ultimate

aim of providing the best form of treatment to the patient. This has been most commonly seen in cancer management. Despite the obvious benefits of such an approach, however, there are potential pitfalls. It is not surprising that there can be difficulties in harmonizing alternative views to result in an agreed plan. Most MDTs are led by surgeons, as surgery

Table 3 POSSUM variables

Physiological parameters	Operative parameters
Age	Type of operation
Cardiac status	Number of procedures
Respiratory status	Operative blood loss
ECG status	Peritoneal contamination
Systolic blood pressure	Malignancy status
Heart rate	Urgency of operation
Haemoglobin	
White blood cell count	
Urea	
Sodium	
Potassium	
Glasgow Coma Scale

Figure 1 Relationship between risk prediction and patient management

still remains the best chance of a relative cure for most solid cancers, and this perhaps encourages oncological resection despite the risks. However, it should be remembered that a decision not to operate is generally agreed to be more difficult than the one to proceed with surgery.

In addition to the fear of cancer spread, debilitating symptoms may influence what degree of risk is acceptable to patient and surgeon. It is likely that these difficult decisions are going to become increasingly frequent with the advancing age of a population that may have more-than-realistic expectations of modern-day surgery. In an increasingly elderly population, the calculation of actuarial life expectancy can be useful when assessing whether the surgical intervention is going to prolong life. Ultimately the patient should decide whether or not to undergo surgery, but some patients are more capable of making these complex decisions than others.³ Though it is important, patient choice should not make the surgeon commit to futile surgery where the operative risks of procedures clearly outweigh those associated with the natural disease progression. The majority of patients are guided by their surgeon, but an objective assessment of risk may help all concerned, especially when the decision is in doubt.

Informed consent

There has undoubtedly been an increased level of litigation surrounding the management of medical conditions in recent years. This may be partly attributed to the increased expectations of patients. These may be tempered by objective prediction, which also offers protection to the surgeon. The ability to predict perioperative morbidity and mortality is thus important in surgical management, as it allows individual patients to give informed consent.

Accurate rates of specific complications quoted to patients should ideally come from departmental audit rather than national figures. These, combined with risk-prediction tools, provide objective assessment of likely surgical morbidity and mortality risks that can be directly communicated to patients. And with the patient being at the centre of any decision-making process, surely it should be the clinician's duty to provide the facts rather than dictate treatment. By providing this information to the patient and using the thoughts and concerns of the patient at the time of consultation, patients can be furnished with a more accurate expectation of their surgery and the risks involved.

Level of medical care

Risk prediction may be used to predict the need for monitoring on high-dependency units before or after surgery. An objective scoring system may also allow high-risk patients relative priority for such a limited resource, as the least-fit patients may be expected to benefit more from the increased intensity of care. As mentioned previously, many of the techniques and strategies used by anaesthetists in elective patients have developed from the critically ill. Such an example is 'goal-directed therapy', a principle by which clear objective goals are targeted in a number of physiological parameters. This aggressive technique has recently been adopted by many intensivists to enhance patients' preoperative status.¹⁶

By identifying groups of patients who may benefit from this strategy, intensivists have sought to enhance their physiological status, aiming to reduce postoperative complications. This can be further supplemented by nursing patients on high-dependency units immediately after surgery. One study identified patients with the highest

POSSUM and ASA scores and admitted them to an intensive care unit both preoperatively for optimization, and postoperatively for care. These patients had significantly lower morbidity and mortality than otherwise predicted using POSSUM.¹⁷

Surgical outcomes

The publication of league tables of morbidity and mortality may deter surgeons from operating on high-risk cases if case mix is not taken into account. The objective preoperative assessment of risk of mortality may become a vital tool in allowing surgeons to offer high-risk patients the choice of surgery, without the fear of adverse outcomes preventing the surgical option being offered. Measuring outcomes for particular surgical units will allow feedback and adjustment to the accuracy of generic risk-prediction tools validated elsewhere. The audit of personal outcomes may also act to protect the surgeon, who would be able to compare observed mortality figures with those predicted preoperatively.

CONCLUSION

Surgical risk predictors have been developed to objectively estimate complications, though this should not be at the expense of surgical intuition. Though there are increasing numbers of prediction methods available, there seems to be no perfect tool. However, it must be remembered that such tools should not be used in isolation and by no means as the sole means of decision-making. Although predictors can be individualized, they largely pertain to populations rather than an individual, whose mortality rate must be either 0% or 100%. As long as these limitations are understood, they may provide a valuable tool that informs patients as much as protects surgeons. We advocate their use, especially in high-risk surgical patients, as with time they will add science to instinctive decision-making. If used to their potential, scoring systems should impact upon perioperative care planning, informed consent and patient selection for surgery, and allow feedback to surgical outcome measures.

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