Surgical Error

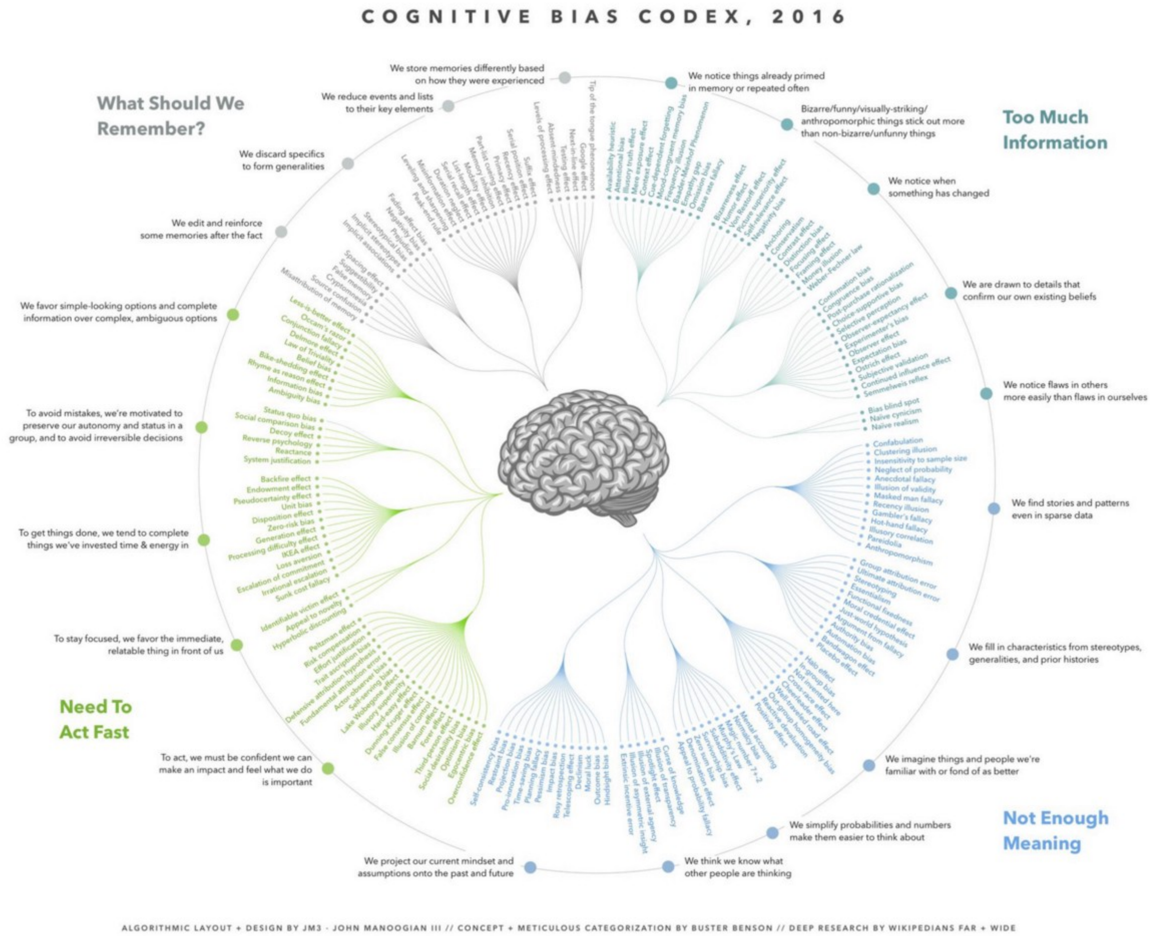
Samantha Gallivan MBBS BSc. FRCS (Tr. & Orth)

Most surgeons are familiar with the visceral lurch of terror that accompanies a near mistake. It is all too easy to pick up the wrong finger to mark for surgery when momentarily distracted in a noisy ward. Or perhaps the sudden realisation dawns that this pale, feeble structure brushed by a 15 blade is not a Dupuytren's cord, but the ulnar digital nerve distorted beyond recognition by disease. We trust that the first error would be picked up by the widely used WHO surgical checklist (1), which like its aviation counterpart looks to eliminate procedural mistakes before the patient comes to harm and a great deal has entered the surgical and anaesthetic literature in recent years about this type of intervention (2). By contrast, the second type of error appears more difficult to pin down and perhaps more difficult to appraise. Surgical decision making relies on clinical wisdom, training and confidence. How do we weigh up evidence and to what extent can we learn from other industries and crafts that rely on high performance from their practitioners? Some surgical errors take place at a distributed level in the evidence base, existing as shared mistaken beliefs about how to manage certain conditions. How do we deal with medical reversals, when new evidence supersedes accepted practice and how can we harness new technology to gather better data to inform our decision making? In this essay, I will examine three ways of thinking about surgical error and offer some suggestions as to how lessons from these can be introduced into practice.

Ways of thinking.

There has been widespread acceptance of the concept of cognitive biases as systematic, predictable failures of rationality in judgement. These were first described in the work of Amos Tversky and Daniel Kahneman in the early 1970's (3), after they noticed the predictable tendency of subjects in psychological experiments to make illogical judgements, especially under pressure or with limited information. Their work describes two different systems of thinking: Type 1- automatic, instinctive and effortless, and Type 2- complex, concentrated effort. Study of these ways of thinking and the ability of the brain to make fast decisions by applying heuristics or 'rules of thumb' has influenced behavioural economics, the science of human error, and almost all branches of social science. Nearly 200 cognitive biases have now been described, however the most commonly tested include:

- Confirmation bias: the tendency to seek data that confirm one's pre-conceived model of the world. 'When asked, "Is Sam friendly?" different instances of Sam's behaviour will come to mind than if you had been asked "Is Sam unfriendly?"'. (3)
- Anchoring: when people 'consider a particular value for a quantity before estimating that quantity… If you are asked whether Gandhi was more than 114 years old when he died, you will end up with a much higher estimate of his age at death than if the anchoring question referred to death at 35.' This partly explains the psychology of house pricing, charitable giving, and negotiations in business. (3)
- Hindsight bias: the belief that one 'knew it all along' with the implication that the future is therefore knowable with an 'illusion of inevitability'. (3)



It might seem clear that we should be wary of these biases and fast heuristics and appeal to our slower, rational ways of thinking when making medical decisions, especially as we are often called upon to make judgements under pressure with limited information. Contrary to this hypothesis, the German psychologist Gerd Gigenrenzer considers efficient medical decision making as using heuristics as part of an ‘adaptive toolbox’. (4) His work studies ‘fast and frugal’ heuristics, those rules of thumb that are adapted to a certain environment. In a 2012 paper he imagines the factors that influence a decision to admit patients with chest pain to CCU in a hypothetical rural American hospital. He notes the defensive tendency to err on the side of caution and admit low risk patients for possibly unnecessary tests, but identifies the risk of being sued as being a driver for this behaviour. In his analysis, this cautious judgement is not the same as erroneously miscalculating the chance of a cardiac event, rather it is an understandable adaptation to a set of circumstances. Gigenrenzer suggests that by changing this environment, the physician can be ‘led to rely on heuristics more beneficial to the patient'. Gigenrenzer has also studied the effect of teaching heuristics to doctors (5) most notably in a study that asked 160 gynaecologists to calculate the likelihood that a woman who tests positive for breast cancer actually has the disease (90% test sensitivity, 1% prevalence and 9% False Positive rate). Infamously, 60% of the gynaecologists believed that 8/9 out of 10 of women who tested positive would have cancer and 18% thought the chance was 1/100. The true answer is 1 in 10. One solution suggested by Gigenrenzer and Marewski is to present statistics as natural frequencies (i.e. x/1000) and communicate these in a clear format such as a tree diagram. When the gynaecologists in the previous study were presented with the data in this format, most (87%) (5) understood how to solve the problem.

The psychology of decision making seems to offer some practical advice to surgeons. The study of cognitive biases challenges our beliefs about clinical reasoning in risk and diagnostics, especially when decisions are made under pressure. It points to the role of the surgical environment in shaping decision making and reminds us to consider the impact of implicit biases such as those concerning gender, race and disability in our decisions. When weighing up risks and benefits of surgery, natural frequencies and diagrams not only help us communicate complex concepts to patients but may also aid in our own cognitive processes.

Ways of Doing.

Although cognitive psychology offers insights into surgical decision making, it teaches less about the practice of surgery as a craft. Surgery has traditionally been taught in an apprenticeship model with a junior watching, absorbing and learning good technique from a senior surgeon. Perhaps we could also learn from seeing simulated errors, rather than making these mistakes during live surgery? Many options already exist for surgical simulation such as cadaveric simulation, arthroscopic trainers, animal models for microsurgery and even the emergence of augmented reality (6). In everyday practice, one can only rectify an error that is picked up and it is easy to miss a common error such as a long screw breaching the joint or a malreduced DRUJ. Simulation offers not only the chance to see ‘perfect’ techniques, but also how easy it is to make simple errors and how to spot these mistakes with no risk of harm to real patients.

There is some evidence that simulation helps with advancing a trainee up ‘the learning curve’ in terms of manual dexterity (7) and familiarity with surgical equipment. What remains unclear, is how much this remote, literally disembodied experience reflects the real operating theatre environment. Alongside traditional surgical simulators at Imperial College, Professor Roger Kneebone has developed ‘Distributed Simulation’ in immersive mobile pop up theatres (8), which recreate the sound and feel of a real operating room. The advantage of this model is that it reproduces the holistic experience of performing surgery; the interaction between members of the team and the realistic feel of simulated tissue in a full-sized model lying on a real trolley at operating height. If the timely application of clinical wisdom helps avoid surgical error, then this environment, rich in unspoken cues and situational knowledge may help develop important skills. In one simulation, this group re-enacted an open cholecystectomy, staffed with a retired surgical team from the 1980’s assisted by younger trainees. At one moment, the lead surgeon tries to explain a point of anatomy but his voice trails off, as a verbal description cannot capture the nuance of tactile sensation that a gloved hand offers (8)As surgical techniques and equipment evolve, some older, open procedures that are vital in an emergency become rare events and today’s new consultants are perhaps under prepared to use them. This distributed simulation offers a chance to share the experience of older surgeons to avoid unforced mistakes in high pressure situations.

Further work by this group (9) has looked at the similarities between the practice of surgery, fine craft and performance art such as parallels between musical ensembles and transient teams in surgery or the importance of warm up, especially for artists like puppeteers who perform fine repetitive dextrous acts. Perhaps the operating theatre of the future will have a warm up simulator available for a morning ‘tune up’ before a list, pre-loaded with augmented reality representations of the anatomy of the patients about to have operations?

Ways of Knowing.

Professor Doug Altman, statistician and co-director of the Oxford Clinical Trials Unit illustrated his talk at the Evidence Live conference in Oxford this year with a quote from 2005, attributed to Andrew Vickers, an attending research methodologist in NYC.

‘A mistake in the operating room can threaten the life of one patient; a mistake in statistical analysis or interpretation can lead to hundreds of early deaths. So, it is perhaps odd that, while we allow a doctor to conduct surgery only after years of training, we give SPSS to almost anyone.’

Although one might expect a statistician to hold such views, the point is nonetheless valid that surgical error is not isolated to the clinic room or operating theatre. Error can take place on a mass scale both by changing practice for the worse, perhaps through the introduction of poorly designed new implants or old practices that are disproved but persist. The routine collection of outcomes measures and the use of joint registries helps mitigate the risk of introducing new technologies by allowing effective surveillance. This was demonstrated by the prompt response to adverse outcomes following the use of metal on metal prostheses in hip arthroplasty in the UK. By contrast, there is no centralised hand and wrist arthroplasty database and as procedures such as CMCJ replacement and wrist arthroplasty become more common, it is difficult to see how a similar intervention would be possible. It is also a surgical error to assume that the treatments offered and the outcomes valued by surgeons are aligned with the wishes and needs of patients. Hopefully the findings of the BSSH/ James Lind Alliance (10) priority setting partnership will go some way to avoiding this mistake in the future. There is always a tension between what is seen to be accepted surgical wisdom and new evidence that comes to light with scientific research. So much of our perception of our individual practice is coloured by the cognitive biases outlined in the first section. The surgeon who has dedicated his or her career to trapeziectomy and believes in its absolute efficacy in pain relief, will naturally tend to favour evidence that supports their viewpoint. Likewise, hindsight is a persuasive but often skewed trick of one’s clinical memory. The only way to obtain an accurate picture of how treatments differ in their effectiveness and of variations in care across the country, is by centrally collected data and then, as shown by the GIRFT project, this allows for best practice to be shared nationwide. In the near future, it should be possible to combine a detailed surgical registry with outcome measures, including free text narratives parsed by natural language processing and then analysed to give a richer picture of the experience of recovering from hand surgery.

When errors happen in surgery, although the ultimate responsibility lies with the senior surgeon, it is normally the product of a complex interaction of human factors, structural pressures and terrible luck. In recent years great efforts have been made to introduce tools from other safety critical industries such as aviation, to help avert procedural mistakes. These include ensuring clear introductions are made by every team member at the start of a case and double checking of swabs and instruments at the end. These measures not only ensure that tasks are done, they also help flatten the surgical hierarchy and ensure that every person feels their voice can be heard. The tragic case of Elaine Bromiley and the work of her husband Martin in improving safety in the NHS is an enduring lesson in this (11). Alongside a structural safety net of checklists and proformas each of us has the opportunity to reduce the risk of surgical error every day. In the first instance, by appraising the evidence base for any given procedure in a rigorous manner, mindful of potential biases and prejudices. Secondly, by taking the time to mentally and physically, warm up before undertaking clinical work (easier said than done with administrative and teaching commitments), and thirdly by supporting centralised registries, pragmatic trials and linked audits to advance high quality research.

‘To err is human, to forgive divine’

An Essay on Criticism. Alexander Pope (1688-1744),

‘Errare humanum est, sed perservare diabolicum’

‘To err is human, but to persist in error is diabolical’

Attributed to Seneca The Younger (4 BC- AD 65).

‘From the errors of others, a wise man corrects his own’

Variously attributed to Publilius Syrius (c.85-45 BC), Otto Von Bismarck (1815-1898) and Groucho Marx (1890-1977) – *‘Learn from the mistakes of others, you can’t possibly live long enough to make them all yourself’*.

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