League tables, risk assessment and an opportunity to improve standards

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Abstract

The implications of the Secretary of State's approval of the introduction of league tables for cardiac surgeons are discussed. Surgeons are to be ranked according to mortality rates for first-time coronary artery bypass graft operations. It is questionable whether anybody will gain from this information: the focus of surgeons' attention is transferred from patient care to self-preservation. The introduction of league tables in New York State has resulted in surgeons being reluctant to operate on higher risk patients and in secondary referrals of patients out of the State. League tables also encourage the manipulation of risk factor status.

Many factors other than the individual surgeon's skill influence the quality of care and patient outcomes. These factors include the patient's status, the timing of surgery, the surgical team, equipment in the operating room and post-operative care.

An alternative to the punitive process of public reporting is the application of continuous quality improvement to healthcare. This starts from the position that most negative outcomes are due not to individual failures but to failures of process and systems.

Key words: league tables, cardiac surgery, coronary artery bypass graft, risk factors, continuous quality improvement.

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Introduction

The Secretary of State has justified the introduction of league tables for cardiac surgeons on the premise that the public has a right to know about individual death rates. Surgeons will be ranked according to mortality rates for first-time coronary bypass (CABG) operations and, by simple statistics, 50% will be below average. Who will gain from this information – the patient, the government, or perhaps the lawyers?

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The precedent for league tables was established in New York State in the US, where the patient has a very wide choice of surgeons and centres.[1,2] Recognising the need for risk-adjusted mortality data, the Society of Thoracic Surgeons (USA) introduced a detailed system for risk stratification on the clear understanding that the patient, rather than the surgeon, is the principal determinant of outcome.[3,4] Risk stratification is an inexact process (not a science) which is open to misinterpretation and gaming (manipulation of risk factor status). It is human nature that any surgeon, however conscientious and honest, will protect his reputation by overestimating risk. It also follows that the simplest way of achieving exemplary results is to avoid operating on high-risk patients.[5] This occurs routinely in the US: complex cases are secondarily referred to university centres, whose distinguished surgeons often have high mortality rates.[6] However, secondary referral is rarely employed in Britain and a recent survey has shown that 90% of UK cardiac surgeons now decline surgery for high-risk cases (unpublished data from the Society of Thoracic and Cardiovascular Surgeons of the UK and Ireland).

It is not a comfort to the patient to be refused surgery on the basis of risk assessment.[7] 'If spared', the sickest patients have most to gain from surgery. Even in New York State, where the Department of Health enthusiastically supported publication of hospital data, the original plan did not include the release of surgeon-specific mortality. When *Newsday* discovered that this information had been collected, they successfully sued to access

it.[8] Publication of individual surgeons' figures was discouraging for those who routinely operate on high-risk patients as their greater mortality was no longer diluted within the larger institutional volume. Because of sample size issues, league tables are disadvantageous for those who perform smaller numbers of coronary artery bypass grafts because their primary focus is in more complex areas of heart surgery.

Risk-adjusted mortality statistics

Complex, statistically based, risk stratification models now exist for CABG patients. Logistic regression analysis employed by the Society for Thoracic Surgeons (USA) database is probably the most accurate process and closest to the ideal.[9] This requires full access to patient records and much more detailed pre-operative assessment than occurs in the British system. Neural networks are complex and costly, requiring powerful computers with large databases.[10] Computer algorithms with artificial intelligence simulate patterns of human thought and, in combination with logistic regression, probably provide the best accuracy. The Parsonnet Score, though simple and in widespread use, omits important variables, over- or under-predicts mortality for many categories of patient and is open to gaming.[11] The more recently introduced Euro Score, based on multivariate analysis of European patients, is an additive model but has inherent inaccuracy and requires further evaluation.

If United States-style league tables are employed in the UK for anything more than political reasons, then the more detailed Society for Thoracic Surgeons (STS) database is mandatory. This needs full-time personnel to collect, verify and manage data in every surgical centre. Even then, the statistical methodology underlying current publication of outcomes is flawed and does not justify the degree of accuracy presented to the public.[12,13] All existing risk adjustment methods have substantial inherent imprecision through sample size differences, clustering of observations, multiple comparisons and failure to account for the random component of interprovider variability.[14]

At the end of the day, the ability to sew bypass grafts on the surface of the heart does not reflect professional competence. The surgeon may have good CABG results but no survivors for more taxing problems such as aortic dissection or post-infarction ventricular septal defect. Accomplished surgeons with excellent results for complete atrioventricular canal defect or aortic root replacement may have below-average CABG results due to case mix and volume issues. Perhaps surgical league tables should follow professional football, with Premiership players and lower divisions according to complexity of caseload?

Avoidance of high-risk cases

Though it has been suggested that a CABG mortality rate > 5% may suggest a problem, first-time CABG for hibernating myocardium in transplant candidates is associated with 10–15% mortality even in experienced centres.[15] The US experience suggests that the public has little comprehension of risk adjustment and that this does shield the surgeon from death rates inherent in high-risk patients.[16] Nor do outcome data affect geographical referral practices.[17,18] After the introduction of league tables in New York State, risk-adjusted mortality fell 41%, from 4.17% to 2.45%.[19] Part of this improvement may have resulted from the 25% reduction in the number of CABG patients operated on by low-volume surgeons (defined as those performing fewer than 50 CABG/year).[20] Others believe that the decrease in mortality resulted from the reluctance of surgeons to operate on higher-risk patients and secondary referral of such patients out of the state to the Cleveland Clinic.[6] CABG patients referred from New York State to the Cleveland Clinic between 1989 and 1993 had high-risk characteristics, including 44% requiring re-operation and 47% in New York Heart Association (NYHA) class III or IV. In the absence of league tables or any formal quality improvement initiative, the mortality rates for Massachusetts decreased correspondingly from 4.7% to 3.3% (a 42% reduction in the same time period).[21] Data collection alone led to reduced mortality but public reporting was not the mechanism of improvement because of the long time lag between data collection and reporting.

Quality control programmes at individual centres identified specific areas for concern. At one institution, mortality occurred primarily in patients with unstable angina. Improvements in medical management to stabilise these patients led to a dramatic reduction in primary CABG mortality, from 4.5% to 1.5%.[22,23] This reflected less than ideal cardiological management and is of particular concern for the UK where more than 30% of CABG patients are referred as emergency cases.

League tables transfer the focus of attention from patient care to self-preservation. Schneider and Epstein reported that 63% of Pennsylvanian surgeons were less willing to accept severely ill patients because of public reporting.[24] Correspondingly, 59% of cardiologists reported increased difficulty in finding a surgeon to operate on such patients. Burack surveyed 104 New York State cardiac surgeons and found that high-risk CABG patients were more likely to be denied treatment than were patients with aortic dissection. They argue that this occurred because dissection was not subject to public reporting.[25] Sixty-two percent of the surgeons surveyed admitted that they had refused to operate on high-risk patients during the preceding year because risk adjustment provided insufficient protection.

Gaming in risk assessment

Gaming is the manipulation of risk factor status and may take several forms.[26] Upcoding of pre-operative co-morbidities (coding creep) involves excessive coding for certain risk factors or increasing the severity of a categorical risk factor.[27] The expected mortality rate rises, thus making it more likely that the actual mortality rate will fall within or below the expected range. This practice probably explains the 73% increase in high-risk cases undergoing surgery in New York between 1990 and 1992.[5] Green and Wintfeld showed a decrease in actual New York CABG mortality from 3.5% to 3.1% in tandem with a rise in predicted mortality from 2.7% to 3.7%.[27] An increase in risk factor coding accounted for 66% of the increase in predicted mortality and 41% of the total reduction in risk-adjusted mortality. Between 1989 and 1991, coding of pre-operative renal failure

increased from 0.4% to 2.8%, congestive heart failure from 1.7% to 7.6%, chronic obstructive airways disease from 6.9% to 17.4% (from 1.8% to 52.9% at one hospital), unstable angina from 14.9% to 21.8% (1.9% to 20.8% at one hospital) and low ejection fraction from 18.9% to 22.2%. The frequency of co-morbidities varied much more than would be expected from case mix differences for different surgeons, including a range of 1.4% to 60.6% for chronic obstructive airways disease and 0.7% to 61.4% for unstable angina.[13,27] Parsonnet noted that the frequency of cases coded as elective in nine New Jersey hospitals ranged from 27% to 95%.[7]

It is easy to shift high-risk patients out of the primary CABG category.[28,29] Revascularisation of hibernating myocardium can be recoded as CABG with mitral valve repair by using a few commissural stitches or the Alfieri procedure. Closure of a patent foramen ovale changes the procedure to CABG with atrial septal defect repair; and a few apical plication stitches can be coded as a left ventricular aneurysm procedure. By adopting such measures, the apparent mortality for the isolated CABG population decreases and the mortality of the unreported combined procedures increases whilst the overall number of deaths remains unchanged. Deaths are simply shifted to categories that are not publicly reported. Is this unethical conduct or is it reasonable behaviour in the face of public reporting?

The last method of gaming is to transfer a deteriorating post-operative patient to a secondary care facility before his anticipated death.[25] This common strategy is not unreasonable in stroke victims and the eventual mortality is not captured at the cardiac facility.

No form of risk factor analysis can compensate for bias through poorly collected or inaccurate data. Precise database definitions, uniform training of data managers and periodic external audit are essential to provide meaningful data. Surgeon-specific outcome measures such as 30-day observed to expected mortality ratio with 95% confidence intervals should be calculated using hierarchical generalised linear models to avoid exaggerated estimates of precision and false labelling of surgeons as outliers.[30] The process is complex and must be performed independent of the surgical team.

Factors which influence quality of care and patient outcomes

League tables for individual surgeons are based on the premise that only one person has the scope to determine patient outcomes. This greatly devalues the team approach and is only true for a tiny proportion of surgeons whose results are well beyond the standard deviation. Which factors really affect patient outcome and how might results be improved without discarding high-risk cases?

In my view, outcome after CABG depends on the factors which are outlined in table 1 and described in greater detail below.

The patient

The patient's own status is the principal risk factor for hospital mortality.[31,32] At one extreme is the young, fit patient with normal left ventricular function, no co-morbid conditions but a single complex proximal lesion which is not amenable to PTCA. At the other extreme is the elderly patient with post-infarction angina, cardiogenic shock, diabetes, previous stroke, generalised atherosclerosis and established renal failure. Both can benefit from CABG but the first requires a single graft, at very low risk, whilst the second may need four grafts and has a projected mortality of 50%. The cardiologist is unlikely to refer the second patient to a novice surgeon. High-risk cases are usually directed towards the technically accomplished surgeon, who may sustain an overall CABG mortality of 10%. The layman, with no previous exposure to heart surgery, has little understanding or interest in the difference between these patients. The *Doctor Foster* publication ignored risk stratification and, worse still, published sub-specialist interests without any verification of expertise, case volume or outcome. Increasingly, the second patient is refused operation: with justification, the surgeon cares for himself at the expense of the patient.

Table 1. Factors which influence hospital mortality after CABG

- The patient
- The cardiological assessment and pre-operative management
- The ability to intervene at an appropriate time
- The skill and experience of the anaesthetist
- The skill and experience of the surgeon
- The quality and consistency of the surgical team
- The availability of monitoring and life support devices
- The quality of post-operative care

The cardiological assessment

Cardiological investigations must now be far more comprehensive in order to identify risk factors for perioperative stroke, infection and bleeding as well as mortality (table 2). After left ventricular failure, stroke is the commonest risk factor for CABG mortality. Atheroma of the ascending aorta is the cause of stroke and its definition by pre-operative spiral computerised tomography (CT) scan or magnetic resonance imaging can improve the safety of CABG. Carotid Doppler imaging provides supplementary information on the brain's blood supply.

All CABG patients should now have detailed echocardiography to define wall motion abnormalities, left ventricular volume indices and the presence and characterisation of mitral regurgitation. If left ventricular ejection fraction is < 35%, the extent of reversible myocardial ischaemia should be determined by a combination of dobutamine stress echocardiography with positron emission tomography (PET) or single photon emission computed tomography (SPECT) scans. This distinguishes the need for revascularisation alone from the need for CABG plus left ventricular restoration surgery. Respiratory function tests should be performed on all patients since chronic obstructive airways disease

Table 2. Risk factors employed by the STS database in risk stratification for CABG mortality

- Age
- Race
- Gender
- Body size
- New York Heart Association (NYHA) class
- Surgical urgency
- PTCA
- Previous CABG/other cardiac surgery
- Left main disease
- Diseased coronary vessels
- Myocardial shock/unstable
- Pre-operative intra-aortic balloon counterpulsation (IABP)
- Angina
- Arrhythmias
- Haemodynamic instability
- Thrombolytic therapy
- Intravenous nitrates
- Diuretics
- Previous congestive heart failure
- Cardiac index
- Left ventricular (LV) ejection fraction
- LV end diastolic pressure
- LV aneurysm (dyskinetic segments)
- Calcified ascending aorta
- Diabetes mellitus
- Cardiovascular disease, cerebrovascular accident (CVA) timing
- Chronic obstructive airways disease/respiratory function tests
- Liver disease
- Neoplasia/metastatic disease
- Serum albumin
- Steroids
- Digitalis
- Arterial bicarbonate
- Charison Comorbidity Score

is an important risk factor. In addition to routine blood tests, immunological and nutritional status are defined by hepatitis B and C tests, HIV screening, liver function tests and CRP measurement. AIDS must not be overlooked as a risk factor in major surgery and it is a grave mistake to withhold hepatitis and HIV screening: the lives of the team may depend on it. All investigations should be performed in the two weeks before surgery. Without detailed assessment, risk stratification is impossible and outcome data are meaningless.

Given that the effective medical management of acute coronary syndromes impacts substantially on CABG hospital mortality, these patients should all be stabilised by the cardiologist before they are accepted for operation.[22,23] The resource implications for UK cardiology are substantial. The 'shoot the dye then say goodbye' approach is no longer tenable.

The timing of surgery

Surgery must take place soon after assessment. A waiting list risks an intervening adverse event which may substantially alter operative risk. Impaired myocardial function deteriorates progressively and 'functional' hibernating myocardium progresses to irreversible 'structural' hibernation. If the waiting time exceed three months, the pre-operative evaluation should be repeated.

When emergency operation is indicated, the surgeon must have immediate access to a fully staffed operating room and intensive care facilities. System delay is inherent in the NHS: it negatively influences survival in acute catastrophes such as aortic dissection, post-infarction ventricular septal defect or PTCA coronary occlusion. When appropriate facilities are not immediately available, the surgeon cannot take responsibility for the patient.

The anaesthetist

The outcome of any operation depends on the practical ability and experience of the anaesthetist. A close working relationship between surgeon and anaesthetist contributes greatly to patient safety. Transoesophageal echocardiography (TOE) is now a routine anaesthetic monitoring tool to assess preload, left ventricular function and de-airing of the heart. Intra-operative echocardiography is also invaluable in the assessment of left ventricular restoration surgery and mitral repair in CABG patients. All cardiac operating rooms must therefore have TOE. Continuous cardiac output monitoring is an important adjunct for high-risk cases and the anaesthetist should have a skilled assistant, particularly if there is no blood gas machine or thromboelastogram within the operating theatre.

The surgeon

The quality of the surgical repair is a function of technical ability, choice of operative technique and experience.

A surgeon's abilities are readily apparent to those around him in the operating theatre. Peer review and regular outside clinical appointments are important. The unfortunate Bristol paediatric surgeons were 'inbred' and conditioned to high mortality, as were those around them. The failure of peer review is the reason why transparency at public level is now called for. Paradoxically, the negative effects of public reporting may be even more damaging because they have relevance for a far greater patient population.

Since the introduction of limited working hours, the hands-on experience of newly appointed consultants has decreased substantially. League tables are predicted to have an additional negative impact on the number of cases available for training purposes. Despite claims to the contrary, it is impossible for the consultant surgeon to guarantee a high quality operation from the assistant's position. If a trainee is to operate, specific informed consent should be obtained from the patient. Very few

surgeons undertake revascularisation in advanced heart failure patients, and league tables will further reduce these numbers.

The surgical team

Every surgeon is entitled to a consistent team of assistants. Both short- and long-term outcome depend on the quality of the bypass conduits harvested by the team. Surgeons in the US have professional assistants and do not rely on ephemeral surgical trainees or junior hospital doctors. Professional surgeons' assistants are available in the UK but in insufficient numbers to provide consistent help.

Equipment in the operating room

Major investment is needed to bring UK cardiac surgery into the 21st century. Perioperative mortality can be reduced by the use of mechanical assist devices and extracorporeal membrane oxygenation in paediatrics. The intra-aortic balloon pump does not provide blood flow and is not a substitute for a left ventricular assist device (LVAD). LVADS are widely available in the US and Europe but have only recently been introduced in a small number of transplant centres in the UK. In the event of failure to wean the patient from cardiopulmonary bypass, days or weeks of mechanical circulatory support may lead to recovery (about one third of patients leave hospital). If the heart does not improve, the patient can be switched to long-term mechanical support or salvaged by transplantation. These life-saving devices are expensive and require constant supervision by trained nurses and technicians. If league tables are introduced, all cardiac units should have equal access to this technology. It is in the interest of patients with poor left ventricular function to be treated in a centre with a mechanical support programme.

Post-operative care

The quality of post-operative care is critically important. In the US and Europe, constant post-operative supervision is provided by intensive care physicians. Cardiac intensive care units should have round-the-clock anaesthetic and surgical cover able to perform emergency re-operation. Dysrhythmic events and deterioration in pulmonary or renal function require prompt management by experienced personnel. Haemofiltration, cardiac output monitoring and echocardiography must be available on-site at all times.

The author recently lost a patient through intubation of the aorta instead of the trachea during percutaneous tracheostomy by a trainee anaesthetist. Even though the author was 3,000 miles away, this was recorded as a primary coronary death. Given published mortality data, the surgeon and his insurance company should insist that the hospital supplies enough personnel with appropriate experience to manage the patients post-operatively.

The way forward

United States-style public reporting of mortality data is now a personal issue for each surgeon, whose livelihood may depend on the results. The enormous gap between the US and UK in staffing, equipment and reimbursement must be closed, particularly now that American surgeons are being recruited to work in the UK. Much more information is required from the cardiologist; the surgeon should not operate on high-risk patients without appropriate backup. Risk stratification is a complex and expensive process and must be undertaken by a dedicated, independent data management team. The information is worthless if left to the surgeon. The package will massively increase expenditure on a cardiac operation but the Government has already committed to doubling the cost of CABG for waiting list initiatives.

Where does the patient stand in all this? The only logical reason to publish mortality statistics is for the patient to choose both hospital and surgical team, but there are no plans for this. In the meantime, many more are denied access to surgery on risk grounds.

Is there a preferable option? In the US, Berwick has pioneered the application of continuous quality improvement (CQI) to healthcare, asserting that most negative outcomes are due to failures of process and systems, not individuals.[33,34]

The confidential peer review process of CQI employs benchmarking, determination of best practice and collaborative education amongst surgeons which is not accessible to the public. The emphasis of this option is improvement of the whole cardiac centre rather than detection of outliers. It seeks to achieve system-wide quality improvement whilst avoiding the distrust, gaming and withholding of treatment from high-risk cases inherent in the league table approach. With this completely confidential approach, New England achieved a mortality reduction directly comparable to that of New York in the same timeframe. By raising standards in all hospitals and reducing inter-hospital variation, the patient is assured of safety when directed to any cardiac centre.

The choice now lies between the deliberately punitive process of public reporting or genuine efforts to improve education, staffing levels and equipment for all cardiac centres. Recruitment rates of both UK and American nationals to cardiac surgical pro-

Key messages

- The introduction of league tables for cardiac surgeons is of questionable benefit
- In New York State, where league tables were pioneered, surgeons routinely refuse to operate on higher-risk patients
- The patient's status is the most important determinant of in-hospital mortality
- The huge gap in staffing, equipment and reimbursement between the US and the UK must be closed
- A more benign alternative to league tables would be the application of continuous quality improvement to healthcare

grammes have fallen dramatically in the last few years. Medicine, let alone cardiac surgery, is a much less attractive career option. It is in the interest of the patient and the profession that changes occur but change must be channelled in the right direction. Who will provide effective leadership?

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