Managing risk to improve cardiac surgical outcomes

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ABSTRACT

Mortality and quality of cardiac surgery are inextricably linked. Mortality can be a suitable measure of the quality of the service as long as risk is taken into account, using one of a variety of available risk models. The measurement of risk-adjusted mortality can provide the tools with which to improve cardiac surgical outcomes, as well as open up an exciting area of future study to identify where further improvements can be made.

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Doctors usually do their best for patients. In medical specialties, if treatment fails and the patient dies, the disease (or the patient) is blamed: "he failed to respond to treatment". It is different in surgery. This is not surprising, because of the strong temporal, if not causal, link between the intervention and the outcome. As cardiac surgery began to stake its rightful claim in the field of treatment of heart disease, surgeons had to justify aggressive intervention by showing that they could achieve cure or palliation for the majority, with an "acceptable" risk of death for the minority. It was inevitable that a link would become established between operative mortality and the measurement of surgical performance.

Does operative mortality matter?

Purchasers of health care are often very concerned about cost, and possibly not enough about clinical outcomes. Surgeons and their patients care more about outcomes (and possibly not enough about cost). Sometime in the late 1980s, a health authority paid a large sum of money to a famous firm of accountants and management consultants to examine the performance of the two cardiac surgical centres in its area. After a long and exhaustive study, the firm reported its findings, summarised in Table 1.

The famous accountants concluded that Hospital A was more efficient at routine procedures and should therefore be restricted to simple operations. However, Hospital B was found to be more efficient in complex and redo surgery, and should therefore be expanded as a quaternary referral centre for such cases. Sadly, the famous accountants did not examine clinical outcomes. Had they done so, even to a rudimentary extent, they would have found that mortality rates tell a different story: the "efficiency" of Hospital B in complex surgery was due to the high death rate during surgery (Table 2).

Operating room deaths cost little. A long and difficult hospital stay is more expensive, but the outcome of survival is undoubtedly desirable for the patient, the family and the institution. It should also be the desired outcome for the (intelligent) health care purchaser. The above example illustrates, admittedly in simplistic terms, the dangers of entrusting surgical performance assessment to accountants, regardless of fame.

Operative mortality matters. Of course, it is only one of many outcomes that determine the success of a procedure, others being morbidity, functional outcome, long-term survival and freedom from re-intervention. However, operative survival is the *sine qua non*, without which none of the other parameters can be measured. It is also the first step in assessing performance, and, until we have a robust method of measuring it correctly and meaningfully, detailed attention to other performance measures may be premature.

Crude mortality is not enough

Whenever operative mortality is compared, surgeons are quick to claim that they operate on higher-risk patients than their colleagues. When mortality for a specific procedure is higher for one surgeon (or hospital) than another, this can be due to one of three reasons, or any combination of the three:

- The difference is due to chance.
- The difference is due to variation in the predicted risk (different casemix).
- The difference reflects better and safer service.

The problem with crude procedural mortality is that it takes no account of the first two factors. The first factor can be eliminated by the appropriate use of statistical methods, and the second can be taken into account by using a measure of casemix, or risk stratification.

Few people realise that the risk for first-time coronary artery bypass graft (CABG) can vary by a factor of over 50. A low-risk elective CABG has a risk of under 1%, whereas emergency CABG in a 90-year-old with unstable postinfarction angina on an intra-aortic balloon is over 50%. Despite the substantial knowledge base on risk assessment in cardiac surgery, one London newspaper published league tables of CABG mortality in the United Kingdom without proper risk stratification. Having found that the range of mortality varied between 1% and 4% across the nation, the

Table 1. Cost of cardiac surgery (pounds sterling)

Procedure	Hospital A	Hospital B
Simple coronary artery bypass graft	£5600	£6800
Simple valve operation	£6400	£8700
Redo or complex	£9950	£4800

Table 2. Outcome of cardiac surgery (mortality)

Procedure	Hospital A	Hospital B
Simple coronary artery bypass graft	1%	3%
Simple valve operation	3%	6%
Redo or complex	9%	48%*

* Most of whom died during the operation.

accompanying article began, "scores of patients are dying needlessly …". The lesson from this is that, if medical professionals themselves do not carry out outcome analysis well, others will do it for them, and do it badly.

How do we measure risk?

Many risk models are available to us. They range from simple additive scoring systems, such as Parsonnet[1] and EuroSCORE,[2] to complex Bayesian and logistic models, such as the Society of Thoracic Surgeons database model,[3] the UK Bayesian model,[4] and the EuroSCORE logistic model.[5]

Additive models are easy to use, need no specialised equipment and are sufficiently simple to remember that a quick mental calculation can be made at the bedside "on the back of an envelope". They are effective as a model of quality control for large series of patients in an institution, as well as for inter-institutional comparison. Their main weakness is in the specific prediction of risk in some patient categories, especially very high-risk patients, in whom they tend to underestimate risk. More complex models can deliver better accuracy for individual risk assessment but require specialised tools. This becomes less of a problem with the exponential growth in the availability of information technology. EuroSCORE now offers a full logistic calculator, which can be used online or downloaded from the Internet for use on local computers.[6] There is even a calculator in lay terms for patients, and surgeons now see patients presenting at their clinics with a better idea of risk assessment than some of their doctors. As EuroSCORE project leader, I naturally favour the EuroSCORE risk models, but it does not matter too much which model we use, as long as risk is properly assessed.

The value of predicting mortality

A very important benefit of assessing the risk of death is to apply this knowledge in determining the indication to operate. When surgery is contemplated on symptomatic grounds, this knowledge is helpful in weighing the symptomatic benefits against the mortality risk. If the operation is purely on prognostic grounds, possession of this knowledge becomes mandatory: we must never offer an operation that carries a greater risk than the risk it seeks to avoid. The corollary of this is informed consent: if the surgeon needs this information to determine whether there is an indication for surgery, then the patient needs it before agreeing to surgery. However, risk prediction has a further and perhaps more important benefit: it provides a standard, corrected for casemix, against which the performance of hospitals, units and surgeons can be measured. Comparisons may be made for overall cardiac surgery, specific operation types, specific periods of activity and individual surgeons' practices, and outcomes can thus be objectively assessed.

Can outcome assessment improve outcomes?

The Hawthorne effect

Naughty children behave better when watched. The Hawthorne effect simply states that the behaviour of individuals may be altered because they know they are being studied. In cardiac surgery, this means that teams are likely to improve their performance with the realisation that their outcomes are being examined. At the most basic level, the easiest way to improve outcomes is to measure them. Furthermore, it is impossible to improve outcomes without measurement: if we do not know how well we are performing, how do we know whether there has been improvement?

Detecting and correcting underperformance

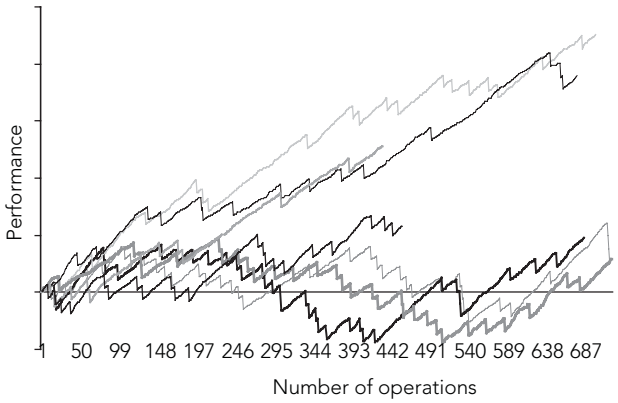
Statistical comparison of actual versus predicted outcomes gives a benchmark against which standards can be set, and the performance of surgeons and units evaluated. Clever use of variable life-adjusted displays (VLAD or cusum curves) allows for a massive amount of information about the performance over time of a surgeon or unit to be displayed in a simple one-line graph (Figure 1) and may act as an early warning system for deteriorating performance. We have shown that a serial murderer will not escape detection for long in an institution where such monitoring is used.[7] The same applies to a clinical underperformer: measurement of outcomes allows quality control and improves outcomes through the detection of "rogue elements" and subsequent remedial action.

Looking at anaesthetists

In the heat of the spotlight focused on individual surgeons and their outcomes, one consultant UK surgeon went so far as to say that, in the field of cardiac surgical mortality, the surgeon is merely "an innocent bystander". The implication was that other team members, especially the anaesthetist, may have more to do with surgical outcome than the surgeon.

Is it possible to improve overall performance by examining differences in outcomes related to individual anaesthetists? A recent study (Ferguson and Nashef, manuscript in preparation) examined the impact of anaesthetists on risk-adjusted mortality in over 10 000 consecutive cardiac surgical patients and found absolutely no evidence of a direct impact on outcome from the individual anaesthetist. This evidence is limited by its provenance from a single institution with fairly tight, uniform anaesthetic protocols, and similar studies elsewhere will be needed before these findings can be confirmed. However, the same study also looked at the impact of individual surgeons on outcomes, and here the findings were just the opposite: it *does* matter who the surgeon is.

Figure 1. Variable life-adjusted display (VLAD) graph showing the performance of cardiac surgeons over time



Each rise in the graph represents an actual survivor corrected for risk (1 minus the likelihood of survival). Each drop in the graph represents an actual death corrected for risk (1 minus the likelihood of death).

Looking at surgeons

We cannot escape the conclusion that one important way to improve outcomes is to optimise the performance of surgeons. The Hawthorne effect and the detection of rogue performers will go some way towards that aim, but more can be done.

A different type of risk

All human ventures are associated with a degree of risk. We take a risk when we cross the road, smoke a cigarette or ride a motorbike. The patient takes a risk in refusing or agreeing to surgery. The anaesthetist takes a risk in the conduct of anaesthesia. In every step of the surgical process, from decision-making to discharge, the surgeon takes risks. If we wish to focus on improving surgical performance, we need to know more about the processes which influence risk-taking.

A surprising study

Occasionally, patients die on the operating table. Does this influence subsequent outcomes? A survey of anaesthetists and surgeons strongly indicated that, if the death was somewhat expected (high risk or emergency surgery), both anaesthetists and surgeons believed that their immediate subsequent performance is unlikely to be affected. However, after an unexpected, low-risk death, they believed that subsequent performance may suffer, and the team should stop for a while to take stock. We investigated the impact of a death on the table on subsequent operations. The findings were diametrically opposite to expectation: a high-risk or emergency death was associated with somewhat worse outcomes subsequently, whereas the low-risk death tended to have a protective effect on patients undergoing surgery immediately afterwards.[8]

Another surprising study

Little is known about the effect of a break from surgery, such as a holiday, on surgeons' performance, but many surgeons, given the choice, prefer to come back to a straightforward, simple operation in case of loss of skill in the break. In a study to assess the impact of a break on outcomes,[9] we found that patients operated on the day *before* leave had mortality more than double that of patients operated on the first day of return from leave, despite being almost perfectly matched for risk.

An hypothesis

Is it possible that there is a single explanation for the two sets of unexpected findings above? Perhaps the answer lies in basic psychology.

Psychologists are able to assess people on several scales, such as introvert to extrovert, calm to nervous, open-minded to close-minded. There is another scale which is not widely studied but which most of us can recognise easily: risk-taking to risk-averse, or "cowboy to accountant", if you prefer. Every one of us occupies a position somewhere on this scale. There are people who are careful, triple-check everything and are terrified of taking a risk, and others with a devil-may-care attitude who positively thrive on risk. Anaesthetists and surgeons come from all points of the scale, and most function well regardless of their exact position on it.

However, whether a particular individual's position is naturally towards the risk-taking or risk-averse end of the scale, there may be a range of variation on either side of that point. Where we are within that range at any one time must be affected by recent experience. Regardless of how risk-taking we are at heart, recent experience can temporarily push us towards becoming even more risk-taking or more risk-averse. If we accept that surgical outcomes, like airline safety, are improved by risk-averse, obsessive and, so to speak, "anally retentive" behaviour, then experience which nudges individual surgeons towards the risk-averse end of their range should improve outcomes. Seen in this light, the findings of the two studies above make perfect and consistent sense.

Conclusions

This brief review suggests that cardiac surgical outcomes, which are already quite good, can be improved further by careful and regular monitoring and feedback. It suggests that anaesthetists are already pretty close to perfection, but that there may be more room for improvement by analysis and modification of surgeons' behaviour.

Good surgical outcomes depend on the proper application of evidence-based practice by well-trained individuals working in well-equipped environments. Modern institutions should provide all of the above, and clinical audit should ensure that it all works properly. Beyond these basic requirements, further improvements in outcome may be possible. One method is by analysis of the variables influencing the performance of the human beings who make up the system of health care delivery. The above review has concentrated on one of several possible approaches to the subject: that of the detailed study of risk-adjusted performance. There are, of course, many others. Some concentrate on protocols and processes rather than outcomes, and all have a role to play in further improving our service to patients.

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