

# Editorial

## Quantifying and communicating peri-operative risk

*Shallow men believe in luck.  
Strong men believe in cause  
and effect*

—Ralph Waldo Emerson

### Life is risky

Risk is the potential that a chosen action or activity (including the choice of inaction) will lead to a specific outcome, and implies that the choice has an influence on the outcome. Most definitions are synonymous with the possibility of an adverse event but, of course, a risk can also be taken in the hope of a favourable outcome, particularly with investment. There is also a personal perspective on risk. A fatalist personality may be very accepting and unconcerned about risk whereas more pragmatic individuals know that there can be modifiable factors involved. This can apply to healthcare; for example, even though surgery may be necessary in a patient, there may be pharmaceutical interventions that could reduce morbidity. Almost any human endeavour carries some risk. Staying in hospital is far riskier than travelling by aeroplane. A recent study showed that a one-night stay in hospital carries a 11.1% risk of nosocomial infection, a 3.4% risk of an adverse drug reaction related to human error or allergy, and a 0.4%

risk of pressure ulcer due to immobilisation [1]. In 2007 in the USA, there were 1.31 fatal crashes per 100 000 flight hours for non-commercial flights and 0.016 per 100 000 for major airlines [2]. Despite efforts to the contrary, healthcare is an intrinsically hazardous business.

Anaesthesia is a medical specialty very much focused on risk management and patient safety and, consequently, the mortality risk attributable to anaesthesia itself has dropped dramatically over the years, from about one death in 1000 anaesthetic procedures in the 1940s to one in 100 000 in the early 2000s [3]. However, although anaesthesia is relatively safe, surgery can be very dangerous. In 2000, the 30-day mortality risk in the UK was one death in 34 emergency operations (2.9%) and 1:177 after elective surgery (0.6%) [4]. The European Surgical Outcomes Study was an observational study in which data were collected on 46 539 patients aged  $\geq 16$  years undergoing non-cardiac surgery, over a seven-day period, in 498 hospitals across 28 European nations [5]. There was considerable variability from country to country but median death rates were 3% for elective and 10% for emergency surgery. Anaesthesia has an excellent track record for patient safety and has been described as the leading

medical specialty in addressing such issues [6], yet it is apparent that the peri-operative process still has great potential for hazard from a host of factors, of which anaesthesia is but one.

Ronald A. Howard, a pioneer of decision analysis, wanted to develop a scale that would more clearly confer risk rather than percentages. He coined the term 'microprobability' to refer to an event with a chance of one in a million. From this concept, a 'micro-mort' (from 'micro' and 'mortality') is then a one in a million chance of death [7]. We face risk simply by being alive and this may be exacerbated by indulging in various activities. A mobile app is now available for illustrating how many micro-morts are involved in our daily activities (see <https://play.google.com/store/apps/details?id=com.zanzibar-tech.micromorts>). The use of micro-morts then allows us actually to quantify risk and translate it into whole numbers. A micromort denotes a one in a million chance of death from one-time dangerous events, a concept that can be easily understood and compared. A one in a million chance is, of course, rare but also an everyday occurrence. For example, the chance of a particular individual's winning the weekly lottery is less than 1 in 32 million

people, but conversely this jackpot gets won almost every week by somebody. Micromorts are an expression of acute risks, such that once that event has been completed the risk has gone. The risk of surgical anaesthesia is in the range of various day-to-day activities. Audits of the risk of death from a general anaesthetic alone vary considerably geographically, but may be around one death in 100 000 operations in a developed country [8], which equates to 10 micromorts per operation. This is the same risk of death, on average, as riding a motorcycle for 60 miles or skydiving. Micromorts rely on aggregated risk data for calculations, so their applicability to specific circumstances or individuals is limited. In contrast with micromorts, there is also a unit called microlife which is a risk (or gain) representing a 30-minute change of life expectancy [9]. It is a way of measuring the impact of long-term habits on the human body. For example, smoking two cigarettes will 'cost' one microlife; whereas bonus life can be gained by taking a statin daily (one microlife per day) or doing 20 minutes of moderate exercise daily (two microlives per day). A user-friendly microlife calculator (see <http://journals.bmj.com/site/microlives>) is available. People in general are notoriously bad at calculating risk. The concept of micromort and microlife can be useful for explaining various risks in our daily peri-operative practice to the general public.

## The blind leading the blind?

Shared decision-making in the healthcare context very often depends on the understanding of

numerical information, in either text or graphical format. The perception of harm and benefit associated with particular options is important for many health decisions. Surprisingly, not only patients but many doctors have severe problems mastering a host of numerical concepts that are prerequisites for understanding information about the harm and benefit of medical treatments [10]. Highly educated people can still have difficulty with relatively simple numeracy questions [11]. Numeracy influences the processing of both numerical and non-numerical information. Less numerate individuals are more susceptible to framing effects, more easily affected by non-numerical information such as mood states, and less sensitive to different levels of numerical risk [12]. The Berlin Numeracy Test is a new psychometric instrument for assessing statistical numeracy and risk literacy in an educated population [13]. It typically takes three minutes to complete and an online version is now also available (see <http://www.riskliteracy.org>).

Statisticians, clinicians and psychologists have recommended the use of numerical as opposed to verbal descriptions for risk communication [14–16]. In addition to probability information, the way people perceive a risk message may be influenced by the framing of risk information, risk comparisons, the message's qualitative content and trust [17]. Conveying relative risks alone without absolute risk or baseline risk is an example of non-transparent framing. Comparing benefits and harm using different scales, such as reporting benefits in big numbers

by relative risk reduction and harm in small numbers by absolute risk increases, is another way of altering risk perception. An example is the 1995 contraceptive pill scare in the UK, where an alarming figure of a 100% increase (relative) in thrombosis caused by third-generation oral contraceptive pills was much more terrifying than a humble increment in absolute risk, from one in 7000 to two in 7000 [18]. Humans can be prone to unwittingly tricking themselves with representative bias in risk assessment in gambling pursuits such as purchasing lottery tickets. If the odds of winning a lottery are one in a million, then buying two tickets will 'double' the chance to two in a million (an apparent 100% increase). However, the odds of *not* winning the jackpot by buying two lottery tickets hardly changes at all (from 99.9999% to 99.9998%; a change of 0.0001%).

Non-transparent and mismatched framings are common phenomena, even for scientific research published in leading medical journals. Studies have revealed that up to half of articles report only relative risks or odds ratios, and about one third adopt mismatched framing for risk-benefit discussion [19, 20]. Risk communication with incomplete and misleading numerical descriptions hinders shared decision-making. Patients are likely to be familiar with the concept of risk, but human nature is such that many do not understand the relativity or perhaps even choose to ignore it. To use gambling again as an example, a recent \$640 million lottery in the USA created much excitement and

a scramble to buy tickets when the odds of winning were approximately one in 175 million. That number may not mean much in itself, but in relative terms the chance of winning is 175 times less than that of being struck by lightning in a given year, a fact that helps conceptualise probability.

As in life, there is no zero risk and no certainty in any branch of medicine, but only risks that are more or less acceptable. Communicating risk information is important but, unfortunately, more difficult than might be expected. Patients' values and preference are essential elements of shared decision-making. In 2011, a report on the peri-operative care of surgical patients published by the National Confidential Enquiry into Patient Outcome and Death principally recommended that "*an assessment of mortality risk should be made explicit to the patient and recorded clearly on the consent form and in the medical record*" [21]. A spreadsheet has been developed to quantify mortality risk before and after surgery by calculating mortality rates, and life expectancy with adjustment for various parameters such as age, sex, co-morbidities, renal function, physical fitness, and body mass index [22]. An on-line calculator is available for estimating peri-operative mortality in order to assist shared decision-making between patients and their doctors when non-surgical intervention is an option (see <https://sites.google.com/site/informrisk/>).

The complex nature of the peri-operative period gives rise to the potential for significant risk to

all patients. Directing efforts towards patient safety can be uncomplicated and inexpensive, yet significantly improve the quality of peri-operative care. The World Health Organization's surgical safety checklist is an example of a simple, cheap and effective method of reducing avoidable complications resulting from surgery [23]. Moreover, the use of a checklist is likely to provide a net financial benefit to the healthcare system because the cost of the intervention is low under all scenarios and there should be a reduction in morbidity and medicolegal claims. Anaesthesia is a medical discipline of applied science related to the art of peri-operative risk reduction by identification, intervention, and prevention.

### To test or not to test

High-risk patients account for no more than 15% of all surgical procedures but over 80% of deaths [24]. However, it is still a major challenge to identify accurately and reliably patients who are at high risk of postoperative mortality and morbidity. Cardiopulmonary exercise testing (CPET) is a measure of aerobic capacity that is becoming more widely employed, with the estimated number of tests performed in the UK alone estimated to be in excess of 14 000 per year [25]. Based on the possible association of pre-operative aerobic fitness with subsequent survival after surgery, CPET has been used for triaging patients with occult cardio-respiratory disease for further investigation and optimisation strategies before major operations [26]. Nonetheless, none of the derived

variables, such as ventilatory anaerobic threshold or maximal oxygen uptake, can be regarded as a cornerstone for the prediction of survival after major surgery [27]. The European Society of Cardiology's guidelines on pre-operative cardiac risk assessment and peri-operative cardiac management, published in 2009, questioned the role of CPET in risk assessment before surgery and emphasised that it is not a substitute for stress testing in routine practice [28]. A scientific statement from the American Heart Association has also highlighted the lack of randomised trials to support recommendations for diagnostic and prognostic applications of CPET [29]. Reliance upon any single factor in predicting future risk is more like gambling than rational assessment, since no test is infallible. No single variable can estimate the extent of survival and quality of life, although physical fitness appears to be an important component [30, 31]. Pre-operative testing should not be a screening exercise for stable patients but a strategic part of the peri-operative risk reduction programme for susceptible patients. Risk assessment should always be tailored to individual patients, and pre-operative tests only reserved for those in whom test results would positively influence and change peri-operative management. Our drive to 'optimise risk' can lead to unnecessary investigation and intervention when we should really be optimising 'risk assessment' through more comprehensive history taking and physical examination. Concerns over malpractice liability result in excessive and unnecessary consulta-

tion, hospitalisation, testing, and treatment can, paradoxically, be a safety hazard for both patients and doctors, with false positive findings leading to costly and possibly harmful treatments or further investigations and delays in surgery. The quantity of tests should not be confused with the quality of care.

## Are drugs the answer?

Is there a pharmacological panacea for peri-operative risk optimisation? One of the main objectives of risk identification is to determine which individuals could benefit from a protective, therapeutic intervention. If that intervention is potentially dangerous in itself, e.g. coronary artery stenting, then careful selection is absolutely essential. There are, however, fairly safe and simple pharmacological treatments that are very promising in this regard. It may not be necessary to investigate patients aggressively with expensive and even hazardous techniques if the indication for surgery is very strong. Why not assume the worst and instigate protective measures anyway? Over the last decade, **statins have been investigated** extensively for their potential multimodal effects in modifying a number of aspects of peri-operative morbidity and mortality [32–34]. Possible **pleiotropic effects of statin therapy are reduction of myocardial infarction and stroke, prevention of atrial fibrillation, improvement of vascular graft survival, protection from renal insufficiency, and inhibition of malignant cell growth** [34]. All peri-operative applications of statins are 'off-label', as their primary indication is lipid-lowering, but the

drugs, which are now available in generic form, are relatively **inexpensive with a very good safety profile** [35]. However, in the latest **Cochrane review of statins for vascular surgery**, there was **insufficient evidence to conclude that use of statins resulted in either a reduction or an increase in any of the outcomes examined**. It was also observed that the widespread use of statins in the population now will make it difficult for researchers to undertake the large randomised trials needed to demonstrate any effect [36].

Peri-operative pharmacological interventions, while having certain benefits, may themselves be associated with risk that could outweigh such advantages. Data from the **POISE trial** suggested that routine administration of **peri-operative beta-blockers** in an un-titrated, relatively high dose starting on the day of operation, **increased the risk of stroke and overall mortality for non-cardiac surgery** in the presence of favourable outcomes on other cardiovascular parameters [37, 38]. **POISE II** has generated **similar controversy** recently over the use of **peri-operative aspirin** [39].

## Conclusions

Anaesthesia, as a service-based speciality dealing with specific incident-related risks, has not yet reached its peak despite being acknowledged as the leading medical speciality in designing fail-secure systems and probably the only speciality in healthcare to have reached the **critical target of six sigma defect rate** [6, 40]. The peri-operative period could be made safer by

revolutionising risk management tactics with corresponding interventions in preventing complications and improving patient outcomes. It has been suggested that the technical aspects of anaesthesia could be delegated to robots [41], so are we ready for our new role as peri-operative risk strategists?

## Competing interests

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