

Medical Student Essay Prize Winner

Ariella Midgen, University College London

What will anaesthesia look like in the next 25 years?

Patients and their families are often fearful about the future. Will the pain ever go away? Will resuscitation work? Will they wake up after general anaesthetic? I once met a patient who when confronted with going under general anaesthesia became a nervous wreck and a fourteen gauge cannula's breadth from punching the consultant and running. Uncertainty is unnerving. Our best weapon for combatting patients' worries is evidence-based medicine. We may not have all the answers, but we have the best ones available. When approaching the future it would be hypocritical not to place that same trust into evidence-based prediction techniques. Clouds of uncertainty also hover above the future of anaesthesia. When asking what it will 'look like' we are not merely asking whether the protocols will be different or the drugs new. We are asking whether anaesthesia will be demonstrably distinct from what it looks like now. Different factions predict shifts towards perioperative physicians inundated with clinics or mere technicians who intubate. There are also questions about how academic and global anaesthesia will fit into the picture. This essay will therefore draw upon the findings of leading psychologists, economists, and statisticians, whilst exploring how other sectors have coped with similar challenges that anaesthesia may face. It will use evidence-based strategies to evaluate potential changes to the role of anaesthesia, showing trends away from academia, but toward becoming safer for patients at home and abroad. Ultimately it will suggest that we embrace new technologies, support research, and lean towards perioperative medicine over the next 25 years.

The first step to making predictions, according to psychologist Philip Tetlock, is to throw out preconceptions formed when listening to famous commentators. They are notoriously wrong¹. Instead, 'superforecasters' look for generalizable trends². For example, anecdotally medicine seems to be changing unbelievably rapidly, with more discoveries last year than occurred in a hundred a millennia ago. Yet, the plural of anecdote is not data. It seems to be the case for science as a whole³ but delving deeper reveals a 'publish or perish' crisis currently facing anaesthesia. The trends anticipate a worrying yearly decrease in article output by 1% globally and 1-6% nationally^{4,5}. This dwindling publication rate may represent higher quality studies and will still contain work that improves outcomes for patients. However, high impact discoveries are largely a numbers game and increase in probability with larger bodies of research. We must stop the publication rate from contracting until academic anaesthesia implodes in 25 years' time. We can tweak these trends so priority areas such as core science, preventing perioperative complications and chronic pain can expect a modest boost in research, but still superimposed upon unimpressive

general trends. Although academia is unlikely to completely disappear, its shrinking would not be an immaterial loss. Doctors' careers are enriched by their research and the resulting culture of continuous learning, and more importantly we would be depriving our future patients of the best possible care they deserve. As the Pandit Report's⁶ recommendations continue to be implemented one can only hope this prediction is proved wrong.

Another trend that could change the face of anaesthesia is the rise of technology. The threat is two-fold: Firstly, robots could replace anaesthetists, as robots like 'McSleepy'⁷ and SEDASYS⁸ continue to juggle the anaesthetic triad with ease and even outperform doctors in some measures⁹. Secondly, telehealth could increase access to 'superstar' anaesthetists to the point where only a few spectacular doctors dominate the profession. Obviously, any developments that make patients safer are welcome, but the trend towards mechanised healthcare must be analysed to anticipate the changes that might take place.

Labour economics may help to solve the first problem. Hyperbole about robots replacing anaesthetists as they did farm labourers has led to an aversion to such technology amongst the speciality, born out of fear of being relegated to technicians. Economists call this 'creative destruction': 'Destruction' as it demolishes jobs and 'creative' because it should create more engineering jobs to fill the employment void anaesthetists leave. Great for engineers but I would prefer not to become a professional line-inserter. However, sectors like marketing and law have seen employment rates rise with computerisation. As they become more efficient, services become cheaper and more accessible, raising demand. Human capital can then be invested into complex tasks as demand for them rises and technology makes them achievable. For example, NASA no longer needs human number-crunchers so it can expand work on projects that would have been too time-consuming before, and now employs more people overall. Strictly formulaic tasks that can be done by computers are known in the software world as 'p' problems, but 'np' problems that require cognitive flexibility and abstract reasoning are thought to be beyond robots' abilities, needing humans to solve them. The key difference between sectors that grow versus shrink on mechanisation is the presence of 'np' problems that people can expand their focus on when simpler tasks are taken care of, and a demand for these more complex services. A robot is not flexible enough to deal with unexpected emergencies in intensive or pre-hospital care, nor able to encode a patient's abstract idea of pain. Moreover, as demand for anaesthesia continues to rise with gross domestic product¹⁰ and our population continues to age and have more anaesthetic needs, one can certainly forecast an increased need for the complex anaesthesia technology could herald.

The answer is not to bury our heads in the sand and hope the technology goes away but to allow it to make our jobs easier whilst we expand our speciality to encompass more complex tasks. Comorbidities currently too risky for surgery could become manageable if 'McSleepy' balances a few variables for us. Meanwhile, if low risk surgeries require less supervision we could use that time to better prepare our upcoming patients before surgery and prevent complications after. More

anaesthetists could subspecialise in pain or emergency management. Research time, highlighted by the Pandit Report as a key contributor to the publication crisis⁶, could even be ring-fenced. Anaesthetists will certainly not be short of work. As technology gives the speciality room to expand it could also shift towards encompassing perioperative medicine. This has so far been embraced with variable enthusiasm, but perioperative medicine represents a clear gap in patient care and cannot be neglected, especially as anaesthetists are so well placed to fill this void. Ultimately patients are our priority and if introducing robots and adapting accordingly would make them safer then we are duty-bound to do it. Furthermore, if the speciality refuses to encompass this 'np' role and another speciality eventually does it for us we risk being saddled with more replaceable jobs when technology finally catches up with us.

The second technological trend that threatens to change anaesthesia is telehealth, as future top doctors may access an unlimited number of patients. The economist Sherwin Rosen modelled the changes professions go through when 'superstars' become accessible worldwide and subsequently dominate the sector's output¹¹. Looking to musicians, although their audiences have increased, the number of people able to earn a living through music has sharply diminished since the arrival of audio recordings. Why hear the village folk band when you can listen to a global popstar on your phone? Given the choice, patients would choose the best anaesthetist in the world. If this star doctor could be a remote presence at every surgery worldwide would the rest of the profession shrink as music has? For the most part anaesthesia fits Rosen's model, but one cannot record an anaesthetic regimen or consultation like a song and make it flexible enough to apply to all patients. It therefore remains unlikely that the specialism could sustain itself on 'superstars' alone without sacrificing patient care. However, it could help anaesthesia become more team-based and patient-centred. When things go wrong one could call upon top anaesthetists who are detached from the stressful situation. If a patient has a problem they could be monitored remotely or schedule a video consultation. The future seems bright, with better patient outcomes and satisfaction ahead.

Having a remotely accessible team-based speciality could prove especially useful in developing countries where expertise is lacking. Moreover, as technology becomes faster, smaller, and cheaper more people should gain access to our equipment-reliant speciality. Projects like Safer Anaesthesia from Education and charities like Lifebox combined with growing political will can benefit from the more accessible equipment and expertise. There will be many potholes on the road to universal health coverage and although this multi-faceted effort is working, the top of the climb is still not within sight. Hopefully we will continue to make great strides forward and improve outcomes for patients around the world.

However, extrapolating predictions from trends is a dangerous game, as the statistician Nassim Nicholas Taleb points out in his book 'The Black Swan'¹²: Swans were once thought to all be white until black ones were discovered, so we cannot assume predictability without knowing all the variables. Taleb characterises 'black swan events' by their lack of predictability, huge impact, and the retrospective explanations historians later give them. Therefore we must take the above trend-based predictions with a pinch of salt as a 'black swan event' could be lurking around the corner. We cannot anticipate the arrival of a computer that can solve 'np' problems. Another Abbottabad-style fake vaccination programme¹³ could derail global healthcare expansion altogether. When predicting the future one must expect the unexpected.

This principle applies to patient safety, where trends show improvements¹⁴ but freak 'black swan events' still occur. Famously, Elaine Bromiley died in 2005 when her surgical team failed to recognise the 'cannot intubate, cannot ventilate' emergency that later killed her. With no warning, a huge impact, and retrospective rationalisations, Elaine's death was a 'black swan event'. This sort of event terrifies patients and according to Taleb we can never predict the next one. How can we reassure patients knowing that? We are not helpless though, and as long as we keep learning from our mistakes we cannot make the same one twice. Never Events buck safety trends, but appropriate investigations reset them with a better trajectory for future patients. We can never truly expect the unexpected, which is why we have a duty to warn patients that things can still go wrong beyond our control. However, in 25 years fewer things will be unexpected and overall patients will be safer.

'Black swan events' cause huge disruption, but their shocking nature also makes us over-forecast them. This is because the availability heuristic¹⁵ makes us think an event is more likely when we hear about it more often. For example, in the aftermath of the epitomic 'black swan event', the September 11th terrorist attacks, we have over-reported terrorism and fooled ourselves into over-forecasting future attacks. Similarly, we must be wary of cognitive biases when predicting the future of anaesthesia. We are prone to over-forecasting rare events and under-forecasting common ones¹⁶. Therefore, although we are often told about big discoveries and big mistakes the future will likely yield fewer of these high impact events than our instinct tells us. We should temper our more fanciful predictions as it is more likely that the next 25 years will still be recognisable to an anaesthetist today.

Looking ahead, anaesthesia will likely become safer and more uniform at home and abroad. Patients who can only dream of having access to surgery now because of their comorbidities or location may even take it for granted in 25 years. However, there are still unknowns ahead. Encouraging academia should remain a priority, and we must continue adapting to 'black swan events' as they occur. Anaesthesia should tackle the looming unknown by leaping into it, embracing new technologies and expanding the speciality to incorporate perioperative medicine.

If we take the future in our stride, it should herald better outcomes for patients and a more fulfilling job for anaesthetists. Ultimately though, in taking an evidence-based approach to our predictions we must reign in our more fantastic visions of the future. Patients are not going to ride into theatre on jet packs.

References

1. Tetlock P. (1999). Theory-Driven Reasoning About Plausible Pasts and Probable Futures in World Politics: Are We Prisoners of Our Preconceptions? *American Journal of Political Science*, 43(2), 335-336.
2. Mellers B, et al. (2014). Psychological strategies for winning a geopolitical forecasting tournament. *Psychological Science*, 25(5), 1106-1115.
3. National Science Board. (2016). Science and Engineering Indicators 2016. Arlington, VA: National Science Foundation. (NSB-2016-1).
4. Feneck RO, et al. (2008). Decline in research publications from the United Kingdom in anaesthesia journals from 1997 to 2006. *Anaesthesia*, 63(3), 270-275.
5. Chen SY, Wei LF, Ho CM. (2016). Trend of academic publication activity in anesthesiology: A 2-decade bibliographic perspective. *Acta Anaesthesiologica Taiwan*, S1875-4597(16), 30057-30061.
6. Royal College of Anaesthetists. *A National Strategy for Academic Anaesthesia*. December 2005.
7. Wehbe M, et al. (2014). A technical description of a novel pharmacological anesthesia robot. *Journal of Clinical Monitoring and Computing*, 28(1), 27-34.
8. Pambianco DJ, et al. (2011). Computer-assisted personalized sedation for upper endoscopy and colonoscopy: a comparative, multicenter randomized study. *Gastrointestinal Endoscopy*, 73(4), 765-772.
9. Hemmerling TM, et al. (2013). Evaluation of a novel closed-loop total intravenous anaesthesia drug delivery system: a randomized controlled trial. *British Journal of Anaesthesia*, 110(6), 1031-1039.
10. Weiser TG, et al. (2008). An estimation of the global volume of surgery: a modelling strategy based on available data. *Lancet*, 372, 139-144.
11. Rosen S. (1981). The Economics of Superstars. *The American Economic Review*, 71(5), 845-858.
12. Taleb N. (2007). *The Black Swan: The Impact of the Highly Improbable*. Random House Publishing Group.
13. [No authors listed]. (2013). The spies who sabotaged global health. *Scientific American*, 308(5), 12.
14. Haller G, Laroche T, Clergue F. (2011). Morbidity in anaesthesia: Today and tomorrow. *Anesthesiology*, 25(2), 123-132.
15. Tversky A, Kahneman D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5(2), pp. 207-232.
16. Ariely D, et al. (2000). The Effects of Averaging Subjective Probability Estimates Between and Within Judges. *Journal of Experimental Psychology: Applied*, 6(2), 130-147.