NZMSJ
New Zealand Medical Student Journal
Te Hautaka o ngā Akongā Rongoā

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How artificial intelligence is transforming healthcare

Original research on an interactive 360° video-based virtual reality simulation

Interview on the ethics of using data from electronic health records

Genomic technology for patients

New statistics primer – understanding Kaplan-Meier plots

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Editor's welcome

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Welcome to issue 28 of the New Zealand Medical Student Journal (NZMSJ)! We have collated a fascinating range of articles that highlight the calibre of work conducted by medical students and academics in New Zealand. This issue focuses on the intersection of artificial intelligence (AI) and the health care sector. As always, we are very privileged to have a number of expert academics covering several pertinent subthemes within the AI-health-care dynamic. Among our invited articles, Professor Tim Dare details some of the ethical dilemmas that have arisen with the introduction of AI techniques and big data approaches into health care. Dr. Mariam Parwaiz, a public health medicine registrar, explores how the rise of AI will impact medical education, and hints at how the role of a doctor might change in a digitised health care sector. Following this, Professor Jim Warren discusses how AI will impact the delivery of health care and the doctor-patient dynamic. Professor Cris Print then outlines the synergy between AI and health care using the example of genomics and other 'omics, such as transcriptomics, in a passionate yet balanced manner. Finally, an interview with Associate Professor Angela Ballantyne summarises the benefits, limitations, and ethical concerns surrounding electronic health records.

We are thrilled to see that a number of the academic articles we have received have a technological flavour to them. This issue features two outstanding reviews, which have won awards in their respective fields. Elizaveta Rakhmanova and Nikita Quinn, winners of the Wilson-Allison Memorial essay competition, answer the question 'will machines replace dermatologists in the diagnosis of skin disease?'. One field that has been quick to adopt the use of machines is urology. Lauren Smith provides the reader with a retrospective analysis comparing robotic assisted with open partial nephrectomy. Virtual reality is rapidly expanding into many facets of modern society, and is quickly gaining traction as one method to improve medical education. One domain of interest is the use of virtual reality in simulation-based training. Shakeel Mohammed assesses the acceptability and feasibility of an interactive, 360 degree video-based virtual reality simulation of an acutely stressful clinical event.

Looking beyond the influence of technology, Michaela Rektorysova sheds light on the complexity between oestrogen and cardiovascular health, highlighting some fundamental limitations as well as the importance of future research.

The features and media reviews in this issue serve as reminders of the challenges that future and junior health professionals face when navigating the health care system. Kaustubha Ghate reviews *This Is Going to Hurt: The Secret Diaries of a Junior Doctor* by Dr Adam Kay, where the reader is taken on Dr Kay's journey through his obstetric training. He uses a juxtaposition of humour and heartbreak to bring home the impact that medicine can have on the personal lives of trainees.

One student-led initiative that has had stood the test of time is HealtheX, a conference for student researchers at the Faculty of Medical and Health Sciences, The University of Auckland. Joseph Chen reflects on the growth and successes of HealtheX since its inception 12 years ago. Not to be outdone, Dr Megan de Lambert outlines her journey in developing student-led mental health support for clinical students at Auckland Medical School, after realising the impact of the clinical environment on students' well-being.

Often as students we get caught up in the minutiae of medical school and lose sight of the numerous opportunities available to us as medical students. Gisela Kristono and Evelyn Lesiawan reflect on their time at the Cardiac Society of Australia and New Zealand Annual Scientific Meeting and Australia and New Zealand Endovascular Therapies Meeting in 2018, and urge students to make the most of similar opportunities. Logan Williams' review of *Deep Medicine* by Eric Topol concludes that a digitised health-care system, and further research into the benefits and limitations of AI in health care may allow us to redirect our focus back on providing humanistic patient care.

Last but not least, as part of our ongoing Creative Arts Competition in partnership with the New Zealand Medical Students' Association, we would like to congratulate Dr Jared Vautier, Libby Whittaker, and Jon Anderson for winning this issue's competition round. We are always impressed with the calibre of submissions and proud of the creative talents that our medical student whānau possess.

The Editorial Board would like to thank the University of Otago and the University of Auckland for their ongoing support towards the journal. Without their financial and academic support, publishing this journal would not be possible. We would also like to thank the Medical Assurance Society for their funding. Finally, we would like to acknowledge the New Zealand Medical Journal and our Advisory Board members for their guidance and support. We hope issue 28 will provide NZMSJ readers with a variety of engaging articles. We would like to congratulate all of the authors who have contributed towards it and encourage all readers to submit their work to NZMSJ in the future!

Ethics of artificial intelligence and health care

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Artificial intelligence (AI) aims to mimic and improve on some human cognitive functions. Humans can identify patterns, apply rules, classify data, and make predictions and decisions based on those activities. Such activity is central to medical practice. Diagnostic radiologists, for instance, examine medical images to identify signs of pathology. The expert radiologist draws on training and experience to identify features in the images that match those seen in cases that have proven to be pathological. Likewise, general practitioners (GPs) assessing the likelihood that a patient has some condition draw on their training and experience to decide whether the patient has features known to be characteristic – or symptomatic – of that condition. Health care policy makers and administrators bring similar cognitive skills to bear when making decisions about population level health needs and more immediate resource and staffing allocations: what happened to June–July hospital admission rates the last time April flu rates looked as they do this year?; what health needs can we predict over the next five years given what information we have about the population our system is serving?

The datasets that would inform these processes in an ideal world are huge. There are too many cases; too many images; too much research; too many variables affecting admission rates; too many combinations between variables; and so on for humans to identify and process. Much of that data now exists in electronic form, or in forms that can be accessed electronically by natural language processing systems. Some clinical and health data may be collected 'manually' as researchers, health administrators, clinical staff, and others enter health information onto computers, GPs claim subsidies for patients, patient appointments are entered as Accident Compensation Corporation claims, or the like. Other data is electronic from the outset: images, input from health-care devices that create digital records as they weigh, ventilate, and pump. The intensive care unit ventilators, health apps on mobile phones, a GP's digital thermometer, blood pressure machines, and scales can all generate electronic records that could be aggregated into datasets. As the 'internet of things', and in particular the internet of medical things expands, so too does the list of potential sources of health data.

These electronic datasets create the opportunity for computers to at least enhance, and perhaps take over, many of the reasoning tasks previously carried out by humans. Computers can access and process vastly larger datasets than their human counterparts. They can identify patterns indiscernible to humans without tiring, and without running out of capacity to consider more cases. It is tempting (and true) to say that they can do so more quickly than humans, but reference to their speed misses the point: humans simply could not get through the data processing tasks managed by computers. So while it is true that computers are fast, their speed is part of their capacity to process vast searchable datasets at the outset, rather than a separate feature.

In the early days, computers simply ran algorithms – a problem solving process or set of rules – set by programmers. Algorithms can be very simple, perhaps a straightforward 'if x then y' rule, or very complicated, involving multiple steps and complex mathematical formulas. Simple versions may look very much like equally simple algorithms used by humans. For example, if my GP is considering recommending a prostate-specific antigen test for me, they are likely to work their way through a checklist – a nonautomated algorithm of sorts: is my patient male? If yes, is he over 50? If no, is he over 40 with a family history of prostate cancer? Is he urinating frequently? And so on. It is easy to imagine a computer running through a similar checklist and making recommendations, though perhaps it is not obvious what advantage there would be to delegating such task.

We might have reason to do so if we feared that the risk factors for prostate cancer were much more complex than our simple algorithm assumed. The number of potential predictor variables in electronic health records may be enormous and the combinatorial possibilities unimaginably large. We might proceed by choosing a limited number of commonly collected variables, but we would risk locking ourselves into the short-sightedness we are attempting to address; the problem might be with our choice of variables and not just with the reliability of processing them.

Suppose then we give computers access to all the electronic data we have about patients who have been accurately diagnosed with prostate cancer and set the computer the task of identifying correlations between the data and the diagnosis? The computer could look at vast numbers of cases and vast numbers of predictor variables and combinations between them, and identify correlations that humans have missed, perhaps because the correlations were only apparent across very large datasets, sets too big for humans to manage, or perhaps because the correlations hold between disease status and complex combinations of variables. And we might go further. The computer could 'learn' from its own outputs. Suppose, given ongoing access to diagnostic outcomes, it notices that risk assessments it had generated on the basis of some correlations were less reliable than it had initially indicated – perhaps its early predictions contained more false positives than would have been the case had it relied on different correlations or assigned different weight to variables. It then adjusts

its own algorithms accordingly. Now the computer would be learning – machine learning – from the data, creating its own algorithms, rather than simply relying on those set for it by its human designers. We might regard it as exercising AI.

It has been shown that AI, more or less as described here, can operate in health care and can at least match humans. A 2018 paper reports a study in which researchers fed de-identified data on hundreds of thousands of patients into a series of machine learning algorithms powered by Google's massive computing resources.[1] The algorithms were able to predict and diagnose diseases, from cardiovascular illnesses to cancer, and predict related things such as the likelihood of death, the length of hospital stay, and the chance of hospital readmission. Within 24 hours of a patient's hospitalisation, for example, the algorithms were able to predict with over 90% accuracy the patient's risk of dying. Earlier, the same team used data on eye scans from over 125,000 patients to build an algorithm that could detect retinopathy, the number one cause of blindness in some parts of the world, with over 90% accuracy, which is on par with board-certified ophthalmologists.[2] Going back to our simple prostate cancer example, a number of studies have shown the potential for AI to improve diagnosis and the identification of treatment options for the disease.[3,4] Of course, not all of the news about AI, in health care and beyond, has been so positive. It is widely accepted, even by those who support the introduction of AI, that the technology promises significant ethical and legal challenges. According to recent books, algorithms are 'weapons of math destruction' increasing inequality and threatening democracy;[12] automated decision-making tools 'profile, police, and punish the poor';[13] tech products are 'full of blind spots, biases, and outright ethical blunders' which 'exacerbate unfairness and leave vulnerable people out'.[14]

Some of these challenges may seem especially pressing in health contexts. Consider the fundamental concern in medical ethics to treat patients with respect, a concern that underpins the obligation to provide patients with full information and to obtain consent in almost all cases (See the Code of Health and Disability Services Consumers' Rights, especially rights one (right to be treated with respect), six (right to be fully informed), and seven (right to make an informed choice and give informed consent). The use of AI may make it difficult to meet these obligations, at least as they have been traditionally understood. It may not be possible, for instance, for humans to explain, or even to know, why a complex machine learning system has classified a case one way rather than another. The classification may rest on complex correlations that cannot be reverse engineered. Algorithms, that is, may not be transparent or scrutable: they might be black boxes.

Some regulation of the use of AI has gone a way toward banning such systems. Under new European data protection guidelines, those affected by automated decision making systems are entitled to 'meaningful information about the logic involved'.[5] Our own Privacy Commissioner and Chief Government Data Steward have issued a set of principles for the use of data and analytics, which specify that 'explanations of decisions – and the analytical activities behind them – should be in clear, simple, easy-to-understand language'.[6]

But, I have argued that the demand for explainable AI (in health and elsewhere) is mistaken.[7] Health professionals do not, and cannot, explain how a lot of familiar health technology works – digital thermometers; magnetic resonance imaging scanners (MRIs)? These familiar tools are neither transparent nor explainable (MRIs rely on quantum mechanical explanations of the spin and orbital angular momentum of subatomic particles, and 'I think I can safely say that nobody understands quantum mechanics').[8] But patients should not care. What matters is not transparency, or 'explainability', but whether there is evidence of reliability: it does not matter how the thermometer identifies my temperature as 36.7°C, providing that I know that it does so reliably. It is evidence of reliability – rather than transparency – that we should insist on in the case of automated decision-making systems too. Evidence of reliability – rather than an explanation of how technology works – also seem to meet the Code of Health and Disability Services Consumers' Rights, right six, to be 'the information that a reasonable consumer, in that consumer's circumstances, would expect to receive'. When I ask about the MRI my GP will probably give me evidence that the scans are accurate and useful, and that – rather than a course in quantum mechanics – seems just the sort of thing I am likely to want.

AI also raises important questions about our privacy and consent, at least as those interests are currently understood.

Consent is widely regarded as essential for legitimate access to and use of health information. Again, it is an important aspect of respecting persons, but our understanding of consent and its importance was forged when information was gathered and aggregated in clear transactions, and in ways that allowed us to track its use toward clearly-articulated goals. In an era of vast datasets in which end-uses and users are often unclear at the collection point, and in which data will be combined, reprocessed, and reused in ways that make it difficult to establish straightforward relationships between providers, processors, and users, it is unclear how traditionally-understood consent might work. Even where it is possible to seek informed consent, the size of datasets may make it prohibitively expensive. Some of our concerns might be met by limiting the use of 'unconsented' data to de-identified datasets, but many important applications require identification. This is not to say that AI requires us to abandon consent. We do need to be clear, however, what holding on to the traditional consent paradigm will cost in terms of the forgone advantages of at least some uses of AI.

Privacy has become a flagship right – we have Privacy Acts, Officers, and Commissioners. We certainly think we have moral rights to privacy (and that they are everywhere under threat). It is certainly true that AI threatens our interests in privacy as traditionally understood. In a famous case, an algorithm allowed an American pharmacy chain to work out that a young woman was pregnant and send her (or, the detail that started the trouble, her father) coupons for baby goods before she had said anything to anyone.[9] Regulation of AI might address some of these problems, but, like our interest in consent, I suspect it would be a good thing if there were movement on both sides. On the one hand, we could limit the use of data to find out 'private things'. On the other, we could all recognise that our current concern with privacy is not always a good thing. Privacy has clear benefits – no one wants to be under constant surveillance – but it is often used to protect people against unjustifiable discrimination. Think about sexual orientation. When discrimination was likely to follow knowledge that a person was gay, people who identified as gay had good reason to keep their sexual orientation private. As we have adopted more sensible views about sexual orientation, privacy has become less important and the resulting openness has been a very good thing. We are all better off in a world in which we do not need privacy about sexual orientation. And it seems that at least some of our concern for privacy is relatively recent. When we lived in smaller communities – villages or small towns, or in rural districts served by phone systems that allowed others to know when we got a call (and perhaps even to listen in) – our neighbours were likely to know a good deal about us. Our concern for privacy is in part a consequence of the urbanisation that has made it possible for us to keep large parts of our lives secret. We have come to think of that secrecy as normal and important, but it is not clear we are right. Privacy may be corrosive and isolating. Knowing less about our neighbours means we do not know who needs a hand. We are more likely to feel threatened and alienated by those we do not know. Perhaps, properly regulated with respect to privacy, AI will allow us to reclaim some of the benefits of an earlier time.[10]

Another common concern about AI that may seem especially relevant in a health context concerns the role or opportunity for human judgment or oversight. Again, the General Data Protection Regulation gives those affected by automated decision-making systems a right, 'not to be subject to a decision based solely on automated processing'[5] and the New Zealand principles for the safe and effective use of data and analytics specify that, '[a]nalytical processes are a tool to inform human decision-making and should never entirely replace human oversight'.[6] As others have pointed out, the right poses little practical constraint – few systems do not, or cannot, or would not wish to, include a human in the loop at some point. The prostate algorithm may generate a risk score for me, but my GP will call me in to discuss its significance. Perhaps health resource allocation processes could be fully automated. But, there is some suggestion that restrictions on delegations of power in New Zealand prohibit delegation, other than to a person). Nonetheless, it is important to see that including humans in the loop is unlikely to improve the accuracy of algorithms. Machines are, or soon will be, more accurate at, for instance identifying and interpreting complex risk factors, than any of the alternatives available to us – most obviously relying on guided or unguided clinical judgment – and, furthermore, it is likely to be easier to state and measure (and remeasure) their accuracy more precisely than that of alternatives; we know how right or wrong they are and so can (try to) accommodate their error rates.

There is another aspect to the importance of human judgment, however, which might be especially significant in health contexts. Amazon has a 'chaotic storage algorithm', which tags every item entering its warehouse with a barcode and assigns it to a location based on available shelf space (i.e, not by type, or manufacturer, or alphabet, etc). There are no humans in the loop, but it doesn't seem to matter. We might not be so sanguine when AI is used in contexts in which relationships matter. Care providers relying on AI suggest Brent Mittelstadt and Luciano Floridi 'may be less able to demonstrate understanding, compassion and other desirable traits found within "good" medical interactions in addition to applying their knowledge of medicine to the patient's case. Put another way, the patient's body and voice may increasingly be replaced or supplemented by data representations of state of being if [AI] practices are adopted in medicine'.[11] But the conclusion seems too quick. Reliance on AI could reduce patients/clients to mere data, but surely it need not; AI might free healthcare professionals to focus on relationships, handing time-consuming diagnostic tasks to systems that are better at some aspects of their current role than they are, and it might spawn new roles or aspects of roles focused on the caring aspects of the professions. It is important to remember that practices are not fixed; their identification with apparently defining goods may be contingent. As health providers and consumers come to appreciate the potential of AI to serve the central health-promoting functions of caring roles, they may come to understand the goods those roles deliver differently. That may be a lesson to be taken on board by those currently training for roles in the health-care system, and for those who are training them.

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Artificial intelligence and medical education: current developments and future considerations

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The growth of artificial intelligence (AI) and the ongoing automation of work are features of our time, and medicine will be increasingly impacted by these trends. AI in medicine generally means the utilisation of computer algorithms and automated processes to aid in the diagnosis and treatment of patients.[1] The medical AI industry is growing rapidly, and there has been an explosion of academic interest in the subject.[2] Although medicine constantly evolves and adapts to new technologies over time, health care systems tend to be naturally risk-averse, and there is some caution within the medical community about the role for AI in health care.[1] The medical students of today will likely experience the opportunities and challenges associated with AI in medicine throughout their future careers as doctors.

The role for medical education in New Zealand is to equip medical students with the scientific knowledge and the professional skills and attributes necessary to function effectively as doctors, and help them progress towards mastering the science and art of medicine. While AI in medical education is still a nascent idea in medical schools in New Zealand, as time goes by and as AI inevitably becomes more of a feature of medical practice, there will be a mounting pragmatic necessity for doctors, and for medical education, to engage with it. This engagement should be done in an ethically-sound way, with the aim of providing high-quality, equitable, culturally-safe, and patient-centric care, in a manner that reflects the values and aspirations of health care delivery in New Zealand.

Researchers recognise the potential of AI in medicine to improve health care delivery, and current literature suggests that AI-based tools can be as effective and accurate as human clinicians.[1] AI competence will become an important skill to add to the vast skillsets possessed by doctors. But doctors will not only need to be comfortable using AI in their day-to-day work, they will also need to have an understanding of the principles behind both AI generally and the specific AI-based tools they will use, as well as the benefits and potential biases and flaws of these. Essentially, the doctor of the future will exist in a world where they will need to be competent at using AI; the role for medical education is to ensure future doctors are prepared for that world.

Currently, medical education arguably does not sufficiently prepare future doctors for the impending AI revolution in health care. To do so will require a transformational reform in medical education, where medical students are taught traditional biomedical sciences and compassionate communication, alongside the principles of AI.[3] As medical education academics are starting to argue, medical schools needs to shift from focusing on information acquisition to 'an emphasis on knowledge management and communication'.[4]

Within the medical profession itself, there is positive news. Recently the New Zealand Medical Association (NZMA) commented on the proposed World Medical Association (WMA) Statement on Artificial or Augmented Intelligence in Medical Care, suggesting that AI should be regarded by the medical community as a technological tool that can be applied to improve the quality and efficiency of health care delivery and education.[5] It is important that medical organisations contribute to the discourse around AI in medicine, and it should be interesting to read and review the WMA's statement once it has been ratified and published. The NZMA also suggested that the clinical impact of interventions related to AI should be subjected to high standards of empirical evaluation, with the possibility of unintended negative consequences kept in mind and beneficial impacts not presumed.[5] This is a reasonable concern, and any AI-based tool developed should be robustly tested and validated before being deemed suitable for wider general use.

In medicine it is always necessary to act in an ethical manner, and with this in mind the Royal Australian and New Zealand College of Radiologists recently produced a draft on Ethical Principles for AI in Medicine.[6] The eight draft principles they identified, which will likely be retained in the final version of the document, were: safety; avoidance of bias; transparency and explainability; privacy and protection of data; decision making on diagnosis and treatment; liability for decisions made; application of human values; and governance.[6] These principles, which are also relevant to AI as applied to other medical specialities, provide an excellent framework to help ensure that AI in medicine is, and continues to be, safe and effective.

Health equity is an important concern that must be kept foremost in mind as AI is further adopted into medical practice. According to the Ministry of Health, 'In Aotearoa New Zealand, people have differences in health that are not only avoidable but unfair and unjust. Equity recognises different people with different levels of advantage require different approaches and resources to get equitable health outcomes'.[7] It is possible that introducing AI-based tools could have

the unwelcome effect of increasing inequities between populations, such as between socioeconomic groups, ethnic groups, or geographic groups of people. For instance, the data that AI systems use could be biased.[8] Data containing implicit ethnic, gender, or other biases will generate results that are also biased.[8,9] Khullar provided a clear example of this in a recent opinion piece, noting that if poorer patients do worse after organ transplantation, AI algorithms may conclude that such patients are less likely to benefit from treatment and thus recommend against it, without accounting for or mitigating for wider factors.[10] As medical professionals and custodians of the health care system, we must ensure that technological advances in health care are implemented systematically, are culturally safe and free from implicit bias, and take account of the most vulnerable. We must ensure that incoming AI tools do not, and will not, increase health inequities, and preferably actually work to reduce the inequities we currently see in health.

It is necessary to state that machines cannot and should not replace human doctors. The role of the doctor will inevitably evolve over time, but doctors will not become obsolete. Humans will always be required to interpret outputs from machines, assess ethical and value-based dilemmas, and communicate empathetically.[11] The therapeutic relationship between doctor and patient is a fundamental tenet of medicine and will remain so. There is no substitute for the human touch. As AI becomes more and more a part of medical practice, the role of medical education in imparting the soft skills of medicine will increase in importance. These skills include an appreciation of ethics, leadership skills, communication skills, and the ability to work in an empathetic manner.[11] These skills are essential to being a good doctor, and will continue to differentiate us from machines.[12] Hopefully we can look forward to a future where AI tools work in an ethical and equity-enhancing manner to complement our role as doctors and improve our effectiveness in the health care system.

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How will AI change health care delivery?

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Perhaps we haven't yet reached the point where computer-based Artificial Intelligence (AI) has overtaken humanity as the masters of the world, but there's a groundswell of sentiment that AI can now exceed human performance for almost any specialised task. In 2015, AI displaced a bastion of human mastery when a computer programme beat a human champion in Go, a game that had long held out against attempts to exceed the best human players, in part due to the size of the board and many possible moves. The winning computer program employed techniques that are hallmarks of the new wave of AI: using a deep neural network (a system of nodes and weighted connections with multiple layers between the inputs and the outputs); 'big data' (a comprehensive collection of transcripts of high-level human Go games in this case), and massive computation (notably, to learn from the data to recognise good moves and the value of board positions, reinforced by the equivalent of lifetimes of simulated games against itself.[1] AI has been an active field of research ever since digital electronic computers emerged after World War II, and while notoriously difficult to define, intertwined with concepts of rational and human-like thought and action AI can be taken simply as the attempt to build intelligent entities.[2] There's a tendency to move the threshold for what constitutes 'real AI' forward to exclude established innovations. For instance, AI accomplishments of past decades, such as the automated interpretation of electrocardiograms (ECGs), may now be seen merely as useful technology without much regard to the human-like nature of the task being accomplished.[3] But this new wave of AI based on deep learning has re-ignited both the imagination of the public in general and the health-care community, in particular in terms of the potential of AI to change our lives.

Learning to beat humans at games is an important part of AI research, not just as a publicity stunt, but for the insights learned in finding ways to out think humans at tasks that have attracted individuals to dedicate a lifetime of training to becoming experts (such as Grandmasters in chess). But AI has always had its applied side as well, including learning to imitate (or exceed) the performance of medical experts. Hard on the heels of the breakthrough in Go, a deep learning system was demonstrated to provide formidable sensitivity and specificity for detecting diabetic retinopathy in fundus images as compared to a panel of United States licensed ophthalmologists and ophthalmology senior residents.[4] The authors themselves took some care to point out limitations – the algorithm would not necessarily detect non-diabetic retinopathy lesions that were outside of its training data, nor would it be a replacement for a comprehensive eye exam – yet there is a temptation for the findings of this frequently-cited article (893 times on Google Scholar at 6 March 2019) to be consolidated simply as – with deep learning, AIs can now match specialists. A recent Journal of the American Medical Association editorial indicated that the new wave of AI is one of a series of technology-based advances, and makes a comparison to how computed tomography has become part of the radiology toolkit.[5] Nonetheless, the concluding words, 'artificial intelligence and deep learning are entering the mainstream of clinical medicine' and, 'physicians need to actively engage to adapt their practice', set a tone that we have reached a tipping point for AI in medical decision making. A medical student could be forgiven for feeling some anxiety, wondering just what a future with AI making better decisions than specialists implies for their role and the doctor-patient relationship, or how they might be expected to engage this phenomenon.

We can expect that AI systems for health application will continue to grow in diversity and effectiveness. 'Super-computing' is now readily available: the graphics processing units in the video cards of our home computers turn out to be superb number-crunchers for neural network algorithms; or we can rent scalable computing power through cloud computing services by Amazon, Google or others. Moreover, the ever-increasing permeation of health-care systems with computing has as its natural by-product a growing archive of electronic medical records ripe for analysis. While this AI boom is indeed likely to be transformative to health-care delivery, there are reasons to take the view that this change will be incremental, manageable, and (hopefully) on balance positive.

First, AI algorithms from deep learning are not so unlike computing capabilities that we have been using routinely in New Zealand for years. For example, PREDICT is simultaneously decision-support software and an ongoing, prospectively designed, open cohort study.[6] The PREDICT software integrates with the practice management system to retrieve patient data, with any remaining required data entered interactively to provide an individualised estimate of the probability of a cardiovascular disease (CVD) event in the next five years, along with treatment recommendations. Participant risk factors captured by software that is regularly linked to national databases included hospitalisations and deaths related to CVD, supporting ongoing research to improve the risk prediction – most recently, based on over 400,000 patient encounters in New Zealand from 2002–2015.[7] At the heart of the risk prediction is a regression model (specifically a Cox proportional-hazards model) that gives a particular weight to each risk factor. The model is structurally much simpler than a deep learning model, but has the advantage that the reasoning behind the model's recommendation is easily explained. Adding explanation ability to deep neural networks is an active research area.[8]

The experience, for patients and health-care professionals, in using a deep learning AI (at least one that has been appropriately developed and carefully tested) will be little different to that with PREDICT, which has integrated smoothly with the existing health-care system and professional roles.

Second, while AI will challenge the doctor-patient dynamic, information technology (IT) challenging the doctor-patient dynamic is nothing new. For over 25 years, the World Wide Web (the Web) has been democratising access to information. Patients are at liberty to bring into their consults printouts (or perhaps nowadays more likely to brandish their cell phone or tablet) with the latest research findings, as well as potentially questionable content biased by revenue generation motives. As the Web has become more sophisticated and IT reaches ever more intimately into our lives, so the diversity of ways patients may bring IT into their health care has grown, now including mobile apps, fitness trackers, and blog posts. An interesting example is PatientsLikeMe, a Web-based network where patients connect to others with the same disease and share experiences. Sharing of quantitative data is encouraged along with the organisation of research studies, for example to test the effectiveness of off-label uses of drugs.[9] In his book *The Patient Will See You Now*, Eric Topol describes medicine as having reached a 'Gutenberg moment', where new freedom of information is enabling health consumers to take a revolutionary degree of control of their health care.[10] Topol cites numerous Web and IT-mediated trends, including sharing of big data and direct-to-patient genetic test results (as exemplified by 23andme).[11] Meanwhile, mobile text-based services are slipping into the mainstream of evidence-based medicine. For instance, a program including motivational messages and behaviour-change techniques was shown to significantly improve smoking cessation rates at six months.[12] The package of intervention techniques and dialog strategies operationalised in this service in fact makes it a form of AI – one that can be recommended to a patient by a doctor, or that a consumer can find and download for themselves over the Web.

Third, health-care professionals can engage with, and encourage or moderate, the advance of AI by routinely asking questions of provenance. You may encounter AI-based decision support presented by a patient, or integrated with the systems you use in your Primary Health Organisation or District Health Board. In any event, you can query where it comes from – who is endorsing and distributing it, and what is their motivation (i.e, is it purely for profit through proliferation – licensing fees or banner-ad revenue – or is it publicly funded; is it endorsed by a medical body?). Is it part of the new wave of AI based on machine learning from big data? Or perhaps (as with the above smoking cessation example) the capability is a product of 'knowledge engineering', where techniques based on human experts have been deliberately selected. If it is based on data, then data from where and when? Does that data seem likely to be a good representation of your own patient population, or would there be obvious gaps (e.g. lacking Māori and Pacific cases)? Can the system be retrained on local data? Can the system offer explanations for its recommendations, or is it just a 'black box' that offers no specific insight for its assessment? Is there evidence of the system's effectiveness? If so, how has its performance been evaluated: in what context, on what population, over what duration, and particularly what was its performance compared to? If the answers to these questions are hard to find, you should be suspicious (or at least cautious); if the answers are unsatisfactory, you should actively communicate about the system's limitations.

To take the concept of engagement further, it is worth noting that Health Informatics is an established interdisciplinary field and a growing profession – this is the field that deals with methods of information processing and management in health care, including AI in health-care delivery. Membership in Health Informatics New Zealand (HINZ) is open to anyone with an interest in the field; HINZ events, particularly the annual national conference, are a great way to learn more about the field and meet the Health Informatics community. Several New Zealand universities offer postgraduate degrees in Health Informatics, and there are numerous options to study online with overseas universities (HINZ maintains a list of domestic and overseas study options: https://www.hinz.org.nz/page/EducationOptions). One can apply to become a member or fellow of the Australasian College of Health Informatics based on contribution to the field, and there now exists a training pathway to fellowship (https://www.achi.org.au/achi-fellowship-program/). While in this article I have taken a particularly medical/doctor centred view of the impact of AI on health-care delivery (given the nature of the journal), it is important to understand that the field is concerned with the whole health-care team; notably, nurses have been especially active in Health Informatics throughout its history. AI will influence and expand the capabilities of every type of professional associated with health care, as well as the health consumer.

The growing application of AI will add new and diverse inputs into the clinical context, but it will be just one more source of information to be considered in medical decision making. If you approach decision making as a shared process in partnership with patients, then they will be less likely to use Google to replace you!

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Genomic technology for patients

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The last five years has been an immensely exciting time for those doctors and medical students who love new technologies, or more importantly, who love what new technologies can do for patients. An expanding range of technological advances competes for our attention, such as: 3-D printing of cells to generate replacement tissues; augmented reality for clinical communication; health robots using artificial intelligence; cancer immunotherapy; and gene sequencing. Some of these new technologies are destined to be used by all practitioners in a specialty within the next five years. Other equally valuable technologies will remain research tools, used to build the evidence base for future medical practice, but are unlikely to be used directly by most doctors. Genomics and related 'omic technologies' sit in both camps, rapidly penetrating into the mainstream of primary and secondary care, while in parallel, transforming our knowledge of disease through research.

This article will argue that omic technologies are an advance that few doctors and medical students can ignore. It will describe the general landscape of omic technologies in New Zealand and overseas, then use two examples of omic technologies to illustrate the potential of this field: personal genomic testing; and polygenic risk scores. It will then discuss two challenges that are currently being addressed: the development of a genomically-literate health-care workforce; and issues of equity. Pertinent web sites and peer-reviewed references will be given for further reading.

What are omic technologies? Omic technologies generate masses of data to characterise pools of biological molecules in cells and tissues. Currently, the most widely used omic technology in medicine is genomics – the characterisation of DNA sequence. This is often divided into whole genome sequencing, exome sequencing (which sequences only that part of the human genome encoding proteins) and targeted panels (sequencing small subsets of the genome that are associated with disease). Other omic technologies are rapidly catching up to genomics, including: transcriptomics (RNA); proteomics (proteins); metabolomics (metabolites); lipidomics (lipids); and glycomics (carbohydrates). In all omic fields, the pace of technical advance is rapid and dramatic. This is best illustrated by genomics, where the shift from Sanger sequencing (sequencing one gene at a time) to massively parallel sequencing (capable of sequencing the whole genomes of many patients simultaneously) has been described as 'the most transformative technological advance in biomedical science since the development of the optical microscope'.[1,2]

So where have medical genomics and related technologies reached in Aotearoa New Zealand (NZ) and what is their future trajectory? Genomic tests using single genes or small sets of genes have been used in NZ for decades. Building on this expertise, NZ clinicians and research scientists have started to use next-generation sequencing in research studies where data can be fed back into patient care. Local examples include paediatric exome sequencing analysis to diagnose rare syndromes, and sequencing of cancers.[3,4] These studies are just a small part of a plethora of NZ medical-genomics initiatives, including Auckland's Genomics Into Medicine program and the national Genomics Aotearoa infrastructure.[5,6] In late 2018, a large-scale collaboration between a network of NZ general practitioners and an Australian genomics company was announced to undertake pharmacogenomics testing (analysis of genetic variants that affect medications) for NZ patients.[7]

However, despite this exciting activity, as a small nation with limited resources, our implementation of omic technologies in health care has lagged behind that of larger countries with similar health systems. For instance, as of December 2018, the United Kingdom (UK) Genomics England organisation had sequenced 100,000 genomes through its 13 Genomic Medicine Centres, facilitated by carefully governed partnerships with researchers and industry.[8] In Australia, the 2018 government budget provided a AU$500,000,000 investment for genomics to save or transform the lives of 200,000 Australians over ten years.[9] This seeded Australian Genomics, an alliance that brings together 80 clinical and research organisations. Investments in genomics for health and well-being are being made in many other Western nations, complementing large health data research studies such as 'All of US' in the United States of America.

An interesting example of medical genomics is Personal Genomic Testing (PGT). PGT involves individuals ordering their own genomic analysis online and is a rapidly growing industry. PGT is sometimes perceived as a route to 'precision health' – optimising the wellness of already healthy people. Although individuals using PGT are sometimes perceived as consumers of health care rather than patients, PGT is rapidly evolving from a purely direct-to-consumer model, into a model where health-care providers, directed by their patients, are intimately involved. PGT can generate a range of information, including: ancestry; predicted traits related to fitness and nutrition; pharmacogenomics; and carrier status for inherited disease.[10] As a result, medical practitioners play a difficult role in PGT, since only a subset of this information has a clear medical indication, a scientific evidence base, and rigorous regulation.[11] The scientific evidence base of some

other information included in these tests is either still emerging or downright absent. This complexity makes it difficult for individuals to interpret their own PGT results using readily available, but sometimes conflicting, web tools and blogs. The bandwidth of secondary-care genetic counsellors and clinical geneticists to assist with PGT impetration, and their knowledge about the ever-changing smorgasbord of PGT available, is also limited. Therefore, primary-care doctors and nurses will increasingly be called upon to order and interpret PGT. This will require them to both learn new material, and use their existing skills and experience to communicate a nuanced interpretation of the range of information provided by these tests in the context of the person in front of them and their medical history. This is a current reality, not just a future possibility. In a 2016–2017 survey of more than 2800 Australians, ~10% had undertaken PGT; of these ~60% would seek help from their general practitioner for interpretation of medical aspects of the test results. Even more challenging for general practice, ~ 25% would seek help from their general practitioner to interpret non-medical test information such as ancestry and traits.[12]

Another example of medical genomic technologies is Polygenic Risk Scores (PRS). PRS involve a set of tens to hundreds of single nucleotide variants in an individual's genome that is being sequenced, which are then summarised statistically.[13] PRS are emerging as important predictive tools to guide screening programs, clinical interventions, and life planning.[14] They are often more predictive of a disease than any single genetic variant is alone. This is in line with large-scale genome-wide association studies, which frequently identify hundreds of individually-weak genetic variants that interact synergistically to strongly influence the incidence or outcome of a disease. PRS have been used for everything from cardiovascular risk prediction to prediction of breast cancer risk and sub-type.[15,16] However, with current methods, the 'uncertainty' in PRS predictions at the level of an individual person can make them difficult to interpret.[14] In addition, many PRS have been derived from limited populations, so biases and inaccuracies can be introduced when they are then applied to populations with different genetic characteristics than those in which they were generated.[17] Since most of these limitations appear resolvable, especially if PRS are intelligently combined with existing clinical data, PRS are a technology likely to reach further into both primary and secondary care over the next five years.

The largest challenge we face today is generating a genomically-literate health care workforce and genomically-literate patients. The 2016 UK Chief Medical Officer's report stated 'modern genomic science has evolved into a new concept of the "clinical team" which now includes: diagnostic staff in laboratories and imaging; computer scientists; statisticians; (bio)informaticians'.[18] A major challenge seems to be clinicians acquiring the data science skills needed to integrate genomic information with health records, pathology tests, and their traditional clinical acumen. However, this integration is essential, since medical genomics is only effective when driven by, and interpreted alongside, patient-specific clinical information.[1] For nurses, general practitioners, pathologists, physicians, and surgeons to undertake this complex integration, significant capability development is often needed as part of their continuing medical education. For instance, in February 2019, Professor Eric Topol's UK National Health Service review noted that, 'within 20 years, 90% of all jobs in the NHS will require some element of digital skills', and that 'all staff will need digital and genomics literacy'.[19]

The rate with which medical genomics is developing has forced us to address issues in equity of access, genomic data governance, data security, and medical ethics, which have not previously been resolved.[20] For instance, current genomic technologies may serve some ethnicities much better than others, due to disparities in the inclusion of different ethnicities in the genomic databases used to interpret gene sequence data.[21] This has encouraged a group of NZ genomic scientists and clinicians to initiate a NZ 'variome' project, which will be co-governed by Māori and Pacific People in order to define the distribution of genomic features across NZers.[22] An additional challenge recently in the news is the ethical issues about genomically-directed technologies for genetic repair in utero using CRISPR-Cas9 and related methods.[22] This has recently resulted in a World Health Organisation panel proposing an international global registry for all CRISPR-Cas9 experiments in humans.[23]

This article has summarised the potential of medical genomics and their challenges. Right back in 2016, Dame Sally Davies, the UK's Chief Medical Officer, said in her annual report 'Genomics is not tomorrow. It's here today'.[18] However, it is clear that omics technologies have reached the clinic in some places earlier than in others. A historical quotation from the writer William Gibson aptly describes the current state of omics in NZ health care: 'The future is already here – it's just not very evenly distributed'.[24] In NZ, despite lagging behind some of our large international partners, we can look forward to an exciting future in medical genomics. Yet, in among this excitement, we need to be vigilant that the genomics we do in NZ has a firm evidence base, that it includes appropriate levels of co-governance with Māori, and that we add data science to our list of required skills.

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Retrospective analysis comparing robotic assisted with open partial nephrectomy in Canterbury

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Abstract

Robotic assisted partial nephrectomy (RAPN) is not currently offered in the public health system in New Zealand, but current research suggests there may be reduced complications and length of stay compared to open partial nephrectomy (OPN). The objective of this study was to retrospectively compare RAPN and OPN approaches in Canterbury, between Jan 2015–Oct 2018. The study showed no significant difference in all baseline characteristics between the two groups ($p < 0.05$), except positive resection margin, which showed a higher number with a resection margin (<1 mm for OPN vs. RAPN; 11 vs. 0, $p = 0.0048$). There was significant reduction in mean length of stay for RAPN (2.3 vs. 4.3 days, $p = 0.0001$) and number of complications (2 vs. 22, $p = 0.0002$) compared with OPN respectively. There was no significant difference in other perioperative variables. This study is consistent with current literature, showing a reduction in length of stay and number of complications for RAPN compared with OPN, and a lower rate of positive resection margins. Costs of providing RAPN therefore need to be considered to determine if there is justification for providing this service in the public health system. Future research could investigate using a longer follow-up period to analyse oncological outcomes, such as metastatic spread and recurrence.

Introduction

Current guidelines suggest removal of small renal masses (<4 cm) with nephron-sparing surgery when suspicious of malignancy.[1,2] Renal masses larger than this would impair a large proportion of the kidney, therefore an inability to preserve its function in nephron-sparing surgery. Nephron-sparing surgery is used to maintain the patient's kidney function, reducing risk of progression to chronic kidney disease.[1,2]

There is no difference in oncological outcomes (local/metastatic spread and recurrence) with tumours measuring <5 cm, therefore this is the treatment of choice if technically feasible, unless the tumour has suggestions of increased oncological potential.[2]

There are now many different approaches to nephron-sparing surgery: open, robotic, and laparoscopic. The laparoscopic approach is not often chosen due to its difficulty for many tumour locations, or for obese patients who increasingly make up the patient population. OPN is most often used in the public sector, but RAPN can now be used as a minimally invasive alternative to OPN in the private sector of New Zealand with the hope of reducing complications and enhancing performance. Two meta-analyses showed lower rates of complications with RAPN, as well as shorter length of stay and reduced transfusion requirements, compared with the OPN approach.[3,4] Xia et al carried out sensitivity analysis with exclusion of studies with obvious selection bias with regard to tumour complexity, allowing more accurate analysis of intra-operative factors.[3] Tsai et al also showed reduced blood loss for RAPN compared to OPN, particularly in highly complex renal masses, but also a longer operative time.[4] Xia et al and Tsai et al both had a large sample size, but inherent limitations involved in observational study.[3,4]

A reduction in mean length of stay with RAPN compared with OPN was demonstrated by several retrospective and prospective studies carried out since 2016.[5–9] Two retrospective studies also showed a reduction in intraoperative transfusion rates[5,6] and complications[8,10] with RAPN compared with OPN.

Overall, there is a need for well-designed randomised control trials with large sample sizes and longer follow-up times, as well as studies using local data. Robotic surgery is not currently used in the public health system in Canterbury, therefore it would be useful to analyse the patient benefit of RAPN compared with OPN using local data. If local data aligns with current literature showing a significant patient benefit, then a cost-benefit analysis could be carried out to determine the feasibility of its use in the Canterbury public health system. For this reason, a retrospective analysis was carried out comparing RAPN with OPN using patients in Canterbury. The aim of this study was to determine if there is any difference between RAPN and OPN in Canterbury with regard to perioperative variables and complications.

Methods

Study design and data collection

Data from all patients undergoing OPN in the Urology Department of Christchurch Hospital were retrospectively collected between Jan 2015–Oct 2018. All patients undergoing RAPN by the Urology Associates (private urologists in Canterbury) between these dates were also included. Exclusion criteria were paediatric patients or patients who were not undergoing tumour removal.

For each patient, we collected data on age, gender, perioperative factors (operative and ischaemic time, blood loss, peri- and post-operative complications within 30 days, and hospital stay), and tumour characteristics (tumour size, histotype, stage, and surgical margin status). Positive resection margin is the margin of surgical tissue that has no notable tumour within the resected tissue, determined through histology.

Data was collected through a combination of electronic records and operative notes, by two different people. Tumour size was determined using information from histology, and complications were recorded according to the Clavien-Dindo classification.[11] This is a classification system, which grades complications from 1–5, grade 5 being most severe.

Statistics

Categorical variables were compared using Fisher's exact two-tailed test, while continuous variables were compared, calculated using the unpaired t-test. All statistical analyses were carried out using Graphpad Prism.

Results

Preoperative characteristics

Overall, 69 patients underwent OPN (43) or RAPN (26) between Jan 2015–Oct 2018 through the Department of Urology in Christchurch Hospital and through the Canterbury Urology Associates respectively.

Table 1 shows that there was no significant difference in all baseline characteristics (age and gender, tumour size, location, histology, and stage) between the two groups ($p < 0.05$), except for positive resection margin. There was a higher number of patients with a positive resection margin of <1 mm in the OPN group compared with RAPN (11 vs. 0, respectively, $p = 0.0048$).

Table 1 Patient demographics and tumour characteristics stratified according to surgical approach

Variables	OPN (n=43)	RAPN (n=26)	P-value
Age	60.4	65.9	0.105
Gender			0.770
Male	31 (72.1%)	17 (65.4%)	
Female	12 (27.9%)	5 (19.2%)	
Tumour Size (mm)	31.4	2.9	0.436
Tumour location			0.505
Upper pole	15 (34.9%)	7 (26.9%)	
Mid pole	13 (30.2%)	3 (11.5%)	
Lower pole	14 (32.6%)	3 (11.5%)	
Histology			0.394
Clear cell RCC	24 (55.8%)	11 (42.3%)	
Papillary RCC	8 (18.6%)	5 (11.6%)	
Tubulocystic	1 (2.3%)	0 (0%)	
Multilocular cystic RCC	1 (2.3%)	0 (0%)	
Benign	9 (20.9%)	9 (34.6%)	
Tumour Stage			>0.999
pT1a	26 (60.4%)	17 (65.4%)	
pT1b	1 (2.3%)	2 (7.7%)	
pT3a	3 (7.0%)	0 (0%)	
pT1M1	1 (2.3%)	0 (0%)	
Positive surgical margin			0.0048
<0.1 mm	8 (18.6%)	0	
<1 mm	3 (7.0%)	0	

Table 2 shows that there was no significant difference in estimated blood loss, warm ischaemic time, operating time, return to theatre, and number of transfusions for RAPN compared to OPN, respectively. There was significant reduction in mean length of stay however, for RAPN compared with OPN (2.3 vs. 4.3 days, respectively, $p = 0.0001$).

Table 2 Perioperative data comparing open and robotic assisted partial nephrectomy

Perioperative variables	OPN (n=43)	RAPN (n=26)	P-value
Estimated blood loss (ml)	159.4	153.5	0.903
Warm ischaemic time (minutes)	14.2	16.2	0.260
Operation time (minutes)	148.5	150.7	0.900
Blood transfusion	2 (4.7%)	0	0.523
Return to theatre	2 (4.7%)	0	0.523
In hospital stay (days)	4.3	2.3	0.0001

Table 3 shows the complications for both groups using the Clavien-Dindo classification system. Overall, there was a reduced number of complications for RAPN compared with OPN (2 vs. 22, respectively, p = 0.0002). The complications for the OPN group were mostly grade 1 complications (13), however there were still a significant number of complications for grade 2a, grade 3, and grade 4 (five, two, and two, respectively) compared with RAPN, whose two complications were grade 2a.

Table 3 Complications according to the Clavien-Dindo classification comparing open and robotic assisted partial nephrectomy

	Open partial nephrectomy (n = 43)	Robotic assisted partial nephrectomy (n = 26)	P-value
Total complications	22	2	0.0002
Grade 1	13	–	
Pleural or peritoneal breach	4	–	
Prolonged pain	3	–	
Pneumothorax	2	–	
Incisional bulge	3	–	
Seroma	1	–	
Grade 2a	5	2	
Sepsis	2	1	
Need for blood transfusion	2		
Ileus	1	1	
Grade 2b	–	–	
Grade 3	2	–	
Post-op bleed requiring surgical revision	2	–	
Grade 4	2	–	
Pneumonia requiring ICU	1	–	
Perinephric haematoma requiring ICU	1	–	
Grade 5	–	–	

Discussion

The robot-assisted approach for partial nephrectomy is currently being used in many countries, due to being minimally invasive compared with OPN, with improved view, precision, and ergonomics compared with laparoscopic.[7] This study included 43 OPN patients and 26 RAPN patients, all with similar baseline characteristics ($p < 0.05$). As expected, there was a significant reduction in mean length of stay (2.3 vs. 4.3 days, p = 0.0001) and complications (2 vs. 22, p = 0.0002) for RAPN compared with OPN, respectively. This is consistent with current literature, which shows reduced number of complications and mean length of stay for RAPN.[3–9]

The study also showed that two OPN patients required transfusion compared with no RAPN patients, however this was not statistically significant (p = 0.523). Two previous studies showed no statistical difference between groups with regard to blood transfusion requirement, which is consistent with this result.[8,10] Several studies including two meta-analyses showed reduced transfusion requirements for RAPN compared with OPN.[3–6] The current study may not have had a large enough sample size to show any statistical significance for an uncommon outcome such as transfusion, therefore a larger study may be required to explore this result. This is the limitation of a retrospective cohort, which requires a large sample size for less common outcomes. The sample size may explain why we found no statistically significant difference in estimated blood loss between groups, although there was some missing data for this variable making it less reliable. Both meta-analyses and the retrospective study by Tan et al showed less estimated blood loss in the RAPN group compared to the open group.[3,4,9]

The statistical power of this study could have been improved if data were analysed New Zealand wide, rather than just Canterbury, although this would have required a lot more time and resources. Recruiting patients that had surgery prior to 2015 would have likely introduced more missing data, therefore this would not be a good solution to increasing the sample size.

In our study there were 11 patients with a resection margin of <1 mm for OPN compared with zero patients for RAPN (p = 0.0048). This result was consistent with a slightly larger study of 200 patients,[8] but many studies showed no significant difference in positive resection margin between RAPN and OPN.[3,7,8,10] It may be worthwhile looking at the way the pathologist reports the positive resection margin, and whether this has clinical significance. The tumour characteristics such as location, size, type, and grade were not significantly different between groups, therefore these factors are unlikely to be acting as confounding factors. A prospective study that involves a longer follow-up period, looking at oncological outcomes for patients in Canterbury would be needed to support this result and improve the level of evidence. Current literature suggests there is no difference in the long-term oncological outcomes between OPN and RAPN patients, although this evidence is limited.[1,2]

Other limitations of this study include the inherent differences in public compared to private care, including socioeconomic status, waiting times, and co-morbidities. The private data were also collected by a different person to the public data, but there was communication about how this was done to keep it consistent and reduce scope for error. Operative time for RAPN included anaesthetic time and occasionally other procedures, therefore an estimate was occasionally required making this result less reliable. Borghesi et al[8] and Tsai et al[4] showed a longer operative time for RAPN compared to OPN, while other studies showed no difference.[1,3,5,7] This included the meta-analysis by Xia et al, which showed no association after controlling for tumour complexity.[3]

Better quality evidence is required to limit confounding and selection bias. Unfortunately, a randomised control trial would not be possible in Canterbury due to RAPN not being available in the public system, and this may be considered unethical due to the amount of evidence showing benefits of RAPN compared with OPN. A prospective study could be considered in the future for the Canterbury region, to reduce bias associated with missing data and to support the current limited evidence. A longer follow-up period would be beneficial to compare oncological outcomes, as there is limited evidence looking at this. Further research could also look at more complex masses as well as patients with a body mass index of >30, which is a readily increasing demographic in the population.

In this audit and literature review I have focused on patient factors for RAPN compared to OPN. Other considerations to justify using robotic surgery for public cases include benefits of partial nephrectomy over radical nephrectomy, the number of patients per year that would benefit, as well as overall cost.

In conclusion, this retrospective audit for Canterbury data aligned with current literature to show that RAPN has a shorter mean length of stay and lower rate of complications compared with OPN. Interestingly, this study also showed a lower rate of positive resection margins in the RAPN group, compared with OPN. All other perioperative factors and tumour characteristics were similar between

the two groups, including operative time, warm ischaemic time, and transfusion rates. Further research to increase the level of evidence would be beneficial, as well as research into the costs involved in using RAPN for the public health system.

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Feasibility of developing a 360° video-based virtual reality simulation of a stressful clinical event

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Abstract

Individuals early in their medical career feel unprepared for acute high-stress clinical situations such as managing a deteriorating patient. Simulation-based learning (SBL) is a method used within medical education to prepare for the clinical environment. SBL has been successfully integrated with virtual reality technology, however there is a lack of literature regarding its use for replicating the stress of a clinical environment and using 360° video to improve fidelity. Our non-specialist team aimed to develop and test the acceptability and feasibility of an interactive 360° video-based virtual reality simulation of a high-stress clinical situation. The simulation was developed within the ten weeks allocated to this project, however standardised measures from our sample could not be collected. Important information regarding the development and creation process was obtained and alpha testing of simulations were perceived acceptable and useful, thus, highlighting the merit of further research in this area.

Introduction

Newly-qualified doctors are likely to be exposed to a variety of physically and emotionally demanding incidents, some of which include witnessing death, violence, and aggression, and participating in resuscitation.[1,2] Factors such as emotional and physical distress are likely to elicit a physiological stress response, which may affect the performance of an individual in managing these situations.[3] It is widely accepted that an individual's self-efficacy is strongly linked with work-related competence and clinical performance.[4–6] Self-efficacy can be defined as an individual's beliefs regarding their capabilities to perform a behaviour or learn at a specific level.[7] Regardless of accuracy, an individual's judgment about their self-efficacy arises from several information sources including emotional state.[7]

Previous research related to clinical self-efficacy has indicated that many newly-qualified doctors feel unprepared as they step into their new roles, which are likely to involve managing stressful clinical events.[8,9] An example of such an incident would include the management of a deteriorating patient. A deteriorating patient can be defined as 'a patient who moves from one clinical state to a worse clinical state which increases their individual risk of morbidity, including organ dysfunction, protracted hospital stay, disability, or death'.[10]

Several studies have used self-reported questionnaires and interviews to investigate factors influencing a junior doctor's management of stressful clinical events. Concepts related to self-efficacy, such as clinical knowledge, technical and non-technical skills, have been investigated and identified that there was a significant lack of self-perceived competence and confidence among many junior doctors.[11,12] The acute stress elicited during stressful clinical events is identified in a study by Paice et al.[13] In this study, a sample of junior doctors were asked the open question, 'please think of a particularly stressful or difficult event that you have encountered during your house officer posts'. The most common response was an incident that involved professional responsibility beyond their self-perceived competence. The lack of preparedness for the role of a junior doctor has caused various mistakes in the past, some of which include delayed treatment, delayed diagnosis, amputation, and death.[14]

The literature highlights the issue that many newly-qualified doctors feel unprepared for common stressful clinical situations and that the emotional stress of certain situations may influence performance. Therefore, our current methods of preparing medical students for these situations may be improved to avoid the previously mentioned consequences.

A strong relationship exists between exposure to stressful events and confidence to perform effectively in these situations.[15–17] Improved practical skills and confidence are observed when junior doctors are engaged in bedside clinical training, while shadowing experienced doctors.[18,19] However, these experiences are often opportunistic and therefore cannot always be deliberately arranged. A widely accepted practice within medical education that allows individuals to have experiences akin to real clinical situations is via SBL. SBL is a practice that creates an artificial environment in which an individual can experience a representation of a real event in order to practice, test, learn, evaluate, or gain an understanding of human actions or systems.[20] Some of the various modalities of simulations include manikin based, computer based, and simulated patient based. The fidelity between and among these different simulation modalities tends to vary. Fidelity refers to the degree to which a simulation replicates the real events and/or workplace, and impacts the quality of the simulation.[21] SBL allows individuals to experience clinical situations, practice procedures or physical manoeuvres, and practice examination skills, among various other clinical situations.[22,23]

Studies suggest that SBL contributes to improved self-efficacy and performance, and eases the transition into clinical settings, along with improving patient safety.[24,25] Junior doctors have specifically emphasised the importance of simulation in acquiring knowledge and practising skills for acutely stressful scenarios, such as managing deteriorating patients.[26,27] Most medical simulations are developed in order to learn specific knowledge and clinical skills.[21] There is sparse literature regarding simulations developed with the aim of inoculating the stress that may be experienced during stressful clinical events.[28,29] However, the literature that does exist suggests that the development of such simulations may be useful in preparing newly-qualified doctors to better manage acutely stressful situations. Specific barriers to including such simulations may include operational challenges in developing and running simulations, such as resources, cost, and time. These barriers may be overcome by the utilisation of recent advancements in virtual reality technology.

Virtual reality uses an artificial digital environment in which the wearer can be physically immersed using devices such as head-mounted displays, and which can lead to the wearer feeling 'present' in the experience.[30] There are variations regarding the definition of virtual reality, however, most definitions highlight common elements. These are immersion in a virtual environment, a subjective sense of presence, and interactivity.[31,32] There have been recent advancements in virtual reality technology that have allowed for greater affordability, accessibility, and quality.[33] Virtual reality technology has successfully been integrated with SBL in various ways, some of which include training for laparoscopic skills, gynaecological procedures, and nasal endoscopy.[34] This integration allows for simulations to maintain the benefits of SBL, while simultaneously providing an opportunity to overcome limitations such as intense resource requirements and ongoing operational costs for repeated simulations.[35] Virtual reality can be used to improve the cost-effectiveness of SBL in medical education and may also be utilised to create high-fidelity simulations. These simulations can be used to better prepare medical students to become doctors capable of managing acutely stressful clinical events. This study aims to assess the feasibility of developing a 360° video-based virtual reality simulation of a stressful clinical event as an education tool for senior medical students.

Materials and methods

This project used a multimedia instructional design process, which involved identifying an appropriate scenario, creating a storyboard of the experience, recording the simulation with a 360° camera (Ricoh Theta S), editing the footage, developing an interactive simulation using a game development platform (Unity), and evaluating the acceptability of the simulation. We intentionally selected hardware and development tools that were affordable and commonly available as a test of their capability to create a viable simulation. The simulation context was designed for a final year medical student (trainee intern). After consulting with four physicians and a nurse, who each had more than four years of experience in managing deteriorating patients, we concluded that the management of a seizure on a minimally-staffed ward would be an appropriate and realistic scenario.

In this scenario, the trainee intern would typically call for senior support. There is a duration of time between calling for help and senior support arriving to where the trainee intern is responsible for managing the situation. In our chosen scenario, this duration was extended due to minimal staffing, which was believed to be a key factor in providing a stressful experience. Towards the end of the simulation, the trainee intern would be expected to give a verbal summary of events to senior support as they arrive. The verbal summary is common practice and another potential source of stress. The simulation would progress by the wearer interacting with the virtual environment to make decisions. We decided to use a non-linear structure to create a sense of realism and control, which allows the wearer to experience the consequences of their decisions. The non-linear structure creates complexity in maintaining the continuity of the narrative, as there are several branching avenues that could be experienced. To maintain adequate continuity and further develop the narrative, we initially created a storyboard within a Microsoft Excel spreadsheet, which contained information on each scene such as scene description, dialogue, interactable objects, and the branching scenes that can be triggered. We had difficulty assessing the continuity of the narrative within the spreadsheet format and therefore developed a flow chart using the open-source software Mermaid (https://mermaidjs.github.io), to better visualise the process and assess the flaws within the storyboard. The flowchart and the spreadsheet had been revised several times with consultation from physicians and nurses to improve clinical accuracy and continuity flaws.

The footage was recorded using a Ricoh Theta S camera. It was essential for us to understand the capabilities of the technology available in order to capture high-quality footage. We elected to record 360° video, rather than developing a virtual reality model of the simulation, for practical reasons. This development approach required much less time and we thought might also enhance the realism of the simulation. We tested recording footage from a variety of camera positions in order to assess the location where the footage best simulated a first-person experience. These test shots were also analysed to assess the field of view, distortions, and viable object placement. The camera also enabled us to capture four-channel audio, which allows for the sound to be mapped according to the virtual space during development.

With the permission of clinical and ward staff, we filmed the scenario in a ward room within Dunedin Hospital. Two medical students and a senior ward nurse had volunteered to act for the roles of patient, senior nurse, and junior nurse. We believed that their clinical experience would play a valuable role in creating a realistic clinical simulation. The footage recorded was then processed through the Ricoh Theta app and subsequently in Adobe Premiere.

The Vive headset can be used to experience a virtual world by viewing images through the head-mounted display. By using sensors, which track movement and subsequently modify the displayed image, the wearer is immersed within the virtual world. The setup also uses two controllers that are tracked and used to point and, hence, interact with the virtual environment. The simulation was built using the Unity game engine (http://unity3d.com/) and programmed using C# for logic control. Unity allows for videos of different stages of the simulation to be systematically linked together and triggered following interactions driven by the wearer.

Wearers interact with the simulation using the hand-held controllers. This involves pointing and then clicking on an object of interest (e.g. patient, blood glucose monitor), which then activates an opaque menu with options on how to utilise the object of interest. This allows for an array of interactable objects in which the wearer can decide to interact without being prompted. The interactions had consequences that either progressed the simulation to a new scene or provided feedback to the wearer through text within the virtual environment.

A training tutorial was developed to orient wearers to the virtual environment, and the entire simulation was piloted on three members of the research team. Informal feedback on early development versions (alpha testing) was gathered from a convenience sample of medical students.

Results

Our non-specialist team successfully developed a 360° video virtual reality simulation of a clinical event. We underestimated the time required for development, due to the difference between 360° VR

and traditional multimedia design. This limited our ability to collect objective data within the ten weeks available for this study. However, important information about the process of developing such a simulation was discovered. We had determined a process for utilising Unity to integrate components of 360° video, interactivity, and virtual reality to create the simulation. Information about the virtual experience was also obtained during feedback from ad-hoc simulations during and post-development for alpha testing.

Anecdotal feedback from the three members of the research team who piloted the simulation suggested that it was successful in achieving a sense of presence in the wearer, and may have the potential to influence self-efficacy for managing clinical emergencies. Alpha testing was done with four medical students with clinical experience and six medical students with no clinical experience. It was identified that students with no clinical experience seemed less likely to feel stressed or to feel more self-efficacious regarding their ability to manage the deteriorating patient. This is contrasted by the individuals with clinical experience who suggested a higher degree of stress and felt more self-efficacious. All individuals commented on the potential and usefulness of the simulation concept.

Discussion

This study has indicated that a non-specialist team can develop an interactive virtual reality simulation using 360° videos. These simulations can be made at a low cost and therefore, may ease operational issues associated with traditional simulation-based learning. Our results have suggested that these simulations may inoculate against stress, may influence self-efficacy, and may be useful within medical education. Preliminary results suggest a degree of acceptability and feasibility, and therefore, justify further research in testing the acceptability and feasibility of this simulation concept. A formal evaluation of this simulation and its impact on stress and self-efficacy will be conducted by the research team in the future.[i]

i This study has been approved by the University of Otago Human Ethics Committee (ref 18/211)

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Will machines replace dermatologists in the diagnosis of skin disease?

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Lizzie is a 5th year medical student with a keen interest in dermatology. This essay was the University of Auckland winner of the Wilson-Allison Memorial Prize in Dermatology.

Introduction

With recent advances in artificial intelligence (AI), not a week goes by without an article with a catchy headline stating that a certain medical specialty will soon be replaced by "robots". But are such claims substantiated? In this essay, I hope to explore this fascinating topic by firstly, reviewing recent literature on the role of AI technologies such as deep learning convolutional neural networks (CNNs) in the diagnosis of dermatological disease. Secondly, I will outline some of the existing technologies that aim to complement contemporary dermatologic practices. Some examples of this include teledermatology, mobile dermoscopy/dermatoscopy, and smartphone apps. Finally, I will briefly discuss patient-centred care as relevant to AI in dermatology. Throughout the essay, I will draw on some relevant personal experiences both as a student doctor and as a patient, to hopefully, provide the reader with additional context from my perspective. Due to the concerningly high rates, and thus, the public health importance of melanoma in New Zealand,[1] as well as the breadth of the topic, for the purposes of this entry I am going to focus on the use of AI and other technological tools in detection of melanocytic cancer specifically. At the same time, I will also acknowledge that AI and technology may be successfully utilised to diagnose other types of skin disease, too.

Recent advances of AI and machine learning in dermatology

As alluded to in the introduction, of particular interest to dermatology is the concept of deep learning CNNs. CNNs are artificial, feed-forward neural networks capable of analysing and learning from visual imagery.[2,3] CNNs are able to improve their future performance according to their previous experiences in image recognition and classification – this process is referred to as machine learning.[2,3] The concept of CNNs has become especially topical after the results of a study by Esteva et al were published in *Nature* last year.[4] In this landmark study (the largest of its kind), over 100,000 biopsy-backed clinical photographs were used to teach a deep learning CNN-based algorithm to discern malignant skin lesions from their benign mimickers.[4] When asked to differentiate between, firstly, melanomas and benign naevi, and, secondly, keratinocyte (i.e. non-melanocytic) carcinomas and seborrheic keratoses, the CNN system performed comparably to a cohort of 21 board-certified dermatologists.[4] For the first time, successful utilisation of a computer algorithm capable of expert level thinking was demonstrated for a relatively subjective task, which is of increasing importance in everyday dermatological practice.

Less than a year later, Haenssle et al reported that a deep learning CNN that was trained specifically to distinguish dermatoscopic images of benign and malignant melanocytic lesions has shown to be, on average, superior in both sensitivity and specificity when compared to an international panel of 51 dermatologists.[6] More than half of those physicians were considered experts with five plus years of dermatoscopic experience.[6] When additional clinical information was provided to the dermatologists (to simulate the real life setting more closely), their overall sensitivity was improved, yet the algorithm still outperformed clinicians in terms of specificity.[5] Therefore, it was suggested that a competently trained CNN may be a helpful addition to any dermatologist's diagnostic toolbox, regardless of their level of expertise.[5,6]

Earlier this year, I had the privilege of attending and presenting at the New Zealand Dermatological Society Incorporated annual conference. Two of the scheduled sessions addressed the topic of machine learning and AI in melanoma diagnosis. These talks, which heavily featured data from the two studies described above, stimulated heated discussion among dermatologists. It soon became obvious that, at present, even local experts may not necessarily be able to reach an agreement; some were sceptical about the technical abilities of AI or expressed concerns regarding patient satisfaction, whereas others warmly welcomed the idea of incorporating CNN systems into their practice, provided it reliably results in fewer missed cancerous lesions and misdiagnosed benign ones.

While, understandably, there is a considerable amount of excitement surrounding CNN, the tangible benefits of the demonstrated accuracy and efficiency of this technology may still be distant.[4–6] This is because initial CNN training requires a substantial amount of resources and time, and actual implementation into routine clinical practice is only possible once local medico-legal boundaries are better defined, and security risks are addressed.[4–6]

Other technology for the most visual specialty

It has been postulated that because of the highly visual nature of diagnosis and management of skin conditions, modern technology constitutes an especially valuable addition to dermatology – perhaps, even more so than any other medical specialty.[7,8] The number of now routine dermatological practices that heavily rely on machines of various kinds (not necessarily AI based) for visual assessment of skin disease in one form or another is vast; among them are whole-body photography, dermatoscopy, and teledermatology.

Given the recent surge of interest in healthcare-related technology, it is not surprising that personal electronic devices are being increasingly utilised by healthcare professionals.[7,8] Indeed, I have personally witnessed numerous dermatologists regularly utilising their mobile phones in their everyday practice, whether to quickly access reputable reference sources (such as DermNet NZ), or to use convenient smartphone dermoscope attachments, which are becoming increasingly popular. Not to mention conventional dermoscopy, which can be considered the gold standard of clinical dermatologic assessment today.[7,8]

With the rise of telemedicine, mobile devices and computers are now becoming increasingly important for patients with skin problems, too, especially those who may struggle to access in-person dermatology advice (for example, individuals from rural/remote or low socioeconomic status communities).[9,10] While both the store-and-forward and live interactive forms of teledermatology have limitations (such as security issues or inability to incorporate palpation, a core component of skin examination), research suggests that, overall, teledermatology is a promising way of efficiently delivering quality dermatological care at a lower cost compared to face-to-face visits.[8–11]

Smartphone applications

Over the last couple of years, countless smartphone applications and internet websites that aim to educate, diagnose, or even help manage various health conditions have become available to both the general public and the physician community.[12,13] Among the more popular are apps designed specifically to help consumers detect malignant skin lesions, especially melanomas, at home.[14–18] Some of these are designed to be more of a triage tool, whereas others virtually aim to replace a dermatologist's consult; most have ambiguous legal/regulatory status.[14–18] Because of heterogeneity in the software employed in such apps and in their purpose, the diagnostic accuracy, and thus, practical utility of this class of apps as a whole is difficult to evaluate.[14–18] According to a large 2018 systematic review conducted by Rat et al, automated smartphone medical apps aimed at melanoma diagnosis are currently considered to be unreliable from accuracy and safety standpoints.[18] Issues commonly reported in the literature include unacceptable rates of false positive results, which could result in unwarranted patient anxiety and increase in demand for unnecessary specialist care, as well as high false negative rates and thus missed opportunities for timely identification and treatment of potentially dangerous skin lesions due to false reassurance.[14–18] The latter especially raises the complex issue of medico-legal liability.[18] Regardless, these tools remain a popular conversation topic among patients: during my time as a student attached to Dermatology and General Practice clinics, discussions around "self-assessment" skin-check apps were a near everyday occurrence.

Way forward

Clearly, considerable efforts to improve melanoma-detecting apps are required before they can become appropriate and widely accepted alternatives for proper clinical skin specialist consultations.[14–18] However, with the impressive results achieved by Esteva and Haennsle using deep neural networks in mind, it is not unreasonable to infer that if similar CNN technology could be competently trained and incorporated into a user-friendly phone application, it would represent a major step forward for skin cancer-detecting apps from a diagnostic accuracy standpoint.[4–6,18] It would also be interesting to observe the future interplay of the fields of whole-body photography, mobile dermoscopy, teledermatology, and modern AI. A successful fusion of these technologies could facilitate the diagnostic process even further and benefit everyone involved in the detection and treatment of skin cancer, from patients to experts.[5,6,8,14] Uncertainty regarding dermatological diagnoses is prevalent among primary care practitioners: despite dedicating large amounts of clinical time to patients with skin complaints, many general practitioners lack formal dermatological training and/or expertise.[19] Thus, the advent of such CNN-based tools for the purposes of decision-making support could be very helpful in the community setting as it could improve system efficiency and reduce the burden of unnecessary referrals to specialists.[5,19] Dermatologists that currently look after high-risk patients would also benefit from AI-based apps due to a streamlined, targeted surveillance process, while patients themselves may enjoy the enhanced convenience and reliability of self-skin checks.[5,12,13]

Touch and empathy versus technology

Finally, I wanted to touch on some of the more philosophical aspects of the interplay between technology and doctor-patient relationships by reflecting on my own recent experience. I was a patient evaluated and treated for a pigmented skin lesion suspicious for malignancy. Without going into too much detail, it was a drawn-out, stressful affair comprised of long periods of waiting and uncertainty, multiple referrals, appointments, and, finally, surgery. This process could probably be vastly simplified, had the timely utilisation of technology such as CNN been possible. However, despite being inefficient and frustrating at times, the overall experience ended up being memorable in a good way because of the wonderful advice, respect, empathy, and reassurance offered by the doctors I encountered on my journey as a patient. At the time of writing this, I still do not know the result of the biopsy, but I do know that, no matter the histological outcome, personally I would not have traded the excellent in-person care I received for a quicker, definitive diagnosis made by a computer algorithm.

Upon reviewing relevant literature, I discovered that similar sentiments (i.e. valuing treatment with compassion, respect, and dignity over efficiency or technical skills in the healthcare setting) are not uncommon among patients.[20–22] Indeed, the positive influence of warm, patient-centric communication and of the act of physical examination on the doctor-patient relationship is a well-documented theme in medical and social sciences literature.[23] Despite claims that traditionally-taught "doctoring" and interpersonal skills are losing importance in the age of modern medicine characterised by staggering technological advance, or that the imperfect art of clinical examination is slowly become obsolete, evidence suggests that patient-centred care (which relies heavily on thoughtful utilisation of these long-established modalities) still appears to be the key to patient satisfaction.[21–24] It has even been postulated that biomedical developments may actually widen both the psychological and physical distance between doctors and patients, although further research is needed to explore this effect.[24] While computer-aided diagnostic systems are abundant and have unique, undisputable advantages,[25] they obviously cannot (yet) incorporate empathy and physical touch as powerful ways of connecting with and healing the patients with skin conditions.[5]

Conclusion

In 2018, both clinicians and patients are equipped with a variety of technological tools that may aid them in the diagnosis of skin conditions. These range from the popular self-assessment mobile applications, to the more formal use of personal electronic devices for the purposes of communicating with a specialist (as in teledermatology). While CNN-trained AI has recently shown some truly impressive abilities in detection of skin cancers, by no means does this represent

a replacement for all aspects of traditional physician consultations such as thorough history taking, physical examination, human touch, and empathy. After all, good medical practice is about much more than solely diagnostic accuracy. Furthermore, heavy reliance of medical practices on any technology inevitably brings with it a unique set of concerns (including legality and cybersecurity issues) that must be adequately addressed before widespread implementation is possible.

To conclude, despite significant technological advances of diagnostic techniques in recent years, I do not believe that machines will replace dermatologists in the diagnosis of skin disease (including, but not limited to malignant melanoma) any time soon. In my opinion, the emphasis should be on using the ever-evolving technology to complement and augment the conventional skill set of physicians, rather than to replace doctors altogether. Such symbiosis would ideally help us achieve enhanced rates of access to high-quality, appropriate dermatological care and improved outcomes for patients with melanoma and other skin disease in the most efficient and economical way possible.

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Man versus machine: will machines replace dermatologists in the diagnosis of skin disease?

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Research into the role of artificial intelligence in medicine is rapidly growing. In 2016, healthcare-related artificial intelligence projects attracted more investment than artificial intelligence projects in any other sector of the global economy.[1] Artificial intelligence is a general term that refers to the use of a computer to model intelligent behaviour with minimal human intervention.[2] Recent advances in this field are numerous and include taking steps towards the automatic detection of diabetic retinopathy, better interpretation of radiography and more efficient diagnosis of skin cancer. In particular, the use of artificial intelligence to distinguish between malignant melanoma and benign lesions has garnered a lot of attention.

Skin cancer remains a major public health issue in New Zealand, with recent data revealing New Zealand has the second highest rate of melanoma in the world.[3] The 2018 skin cancer index published by German medical analyst group derma.plus stated almost 2,500 new melanoma cases are diagnosed in New Zealand every year.[4] Early detection of melanoma is critical to patient prognosis and survival. The five-year survival rate of early stage melanoma is 99%, falling to only 20% for melanoma that has spread to distant sites in the body.[5]

Currently the process of diagnosing a malignant lesion begins with visual examination by the general practitioner or dermatologist. Many physicians will also use a dermatoscope, a hand held microscope that provides low level magnification of the lesion. If these methods are inconclusive or lead the physician to suspect the lesion may be cancerous, a biopsy and subsequent histopathological examination are the next steps.[6] However, accurately distinguishing which lesions require a biopsy and which do not is often poorly achieved by medical professionals. Dermatologists and other medical practitioners formally trained in this field have been shown to have an average sensitivity for detecting melanoma of less than 80%.[7] This can have damming consequences for the patients affected, given the imperativeness of diagnosing melanoma at the earliest possible stage.

In recent years a lot of work has been carried out to develop automated computer image analysis of skin lesions, with the hope this may help physicians to more accurately identify potentially dangerous lesions. Traditional methods have focused on teaching computers to identify suspicious lesions on the basis of certain 'manmade criteria' such as lesions with an asymmetrical appearance, irregular border or multiple colours.[7] In 2017, a landmark paper from researchers at Stanford university proposed that the recognition of malignant lesions via machine learning was a feasible alternative.[8] The basis of machine learning is that the computer is programmed to 'figure out' the answers itself, rather than having answers pre-programmed into it. Not being restricted to certain man-made criteria allows a much broader range of malignant lesions to be identified, which is useful given the large variation that is seen in the appearance of melanoma.[7]

In 2018, leading cancer journal Annals of Oncology published a study that showed that a form of machine learning known as a deep learning convolutional neural network (CNN) was in fact better than most dermatologists at detecting skin cancer.[7] A CNN is an artificial neural network inspired by the biological processes used when neurons in the brain make connections with each other and respond to what is seen with our eyes.[9]

In the study, researchers from Europe and the United States of America trained a CNN to identify melanoma by showing it more than 100,000 dermoscopic images of the disease, as well as benign naevi, and attaching to each image what the correct diagnosis was. The network was able to learn rapidly from example, by deconstructing each image down to the pixel level, and creating its own diagnostic clues for classifying the images. After training the computer, the researchers created a set of 100 test images which again comprised both melanomas and benign naevi (these images had not been used for training and therefore had never been seen by the CNN before). The images were used to test the CNN and compare its performance to dermatologists around the world. 58 dermatologists agreed to participate in the study. In the first instance (level I), the dermatologists were shown each image on its own and asked to make a diagnosis of melanoma or benign naevi, and to indicate how they would manage the lesion (either surgical excision, short term monitoring of the lesion, or no further action required). In the second phase of the study (level two), the dermatologists were again shown each image and asked for a diagnosis and management decision, however this time they were also supplied with some additional clinical context (including the age and sex of the patient, and the location of the lesion).

In level one, the dermatologists on average correctly diagnosed 86.6% of melanomas, and 71.3% of benign naevi. When the CNN was tuned to have the same specificity as the dermatologists (i.e. to correctly identify 71.3% of benign naevi), the CNN was able to identify 95% of melanomas. The clinical context provided in level two of the study significantly improved the dermatologists' performance such that they accurately identified 88.9% of melanomas and 75.7% of benign naevi. However, while the performance of dermatologists improved when provided with more clinical information, the CNN continued to outperform them even at this level. These findings suggest the increased sensitivity and specificity provided by the CNN could result in fewer missed melanomas as well as less unnecessary biopsies if implemented into clinical practise.[7]

Lead researcher, Professor Holger Haenssle, from the University of Heidelberg, stated he does not envisage the CNN will replace dermatologists in diagnosing skin cancer, but that it could be used as an additional aid. 'Most dermatologists already use digital dermoscopy systems to image and store lesions for documentation and follow up. The CNN can then easily evaluate the stored image for an "expert opinion" on the probability of melanoma.[9]

As discussed above, at present the decision to investigate a skin lesion is dependent on the opinion of the treating clinician. Research has suggested the accuracy of this can vary widely depending on the training and experience of the doctor in question. It is hoped the use of automated computer image analysis may help to standardise the level of diagnostic accuracy seen across the world, such that all patients, regardless of where they live or which doctor they see, will be able to access the same level of care.[9]

While the technology currently exists on computers, there is a possibility it could become available as a smartphone app in the future, allowing almost ubiquitous access to skin lesion analysis right at our fingertips. There is also the potential for this technology to be used in combination with 2-D or 3-D total body skin imaging systems. These imaging systems are currently able to image close to 90–95% of the skin surface. This would mean the majority of a patient's benign lesions could be filtered by the machine, allowing dermatologists to focus more of their time on the more suspicious or concerning lesions. In addition, one of the major issues pertaining to the implementation of a melanoma screening programme is the lack of a suitable test – in that a whole body inspection by a physician lacks both sensitivity and specificity. The CNN may fill this gap by acting as a more precise screening tool.[6]

While this is an exciting development in the diagnosis of skin cancer, the concept is not without limitations. Firstly, in regards to the study, the dermatologists knew they were in an artificial setting and therefore were not making 'life or death' decisions. Difficulty in accessing validated images meant there was a lack of images from non-Caucasian ethnicities, raising concerns about the accuracy of the CNN when applied to a broader range of real-world settings. In addition, as this study shows, clinical context is crucial. Clinicians were not able to examine the rest of the patients' skin and look at their other moles and they could not ask questions such as what sun exposure the patient had experienced throughout their lifetime, if they had ever had a previous skin cancer, or if there was any relevant family history.[7] These are things that can be ascertained very quickly in a real-life clinical setting and would likely have a significant impact on a doctor's clinical decision making.

Further refining of the technology is also needed. Areas of the body that are difficult to image such as the scalp, fingers, and toes are problematic for this type of technology.[7] In addition, researchers have discovered the CNN can be tricked in unexpected ways. For example, previous studies have shown lesions with a ruler in the image are much more likely to be deemed malignant by the machine. This is because dermatologists are more likely to measure lesions they are concerned about and thus within the portfolio of validated images available for training, malignant lesions are more likely to have been photographed with a ruler.[8] This bias occurs due to the technology analysing the image in its entirety, rather than just the lesion alone. Other situations that could fool the technology could be unusual combinations of lesions such as a benign naevus in close proximity to a seborrheic keratoses, which could closely mimic a melanoma.[7] This also highlights another downfall of CNN technology – it is a black box system. This means that we do not know exactly what diagnostic clues the machine is using to formulate its diagnosis and thus its implementation is opaque.[10] If no clinician is involved in the diagnostic process, this could also lead to issues of accountability when the machine gets it wrong.[7]

It is also important to consider the impact this technology may have on the health-care system. Widespread adoption of a skin analysis app by consumers poses the potential for a flood of real and potential skin cancers to pour into the health-care system – rather than being replaced by machines, dermatologists may end up busier than ever. Dr Allan Halpern, chief of dermatology at the Memorial Sloan Kettering cancer centre in New York, stated 'what's not clear is what percentage of cancer cases can be left alone. Assuming there are a lot of cases that right now go undiagnosed, if all of a sudden artificial intelligence can bring all those cases into the healthcare sphere, it'll be enormous'.[11] This also raises the possibility of increased harm from overdiagnosis. It is possible increased analysis of skin lesions may result in skin cancers being diagnosed that would never have caused the patient any harm in the first place, resulting in unnecessary treatment.[11]

All in all, the use of artificial intelligence in the diagnosis of skin disease is likely to become a useful aid for dermatologists, however it is unlikely to ever replace them. The above research only relates to the diagnosis of melanoma, however, dermatologists are instrumental in diagnosing hundreds of different skin conditions. Furthermore, making a diagnosis is only the tip of the iceberg – dermatologists must then educate patients about their diagnosis, support them through the appropriate treatment, and guide them on how to best prevent future disease. In addition, many technological issues still need to be resolved, such as how to avoid the machine being tricked and how to image difficult areas such as the fingers, toes, and scalps.[7] More real-world research is also needed before the use of this technology can become widespread, including research on how acceptable using artificial intelligence to make a diagnosis would be to patients and clinicians. There is no guarantee clinicians would follow the recommendations of the machine, particularly if they do not entirely trust it.[7]

Overall, the use of artificial intelligence in the diagnosis of skin disease is a promising area of research that may well become an integral part of a dermatologist's tool kit in the future. This is also an exciting development for current medical students who are likely to see artificial intelligence become integrated into, not only the diagnosis of skin cancer, but across more and more areas of health care throughout their future careers. In summary, while artificial intelligence is likely to be a valuable resource, it is unlikely to ever become a full substitute for seeing a clinician and therefore, dermatologists should be encouraged to view artificial intelligence as an exciting opportunity rather than a threat.

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Oestrogen and its effect on hypertension

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Abstract

Non-menopausal women have a lower incidence of hypertension and cardiovascular complications compared to age-matched men. This cardiovascular advantage is thought to be the result of oestrogen's antihypertensive effects. However, results of current studies contradict each other and therefore our knowledge on the topic is limited.

Oestrogen has been shown to decrease the production of oxidative stress in the vasculature. Oxidative stress has been linked to high blood pressure (BP) and therefore its decrease is thought to aid in prevention of high BP. Excessive vasoconstriction is opposed by nitrogen oxide. However, nitrogen oxide production decreases with age and therefore poses a hypertension risk.

Studies in mice have shown that low doses of oestrogen given to non-ovariectomised mice have the effect of increasing oxidative stress. Additionally, high doses of oestrogen in ovariectomised mice have shown the same effect, however, low doses were shown to decrease oxidative stress.

Surprisingly, it is shown that the oestrogen in oral contraceptive pills (OCPs) given to premenopausal women causes an increase in BP. The effects of hormone-replacement therapy on BP have been shown to depend on the administration route.

Hypertension

Long-term hypertension is associated with a range of cardiovascular diseases such as coronary heart disease and stroke.[1] In New Zealand, hypertension affects 31% of the population.[1] The American Heart Association reports that on average, more men than women have high BP, this difference disappears at around 55–64 years of age.[2] The prevalence of hypertension, regardless of sex, increases with age.[2]

Sex is a large determinant in the likelihood of developing hypertension.[3] It has been found that non-menopausal women are at lower risk of developing hypertension than men; however, this difference disappears after menopause.[3] The complexity of hypertension combined with the high prevalence of the condition has led to numerous attempts to elucidate the pathophysiology of hypertension and its possible treatments. One of the suggested connections is the link between the hormone oestrogen, the renin-angiotensin-aldosterone system (RAAS), and oxidative stress.

Oestrogen

Oestrogen is a sex hormone mainly produced by the ovaries.[4] Its general functions include promoting the growth of secondary female sex characteristics and triggering ovulation.[4] As hypertension prevalence increases post-menopause, it is suggested that oestrogen, more specifically the form 17β-oestradiol (E2), provides an antihypertensive effect on BP that is otherwise lost post-menopause.[4]

It has been shown that 17β-oestradiol activates antihypertensive mechanisms such as stimulation of nitrogen oxide (NO) release and a decrease in oxidative stress,[5] both of which result in relaxation of vascular smooth muscle, thereby conferring protection from excessive vasoconstriction.[5]

The renin-angiotensin-aldosterone system

The RAAS is a mechanism regulating BP and blood volume.[6] It is activated by a reduction in glomerular filtration rate and one of its final effectors is angiotensin II (Ang II). Ang II causes vasoconstriction, production of vasopressin, and the release of aldosterone. All these actions eventually lead to an increase in water reabsorption, leading to an increase in BP.[6]

The angiotensin II receptor 1 and oxidative stress

One of the effector receptors of Ang II is the angiotensin receptor type 1 (AT1).[7] AT1 is expressed in many parts of the body, but particularly in vascular smooth muscle cells (VSMC). One of the effects of the VSMC AT1 receptor is production of reactive oxygen species (ROS).[8]

ROS are produced in the Ang II pathway as an intracellular signalling molecule. Usually, ROS are in balance with antioxidants to prevent oxidative damage, however, an excess in ROS production results in an imbalance, termed oxidative stress.[9] Vessel wall oxidative stress has been found to be involved in the development of hypertension. AT1 is mainly linked to production of the ROS superoxide anion (O_2^-) by the nicotinamide adenine dinucleotide phosphate (NADPH) oxi-

dase in the VSMC. NADPH is a part of the electron transport chain involved in the aerobic production of ATP.[9] ATP is necessary for contraction and therefore vasoconstriction. When the vasoconstrictor Ang II binds to AT1, production of ATP, and therefore activation of the electron transport chain, will occur. Normally, O_2, which is created as a by-product, would be reduced to water.[9] However, when it is produced in excessive amounts it can escape the reduction and gain an electron to become O_2^-.[9]

Experimental studies in rodents have shown that Ang II causes an increase in NADPH activity, leading to an excess production of O_2^-.[8] It has also been shown that O_2^- alone can cause vasoconstriction, which contributes to the development of hypertension.[10] O_2^- production can also affect the activity of Ca^{2+} and K^+ ion channels through the activity of CaMKII, which alters contraction of muscles, adding further to vasoconstriction[11]

Nitrogen oxide

Additional evidence suggests O_2^- interacts with nitrogen oxide (NO). NO is produced by the endothelium of blood vessels and causes vasodilation, contributing to the lowering of BP.[5] NO generates peroxynitrite ($ONOO^-$) by reaction with O_2^-.[5] By this action, the amount of NO is reduced, causing a reduction in its vasodilative effects.[5] But, as mentioned, $ONOO^-$ is created, which can form peroxynirous acid, a very reactive oxygen species of similar effects as O_2^-.[5] The absence of NO, and therefore impaired vascular relaxation, is one of the suggested mechanisms for the development of hypertension.

Oestrogen and oxidative stress

Deficiencies in antioxidants have been found in patients suffering from hypertension.[12] This suggests that not only are ROS increased in hypertension, but also the concentrations of antioxidants are decreased. It has been shown that oxidative stress levels tend to be higher in males than in females and that when induced by a dose of Ang II, a larger amount of O_2^- is produced in male arteries than female arteries.[13,14] This suggests that there is a difference between either the oxidative stress levels or in the amount of ROS the body can produce between males and females.

Treatment of ovariectomised rats with E2 has been shown to reduce the expression of some NADPH regulatory subunits, suggesting that the production of O_2^- by NADPH can be regulated by E2.[15] Upon exposure to Ang II, the expression of other NADPH regulatory subunits increases and this can then be normalised by treatment with E2.[16]

It has also been found that ovariectomised rats, which cannot produce their own E2, have an increase in AT1 receptor abundance and that this effect can be prevented by E2 replacement.[17] This E2-induced AT1 reduction occurs through a decrease of AT1 translation and a reduction in its binding capacity with Ang II.[17] This suggests that E2 controls the abundance of AT1 receptors and thereby regulates Ang II induced production of O_2^-. By decreasing O_2^- production, E2 protects against oxidative stress. As stated above, an increase in oxidative stress has been linked to hypertension, but the presence of oxidative stress does not necessarily lead to hypertension. Unfortunately, this study did not assess the BP of the rats.

Oestrogen dose and blood pressure

A study by Subramanian et al has explored chronic exposure of non-ovariectomised rats to low levels of E2 and its connection to hypertension.[18] Rats exposed to 20 ng/day of E2 (low dose) had an increase in mean arterial pressure compared to controls. In addition, the E2-treated rats had significantly elevated O_2^- levels.

On the other hand, a study by Meng et al (19) has shown that ovariectomised mice do not have a change in BP in response to 20 ng/day of E2 (low dose).[19] This study also showed that the ovary reduction itself causes an increase in oxidative stress and that this is reversed by a low dose of E2. Ovariectomised mice receiving a high dose of E2, 4.2 µg/day, had an increase in oxidative stress in their vasculature and no significant increase in BP. This is a surprising finding since it conflicts with those of many other studies (see above) that demonstrate how oestrogen leads to a decrease in oxidative stress. The findings of these authors also suggest a dose-dependent association.

Oestrogen and oral contraceptive pills

Oestrogen is the main ingredient in most oral contraceptive pills (OCPs).[20] OCPs are taken mainly by non-menopausal women, so it is supplemental to normal levels and would be comparable to oestrogen given to non-ovariectomised mice. A review by Woods et al has shown that the majority of subjects prescribed OCPs either had an increase or no change in BP.[21] This is again a surprising finding as it is conflicts with results of other studies on the anti-oxidative stress effect of oestrogen.

It is important to consider that OCPs also contains progesterone, which may confound the effects that are being attributed to oestrogen only. The Woods et al article quotes sources supporting the notion that progesterone has an effect on BP.[22] However, other evidence suggests that the effect is negligible.[23] Further consistent research on this topic is required to confirm our understanding of progesterone and its effect on BP.

Oestrogen and hormone replacement therapy

During menopause, the ovarian production of oestrogen decreases and the likelihood of hypertension increases.[3] The onset of menopause is accompanied by many symptoms such as insomnia and migraines. Hormone replacement therapy (HRT) is a hormonal supplement aimed at easing the transition from high to low levels of oestrogen production and to relieve menopausal symptoms.[24] It is also speculated to have an effect on cardiovascular complications such as hypertension.

A study by Ichikawa et al explored the effects of transdermal and oral delivery of low doses of HRT.[24] They found that transdermal delivery of HRT resulted in a decrease in mean BP, but no change in Ang II plasma levels. Additionally, oral delivery of HRT did not change BP, but did increase the Ang II plasma levels. The levels of bradykinin, a vasodilator, decreased in the transdermal HRT group and increased in the oral HRT group. The suggested mechanism includes transdermal oestrogen activation of NO-mediated relaxation of vasculature. This leads to downregulation of sympathetic activity, leading to a decrease in AT1 messenger ribonucleic acid concentration, leading to decreased vasoconstriction and oxidative stress.[25]

However, oral HRT resulted in an increase in Ang II and bradykinin levels, but had no effect on BP. It has been suggested that BP did not change due to the increase in bradykinin alongside Ang II, as their actions are opposite. Therefore, HRT has varying effects on BP depending on its administration.

It is important to consider that while post-menopausal women do not produce as much oestrogen as non-menopausal women, they still produce a small amount.[3] Therefore, post-menopausal women are not strictly comparable to ovariectomised rodents. This is a limitation in study design that appears to be repeated in most previous research. A new rodent model, which is comparable to post-menopausal women, is necessary for future research.

Conclusion: the role of oestrogen

In conclusion, the role of oestrogen in hypertension is complex and not well understood. Studies reviewed in this article have demonstrated that the addition of oestrogen above its normally produced levels (i.e. non-ovariectomised rats receiving oestrogen) is linked to an increase in BP and an increase in oxidative stress. Additionally, it is noted that giving low doses of oestrogen to ovariectomised rats decreases oxidative stress, but that giving high doses increases oxidative stress. These findings demonstrate that the complexity of oestrogenic action is beyond a simple reduction of oxidative stress effect.

Finally, it is important to recognise that the most valuable studies are those that include results from humans, as it is ultimately the oestrogen received by women in the forms of OCPs and HRT that is of interest. Further research on the effect of varying doses of oestrogen in OCPs and HRT is required.

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Conflicts of Interest

Michaela is a student reviewer for the NZMSJ. This article has gone through a double-blinded peer review process applied to all articles submitted to the NZMSJ, and has been accepted after achieving the standards required for publication. The author has no other conflict of interest.

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Interview with Associate Professor Angela Ballantyne about electronic health records

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Rex has recently completed his 5th year of medicine at the University of Otago, and is undertaking a BMedSc(Hons) with the Public Health department in Wellington. He is concerned about the overlooked health disparities that affect Asian New Zealanders, and is working on developing the skillset he needs to effectively engage with these issues.

Logan is a final year medical student at The University of Auckland. He is passionate about academia and is currently pursuing a career as a clinician-scientist in neonatology and neurodevelopment. Most recently, he has developed an interest in open science, and how new technological advances will impact the future of medicine.

Gisela is a 4th year medical student in Wellington who has had the privilege of doing her intercalated PhD with the Wellington Cardiovascular Research Group. She tries to maintain some of her hobbies outside of medicine and research, such as card making.

Angela Ballantyne is an Associate Professor of bioethics at the University of Otago, Wellington. She has an interest in the ethics of big data, such as that contained within electronic health records (EHRs) and has published several papers on this topic.

Electronic health records are digital files containing patient information that are used by medical practitioners to guide management. In some circumstances they are also used for research.

This interview has been edited for clarity and conciseness with Associate Professor Ballantyne's approval.

Are there particular benefits of conducting research from EHR data over other study methods?

EHRs usually give you a much broader picture. They do not replace something like a randomised control trial (RCT), but in combination they can be really helpful. Populations that are typically excluded from traditional research can be represented by EHRs. RCTs give you high-quality evidence by reducing the variables and therefore are often not representative of real-world populations. Historically, women, particularly if they were of child-bearing years or pregnant, were excluded from trials. This still has an impact today, for example, on the accuracy of our cardiovascular clinical guidelines, which were based on populations with systemically under-represented women.

However, all of these patients will typically receive clinical care, so often the only place you can find a picture of how interventions are working for these populations is in the clinical data.

What are some ethical considerations of using this data for research?

Research with clinical records is a type of secondary use of the data. You collect the data for clinical care, and subsequently use it to answer research questions. There is so much data-sharing, linking, and secondary use going on – it is a very complex ecosystem. The first ethical challenge is that it is very difficult to get patients' consent for each use of their data, but we could take a more transparent approach. If we are not getting explicit consent from patients to use their data for research, we must increase transparency so patients can easily find out what is happening with their data, the justification for its use, and who is responsible for managing data security. After transparency comes public engagement. There are concerns of backlash if the public are not engaged. For example, with EHRs in Australia, where 2,500,00 people opted out of the new EHR system.[1]

There are concerns around bias in the data as well. If the input data are biased, the result will also be biased, and 'knowledge' based on the data can risk embedding and perpetuating bias. If the data coming in is not representative, then the results will naturally not be representative. There was the case in Aotearoa where the passport photo of an Asian applicant was rejected by the automated photo checker when it concluded his eyes were shut.[2] Most of the faces used to train facial recognition programs are European, so it is much less accurate with non-European faces. While clinical data is much more representative than traditional research data, it still reflects the bias that results from different ethnic, gender and geographic access to care. We know that doctors systematically undertreated African Americans for pain, and if we do not effectively correct for this bias when using the clinical data, there is a risk the resulting algorithm could suggest African Americans need less pain relief than European patients.[3]

Governance is another important ethical consideration. Te Mana Raraunga, the Māori Data Sovereignty Network, are a group of Māori academics who advocate for formal co-governance and power-sharing models for the use of datasets containing Māori data.[4]

Are there circumstances where ethics review may not be needed?

The regulatory system is incredibly fragmented, so health data can fall under many different pieces of regulation. This makes it very complex for researchers to know how they can use it. Under the Health Information Privacy Code, health agencies can release data if it is not identifiable, or if it is within the parameters of the purpose for which the information was disclosed. So if a patient is in hospital, and discloses their health information to the clinician, the clinician can share that with the rest of the clinical team or call other departments for advice. The patient would expect that to happen in a hospital, so you do not have to ask for consent each time.

However, research is outside the original purpose for which the data was collected from the patient. So if clinicians or researchers want to use it for research (in an identifiable form), they either need to go back and re-consent each patient or ask a research ethics committee for approval to use the data without explicit consent. One argument I have made in a recent paper is that I think we need some sort of data-specific research ethics committee in Aotearoa.[5] Research ethics committees have expertise in clinical and observational research, but do not really have expertise in data security, computer science, or statistics. A data-specific research ethics committee would include experts in data science, data ethics, lawyers, Māori data governance, and health.

Also, in a lot of health research, people want access to identifiable data too. The EHRs are not accurate enough that researchers are prepared to use them in their current state. Typically, they need to go back and recheck things, and to do this they need the identifiable datasets. As soon as you want access to identifiable data you need to go through research ethics approval, which can be burdensome and discouraging for researchers.

If the data has been made non-identifiable, are there any issues with using the data for research without going through an exhaustive process?

The glaring problem with this is that existing regulation assumes there is a clear difference between identifiable data and de-identified data. However, this is not really true, and our regulations have not caught up with that.

There have been cases where data scientists have proved they can re-identify individuals from supposedly de-identified datasets. Although there is probably not a huge incentive for someone to do that, it is very misleading to the public to say that de-identified datasets are unable to be re-identified. Take for example the Integrated Data Infrastructure (IDI). A lot of the rhetoric around it is that it is all anonymous, but Aotearoa is a population of around 4,700,000 people, and there are data about many aspects of our lives in there. I think we need to have a much more nuanced conversation with the public about this. I trust the IDI because I trust their process of vetting and training researchers, and I trust the professionalism of the researchers; just like I trust clinicians and medical students not to share my clinical data inappropriately when I see them at the hospital or at the general practitioner's (GP) clinic.

I am also bothered by agencies who claim their datasets are secure, but then act surprised when there is a data breach. There will be data breaches, just as there will be medical errors in the medical system. The question is how often we think it is going to happen, what plans we have to mitigate that harm, and how these risks are weighed against the benefit we think we can achieve from sharing and using the data.

Should the primary function of EHRs be for patient care or for research?

This relates to the concept of a learning health-care system. Clinical care operates under a best interest model – the goal is to help this patient get better. In research, you are trying to generate knowledge to inform medicine and so you are weighing the goals of society against the interests of the research subjects. In the past, we separated clinical care and research in response to high-profile research ethics scandals. These were cases of doctors exploiting their patients by conducting research on them at the expense of the patients' best interests. Some examples include the Tuskegee study in the United States and the "unethical experiment" in Aotearoa (addressed in the Cartwright Inquiry).[6,7] In response to the public outrage – which was justified – many governments had public inquiries, and the results of which effectively split research off from clinical care.

Proponents of a learning health-care system challenge this separation, and argue that it would be better to have a constant feedback cycle where you are providing clinical care, evaluating that care, then feeding this new knowledge back into clinical care.[8] They are arguing for much more integration of research into clinical practice, and this could take a whole range of different forms: from the use of EHRs for research, to pragmatic trials. For example, you could take two GP clinics; one might roll out a new policy on how to treat back pain while the other continues their existing care, and then we compare results. Some have argued that for these sorts of minimal-risk trials you could add a simplified informed consent process into the clinical consultation, rather than having the full research informed consent process.

I recently published papers that argued, in certain contexts, patients have an ethical obligation to share their data.[9,10] In Aotearoa the health care we receive is evidence-based and the reason we have this evidence is because prior patients (from around the world) have contributed to the research enterprise. So as part of paying that forward, we should, under certain circumstances, be willing to share our clinical data for research. This enables future patients to benefit from the knowledge gained from our data just as we have benefitted from previous patients. Ethically, I think this is much clearer in a public health system, in the sense that there is solidarity with all of us generating knowledge and benefitting from each other. I think this would be different in a private health system. Regardless, there have to be parameters of some kind to ensure the data is being used in a trustworthy way, and governed appropriately.

Overall, I think the primary function of EHRs should still be patient care, but I think a very important secondary function is research.

Can there be a conflict between these two goals?

One way there could be conflict is if groups who have high levels of distrust of the medical community choose not to seek the needed health care because they are worried about lack of data confidentiality. One place we saw this was the controversy involving the Ministry of Social Development (MSD) data-for-funding contracts. The MSD argued that it had a right to individual client level data (rather than aggregated data) because it needed the client level data to properly evaluate non-governmental organisation (NGO) services, particularly where clients were using multiple services. Some NGOs, such as Rape Crisis, pushed back on that.[11] They serve a vulnerable community and they warned that people would stop seeking their services (or lie about their personal information) in fear of the NGO passing that information to the MSD. So we need to avoid a situation where public distrust of data sharing and/or secondary research leads to patients failing to seek care, or being reluctant to disclose sensitive information to their providers.

Are there times where public health research involving these datasets outweighs the individual interests of patients in control over their data?

Again, I think it is a spectrum. We already have accepted public health principles for when we can take data, whether a patient consents to it or not. For example, with notifiable diseases the potential threat to the public outweighs the interests of the individual. We must still minimise the autonomy and liberty restrictions, and maximise data security and de-identification as much as possible.

Ethics committees do grant consent waivers to allow researchers to use health data without consent when the public interest in the research outweighs the personal interest in privacy. I think this is broadly reasonable (though I would argue for slightly different criteria). For example, maybe we want to look at the relationship between influenza immunisation during pregnancy and fetal and neonatal health outcomes; we would need to link the mother and child's health records, and might also want to link to Births, Deaths and Marriages Registration to include data on still births. I think this sort of study, prima facie, has high public interest and could potentially justify proceeding without consent. Transparency, community engagement, and governance would be important issues to consider here.

It has been suggested that alongside basic demographic and clinical information, EHRs should also include a more comprehensive evaluation of societal and behavioural determinants of health. What do you think about that?

A lot of that information is probably getting discussed in an informal manner but not comprehensively collected. I can see the benefit of collecting social data, though GPs do not have a huge amount of time anyway, so you are weighing up how valuable it is going to be with how long it will take to collect. You also need to try to ensure consistency in how the information is recorded and coded, and the more information you collect the more variability you are going to have to manage. Another concern is how quickly that information changes and keeping the information updated. For example, living situations might change reasonably often. However, if you can also use those records for research purposes, you are maximising the benefit relative to the investment in data collection.

I also think you are going to run into trust issues with patients. When questions arise organically and are relevant to the clinical consultation, I think patients find that quite natural and understand its purpose. However, they might be wary if they suddenly feel like they are getting this interrogation from their doctor, the sort they might expect from Work and Income. For any data you are collecting, you have got to make sure that you are still operating within the spectrum of trust and that patients understand why these questions are being asked and feel that it is safe to tell you. One thing we know in relation to data collection is that patients make up stuff if they do not trust you. Trust is core to the clinical relationship, and we can not lose that.

Theoretically, if collection of this information was normalised, could this information be used in a way that affects health inequities?

It is a question of what you do with the data. You have to ask what is the purpose of collecting the data, what is the context, have you communicated appropriately with the target group, and is everybody on the same page? It could decrease health inequities if that data ensures more vulnerable patients get the care they need. For example, we can map populations to show where the health need is greatest. One way you could see an increase in health inequities is if there is backlash among certain populations who suddenly feel like they are being surveilled in a way they do not trust. They might start to disengage from the health system.

It is also important how you present the output of the research. Do you frame the results according to a deficit narrative (why certain populations are failing to achieve good health) or do you have a resilience narrative (why, despite systemic racism, are some populations doing well and how can we learn from that). These narratives can be really powerful.

Part of what is tricky about EHRs is that on one hand, they give you the most comprehensive picture of health needs in Aotearoa. They are often better than research that systemically excludes a lot of populations from the research pool. So, they are especially useful for planning health service delivery and trying to address complex multi-dimensional problems such as the relationship between poverty and health, and to target high needs groups. On the other hand, vulnerable marginalised groups tend to have more distrust of centralised systems. They are the ones who may be more reticent about volunteering their data to the government, and often for very good reason. When you look at the history of research and public health, we see that governments have collected data about populations in order to implement policies around segregation, forced re-education of children, dispossession of land, and so on. This is why it is so important to proceed at the pace of trust and involve communities in setting a research agenda that meets their needs.

Are there any unique perspectives that we should keep in mind as future doctors of Aotearoa that international research will not necessarily cover?

First, it is important to consider the extent to which research based on overseas data will be relevant and applicable to our population – both in terms of biological samples and health data. Māori and Pasifika populations are not well represented in the international genomic resource base. There is a risk of increasing health inequity if this under-representation is not addressed, because the research results will not deliver genomic technologies with clinical utility for these ethnic groups.

A second challenge is how to honour Te Tiriti o Waitangi and the need to develop appropriate co-governance models for big data (derived from EHRs or biological samples). There is lots of debate about social license. Social license is the degree to which a community accepts a practice, in this case data sharing, linking, and re-use. Often you do not know you have breached the social license until you have stepped too far and you get public backlash. So, the idea is that you have accepted data use within the social license. Te Mana Raraunga has argued that we also need a cultural license, which means the extent to which iwi and Treaty partners think data use is culturally appropriate.

Finally, if people wanted more information about this topic what do you recommend?

I would suggest people look at the United Kingdom (UK) Nuffield Council Reports.[12] They do high-quality and accessible work on all sorts of medical ethics topics, with recent reports on artificial intelligence and big data. Also, the UK health system is similar enough to what we have in Aotearoa that a lot of the information is still very relevant to us.

One thing it does not cover is the Aotearoa-specific focus on the Te Tiriti o Waitangi. Te Mana Raraunga and their website has links to great resources on data sovereignty.

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On the wards: Clinical medical student mental health and support – what are we doing about it?

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Megan de Lambert is an undergraduate PGY1 House Officer at Tauranga Hospital, recently graduated from the University of Auckland with an MBChB. She was the founder of University of Auckland medical school's first formal clinical student support programme; providing emotional, educational and social support to clinical medical students across all eight clinical sites. She is currently the NZMA Doctors in Training Council PGY1 Representative hoping to continue her journey in advocacy and leadership.

In the medical world, where it can seem as though nobody has any spare time, we uncovered something beautiful and too often forgotten: people want to help each other – especially those in shared struggles. In response to the experiences University of Auckland clinical medical students had in the often isolating, intimidating, and uncertain world of hospital placements, particularly in the larger hospitals, we created the first Clinical Student Support Programme in 2018. With over 400 students involved, this programme has attempted to start a tradition of students participating in an environment filled with educational, emotional, and social support. It seems like such a simple concept, so why had something like this not already been done? I wondered the same.

As a new fourth-year student, thrust into the wards harder and faster than a gravida 4 woman completes labour, I was startled by the nature of being a clinical medical student. It was exciting and self-directed, but isolating and uncomfortable.

Early medical school itself has its stressors. Remnants of the competitiveness of pre-medicine linger on in a class of 260 or more incredibly high-achieving peers. You are told you only need to pass, but are graded from A+ to C- and prestigious awards are given to the top performing students. Our perfectionist and 'Type A' personalities can render it hard to settle for what we perceive as mediocre. This is all while navigating the difficulties of new relationships, cliques, a binge-drinking culture, and living away from family – which is what many university students experience. Season that with entering the foreign, confusing (and scarily sterile), environment of the hospital at the beginning of fourth year, and one can feel helpless, almost dependent on any given team to include you and teach you something. You meet new people every day and before you can integrate into a team or department you are shifted on to your next placement. We are occasionally exposed to suffering, death, and hospital politics. Many of us were just twenty-one years of age when entering the hospital on full-time placement. It is the perfect recipe for anxiety and depression.

I remember being surprised by the lack of university follow-up and support. It seemed that no one knew who was supposed to be our principle custodian. The support system provided to us appeared like an 'ambulance-at-the-bottom-of-the-cliff' strategy – once things go awry, come and see us and we will try help you. However, I can understand the challenge for the university – there are almost 300 students in each cohort now, all span across eight different placement sites, and students often raise concerns or ask for help only when the situation is dire, or not at all. The faculty has employed many superb individuals acting in pastoral care, as Directors of Medical Student Affairs, and in the Professional and Personal skills department, advocating for education around medical student well-being. Despite this, I still felt isolated even though I was placed at a wonderfully sociable and supportive semi-rural hospital in my first clinical year. There just is not enough on-the-ground support. In a poem I wrote in my fourth year for a reflective assignment, one stanza reads '[You] travel to and from the hospital on your own, feeling alone despite being surrounded by many others. My only real support is 950 kilometres away, and this is my mother's'. We were fortunate to have friendly sixth-year students and had the opportunity to ask them questions and talk to each other about difficult experiences on the wards. Students based in Whangarei for their fifth year have been supported socially, emotionally, and academically as a part of the culture there over the years. Why is it that this kind of supportive environment only seems to be reserved for those lucky enough to be placed at certain sites?

During fifth year I fell into a dark and nasty bout of depression, and only then did I truly realise the immense difficulties that many people may feel as a clinical medical student. Some of you might think that I was particularly acopic, susceptible, or pre-disposed to mental illness, and that it would have happened regardless of what university path I chose. That could be true, but too many friends, peers, and participants in international research projects have experienced the same as

me for this phenomenon not to be a pattern. Since opening up about my own mental-health journey, I have been overwhelmed with the number of my peers who could relate with their own similar struggles and, heartbreakingly, how well they hid it.

I wondered what role we, as students, could have to support each other, so I decided to do something about it at the end of my fifth year. With the help and advice of many incredible people that I look up to – Holly Dixon, Ajda Arsan, Jibi Kunnethedam, Sung-Min Jun, Sophie Maisey, Lucy Gray, Christi Bowen, Zoe Wells, and many others – the idea started to come together. I began the arduous process of creating the "Clinical Student Support Programme" (CSSP).

The crux of this programme is to provide student-led, group-based, educational, social, and moral support to clinical medical students from other clinical medical students who have walked in their shoes. One-on-one mentor programmes seemed too tedious, old school, and paternalistic to me. I was inspired by Auckland medical school's pre-clinical Small Group Activities (SGAs) (or 'cuddle club' as some of my peers adoringly called it, which are group-based teachings encouraging learning through sharing experiences and critical reflection). I also gained inspiration from 'Balint groups', which are educational groups created in the 1960s to discuss cases and to better understand the doctor-patient relationship).

The CSSP was aimed at being done on a regular basis, where students were encouraged to talk about mental well-being, difficult patient cases, bullying, their lives outside of medical school, and everything in between; a proactive approach to well-being was the goal. A secondary goal of this was for the leaders to gain valuable leadership, teaching, and peer support skills. Initial sign ups yielded overwhelming support with over 400 students enthusiastic about being involved. I found some brilliant sixth-year students at each of the eight University of Auckland clinical placement sites to facilitate the programme at their site, and these support groups were allocated with sixth-year students as leaders. The sites are Auckland City, Waitakere/North Shore, South Auckland, Waikato, Bay of Plenty, Rotorua, Whangarei, and Taranaki. Leaders were encouraged to contact their groups to organise meet ups and to assist in the orientation of the fourth- and fifth-year students to the hospital. Leaders were provided with a guidebook containing ideas on how they can support their students, conversation starters, a reminder of the assessments in each year, and a summary of where students can get help. We were fortunate to have my friend Glenn Nightingale, from the accounting firm Nightingale Associates, to generously sponsor us, as well as financial support from the New Zealand Medical Students Association and the Auckland University Medical Students Association (AUMSA).

So how did it go?

'A good first step' is how I would describe it to those curious. According to a survey I put out in September 2018 to participants, 68% of fourth- and sixth-year students met with their group at least once, with 11% meeting three or more times. This was a pleasing start, as in previous years there had been minimal formally organised support, so any improvement on this was realistically a positive. Many leaders found it difficult to engage their groups and to meet on a regular basis – this may be because of lack of free time, students believing they are not in any need of assistance, the reactive "she'll be right" Kiwi attitude, shyness, or a combination of all of these. As the year went on, students became more comfortable and confident as clinical students, so the groups met less often, but they had the contact details of their leaders in case they had any questions or issues. This emphasised the importance of the meet-ups at the beginning of the year when the fourth-year students are new to the clinical site. Educational support was a success; progress test tutorials, mock objective structured clinical examinations (OSCEs) and electrocardiogram (ECG) tutorials were some of the events organised by the leaders. This educational support, accompanied by the enticing effect of free food, was a great way to gather the students together, show them we care about them, encourage them to meet with their support group, and an opportunity for them to ask questions. A barrier to this was that these educational sessions (and the whole programme for that matter) relied on fifth- and sixth-year students being motivated, organised, and willing to give up their spare time.

The September 2018 survey yielded other interesting results. When asked to rate what being a clinical medical student was like on a scale of 0 to 10 (with 0 being awful and 10 being amazing), the average score was 7.3 for the 152 student responders. Fifth-year students' rating of what it is like being a clinical student was the lowest of the year groups. When asked what they felt they needed the most and would like to see in the programme this year, they responded: (1) mock OSCEs; (2) meetings to talk about how things are going and to ask questions; and (3) tips before their placement starts. 95% liked the idea of having a Clinical Student Support Programme, with 5% who had not yet made up their mind. Lastly, there was the opportunity for students to nominate peers who have been particularly helpful and supportive, and over 50 students were nominated as making a significant impact. I have personally thanked each of the nominated students – possibly the most rewarding part of this journey so far for me.

Going forward, past and present AUMSA Executive members and I have been working hard to build on this initial year of the CSSP. 2019 is incredibly important, as two successful consecutive years of this programme will be a key step towards this becoming a tradition. We are hoping to target the crucial stressful components of clinical years – the beginning and initial orientation to the hospital, final-year OSCEs, more intense runs like general surgery, obstetrics and gynaecology for fifth-year students, and the orthopaedics practical assessment. In addition, an ongoing aim is to: encourage proactive approaches to well-being, with AUMSA Site Representatives organising social events, support group leaders encouraging regular meetings (at least initially at the beginning of the year); and candid discussions about mental well-being, bullying, and other difficult experiences.

2019's AUMSA President, Cameron Tuckey, encouraged me to articulate my overall goal for this programme and what I hope medical student clinical life to be like for my successors, and this is what I came up with. Ideally, every fourth-year student starts their clinical years excited to be a part of something special – a connected, supportive, and enjoyable hospital site environment. They receive an adequate orientation to the hospital, are in regular contact with fifth- or sixth-year students throughout the year, and are given opportunities to speak about any difficulties or challenges they are having or have had. Any student in distress is referred to appropriate services or escalated to the University. Fourth- and fifth-year students receive educational support from leaders, enabling them to feel prepared and confident for their assessments. Fifth- and sixth-year students get an opportunity to be leaders and teachers, to improve their emotional intelligence, responsibility, communication skills, and sense of community. This whole environment described becomes a tradition that is self-sustaining and operates with ease, purely because students care about, and want to help, each other.

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HealtheX: proudly celebrating student research

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Joseph was HealtheX Co-Chair in 2017–2018 and thoroughly enjoyed his experiences in organising HealtheX. In his spare time, he is a postgraduate research student in the field of neuropsychopharmacology.

Introduction

Figure 1: Welcome to HealtheX 2018

The Health Exposition (HealtheX) Conference has been the flagship student-led conference for student researchers of the Faculty of Medical and Health Sciences (FMHS) at the University of Auckland since 2007.[1] All FMHS research students (i.e. summer research scholarship, honours, masters, and doctoral) are invited to partake in this one-day conference, typically held on a Friday in early September. Enterable categories include the traditional poster and 10 minute oral presentations (with a question and answer session), as well as an expeditious 3 minute elevator pitch. Aside from the $15,000 NZD worth of monetary prizes and travel grants made available by generous sponsors and supporters (in 2018), the competitive nature of this conference lends itself to augment one's curriculum vitae. The scale of this event has grown impressively since its inception to encompass over 100 student presenters in 2018: 64 oral; 12 elevator pitch; and 40 poster presenters.

Inevitably, the organisation of such a large event presents a host of tasks, such as: applying for funding for conference expenditures; producing marketing materials; proof-reading over 100 abstract submissions; allocating presentation types to each presenter; assigning at least three staff or student judges to each presentation; publishing print materials; meeting sponsor requirements; managing judging app systems; organising catering; and abiding by health and safety regulations. Completing these tasks involve 20 HealtheX executive board members, three subcommittees spanning a further 30 student volunteers, 20 student judges (at PhD level), over 50 staff judges, and several 'super judges' – who preside over the judging process across the entire day in order to maintain consistency and ultimately determine the final prize winners. This conference is overall headed by two staggered co-chairs in order to ease the transition process for the future HealtheX organisation (e.g. one co-chair serves in 2017 and 2018, a second in 2018 and 2019, a third in 2019 and 2020, and so on). Furthermore, past co-chairs are invited back to the HealtheX Board as advisors, and the staff mentors present on the Board have often been HealtheX alumni, contributing to the legacy of this event. Institutionally, HealtheX is heavily supported by the FMHS through the Associate Dean of Postgraduate Studies.

However, of utmost importance is the ethos behind HealtheX, which is constituted by three broad underlying themes: mastering the art of science communication; networking with the wider research community; and developing student academic enquiry.

Mastering the art of science communication

Given the diverse nature of research at the FMHS, from molecular biology through to population-wide epidemiological studies, HealtheX places emphasis on the ability to disseminate complex research concepts to general audiences. To aid student preparation, HealtheX organises an annual presentation skills workshop discussing vital tips for successful presentations through rigorous preparation methods, effective body language, verbal modulations, aesthetic considerations in visual media, and practical poster-printing tips. HealtheX provides an important staging ground for young and early career researchers to confidently prepare their presentations amongst their peers prior to presenting at larger international conferences, where the perceived stakes may be higher.

In the context of New Zealand, this prized skill also underlines the crucial role that researchers of a publicly funded tertiary institution act in as "the critic and conscience of society" in accordance with the Education Act.[2] The ability to reconfigure complex concepts to

maintain accessibility to audiences of different levels allows for more effective communication with the general public. This is particularly important in research areas with greater ethical challenges that require more stakeholder discussion (e.g. experimentation using aborted embryos, growing miniature human brains from induced pluripotent stem cells, gene editing of embryos). Thus, HealtheX provides an important opportunity for the professional development of vital scientific communication skills.

Networking with the wider research community

The FMHS itself harbours an impressive breadth and quality of research. Simply knowing about other research conducted within the same institution paves a convenient path to collaboration. For example, many biomedical research groups integrate clinical research, given the close physical proximity of the FMHS to Auckland City Hospital. While intra-institutional seminars, mailing lists, and research group websites allow for effective internal bridging between research groups, HealtheX represents the largest cross-section of active research undertaken at the FMHS. In order to aid this networking process, HealtheX stratifies its oral presentation sessions by research methods. This allows students and staff to understand how their research modality can be applied to other disciplines, thereby encouraging networking and collaboration.

Developing student academic enquiry

HealtheX provides a momentous platform to introduce young potential researchers to the diverse world of research and academic enquiry. By involving students in every stage of organising and participating in this conference, it acts to inspire a new generation of academics and also highlights the importance of research.

In the context of New Zealand, a relatively small country, importing international research to inform best clinical practice is common – often due to the lack of domestic research. However, this procedure may prevent effective treatment of indigenous and minority groups, given their inevitable under-representation in the source research populations. As such, best clinical practice guidelines may not translate directly from overseas to New Zealand due to genetic or cultural variability – an example of which is the treatment and diagnosis of obesity, due to underlying genetic and dietary differences in populations.[3,4] Consequently, using international research to inform best clinical practice could exacerbate health inequities in Māori and Pacific Island populations in direct contradiction to te Tiriti o Waitangi.[5] Therefore, conducting research in New Zealand through the principles of kaupapa Māori is crucial in applying research findings to improve the health of all New Zealanders equitably.[6] As such, HealtheX provides a formative platform to inspire the importance of research in the context of New Zealand.

Conclusion

Having celebrated 12 years of student research, HealtheX has firmly embedded itself in the culture of the FMHS. Its competitive nature and monetary prizes have nurtured an atmosphere inspiring improved science communication, and have created novel travel opportunities for students to attend external conferences or international collaborators' laboratories. Furthermore, the scale of this event has played a major role in encouraging collaboration and has introduced the expansiveness of research at this tertiary institution to young researchers. Through extensive student recruitment, staff mentorship, and institutional support, HealtheX is able to improve year on year to hold itself to ever higher standards.

Figure 2: HealtheX 2018 winners. Back row (left to right): Sam Blanchett, Farha Ramzan, Jason Yeung, Micah Daniel Austria, Luis Knight, Sarah Maessen. Front row (left to right): Joyce Mathan, Daniel Ho, Hannah Ng, Yukti Vyas, Grace Borichevsky, Rebecca Griffith.

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The CSANZ Annual Scientific Meeting and ANZET Meeting 2018

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Evelyn is a 6th year medical student who will be based in Whangarei in 2019. Outside of medicine she enjoys cooking, photography and café hopping.

The Cardiac Society of Australia and New Zealand Annual Scientific Meeting and Australia and New Zealand Endovascular Therapies Meeting 2018

2–5 August 2018
Brisbane, Australia

The first half of August was quite an important time for the cardiology community; rivaroxaban became funded in New Zealand and the Cardiac Society of Australia and New Zealand (CSANZ) updated its 2011 Heart Failure Guidelines. Perhaps most excitingly, early August signified an opportunity to attend the CSANZ Annual Scientific Meeting and the Australia and New Zealand Endovascular Therapies (ANZET) Meeting in Brisbane.

The CSANZ Annual Scientific Meeting is a conference where healthcare professionals and researchers can present their work, learn about updates in the field of cardiology, and have a chance to network. The majority of the delegates were from Australasia, but it was an international conference with speakers from the United States and Europe. The ANZET Meeting was held concurrently with the Australasian CSANZ conference. In previous years this was part of the CSANZ conference, but, with the growing field of interventional cardiology, organisers decided to host an inaugural conference dedicated to this evolving subspecialty.

CSANZ and ANZET comprised of separate academic sessions and combined social events that included a welcome reception, dinners, a poster session, a cocktail night, and a "wellness walk" to maintain participants' cardiovascular health. The academic sessions for CSANZ were often divided into streams that occurred concurrently, catering for a wide range of interests. These topics included clinical, basic sciences, imaging, heart failure, arrhythmia, paediatrics, and multi-disciplinary. The ANZET conference was mainly aimed at challenging clinicians with difficult clinical scenarios through live case sessions from various Australian hospitals. ANZET also provided different topics such as imaging, latest devices, and those currently being developed. What was unique about this conference was that they offered practical workshops for hands-on experience of infrequently used devices. Both CSANZ and ANZET had mini-oral presentations that occurred during the lunch breaks and poster session. Evelyn Lesiawan presented at the poster session, while Gisela Kristono presented at one of the mini-oral sessions.

Many aspects of the meetings surprised us when we compared them to conferences that we had attended in New Zealand. One factor was the size of these two meetings – there were over 18,000 delegates in total! It was mind-boggling to see such a large number of people who were all interested in one medical specialty. Instead of free pens, many of the stalls had baristas serving free coffees, which was certainly a clever incentive to attract doctors. The coffees were also a much-needed perk, as some of the days started with breakfast sessions very early.

We were able to attend these meetings due to our involvement in cardiology research projects, and it was amazing to see the volume and variety of research being presented. There were sessions on summaries of clinical trial findings, discussions that were based on past studies, and talks on speakers' basic science or clinical research projects. CSANZ also had a greater focus on genetics this year, highlighting the increasing role it plays in clinical cardiology. One memorable presentation was a research project that used zebrafish to look at the role of the TTN gene and its protein in dilated cardiomyopathy, an often hereditary condition that can lead to heart failure.

The academic sessions broadened Gisela's knowledge in cardiology, which was previously only made up of her pre-clinical learning and her research project. She saw images from an optical coherence tomography for the first time and learned which nutraceuticals were most effective for lowering cholesterol levels. There were many interesting research projects that were presented such as creation of a microwave transcatheter to ablate the renal nerve, which has been shown to affect blood pressure. There were also a few talks that were more generalised and directly applicable to us as medical students, one of which was on well-being and one on maximising your chances of publication in academic journals. The well-being talk was novel, as it included topics rarely discussed in student well-being talks.

One of these was how we all had a role to play in influencing the culture of our workplace, which has been underestimated in how it affects our colleagues' attitudes and well-being. It was reassuring to see that well-being was being discussed amongst doctors as well as medical students.

A unique feature of the ANZET conference is their live case sessions where the Prince Charles Hospital, Brisbane; Royal North Shore Hospital, Sydney; and Royal Victoria Hospital, Belfast would present their challenging cases to a room of health professionals. Following the presentation they would propose a question to the room and ask everyone to cast their answers through the conference application on their phones. This was followed by a discussion throughout the room. It was fascinating to see the different perspectives from varying clinicians regarding how they would manage the same patient or how they would navigate through difficult procedures. Despite how interesting this conference was, it was difficult to follow these cases as the hospital representative presented the most challenging cases they encountered to gather other clinicians' thoughts regarding particular scenarios.

Evelyn was fortunate to attend the wet lab workshop which was an extensive session learning about cardiac anatomy. What was particularly useful about this session was that at each stage of the dissection process the corresponding echocardiographic view was presented. The various views provided by this imaging technique reinforced the learning. Additionally, the session highlighted the aortic valve anatomy in relation to transaortic valve replacement, which is a growing procedure carried out in interventional cardiology. The wet lab workshop was helpful for supporting our knowledge of cardiac anatomy, especially the relationship between the different aspects of the heart.

Both CSANZ and ANZET had prizes for research and case presentations. One of these prizes was the Geoff Mews Memorial ANZET Fellows' Prize for the best case presentation given by an interventional fellow. Five finalists presented at ANZET, one of whom was Dr Ben Wilkins, an interventional fellow from Wellington Regional Hospital. He presented a case of a 67-year-old man with no previous cardiac history, who, during the procedure, developed thrombosis in the guide catheter and stents they deployed to treat his lesion. Administering heparin to counter this was not successful, but bivalirudin proved effective. We were proud that Dr Wilkins, being the only New Zealand finalist, took home the prize.

CSANZ and ANZET ended their academic programmes with a very useful joint session: "What's hot and happening: coronary artery disease, valvular heart disease and beyond!". Speakers from each stream gave a summary of current knowledge and what the upcoming management options of several conditions were. This was a thought-provoking session where experts highlighted the benefits and limitations that clinicians needed to consider when using different drug therapies and devices. Cardiovascular medicine is an evolving field and the specialty has several innovations currently in development for the diagnosis and treatment of several conditions. Unfortunately, many of the new therapies discussed are not available in New Zealand. However, attending this conference has made us aware of these treatment options for when they do become available in New Zealand.

Although at times we may have felt out of our depth, these meetings were an incredible experience and they were a privilege to attend as a medical student. Overall, this conference was a strong reminder of the importance of research for advancing our medical knowledge and techniques. We would highly recommend CSANZ and ANZET to any medical student interested in this field, as these two meetings definitely sparked our interests in cardiology.

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Kaplan-Meier plots

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Survival analysis investigates the time until the occurrence of an event. Often, the event of interest is death, however, it can equally be time to any other event such as recovery from a condition, wait time for elective surgery, first recurrence of cancer after surgery, the intervals between successive births, or the time until equipment failure. Why is time-to-event analysis different from other analyses? Why can we not use other standard statistical tools like a t-test or least square regression to analyse it? First, most of those analyses rely on the normally distributed residuals assumption, which does not hold with time-to-event data because this data is always positive and sometimes highly skewed. For example, consider time to death after a high risk surgery; many patients may die shortly after surgery and those who do survive will then live for a long time. Second, it is common, when measuring time-to-event outcomes, for events to not happen during the study period for some individuals, which means some observations are 'censored'. Survival analysis using the Kaplan-Meier (K-M) survival estimator does not assume a specific distribution, therefore it is a nonparametric method. This means that the normality assumption and the assumption that all outcomes are observed are not required. Before explaining the K-M estimator, let us look at some terminology.

Imagine measuring the time to an event among a cohort of individuals. Not everyone will enter the study on the same date, so time zero for each individual is the day the person entered the study. The study period might end before all participants experience the event, also, some people might drop out during the study. We will use the following terminology:

Censored: the event has not occurred, or the subject was not under observation when the event occurred.

Interval censoring: rather than observing the exact time of event, we only observed that the event occurred between two known time points.

Followup period: the period during which the subject was under observation. Followup starts when the person enters study, and ends when either the event occurs or the study ends – whichever comes first. This period can be shorter than the study period if the event occurred during the study, or if the person leaves the study.

Survival function: the probability of survival up to a particular time point as a function of time. This is different to the instantaneous probability of survival as a function of time.

Hazard rate: the instantaneous rate of an event occurring. This is known as the failure rate, conditional failure rate, or hazard function. This rate has no upper bound, unlike a probability.

Hazard ratio: the ratio of hazard rates corresponding to two levels of an explanatory variable. For example, in a drug study, the ratio of hazard rates among treated and control populations is used as a measure of the effect of the treatment.

Presenting a survival function as a K-M plot is one way to describe a cohort's survival time graphically. The focus of this article is to describe K-M plots and in which circumstances they can be used, and thus, how to interpret them correctly.

Table 1 gives an hypothetical example of survival times in days in ascending order for two groups of people treated with two different procedures for the same condition. All 21 people in Group 1 and 11 of 20 people in Group 2 died during the followup period of 36 days. The other nine people in Group 2 were either lost to followup, or alive at the end of the study, therefore their survival times are censored. The question is, how do we compare the survival in these two groups?

Comparing the mean survival times in two groups (ignoring censoring), Group 1 (8.4 days) has about half the survival time of Group 2 (16.3 days). Alternatively, comparing the risk of dying, or the hazard, in two groups (again, ignoring censoring): the mean hazard in Group 1 (21 deaths in 177 days of followup or 0.119 deaths per day) is about 3.5 times that of Group 2 (11 deaths over 326 days of followup or 0.034 deaths per day). Neither of these methods are satisfactory because they ignore the censored observations.

The K-M curve compares instantaneous rates in the two groups. The K-M curve is defined as the probability of surviving a given length of time (treating time as many small intervals). There are three assumptions in this analysis: (1) at each time interval, censored individuals have the same survival prospects as those who continue to be followed during the interval; (2) survival probabilities are the same for those recruited earlier and later in the study; and (3) the events happen at the times specified, rather than between two time points.

The K-M estimate involves first computing probabilities of survival during each time interval as the number who survived over the period divided by the number at risk at the start of the period. The total probability of survival to the end of each time interval is calculated by multiplying the probability of survival for that interval with all the

Table 1: survival times in days for each person.

Group 1	Group 2
1	6
1	6
2	6
2	6+
3	7
4	9+
4	10
5	10+
5	12+
6	13
8	16
8	17+
8	18
9	20+
11	22
12	23
13	25+
15	32+
17	32
20	36+
23	

+ *indicates censoring.*

Kaplan-Meier plot for two groups

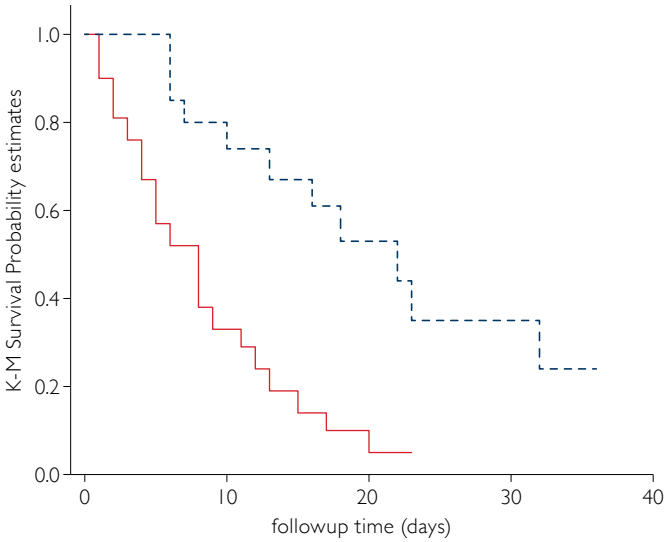

Figure 1: K-M survival plot comparatively describing survival in two groups.

probabilities for earlier time intervals. This calculation is shown in Table 2 for Group 2, the group with censored observations. The table begins at time zero (start of followup). The reason for this is to allow for the possibility of censoring before the earliest failure time.

Note that although 11 out of the 20 in Group 2 (55%) died over the 36 weeks (and 45% did not), the K-M estimate for the survival at 36 weeks is 24%. That is because the K-M estimator does not consider those who died or survived beyond their followup. The K-M survival plot displays the first and last columns of this table. Figure 1 shows the K-M plot for both groups.

Figure 1 shows that estimated survival is lower in Group 1 than in Group 2. The steeper slope shows that the rate of events is higher, i.e. events occurred faster. If we repeated the experiment, we would be unlikely to get the same two curves because there is uncertainty associated with these estimates. The logrank test is often used to decide if the observed difference between curves is expected if the two corresponding populations have the same survival rates.[1] In other words, the logrank test is used to test the hypothesis that there is no difference regarding survival among individuals in two groups. Another commonly used method to compare survival curves is the Cox proportional hazards model. This model allows for adjustment of potential confounding. More information on this method is given by Bewick and colleagues.[2]

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Table 2: estimating K-M probabilities for Group 2 (the group with censored data).

Followup time period (days)	Number alive (ie, at risk) at start of the period	Number dead during the period	Number censored	Survival probability over the period	Probability of survival up to the end of the period
0	20	0	0	1.00	1.00
6	20	3	1	(20–3)/20=0.85	1.00*0.85=0.85
7	16	1	0	(16–1)16=0.94	0.85*0.94=0.80
9	15	0	1	(15–0)/15=1.00	0.80*1.00=0.80
10	14	1	1	(14–1)/14=0.93	0.80*0.93=0.74
12	12	0	1	1.00	0.74
13	11	1	0	0.91	0.67
16	10	1	0	0.90	0.61
17	9	0	1	1.00	0.61
18	8	1	0	0.88	0.53
20	7	0	1	1.00	0.53
22	6	1	0	0.83	0.44
23	5	1	0	0.80	0.35
25	4	0	1	1.00	0.35
32	3	1	1	0.67	0.24
36	1	0	1	1.00	0.24

Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again by Eric Topol

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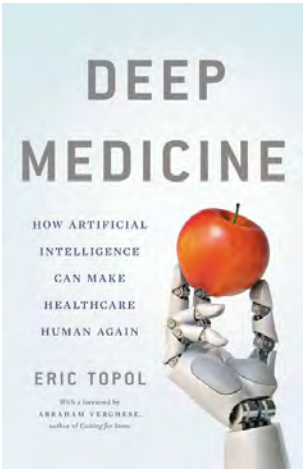
Logan is a final year medical student at The University of Auckland, and Editor-in-Chief of the New Zealand Medical Student Journal. He is passionate about research, and is currently pursuing a career as a clinician scientist in neonatology and perinatal neurodevelopment. More recently, he has explored the digitisation of healthcare and open-access science.



Professor Eric Topol has had his finger on the pulse of digital medicine for over a decade. An American cardiologist and distinguished academic, Topol has been an early proponent of digitalising the health-care sector. In his third book *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Topol surveils the new health-care landscape emerging as disruptive technologies become standard. For any future-focused health professional, *Deep Medicine* is a detailed and balanced exploration of the current state-of-play of artificial intelligence (AI) in medicine. Moreover, it serves as a guide on how to advocate for a health-care sector that benefits patients, not the pockets of financial stakeholders.

The reader is taken on a journey that explores how digitisation of the health-care system may be an unlikely, yet promising candidate for allowing clinicians to provide humanistic patient-centred care. At the outset, Topol laments the shortcomings of the current health-care climate, which prohibits clinicians from truly engaging with patients. Clinical decision making is fraught with cognitive biases and our mental bandwidth is pushed to the limits. The observation that we are 'attending to keyboard rather than our patients' confirms that our empathy is slowly but surely fading. We have somehow found ourselves trapped practicing shallow medicine. The judicious use of screening and diagnostic tools is becoming a lost art in a health-care sector that is increasingly focused on efficiency and productivity. Our culture of overuse is harming patients 'physically, psychologically and financially, and could threaten the viability of health systems by driving up costs and diverting resource'.[1] We have forgotten our commitment to 'primum no nocere'.

The remedies for shallow medicine have so far been reactive and incremental. For Topol, the overarching solution lies at the intersection of medicine and AI. Proponents of AI have claimed that "the AI revolution is on the scale of the industrial revolution", and Topol discusses several areas where the synergy between AI and health care has created tangible results. Details of machine-learning algorithms that can outperform radiologists in detecting pneumonia on chest x-rays leave the reader feeling that a health-care revolution is just over the horizon. Yet, Topol's optimism for what a digitised health-care system might look like is tempered by a wealth of clinical knowledge and research experience. He is quick to remind us that even though the use of electronic health records represented one of the first efforts to digitise the health-care sector, it is still viewed by many, including Topol himself, as an 'abject failure'.

The digitisation of medicine impacts us all, with some fearing that it's adoption will lead to a system devoid of empathy and connection. Throughout *Deep Medicine*, one senses that Topol's primary motive is profoundly humanistic. We are reminded that the consequences of these technologies extend beyond quantitative health-care metrics, like the length of hospital admission. Sir William Olser noted that it is "more important to know what sort of a patient has a disease than what sort of a disease a patient has".[2] With the current state-of-play, it is difficult to imagine that AI will ever truly understand the patient narrative like nurses and physicians can. Yet, Topol doesn't envision a system where doctors are replaced by machines. Rather, he advocates for one where health-care workers are liberated from administrative burdens through augmented decision-making and the automation of mundane obligations.

Personally, this book underscores the idea that conversations about the future directions of a digitised health-care system shouldn't be reserved for high-profile internet technology companies. For those at the coalface, and receiving end of medicine, it is much easier to

criticise the shortcomings of such technologies. Sadly, we remain ill-equipped to engage in conversations and contribute to their design. There is a paucity of teaching dedicated to understanding the intersection of AI and health care in medical school, and navigating the literature is an onerous and overwhelming task. *Deep Medicine* brings the reader up to speed on current advances and outstanding questions in the domain of digital medicine. More importantly, Topol sows a seed inside the minds of our future health-care advocates. The much-needed overhaul of the current health-care climate may be just over the horizon, but it is imperative that all stakeholders – especially patients and future health professionals – take initiative in curating a system centred upon deep humanism rather than shallow medicine.

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Conflicts of Interest

Logan is the Editor-in-Chief of the New Zealand Medical Student Journal. This article has gone through a double-blinded peer review process applied to all articles submitted to the NZMSJ, and has been accepted after achieving the standard required for publication. The author has no other conflict of interest.

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This is going to hurt: secret diaries of a junior doctor by Adam Kay

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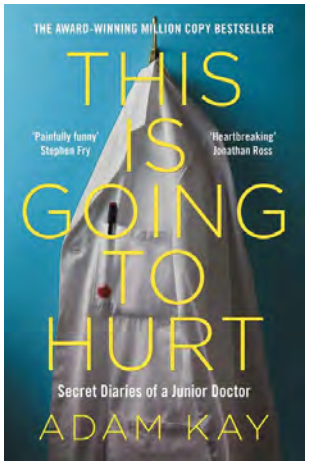
Kaustubha is a final year medical student based at Middlemore Hospital. Though yet to commit to a specialty, he hopes to one day integrate research alongside clinical practice.



"Hilarious." "Riveting." "Painfully funny."[1] These are not typical descriptions one would associate with books of the medical non-fiction genre. Then again, this book is not like other medical memoirs.

In 263 short pages, Adam Kay provides his perspective on the medical profession through his five-year journey as a junior doctor working in Britain's National Health Service from 2005–2010. Through a diary-entry writing style, he reflects on his most memorable moments on the job – both the highlights and the lowlights. In doing so, Kay achieves the difficult balance of delivering an important and powerful message in a thoroughly entertaining manner.

Kay has been a professional comedian and writer since 2010. We need to understand his motivations for writing this book in order to appreciate its message. For this, we need to rewind to 2016 when there were a series of strikes as part of industrial action by the British Medical Association – the union for junior doctors in the United Kingdom. This was the first strike action by British doctors in over 40 years following disagreements in contract negotiations with the government regarding pay and safe working hours.

Contract negotiations had in fact started from 2013 but had been affected by "media manipulation and attempts to sway public opinion".[2] From the author's perspective, "junior doctors… [were] struggling to get their side of the story across".[1] Having worked on the front line himself, Kay felt he "had to do something to redress the balance."[1]

The reader is taken on a vicarious journey of Kay's progression up the professional ladder through nine chapters over five years – ending as a senior obstetrics & gynaecology registrar. We begin alongside him in his very first post as a house officer. Through a series of selected stories of his days in the hospital – whether it be the workload, a troublesome patient, a difficult decision or being perpetually exhausted; the lifestyle of a junior doctor becomes more and more apparent.

We also gain an insight into the personal toll of the job – one Kay describes as often being dominated by challenges and difficult situations but also having significant highlights that make the job seem worthwhile. However, as the author warns right from the onset, there is no happy ending; his account culminates in an event which proves to be the end of his medical career.

Overall, these diaries of a junior doctor are a blend of two contrasting themes; a dichotomy of heartbreak and hilarity. As one reviewer puts it, "hilarious as they are horrifying".[1] This is a unique example of writing when considering the genre and the author's overarching message. Never does the reader feel weighed down by the stories and this is due to the writer's ability to bring forward the humour in his situation without belittling the humbling, sometimes painful, reality of the job. Although the book is largely aimed at those who may be unaware of the truth of what it means to be a junior doctor, doctors and other health professionals alike will also revel in Kay's story-telling craft.

The book concludes with an open letter from Kay to the Secretary of State for Health: "you and your successor and their successors… should have to work some shifts alongside junior doctors…to know what the job really entails. If you knew, you'd be eternally grateful for everything they do. The way you treat junior doctors demonstrably doesn't work".[1] Unlike the carefully constructed nine chapters where he has subtly portrayed his thoughts, here Kay is blunt and direct. The message is crystal clear.

This collection of tales is particularly relevant in New Zealand given the ongoing contract dispute between the Resident Doctor's Association and District Health Boards regarding safer working hours. From the opposite side of the world, this is a timely reminder of the invaluable work done by junior doctors. Kay's goal is to represent an honest and moving perspective from someone who has been in the trenches themselves. If the numerous positive reviews are anything to go by, this award-winning Sunday Times bestseller has achieved exactly that.

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Five Days at Memorial: Life and Death in a Storm-Ravaged Hospital by Sheri Fink

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Michael is a Trainee Intern based in Tauranga this year. He is an undergraduate student originally from Hawkes Bay. In his spare time he enjoys surfing and playing football.

I am sure we have all asked ourselves at some point how we might react if the worst struck. If faced with a disaster, would we show some semblance of courage or bravery? Would we make the 'right' call? The numerous stories of heroism to come out of any significant event, like the earthquakes and the recent tragedy in Christchurch, are examples of how the worst situations can bring out the best in people. Part of what differentiates medical professionals from the public is how we respond to these life-threatening situations involving patients. This ability to work under pressure and make the right call is paramount. This is why resuscitation scenarios are practised regularly. But we are still fallible. We are all human and we are all capable of making mistakes, especially when we are under pressure.

The events to come out of Memorial Medical Center in New Orleans, Louisiana following Hurricane Katrina highlight this fallibility in the most tragic way. In 2005, Katrina hit New Orleans and led to significant flooding surrounding the medical center. For five days, the hospital was cut off from power, water, or any basic services. Windows were smashed to circulate air, and at night gunshots and looting could be heard echoing through the city. In the days following, staff and patients were left to survive while the hospital was slowly evacuated by air and boat. The evacuation process was flawed from the beginning. Rescue helicopters were turned away after daylight hours with over 100 patients still left inside. Priority was given to the healthiest patients, the ones deemed most likely to survive, and over 50 of the sickest patients lay in an Intensive Care Unit in the sweltering August heat and humidity. When supplies were almost gone, doctors and nurses were grappling with decisions about administering fatal doses of morphine to patients that they felt were not going to make it out. Ultimately, 45 patients never made it out alive. A state investigation was launched and it was determined that 20 out of the 45 were victims of homicide, yet a grand jury refused to convict the doctors and nurses in question.

Sheri Fink, a former medical doctor and now investigative journalist for the New York Times, reported on the story as the truth of what happened in the hospital became public knowledge. *Five Days at Memorial* is the culmination of her six years of reporting, which led her to a Pulitzer Prize in 2009.[1] The story is told in two parts: how the five days played out inside the hospital, and the legal and political consequences of what followed the disaster. The book is well-paced, keeps you hooked, and I constantly found myself absorbed in a tale that seemed too outlandish to have actually occurred.

Despite the gravity of accusations toward some of the staff, you never get the sense that Fink is condemning them. The desperation of the staff caring for these critically-ill patients without power, running water, or basic medications is not lost on us and this provides a very balanced view of what really happened. Fink allows the reader to understand the staff's perspective of the palliative care they were providing, while also making it clear about her own position. 'Moral clarity was easier to maintain in concept than in execution.'[2] This clarity surrounding her own position while offering a balanced viewpoint is certainly one of the book's strongest points.

Five Days at Memorial is also Fink's condemnation of the lack of preparedness by Tenet Healthcare, the organisation that owned Memorial Medical Center. She writes, 'sometimes the ethical—the most important ethical question sometimes is the one you ask not at the moment of crisis, but the duty you have to anticipate certain kinds of crises and avoid them.'[1] You get a sense of not only what happened during the five days, but how Memorial Medical Center was so unprepared for the flooding. Fink addresses the numerous system failures of the privately-owned hospital. She shows us that post 9/11, disaster planning was focused on terror rather than natural disaster. She shows us that previous flooding in New Orleans had exposed how poorly prepared the city and the hospital were for a significant weather event. It is clear that Fink blames the company as much as the individuals for what took place over those five days, and you cannot help but agree.

There are books that we typically read as medical students. These often focus on medical professionals that exemplify the characteris-

tics of what makes a great doctor. We read them in awe, and often finish them aspiring to be the next Oliver Sachs or Atul Gawande. *Five Days at Memorial* does not have this allure. It certainly does not provide many glowing examples of doctors or nurses in their finest hour. However, I believe it is a necessary read for any medical professional who wants to understand medical ethics and medical systems in practice. There is no question in my mind that we all will face similar scenarios with extremely ill patients in front of us. The actions of the doctors and nurses who were administering lethal doses of morphine to patients who were critically ill, obviously seemed like best practice palliative care to them. Conversely, the idea of 'first, do no harm' comes to mind and had been forgotten. On reflection I can understand their reasoning, even though it is flawed. While I hope that I am never in the same situation, the same ethical decisions apply to how we treat particular patients on the ward. Decisions to halt treatment, decisions to make some patients not for resuscitation, and decisions to ease their passing with medication; all of these decisions need the ethical framework required to make the 'right call', something that the doctors at Memorial Medical Centre had forgotten. Having read *Five Days at Memorial*, I hope I make the 'right' call, but it also showed me that wrong decisions can still be made with the best intentions.

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CPR in progress

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Libby completed her fifth year medical studies at the Dunedin School of Medicine in 2018 and is currently taking a gap year. She has an interest in general practice and women's health. Libby is one of the winners of the Creative Arts Competition for Issue 28.

Running into hot sun, stillness, cicadas
Defib cradled by my fast beating heart
Sighted! Yellow vests punctuate the trail
Closer now, I hear counting – *four, five, six* –
and the hushed half sob of a friend

He is dusky beneath a cloudless sky
No breath, no pulse, unflinching eyes
Non-shockable, an hour elapsed, yet stopping
still shocks me, somehow – the finality.
Spring is here; lives begin, others end.

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The story of Huka, and the disease that she brought

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Kia ora koutou. Jon whakapapas back to England, but it seems he's accidentally buried his whenua here; many people have said that they came to visit these lands and never returned to the country of their birth, and he fully understands why. Since growing up here and entering medical education, Jon has developed a strong interest in the well-being of our indigenous people. He would love to see Māori flourish and prosper, and for their culture to sit proudly on the world's stage and within our own country. Jon is one of the winners of the Creative Arts Competition for Issue 28. Ngā mihi.

Long ago, the people of this land ate the food that was provided to them by the gods of the forests, plants, and sea. It was plain and bland, but it was good and filling. From this variety of food, they grew strong warriors and mighty wāhine, and they were satisfied.

Then, one day, tūārangi arrived and brought with them things that had never been seen before: they brought food that had never been tasted and items that couldn't have been imagined. But the most stunning of all the things they brought was a little bird, called Huka.

Compared to the other birds of the land, she was most similar to the cheerful pīwakawaka, but she was white all over with feathers like the kōtuku. Her song was pleasant and all the hearts that heard it were warmed.

But, most astonishingly of all, wherever Huka went, the people's food became more flavoursome than it had ever been before, and it filled them with more vigour and vitality. But the spell only lasted as long as she was in one place, for, just like the excitable pīwakawaka, she never sat still and darted from one place to the next.

Soon, the people became greedy, and wanted to keep the powers of Huka's gift for themselves, and so they devised a plan. They planned to wait by the stream that Huka drank from when she visited, and capture her in a woven kete created especially for the occasion.

So, the next time Huka came to visit, they hid behind some harakeke bushes and waited for her to land. When she did, and began sipping at the cool water, they jumped out and slammed the kete around her.

At first, she laughed, because that was her nature, but soon she became afraid. They tied the kete shut with muka enchanted with their strongest magic. Huka knew she would never escape.

That night, the men brought all their families together and had a great feast, and it was the sweetest meal that any of them had ever tasted.

But while they ate, Huka mourned her fate and sang a song unlike any song she had ever sung before. It was filled with sorrow and told of her longing for freedom. As she sang, she slowly withered and died.

No one noticed that she wasn't singing anymore: they were too busy eating. But, rather than growing strong from the food enchanted by Huka's presence, they grew weak and afflicted by diseases they had never known before. Men's legs withered and other men lost sight.

When a young boy, who had been away at the time Huka had been captured, returned and saw the state of his whānau, he cried, 'Auē, auē! What has become of my people?' He tore at his chest and cried, 'We were once a strong and mighty people, and known throughout the lands for our vitality! And now we have fallen amongst the lowest of the low.'

And then he found the old kete where Huka had died. With strength borne from his grief, he tore open the bindings and found the remains of the little bird, who he recognised as belonging to Huka.

'Oh, my family!' he cried out again, 'How could you have been so short-sighted? Did you not know that Huka's gift was only sweet because it never lasted? That her gift was only sweet because it disappeared? Why have you cursed yourselves by casting her magic over all that you eat? By her death, you have surely brought this ruin upon yourselves!'

And this is why the disease that Huka brings is called mate huka, which means the death of Huka, or the disease that Huka brings.

Acknowledgements:

The staff at Te Piki Oranga, Motueka, for welcoming me so well, as well as to the online Māori Dictionary (maoridictionary.co.nz) for clarification of words, and to He Papa Tikanga course from Te Wānanga o Aotearoa for the development of my understanding of te Ao Māori.

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Wildfire

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Jared is currently a PGY1 House Officer based at Southland hospital. Sometimes he takes photos, and occasionally they turn out all right.

Taken in his Trainee Intern year while on elective in Tanzania, these elephants roamed the Serengeti plains in small family units. The fire you see in the background is actually a deliberate act by the park rangers to encourage new grass growth for grazers and to help control the spread of bushfire.

Jared is one of the winners of the Creative Arts Competition for Issue 28.

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