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The Ulster Medical Journal

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Ulster Med J 2023;**92(3):**117-119

Editorial

Good Things are Difficult

David J Armstrong

χαλεπὰ τὰ καλά 'Good things are difficult' is a truth which is fairly evident in the life experience of most people, including Socrates[1]. The inference from his aphorism, as recorded by Plato, was not however that good things should not be attempted, but merely that a principled person embarking upon a moral or beneficial act might encounter difficulty, and should prepare themselves for it.

Such encouragement might be well welcomed by anyone trying to negotiate their way out of the current crisis in Northern Ireland healthcare. We might look fondly back to the days of leisurely ward rounds and relaxed GP home visits, or indeed forward to some imagined future with bottomless health service funding and half a dozen well-qualified applicants for every vacant post, but we can only act as we find ourselves now in 2023.

While every doctor working in Northern Ireland today might provide examples of how current resources might be better used, managed or publicised, there is general agreement that a significant uplift in funding is required to deliver a quality health service for both patients and those providing the care.

Therein for many lies the problem. As doctors we are unable to raise any income or increase funding. We might work for patients' charities, lobby ministers and plead on social media, but in terms of funding we simply have to manage what others give us. As a result, a feeling of powerlessness can pervade when faced with the current crisis.

In this respect, I would direct you to some of the contributions in the ongoing Healthcare Crisis series, and most especially to the article from Drs Corry and McGilliard[2], young doctors who having trained as students and foundation doctors in Northern Ireland, have just spent a year working in Australia. They have, as I hoped on commissioning the piece, focussed on what it is actually like to be a doctor in Australia, rather than on the weather and opportunities to surf. And the point I feel worth emphasizing here is that many of the things which makes medical life more attractive Down Under are potentially achievable in Ulster without a huge funding uplift. In fact some might be achievable here without even having to involve managers or Ministers.

I would highlight just two points. First, the hospital went out of its way to ensure that the couple were able to request matched rotas so that, without family and friend and working 1000 miles from home, they were able to have time off together. Such a simple initiative and yet the difference it made to the quality of their lives seems enormous. Second, there was active help with accommodation and arranging basic utilities. They were made to feel valuable and welcome, and the quality of their lives outside the hospital appeared to be a concern to the authorities. Note also the mention of hospital security, and how they felt the safety of staff at work was better.

Translate this to Northern Ireland. As I covered in my previous Editorial[3], it is often working conditions and feeling undervalued that are the biggest problems in Northern Ireland, rather than low pay. Of course we could be paid more by moving even to the Republic of Ireland – Aine and William mention that their hourly rate is *double* what they would have been paid back in Belfast – but it is the support with rotas, accommodation, teaching and general quality of life that makes Australia such an attractive option. And these are actually things which we could potentially do something about in Northern Ireland without a massive injection of cash.

Many rotas here are filled with overseas doctors working on temporary contracts or as locums. Few stay in the long term. Hospital accommodation is often terrible, and little help is given to negotiate local renting. They must arrange their own lives as best they can, with all the culture and language barriers which they might encounter. We lost an excellent long term locum within the last few years predominantly over a disagreement about accommodation. He left, the gap was unfilled and the waiting list grew. In the long term it will have cost much more to lose him than the exercise of some imagination on making sure he was happy with where he lived. A senior colleague from St Elsewhere told me within the last few weeks that two overseas doctors, skilled trainees providing a vital service to patients in Northern Ireland while training, had not been paid for two months. One was struggling to buy food. Was the problem with Human Resources? Or with Finance? Or who hadn't signed the right form? Or perhaps that person was on Leave? I suspect the trainees involved won't be back at the end of their post. They certainly won't recommend Northern Ireland to colleagues back home. The welfare of the trainees – our guests in Northern Ireland – was no-one's concern. It was an embarrassment.

The days when our own junior staff could be treated as dispensable, because they trained here, live here and will want to work here, are gone. Rota problems come up again and again. Induction to ward routines, ordering imaging and getting identity passes seems to have improved, but so many

other aspects of medical life haven't. Read the stories on social media of doctors told to come back from the airport and cancel their holiday because the rota wasn't filled. Colleagues unable to attend the wedding of a close friend or a family funeral because there was no understanding or flexibility from managers. There are , it must be admitted, sometimes faults on all sides when it comes to rota issues, but it is little wonder younger colleagues choose to work elsewhere.

These problems are things which we as the medical profession can do something about. A very worthwhile project would be to address quality of life of doctors of all grades in Northern Ireland. A group comprising junior and senior staff with a motivated and engaged senior manager from each Trust might be a start. I would suggest representation from at least one overseas locum working in NI. Start with the article from Dr Corry and Dr McGilliard and ask what we can do better here. Ask GP colleagues struggling in rural or inner city areas how we might make their work life balance better.

Read also the contribution from Dr Neill[4], writing after his first week working as a doctor in Northern Ireland. Realistic, certainly, but still with hope for the future, a desire to work in general practice and a note of optimism. Perhaps we there is still hope. Note also how he defines professionalism as being able to look after yourself as well as your patients.

We are not going to see our pay doubled, or increased by even fifty or twenty-five percent. So let's concentrate instead on what we can do to make our own lives better, to treat juniors fairly, to make doctors from overseas feel welcome and valued. Some might even stay. Some colleagues, nostalgic for the steady cold rain of a November day in Belfast, might even return from Australia. Plato wanted to build a fundamentally different society[5]. We might just need to improve the lives of our medical colleagues a little.

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4. Neill T. First Impressions – week one as a doctor in 2023. *Ulster Med J*. Forthcoming 2023.
5. Plato. The Republic. ca 380 BC.

Ulster Medical Society Lecture Programme 2023-2024

Dr Athinyaa Thiraviaraj

Athinyaa is a diabetes doctor working in Derry. She undertook her under-graduation in Chennai, India and pursued her postgraduate training in Northern Ireland completing her speciality training in 2012. Athinyaa now works as a Consultant Physician in Endocrine & Diabetes at Altnagelvin Hospitals in Derry/ Londonderry @WesternHSCTrust. She is a Fellow of the Scottish Quality and Safety fellowship Cohort 9 @SQSFellowship and a qualified quality improvement team coach @FCACoaching. She is Director of Medical Education at Western Trust.

Athinyaa's interests are Medical education, quality improvement, type 1 diabetes, diabetes in pregnancy and diabetes care in the young person. Her interests lie in exploring new interfaces and technology that can enhance the experience for the user in both health care and education. Mottos that best describe Athinyaa's approach to life:

- *Festina lente* (make haste slowly);
- Be the change you wish to see in the world.

You can find her @athinyaa (platform previously called Twitter)

UMS Lecture/Meeting Dates

Date	Lecture	Speaker & Subject	Venue	Time
Thurs 12th Oct	Presidential Address	Dr Athinyaa Thiraviaraj *Consultant Physician in Diabetes and Endocrinology Western HSCT and President Ulster Medical Society* **Portrait of a Clinician**	PG Centre, BCH	7.30pm
Thurs 19th Oct	UMS	Dr Sean Owens *GP, Blackrock Co Louth* **Embracing Planetary Health: a generational opportunity for modern healthcare**	PG Centre, BCH	7.30pm
Thurs 2nd Nov	Joint meeting UMS with BCH	Dr Shane McKee *Consultant in Genetic and Genomic Medicine, Belfast City Hospital, Clinical Director Regional Molecular Diagnostics Service & Deputy Chief Clinical Information Officer, Belfast HSC Trust* **Pandora's Lego - assembling the components of tomorrow's healthcare**	PG Centre, BCH	Buffet 6.30pm Lecture 7.30pm
Thurs 9th Nov	UMS/QUB/NIMDTA Joint Meeting	Trainee Research Day Professor Calum MacCrae *Director One Brave Idea/PI, Apple Heart & Movement Study/Vice Chair for Scientific Innovation Department of Medicine Brigham and Women's Hospital/Professor Harvard Medical School*	Online	9.00am – 12.30pm
Thurs 16th Nov	Robert Campbell Oration	Professor Seán Dinneen *Consultant Endocrinologist, Galway University Hospitals, Galway and Professor of Diabetic Medicine, University of Galway, Galway, Ireland* **Delivering person-centred care: a diabetologist's perspective?**	PG Centre, BCH	7.30pm
Thurs 7th Dec	The Gary Love Lecture Joint meeting with Ulster Society for History of Medicine	Dr Michael Trimble *Clinical Reader in the Centre for Medical Education, Queen's University Belfast & Consultant in Acute Medicine, Royal Victoria Hospital Belfast* **Sir William Whitla and the Apocalypse**	South Lecture Theatre Queen's University Belfast	7.30pm
Thurs 11th Jan	Joint Meeting with Ulster Obs & Gynae Society	Dr Jonny Cash *Consultant Hepatologist in the NI regional liver unit, RVH* **Liver disease in pregnancy**	PG Centre, BCH	7.30pm
Thurs 25th Jan	UMS	Dr Emma Wilmot *Associate Professor University of Nottingham, Honorary Consultant Diabetologist University Hospitals of Derby & Burton and Founder ABCD Diabetes Technology Network UK* **Diabetes care: Technology now and the future**	Online	7.30pm
Thurs 8th Feb	UMS	Dr Camille Harron *Postgraduate Medical Dean and Director of Education at NIMDTA* **Liberating Postgraduate Medical Education: Principles and Practice**	PG Centre, BCH	7.30pm
Thurs 22nd Feb	UMS	Clare Morrison *Director of Community Engagement, Healthcare Improvement Scotland* **Leading change: learning from projects that spread**	Online	7.30pm
Thurs 7th Mar	Desmond Whyte Lecture	Lorna Ross *Chief Innovation Officer, VHI Health and Wellbeing and Big Life Fix Science* **Insights, contradictions & tensions in healthcare innovation; a design perspective on systemic change**	Centre of Medical & Dental Education & Training, Altnagelvin Area Hospital	Buffet 6.30pm Lecture 7.30pm
Thurs 21st Mar	Sir Thomas and Lady Edith Dixon Lecture	Professor Cathryn Edwards *Registrar, Royal College of Physicians; Visiting Professor, University of Cape Town; Consultant Gastroenterologist, Torbay and South Devon NHSFT;* **Providing healthcare leadership through challenges**	PG Centre, BCH	7.30pm
Fri 26th Apr	UMS	**Annual Dinner**	The Great Hall QUB	7.30pm
Thurs 9th May	UMS	**AGM**	UMS Rooms	5pm

All lectures can be booked via Eventbrite at https://www.eventbrite.com/cc/ulster-medical-society-lectures-1108089 or by emailing administrator@ums.ac.uk

Ulster Med J 2023;**92(3):**120-124

Northern Ireland Healthcare Crisis

'The second in a short series of articles in which doctors from various specialties, backgrounds and experience are asked to express their personal views on their career, and thoughts about the future, in the light of the current crisis in healthcare provision in Northern Ireland'

David J Armstrong, Editor

A Year Down Under: Perspectives from a distance

In a 2022 British Medical Association (BMA) poll, 40% of junior doctors in the UK were actively planning to leave the National Health Service (NHS) and 62% of those were planning on travelling to Australia or New Zealand to work there.[1] Two of those junior doctors were ourselves. We had completed our foundation training in Northern Ireland (NI) after starting early and stepping up with trepidation due to the coronavirus pandemic, and then spent five months working as locum doctors, to plan and finance our journey across to work in Australia for one year. Our aim was to experience a different healthcare system, to verify that what we had heard from colleagues - that the quality of life for doctors was better down-under - was true. The decision to leave was not easy, but the possibility of better pay; learning opportunities; work-life balance; and weather, convinced us to go for it.

Following a moderately unpleasant 36 hours of travel, we touched down in Perth, Western Australia (WA), where we have been working in Emergency Medicine in a tertiary hospital. Our intention is to return to further training in Northern Ireland, though we have experienced the stark differences between the health system which we left and the one we are currently working in. We hope to highlight the journey and experiences which many junior doctors choose, and provide an insight into why many choose not to return.

One of the biggest attractions to the southern hemisphere for doctors is pay. The standard hourly pay rate is twice that of the UK. In addition, there is the benefit of fortnightly payslips and salary packaging. Salary packaging involves signing up with a salary packaging company who can then deduct a portion of your gross pay on each payslip, before tax is applied, and then pay this amount back into your bank account. Ultimately this means taxes are paid on a lesser amount of salary and the idea is that this 'extra' money is used to pay for living expenses like mortgage, rent, and household bills. There is the choice to set up other perks such as car leasing and a 'meal and entertainment card' which can be used to pay for meals out and other activities. All of this combined creates the feeling that we have significantly more disposable income, simultaneously being able to save money without much sacrifice.

Some hospitals offered other enticements, such as compensation for flights and free initial accommodation, but we decided to come to Perth where a paired rota was more valuable to us. A rota on which, except for one week every two months, we work the same shifts and receive the same days off.

This was not available everywhere in Australia and to our knowledge has never been facilitated in a training post inside the UK. The ability to have a paired rota enables us to plan holidays together, organise social events and enjoy the privilege of spending significant time with each other outside of work. It cannot be overstated how important it is to have your personal life respected and facilitated, especially following two years of opposing rotas and fighting with administration for leave that lines up. Back at home, doctors are often forced to make unpleasant swaps and take on extra shifts to simply get a joint week of leave. We have heard many stories of colleagues being declined wedding leave, annual leave and last minute leave to attend funerals because they are not considered "close family". Rotas inside the UK are often produced without the 'adequate' six weeks' notice so it is difficult to plan life events further than a few months ahead.

In stark contrast, the rota in our department in Perth is very manageable. With a 40 hour week based upon 10 hour shifts, weeks are four days on, three days off. Despite an unfortunate eight day run, the rest of the rota is quite enjoyable, with an incredible six days off built in, we are able to travel and recuperate without taking annual leave. The roster is much better stocked with the number of doctors working per day noticeably more compared to the NHS. The vast majority of leave requests are usually granted and with far less stress and uncertainty than at home.

The Emergency Department (ED) we are working in is a tertiary centre and offers neurology, neurosurgical and

toxicology specialist centres. The majority of doctors we are working with are British or Irish, consultants included. It receives around 200 attendances a day, akin to some NHS hospitals,[2,3] and patients are transferred from all across Western Australia. Patient management is senior-led and all patients must be discussed with a registrar or consultant. There are obvious benefits to being senior-led, however, we had been accustomed to working more independently. The top-down approach allows for excellent learning opportunities and reduces the stress and worry you take home with you after work, but it can feel as though your clinical judgement is under-encouraged and your experience disregarded. The ED also takes much more ownership over the patients in it, similar to an acute medical ward, even following referral to a specialist team.

Practical skills are greatly encouraged whether they are ultrasound guided blocks, Biers blocks, procedural sedation, intubation or arterial lines. This is in contrast to NI where we found such opportunities scarce.

There is also a different workplace culture with regards to disruptive patients. Hospital Security plays a much bigger role in ensuring our workplace is a safe place to both work and be a patient. Those with capacity who are behaving inappropriately are quickly escorted out of the hospital while patients who lack capacity may be restrained to allow for intravenous sedation. Although this was a bit of a shock initially, this approach protects staff and other patients from being assaulted, creating a much more peaceful environment to work in. In contrast, assaults on NHS staff and patients are at an all-time high.[4]

Of course, there are some differences in prescribing practices, the most stark being antibiotics and analgesia, with ketamine and fentanyl being fairly commonplace within the ED.

In comparison to our experiences back home, we find we can offer a lot more to patients when they present to the emergency department. There is also always the option of referring or liaising with a patient's own private specialist team, if known, who then often accepts them for admission, lessening the burden on the public system.

"Teaching is sacred" is what we were told prior to commencing our job in Perth and it certainly rings true. Interns and Resident Medical Officers (RMOs - equivalent to Senior House Officers) receive 2.5 hours of teaching every Thursday which is overseen and often partially delivered by a consultant. Interns and RMOs as well as Allied Healthcare Professionals (ACPs) and registrars will deliver the teaching which includes simulation training and practical sessions. We are also advised to try to wrap up and hand over any patients to seniors, meaning we aren't contacted during teaching.

Furthermore, there are ample opportunities to get involved in audits and quality improvement and we are encouraged to use our professional or study leave to enhance our Curriculum Vitae. Happily, Professional Development Leave courses or conferences can be claimed using salary packaging.

Ultimately, all of this gives us a much improved work-life balance, and the better weather with the vast geography and wildlife provides lots of opportunities for adventure. Many of the Australian and international doctors take advantage of time off to travel either locally in WA or elsewhere in Australia or even further afield.

The grass however, isn't always greener. The greatest struggles we face are the personal pressures - the distance from family and friends. A recent BMJ article referenced a family torn apart from their divided choices to come to Australia or remain in the UK.[5]

Our choice of moving as a couple made things easier and we have been lucky enough to have family come out to visit us. Logistically, there were also teething issues. With the demand for rental properties in WA at an all-time high, we found it quite stressful to juggle work with organising and viewing rentals. We often found ourselves alongside sixty other keen applicants, who were frequently willing to offer increased weekly rent and advance payments. This is similar, if not worse, in other large cities like Brisbane, Melbourne and Sydney.

Founded in 1984, Medicare is the Australian universal health care system, covering some or all necessary healthcare costs.[6] Enrolment is mandatory, however the Australian government incentivises private health insurance with tax breaks. Public emergency departments are free to Medicare patients but a General Practitioner (GP) appointment costs around $40 or £20.[7] In terms of pressure on the health care system, in our opinion, the NHS is about 10 years further down the line when compared to the Australian public system. The NHS has a 7% vacancy rate for doctors and almost 7 million people on waiting lists; primary care is under increasing pressure often leading to an increase in ED presentations and both systems have lengthening waiting lists for public outpatient consultations.[8,9]

It seems that while the Australians are using the weaknesses of the NHS to attract doctors to strengthen the cracks in their own system, the NHS is clinging to government plans to dilute the medical workforce with non-medical clinicians.[10]

The private healthcare industry in the UK is a developing sector largely due to underfunding of the NHS and lengthening waiting lists. In the UK and within Northern Ireland patients' operations are being subsidised and completed in the private sector to improve waiting

lists. In addition, more NHS patients are now actively choosing private health insurance to access elective operations such as hip replacements, or outpatient clinic appointments.[11]

A 2021 report by the Royal College of Ophthalmologists stated that according to NHS England data "in 2016, 11% of cataract procedures were delivered in the independent sector… by April 2021 there was almost a 50/50 split with 46% in the independent sector."[12] While the Australian healthcare system has only fairly recently introduced the publicly-funded system, UK healthcare has always been dominated by the public NHS. If the under-funding of the NHS continues, it is likely that the UK landscape will start to mirror the two-tiered system we see in Australia. The general public needs to be made aware of this to allow for informed public and ultimately, patient choice regarding incremental and ungoverned privatisation of the NHS.[13]

If we could transport our entire lives, including family, to Australia, would we? Possibly.

We have learned and experienced a lot from our time away. Work doesn't have to leave you physically, emotionally and mentally exhausted. You shouldn't have to feel that you can't give your best for patients because you are stretched too thin. You shouldn't feel that work seeps into your personal life, so you can't enjoy your time off. We are professionals, have worked hard to get where we are and deserve to take pride in our work.

Of course, this is our experience and our journey. From afar we have witnessed the collapse of General Practices, the toppling of District General Hospitals and the discontent among doctors at every level. We both believe firmly in the NHS and it's free-at-the-point-of-service core principle. We would like to see it strengthened and re-established in the global sphere as one of the best healthcare systems in the world and something we can all take pride in once again. On the anniversary of 75 years of the NHS we see a system starved of funding, starved of staffing and starved of passion. We hope a future exists where this can be reignited, however there has to be a realisation of the cost required to defend and protect this institution as well as the many people that rely on, and work within it.

The NHS is being deprived of many highly qualified doctors who were trained in the UK/NI, but are now leaving our healthcare system because the system is not fit to retain them. We believe unless there is a radical change to pay and training which reflects the value of the profession then doctors will leave and the NHS will be lost.

"The NHS will last as long as there are folk left with the faith to fight for it." - Aneurin Bevan (NHS founder).

Áine Corry and William McGalliard
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First Impressions – Week One as a doctor in 2023

After graduating from Queen's University Belfast in July 2023, I have taken up a post as a Foundation Year 1 doctor. I am a first-generation medical professional and began medical school straight after my A-Levels.

What does the "crisis" mean to me? Well, the pandemic wreaked havoc on my Medical School experience by revolutionizing the delivery of training. I found myself plunged into clinical placements that were overwhelmed by the management of patients with COVID, reducing my exposure to so-called "routine" care. However, I took up part-time work as a Healthcare Assistant through the Workforce Appeal which supplemented my learning extensively. As I look back now, it's highly unlikely that I would have taken this role only for the crisis that was unfolding.

In final year of Medicine, I had the pleasure of holding the office of President of QUB GP-Society, an experience which gave me incredible insight into the clockwork of Primary Care. It has been proven time and time again that Primary Care is one of the most cost-effective ways to provide Healthcare to a growing and ageing population and the current situation in local General Practice is disheartening to say the least. Increased expectation and restricted funding are a recipe for disaster. A lack of workforce planning means my future career pathway is forecast to get even worse before it recovers. Despite my first-hand experience of the effect of increased workload, I remain steadfast in my passion to join the GP workforce when the time comes.

As I write, I have just finished my first week of FY1. The pressures in hospital are equally evident, not to mention the waiting lists of patients waiting to receive elective care. The greatest impact is an unsustainable workload, coupled with an underappreciated healthcare workforce. The balance of professionalism to put patients first and professionalism to understand one's own breaking point is difficult to achieve. How can any medical professional reach the end of their shift and walk away leaving jobs incomplete? Yet we all have a responsibility to look after our own health and wellbeing for the good of our patients.

I am very much at the early stages of learning how to be a doctor. I know it's a long road. However, when I speak to some of my colleagues, there is fear for the future. There is little hope for resolution; a heartbreaking reality. My friends and family have always described me as an optimist. Now I wonder if I am simply ignorant to the facts.

I truly believe medicine is a vocation. I distinctly remember in my first week of medical school being told, "if wealth or fame are your goals, leave now." Even amid the current crisis, the passion and enthusiasm of a new generation of healthcare professionals will ring clear above the doom and gloom. Our patients are our priority, and the powers that be must take responsibility for the necessary decisions to be made.

Tim Neill

Foundation Year One doctor
Southern Health and Social Care Trust

The view from ICU - and from an Associate Specialist

SAS stands for Specialist, Associate Specialist and Speciality doctors. We are doctors who are not consultants, GPs or part of a recognised training programme, and may be employed on a number of different contracts. These include the nationally negotiated contracts, which are currently the "Specialty Doctor" and "Specialist." Older historical national contracts, which include the "Staff Grade" and "Associate Specialist." These grades are known collectively as SAS.

The closure of the Associate Specialist posts meant that there was no formal way of recognising experienced specialty doctors capable of working autonomously. This formed the basis of a new contract for SAS and a new Specialist post was introduced in 2021. SAS doctors are a diverse group with Speciality doctors requiring a minimum of 4 years postgraduate experience and Specialists 12 years.

SAS posts have traditionally been looked at as "just for service", but there has been a growing acknowledgment of the contribution that SAS doctors make to the NHS and to the fact that all doctors need support and development to provide the best service they can for their patients. BMA NISASC, though its work over the last number of years has been successful in getting SAS leads appointed in each trust. In addition, Trust Management has recognised the importance of opening management positions to SAS doctors as a matter of course. These actions mean that although there is still work to do, we are now on par with the other devolved UK nations with respect to SAS development.

Choosing a career as a SAS doctor should be a viable career choice. I chose SAS after passing my Royal College of Physicians Membership exams, as I wanted to continue the direct patient facing aspect of my staff grade job in RICU. I have always felt supported to pursue my career on my own terms and at my own

pace in this role, developing my own area of expertise with tracheostomies, high spinal cord injuries and more recently with ICU follow up clinics.

Like all my colleagues in primary and secondary care, I faced many challenges over the last 3 years. When reports started coming through from China and then Italy, concern began to grow about what this pandemic would mean for ICU care. This included the training of non-ICU staff to look after ventilators and prone patients. We had to plan for massive upscaling in beds, oxygen delivery and ventilators as well as devise new infection control measures. We worried about how we would cope if we had to nurse our colleagues or our own families and made preparations in case we ourselves succumbed to COVID. Those of us with school age children also had home schooling to deal with.

We got through it, in no small part due to the camaraderie and teamwork, as well as the successful implementation of vaccines but having come through all of that, staff are exhausted and burnt out, and are now also dealing with the aftermath of COVID.

The current crisis facing the NHS, especially in Northern Ireland is worse than anything I have seen before even during the pandemic. Excluding Scotland, Northern Ireland comprises 3% of UK population but 96% of all UK patients waiting over one year for treatment[1]. In 2016, people in Northern Ireland were nearly three times as likely to be waiting for planned care as those in England, and the situation has deteriorated since: they are now nearly four times as likely[2]. The infrastructure around service delivery is years behind where we need to be. The pandemic has exposed the systemic failures that decades of underinvestment and cuts have inflicted on the NHS and social care. The NHS was running on goodwill long before COVID, but this is not sustainable anymore. Doctors are leaving NHS to work in Ireland, New Zealand and Australia, taking up non-clinical posts or even early retirement.

We need our politicians back in government to work with us in taking action to ensure that our health service remains safe and sustainable. We cannot keep trying to fix a leaking bucket by pouring more water in – staff need fair pay for the work they do, and we need enough staff to run services safely.

SAS doctors need parity of esteem. They need to be employed on the right contract for their job and their expertise. They should be encouraged to take up roles in leadership, teaching and research. The expectation should be that they will be supported in progression to specialist post or to specialist registration via portfolio pathway if they wish to do so. They should not be referred to as "other" or "middle grade", nor should their opinion and expertise be overlooked because they are not on the Specialist Register. Workforce planning needs to include SAS doctors, with Trusts being encouraged and incentivised to recruit speciality doctors, to offer SAS contract to doctors working long-term non-standard contracts and to appoint specialist posts.

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Ulster Med J 2023;**92(3):**125-127

Clinical Paper

Does performing manipulation of nasal bones under local anaesthetic beyond two weeks after injury affect outcomes? A prospective study during the SARS-CoV-2 pandemic.

J Smith[1], K O'Doherty[2], B Hanna[3]

Abstract

Introduction

ENTUK guidelines recommend that manipulation of nasal bones (MNB) should be performed within 14 days of injury. However, evidence suggests treatment under general anaesthetic remains effective up to 5 weeks after injury. With the SARS-CoV-2 pandemic leading to delays in referral and limited access to theatre, local practice changed to offer delayed MNB under local anaesthetic. This prospective study assesses the effectiveness of MNB delayed until 3 weeks or later from time of injury when performed mostly under local anaesthetic.

Methods

Data was prospectively collected between April and November 2020. All patients referred to ENT with a new nasal bone deformity presenting more than 21 days after injury were included. Demographic information, injury details and patient satisfaction was recorded for each patient.

Results

11 patients were included. Average age was 32.6 years (Range 8-65 years). 10 procedures (91%) were performed under local anaesthetic, with 1 (9%) performed under general anaesthetic. 9 patients (82%) gained complete reduction of the deformity, and 1 patient (9%) gaining partial reduction. 10 patients (91%) patients were satisfied with the cosmetic outcome.

Conclusion

This study supports the small volume of recent literature showing that delayed manipulation of nasal bones is effective and additionally demonstrates that efficacy is maintained when performed under local anaesthetic

Keywords:

Nasal bone; nasal bone fracture; manipulation of nasal bones; local anaesthetic

Introduction

Manipulation of nasal bones (MNB) is a useful and effective procedure that can improve the cosmetic appearance of the nasal bones following trauma. It is commonly performed under general anaesthetic less than 2 weeks after initial injury, a pathway traced to a study by Staffel[1] examining the optimization of nasal fractures. Indeed, current ENTUK guidelines align with his expert recommendation, stating the procedure should be performed within 14 days of injury.[2]

The necessity for the use of general anaesthetic has been challenged by recent studies and there is now a significant evidence base demonstrating that MNB with local anaesthetic is a more cost effective and convenient procedure with higher patient satisfaction and comparative success rates of fracture reduction.[3]

Two recent studies[4,5] have also suggested an extended time-frame for offering intervention post injury but MNB was performed under general anaesthetic in these studies.

The emergence of the SARS-CoV-2 virus changed traditional referral pathways and ultimately led to delays in presentation of patients with nasal trauma to the ENT department. Equally, theatre access was limited thus restricting application of the procedure under general anaesthetic. This unique situation led to a change in local practice with patients receiving MNB outside the traditional 2 week window, and with local anaesthetic rather than general.

A literature search did not reveal any study discussing the outcomes for patients undergoing delayed MNB under local anaesthetic. Thus, our prospective study aims to assess outcomes of a cohort of patients undergoing MNB with local anaesthetic and affirm whether this is a viable treatment option in future cases.

Methods

Data was prospectively collected between April and

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November 2020. All patients referred to ENT with a confirmed nasal bone deformity presenting more than 21 days after injury were included. All patients were offered MNB under local anaesthetic with the option of general anesthetic restricted to those cases that could be justified to the theatre planning committee. Demographic information, mechanism of injury, time from injury to manipulation, and outcomes relating to both patient satisfaction and completeness of fracture reduction were recorded for each patient.

Ethical considerations

This study is a prospective observational study of a change in clinical practice that occurred during the SARS-COVID pandemic. It presented a unique opportunity to the record the effect of delayed MNB under local anaesthetic, an event which would not normally occur on a sufficiently frequent basis to permit sufficient data collection. All data was anonymized.

Results

11 patients were included, 6 females (55%) and 5 males (45%). Average age was 32.6 years (Range: 8-65 years). 6 injuries (55%) were caused by mechanical fall, 3 during sport (27%), 1 during a seizure (9%), and 1 during an alleged assault (9%). (see table 1)

10 patients (91%) had MNB under local anaesthetic, with 1 patient (a child) accepted for general anaesthetic. The average time of manipulation from point of injury was 29 days (Range: 17-45 days). All assessments and manipulations were performed by suitably trained junior ENT surgeons under appropriate senior supervision.

There was movement of the nasal bones in 10 patients (91%) and complete reduction of the nasal bone deformity in 9 patients (82%), with 1 patient (9%) gaining partial reduction. 1 patient (9%) did not gain any benefit with no palpable movement nor reduction. 10 patients (91%) were satisfied with the outcome of the procedure. (see table 2)

The single patient who did not demonstrate any nasal bone movement and was not satisfied was treated 28 days from the time of injury, which correlates with the median of the time from injury to MNB.

Discussion

Nasal bone fractures are the most common facial fracture, accounting for 59.8% of all facial fractures in children and adolescents[6] and 17.7% in adults[7]. They can be accompanied by a cosmetic deformity that may be psychologically debilitating. MNB is a well-established procedure that can be performed in such cases with studies recognizing an 85.6% satisfaction rate due to improvement in cosmesis.[4]

Current ENTUK guidelines echo the expert opinion of Staffel[1], noting that MNB should be performed less than 14 days after injury. A prospective study by Basheeth[4] et al challenges this, demonstrating satisfactory outcomes in 3 patients treated 4 weeks or more after nasal injury. A similar study by Perkins et al[5] found 8 out of 10 patients offered MNB greater than 21 days post injury to have mobile nasal bones, noting this patient group to have comparable satisfaction scores when compared to a cohort treated less than 14 days after injury. These studies, however, present data associated with general anaesthetic procedures and are therefore not entirely analogous to our own.

A systematic review by Chadha et al[8] assessing the use of local anaesthesia in MNB notes this to be a safe and efficacious method, with the procedure being well tolerated and little reported evidence of major adverse outcomes. They also note no statistical difference in patient satisfaction in those treated by general or local anaesthetic.

Noting 10 out of 11 of patients (91%) to have had MNB performed under local anaesthetic, our cohort demonstrates outcomes comparable to the documented literature with mobile nasal bones in 10 patients (91%) and complete reduction of the nasal bones in 9 patients (82%). This study therefore demonstrates that a delayed MNB under local anaesthetic is a clinically justifiable procedure when undertaken by an appropriately trained practitioner. There is no literature evidence comparing the outcomes of MNB when performed by different grades of clinician, however it is logical to surmise that appropriate levels of training in assessment and manipulation are required to obtain similar results to that reported in our cohort.

The upper limit of an extended time-frame is not predicted by age, sex or mechanism of injury, however with 2 patients (18%) undergoing the procedure over 42 days from the initial injury, we suggest that the traditional 14 days is an overly conservative timeframe.

With the inclusion of a single child, it is impossible to draw any firm conclusions of the applicability of our findings to a paediatric population. However, the successful reduction in this patient suggests that an extended timeframe in children may be worthy of further research. Children's bone is less calcified with a greater propensity for greenstick fractures.[9] This would be of particular clinical benefit to the child, as any invasive surgical procedures on the midface are usually avoided until fully grown and thus, appropriate intervention with an MNB may prevent the young patient carrying a persistent nasal bone deformity through their formative years and avoid any potential bullying or psychological issues that may accompany this.

Conclusion

As evidence of an increased time frame continues to be documented, our cohort, whilst small, demonstrates that the current recommendation of performing MNB less than 14 days from injury is overly conservative. Our data suggests that local anaesthetic MNB in the outpatient setting as far as 45 days after injury can be offered, with no expected compromise in outcome.

Patient	Age	Sex
1	35	Female
2	26	Female
3	36	Female
4	65	Male
5	15	Male
6	24	Male
7	58	Female
8	60	Female
9	8	Female
10	15	Male
11	17	Male

Table 1: Demographic information

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Patient	Injury type	Days from injury to manipulation	Anaesthetic used?	Movement of nasal bones?	Reduction of nasal bones?	Patient Satisfied
1	Seizure	45	Local	Yes	Complete	Yes
2	fall	25	Local	Yes	Partial	Yes
3	Sport	28	Local	No	No reduction	No
4	Fall	28	Local	Yes	Complete	Yes
5	Assault	24	Local	Yes	Complete	Yes
6	Fall	23	Local	Yes	Complete	Yes
7	Fall	39	Local	Yes	Complete	Yes
8	Fall	22	Local	Yes	Complete	Yes
9	Fall	26	General	Yes	Complete	Yes
10	Sport	42	Local	Yes	Complete	Yes
11	Sport	17	Local	Yes	Complete	Yes

Table 2: Mechanism of injury, procedural details and outcomes

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Clinical Paper

Regional Elective Day Procedure Centre Pilot– the solution to waiting lists and trainee deficit in the reshaping of services following COVID-19?

Rachael Coulson[1], Sarah Small[1], Robert Spence[2], Ian McAllister[2]

ABSTRACT

Background: Consequences from the COVID-19 pandemic have resulted in the secondary impact of cessation of elective surgical services, amplifying the waiting list problem with devastating patient and surgical training repercussions. With the introduction of the first regional inter-trust daycase elective care centre pilot in Northern Ireland, we aim to assess the impact of this pathway on elective inguinal hernia waiting lists, patient outcomes, and influence on surgical training.

Methods: Data was collected prospectively over a 10-week pilot of consecutive elective day case hernia lists at a newly established regional day surgery centre. Key operative time points for each patient were collated via the Theatre Management System (TMS). Retrospective patient feedback was collected from participating patients via 26-question telephone survey at 6 weeks post-operatively. Trainees allocated to the participating units during this pilot received a retrospective electronic survey.

Results: Fifty-five patients underwent open unilateral elective inguinal hernia repair, 54% of cases were trainee led. Median trainee operating time of 53 minutes compared with 51 minutes for consultant led procedures, with no significant difference consultant vs non-consultant as primary operator ($p>0.05$). On completion of the pilot, waiting list numbers were reduced by a third, 75% of trainees feedback reported increased confidence with surgical operative exposure, and high levels of patient satisfaction reported.

Conclusion: Inter-trust day surgery at a dedicated green site could successfully contribute to resuming and reforming surgical services, addressing the impact on mounting waiting lists with positive patient impact as well as providing an excellent training opportunity to narrow the observed training deficit.

Key words: Day Case, Centre of excellence, trainees, surgical workforce

INTRODUCTION

In the post-COVID-19 healthcare era, services and systems are restructuring with renewed opportunity to meet patient and workforce interests[1]. Elective surgical procedures were withdrawn from March 2020 due to demand for urgent and emergency resources and critical care facilities in response to the pandemic. Consequently, elective surgery and day case operating has been one of the casualties of COVID-19 with ramifications for patient, surgical waiting times, and trainees. The COVIDSurg Global Collaborative study estimated the UK would cancel or postpone more than 40 000 elective operations per week during the peak of the pandemic and this downturn in surgical capacity was observed, devastating for patient scheduled care as well as training opportunities[2]. Further to the acute burden on healthcare structures, the pandemic exposed existing faults in the framework of services[3,4]. As healthcare trusts and their leadership look to restart and reorganise services, initiatives are needed to regenerate beyond pre-existing systems to redesign services fit for patients and address the training deficit created for a long-term sustainable workforce[5,6].

Prior to the pandemic, waiting times in Northern Ireland for elective care were the worst in the UK and amongst the worst in Europe with 2017 figures outlining 11,261 patients waiting more than 52 weeks for a day case admission[7]. Recent Department of Health statistics within Northern Ireland show in March 2020 that 94,000 patients are on waiting lists for day case and inpatient admissions. There are significant mental and physical health implications as well as widening healthcare inequalities. An all-region strategy has been proposed with a commitment to narrow the gap between demand and capacity by 2026. The resumption of services has given the opportunity of redesigning patient care with a proposed elective care road map developed, aiming to meet the needs of the patient population and secure a future workforce through a newly established regional centre of excellence for day case elective surgery[8,9].

Elective care delivered in centres with streamlined patient pathways have been successfully modelled in the wider UK as an initiative to meet the rising demands. This has

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transformed the elective treatment landscape to improve patients' timely access to care, travelling beyond their local hospital to independent centres with devoted service provision and staffing undisrupted by emergency and unscheduled work in the context of COVID-19 guidance. In addition to improved patient outcomes, professional guidance has outlined the benefit of elective day case working for staff with productivity and standardisation of care as well as excellent training opportunities. Therefore, in line with the strategic framework for rebuilding of services, recruitment and training of staff is essential for retention of a trained workforce required for service recovery[7,8,10,11].

We have selected a pilot set from the general surgery elective population waiting list; identifying patients waiting for unilateral open inguinal hernia repair at a newly established regional centre of excellence for day surgery to assess the impact of this 10-week pilot on waiting list numbers, theatre efficiency, and acceptability of this experience and service for patients. In addition, review the impact of non-consultant led operating on theatre list productivity to identify the potential training opportunities daycase can offer to overcome this training shortfall.

Aim

We aim to assess the introduction of a regional inter-trust daycase open inguinal hernia day case pilot in a dedicated elective pathway site outside and the impact on patients and surgical training.

METHODS AND MATERIALS

A prospective database was established over a 10-week pilot of consecutive elective daycase inguinal hernia operating lists at a newly established regional centre of excellence for day surgery. Specifically, key time points in surgical cases including time ready, knife to skin, last suture, theatre exit and operator were recorded. This was achieved using the Theatre Management System (TMS). Patients were selected having completed a telephone preassessment, consultant consideration deemed suitable for a daycase list and on an existing waiting list for open unilateral inguinal hernia repair. They attended a COVID free corresponding community hospital for pre-operative blood tests and a COVID PCR test within 72 hours pre-operatively following which all patients self-isolated. Anaesthetic techniques included general anaesthetic, spinal or local anaesthesia. Exclusion criteria included recurrent hernias, complex medical needs requiring post-operative admission or possible need for level 3 care.

All patients who underwent hernia repair from September to November 2020 were contacted retrospectively six weeks postoperatively by telephone offering an opportunity to participate on a voluntary basis in a 26-question telephone survey assessing patient outcomes, complications, and their experiences. This was governed by members of the clinical team involved in the pilot. Verbal consent was obtained at time of contact. Patients who did not respond were given further opportunity by being contacted at an alternative time; minimum of two attempts greater than 24 hours apart.

In addition, trainees allocated to the participating units during this pilot were sent a voluntary 10-question electronic anonymised trainee satisfaction survey to assess their experience of attendance at these lists. Trainees were contacted via a central single email administrator to ensure confidentiality. A completion period of 6 weeks was outlined with further reminder emails at 4-weeks and prior to survey closure.

Analysis

A comprehensive review of the collated database was completed. Surgical case time in minutes was collected for time ready, knife to skin, last suture placement, theatre exit time, and primary operator grade. Time ready is categorised as patient preparation for theatre is completed including consent, gown, TED stocking placement, and care plan complete. Knife to skin was decided by: anaesthetic administration, draping, skin preparation, and commencement of the operation. Last suture with closure of skin.

Patient feedback information from the telephone survey was compiled into a database to include surgical consultant, date of operation, age at time of surgery, pre-operative written information received, and length of travel time to the regional centre; category one: 0 to 30 minutes, category two: 30 to 60 minutes, category three: 60 to 90 minutes, category four: 90 to 120 minutes, or category five: greater than 120 minutes. Employing the Likert scale (1-5), patients' feedback in relation to the location and facilities were collected. Questions included if the regional centre was deemed a convenient location, how they rated hospital facilities, clarity of travel directions and signposting as well as car parking facilities. In addition, usefulness of post-operative written discharge information, pain score at discharge, pain score at 6 weeks, 30-day post-operative complications and if the patient returned to baseline activity at 6 weeks postoperatively. A cross analysis of the theatre data and patient database was completed to catalogue the patient reported outcomes by primary operator, surgical trainee versus consultant. Trainee led operations were performed by core trainees year 2 up to specialty trainees year 6, with the majority of trainee led operations by higher specialty trainees.

Electronic feedback was collected from trainees identified as part of the pilot and in a training placement via anonymised survey. General surgical higher specialty trainees and core surgical trainees were included in the survey; foundation doctors were excluded as they have not been recruited to a surgical training programme or engage with the Intercollegiate Surgical curriculum. The trainee information collated included level of training and the impact of COVID-19 on training, specifically access to surgical cases, cases logged as primary operator, impact on confidence of surgical skills,

and access to supervised training opportunities during the pandemic. As a consequence of the daycase pilot, trainees were asked if they had more access to surgical cases, logged more primary operator cases, the impact on their confidence in surgical skills, and opportunities for supervised learning. Statistical analysis was performed via IBM SPSS using t-test and ANOVA techniques. Significance was defined as a p-value of less than 0.05.

RESULTS

A total of 55 patients underwent an open unilateral elective inguinal hernia repair; 46 of which had complete theatre data available. The median age at time of operation was 52 years old.

Prior to the pilot, 165 patients were awaiting open unilateral inguinal hernia repair. From September to November 2020 on completion of the 10-week pilot, 110 patients remained on the waiting list.

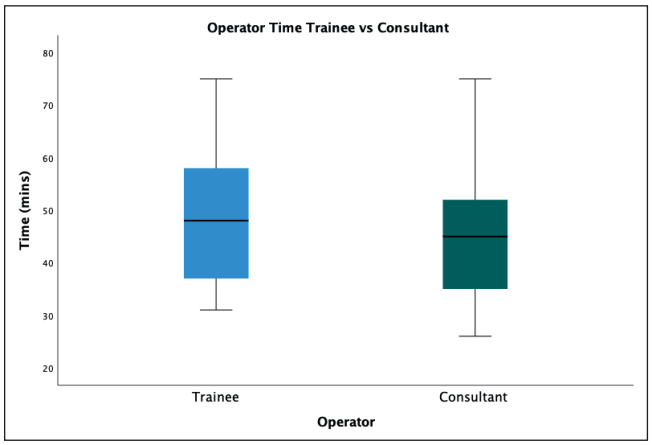

Figure 1:
Demonstrating trainee vs consultant operative time

Fifty four percent (N=25) of cases were trainee led with median trainee operating time of 53 minutes compared with 51 minutes for consultant led procedures with all lists at theatre capacity with no significant difference (p>0.05) (Figure 1). Theatre capacity was standardised across the pilot of patient cases.

There was no significant difference between patient pain score on discharge or at 6 weeks postoperatively for trainee or consultant led procedures (p>0.05). Eight patients reported a postoperative complication at six weeks classified by the Clavien-Dindo grading; six patients had a grade 1 complication and two patients with a grade 2 complication. The trainee led group did not have a higher rate of complication compared with the consultant led group. No patients required readmission to hospital.

Patient experience

Forty-nine patients completed the follow-up survey, 1 patient declined to participate, and 5 patients were non-responders. One hundred percent of patients received pre-operative written information, 96% (N=47) of which found the information useful.

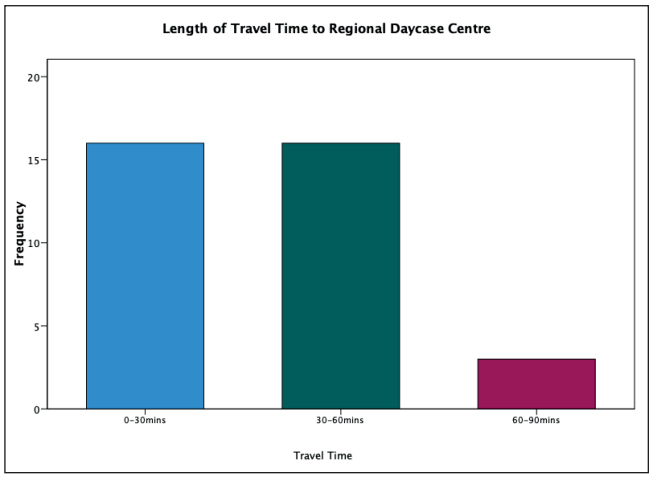

Figure 2:
Demonstrating patient travel time to regional daycase centre

Location of the daycase centre was reported as convenient in 94% (N=46) of patients; 92% (N=45) of participants had a travel time of less than 60 minutes (Figure 2). Furthermore, patients scored the daycase centre facilities as excellent; median Likert score 9.6 (Likert scale 1-10).

Written discharge information was given to 90% of patients, all of which stated they found it useful. Overall high levels of patient satisfaction were reported with a median Likert score was 9.5. Ninety eight percent (N=48) of patients reported return to baseline activities at 6 weeks.

Trainee experience

Eighteen trainees were identified as having rotated through the unit during the pilot, 12 of which responded. Level of training were categorised into 5 core surgical trainees and 7 higher training specialty registrars (Figure 3).

As a result of the diversion of workforce and resource to address the COVID-19 demand, 92% (N=11) of trainees stated they have had less access to surgical cases in addition to less access to supervised training opportunities. One

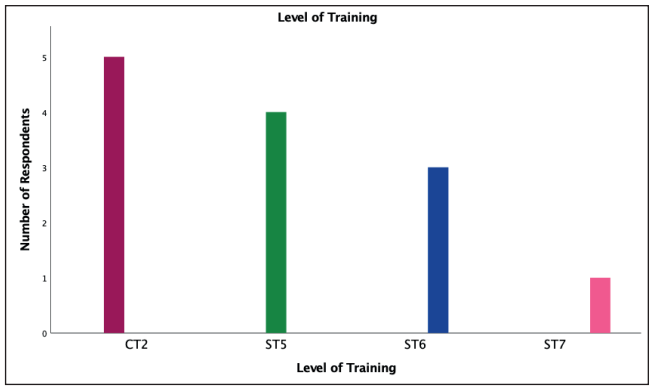

Figure 3: Training level of respondents

hundred percent (N=12) of trainees stated they had logged less cases as the primary operator as a result and 83% (N=10) stated their confidence in performing surgical skills had been negatively impacted.

By engaging in the pilot, 67% (N=8) of trainees reported more access to surgical cases as a result of their attendance at the elective care daycase operating lists. Seventy five percent (N=9) stated they logged more primary operator cases with more access to supervised training opportunities, and 83% (N=10) stated their confidence in performing surgical skills had been positively impacted. Overall, 75% (N=9) expressed attendance at the daycase operating lists had a positive impact on their training during the COVID-19 pandemic.

DISCUSSION

Unacceptable surgical waiting lists pre-pandemic have been witnessed across the UK; this has been exacerbated to unpresented levels in the current 2022 COVID-19 era[7-9]. The waiting list for unilateral inguinal hernia repair trebled in parallel with the observed COVID-19 surges, compounded by the continued downturn in surgical activity. The daycase pathway is scheduled care with advanced planning separated from emergency workload centred on the ethos of providing an equitable and undisrupted service[12,13]. UK based models have demonstrated success when adequate facilities, resource, and workforce are co-ordinated in centres of excellence. This requires patient empowerment with knowledge to facilitate same day discharge and training and education at its core for a sustained workforce. Within Northern Ireland, the Department of Health strategies have proposed an adaptive approach and overwhelming drive to deliver the right service to the right patient at the right time, aiming to create a restructured service ambition beyond the remit of geography with inter-trust regional working[5,8,9,11]. This daycase elective surgery pilot within a centre of excellence was the first within Northern Ireland adopting this strategy. It has demonstrated the benefit of addressing waiting times without overwhelming acute systems, as well as providing effective training opportunities for general surgical trainees prioritising a surgical workforce.

A recent Northern Ireland Department of Health survey found 78% of patients questioned reported they would be prepared to travel beyond their local hospital, with up to one hour was deemed to be acceptable in 82% of cases to benefit from expedited care. Through this pilot of fifty-five-patients undergoing elective hernia repair, the concept of this survey in practical terms was supported by our findings; most patients travelled less than 60 minutes to reach this elective care service and reported that the daycase centre was convenient to them. This is important in the accessibility and acceptability of this format to patients[8,9].

The British Association of Day Surgery recommendations include inguinal hernia repair as an indicative general surgical procedure of which 80% should be carried out as daycase despite operative technique[15,16]. We have demonstrated through this pilot, inguinal hernia repair can be carried out as day case in an acceptable format to patients with significant positive impact on waiting list numbers. For same day discharge to be successful, adequate preoperative and discharge information is required. We evaluated patients experience having received written pre-operative information, which they deemed useful as well as discharge guidance. We observed patients had returned to baseline function at 6 weeks and at 30 days no reattendances or readmissions, critical elements in the daycase strategy. Patient selection regarding appropriateness for day case in the context of complex co-morbidities and an ageing population also need to be reviewed. Acceptability of this experience was demonstrated with high patient reported satisfaction scores, supporting that delivery of care within centres of excellence potentially outside patients' immediate locality can be effective but patient selection needs to be considered for this pathway to deliver maximum patient benefit.

Teaching, training, and research is recommended to be amongst the core functions of the elective care framework. A recent study of national surgical trainees analysing the COVID-19 training impact highlighted difficulty achieving indicative numbers with a significant reduction in recorded operative experience in 2020 compared to 2019 with elective surgery affected more than emergency operating[17,18]. In addition, 1 in 8 trainees in their final year of training extended their training[19]. More than one quarter entering their final year of training stated this was below their expected training trajectory, emphasising a concern regarding available trained workforce as a key challenge in care delivery and sustained service[17,19]. The Healthcare landscape has changed with the impact of COVID-19 influence aggravating workforce retention and shortages however a culture of resilience and innovation has developed.

The pandemic has impacted trainees with less theatre access, redeployment, and disruption of competencies. Within this study, a survey of trainees has supported this operative impact, notably outlining a reduction of logged surgical cases, confidence in surgical skills, and supervised training opportunities. As a result of engaging in the pilot, trainees had access to these dedicated elective lists, without interference from emergency disruption or demands. They logged more primary operator cases, showing high levels of confidence, with supervised training opportunity and had a positive impact on training because of attending the lists[20-22]. In order for trainees to avail of these daycase lists, provision of general emergency care and base hospital elective lists as well as inpatient cover had to be ensured. Consultant cover for the daycase lists were on an adhoc basis as established schedules had been disrupted over the pandemic. Safeguarding of these opportunities can be met through trainees driving and being motivated to identify potential lists and working together to rotate these opportunities with more senior trainees covering base sessions as well as a culture of change within units and approach to day case surgery.

Our results disclosed that trainee-led operating in this setting did not demonstrate a significant difference in theatre capacity or efficiency in terms of operative time when trainee led operating compared to consultant led. In relation to patient pain score on discharge and subsequent morbidity at follow-up no significant difference was demonstrated between consultant versus trainee primary operator. The implication of prioritising training does not confer negative patient outcomes or adversely impact productivity. Consistency of procedure under experienced supervision and feedback is an established formula for successful training. Given the success of the initial 10-week pilot, the service has become established beyond the pilot, with inter-trust staffing basis as an equitable regional service for patients. Restoration of systems should maximise opportunities for trainees to narrow the deficit of missed training opportunities, including enhanced theatre time with a change of the surgical curriculum to competency based and create an environment to support this; as if we don't train today, we will have no surgeons tomorrow[17,23,24].

LIMITATIONS

All initial survey non-responders were followed up with further telephone or electronic written communication to ensure the highest possible response rate. The COVID-19 pandemic has created a challenging environment with dynamic guidance changes and those within this pilot were in keeping with the COVID-19 recommendations at the time.

CLINICAL IMPLICATIONS AND FUTURE RESEARCH

COVID-19 is an ongoing healthcare preoccupation; we have demonstrated that elective care daycase centres of excellence can be utilised to address the waiting lists and training burden.

With the right framework and resource, there is an opportunity to redesign service delivery in a renewed way not limited by council or Trust. Patient selection and procedure consideration would need to be scrutinised to ensure the correct pathway for individual patient safely. Future research should focus on larger scale pilots, extending procedural type, and reviewing stakeholder and wider team feedback in service analysis.

CONCLUSION

This pilot has demonstrated a dedicated site for day case elective surgery can be successful during the period of COVID-19 restrictions and should be incorporated and prioritised in healthcare recovery planning. We have shown an opportunity to address the mounting waiting lists and develop training without negatively impacting patients experience or health outcomes which are key to the concept of regional day procedure centres.

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Clinical Paper

The use of colonic stents as a bridge to surgery in malignant colonic obstruction – A dual trust experience over 10 years

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ABSTRACT

Introduction

Worldwide colonic cancer is the third most common cancer with up to 30% of cases presenting with large bowel obstruction. Self-expanding metal stents (SEMS) have been used as a bridge to surgery (BTS) in the treatment of this malignant obstruction. We review the outcomes of SEMS as a BTS across two high volume colorectal units.

Methodology

A retrospective analysis of patients undergoing colonic stenting as a bridge to surgery was performed; outcomes were compared to previously published figures on emergency colonic resections. Inclusion criteria were adults (>18 years of age) undergoing colonic stenting for colonic obstruction with a view to elective resection. Patients undergoing stenting for palliation of symptoms were excluded.

Results

39 patients were identified across both trusts over a ten-year period. 90 day mortality following BTS was found to be 3.6% and there was an 82.1% (32/39) technical success rate. 46.4% proceeded to an elective resection which was started laparoscopically. Permanent stoma rate was observed at 14.3% for elective surgery.

Conclusion

Stenting for relief of acute malignant obstruction as a bridge to surgery is a viable option in select patients. Further research is required to determine oncological safety and rate of local recurrences.

Keywords

Intestinal obstruction; self-expanding metallic stents; colorectal neoplasms; colonoscopy

INTRODUCTION

Colonic cancer is the third most prevalent cancer internationally and emergency presentation with obstruction has been reported in 15-30% of cases [1]. Traditional treatment for large bowel obstruction has been emergency surgery, often with a colonic resection and the formation of a stoma. Emergency surgery carries significant risks of morbidity and mortality. The mortality related to emergency surgery for large bowel obstruction presenting acutely has been quoted at up to 15% in the UK and Ireland[2] with morbidity following the procedure of 40-50% [1]. Colonic stents have been a long established treatment for colonic obstruction. In the past the principal use of stents in this setting had been for palliation of symptoms. In recent years there has been a move towards colonic stents as a bridge to surgery in emergent malignant colonic obstruction. Several trials have compared the use of self expanding metallic stents (SEMS) to emergency surgery in the treatment of malignant large bowel obstruction[3–8] The purported benefits have included time pre-operatively to physiologically optimise the patient, a higher rate of laparoscopic procedures, a lower rate of permanent stoma formation and a shorter operating time.

Following passage of a fluoroscopically guided wire across the tumour a self-expanding metallic stent is placed endoscopically. The contracted stent traverses an obstructing lesion and is deployed. Following deployment, the stent expands radially creating a lumen through which stool can pass, relieving the obstruction.

There are concerns regarding oncological outcomes, in particular; silent perforations, risk of peri-neural invasion, local invasion and rates of local recurrence. [9–11]

We reviewed data from two large colorectal units in Northern Ireland over a ten-year period. We aimed to ascertain the safety of colonic stents as a bridge to surgery in patients presenting with an acute malignant large bowel obstruction.

METHODOLOGY

Data was collected from the radiology PACS system, the theatre management system and endoscopy records for all

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patients undergoing colonic stenting for acute large bowel obstruction from January 2010 to January 2020.

Large bowel obstruction was defined when patients had radiological and/or clinical evidence indicating this following assessment and computed tomography (CT) imaging. Emergency surgical resection was planned in the event of unsuccessful stenting.

Inclusion criteria were defined as adults undergoing colonic stenting following an emergency admission for malignant large bowel obstruction with the intention of proceeding to curative resection. Patients with metastatic disease were not excluded at this point. Patients were excluded if the stent had been performed for palliative intent, performed electively or performed for benign disease. Retrospective data was then collated from electronic notes.

All stents were inserted by a consultant in gastrointestinal medicine or surgery, experienced in therapeutic endoscopy and with experience of >100 therapeutic procedures.

Primary endpoints were defined as mortality in the 90 days following surgery and success of endoscopic stenting in relieving obstruction (technical success was defined as radiological evidence of stent passage without complications and clinical success was defined as clinical evidence of relief of obstruction).

Secondary endpoints were further defined as rates of laparoscopic procedures, permanent stoma rate, histopathological outcomes and length of time to surgery.

Results

From 2010 to 2020 thirty-nine patients who had an emergency presentation of malignant large bowel obstruction were treated with insertion of a colonic stent with the intention of bridging to surgery.

The average age of patients who were considered for a stent as a bridge to surgery was 70.7 years. Twenty-seven (69.2%) were male and 12 (30.8%) were female.

The majority of cases of large bowel obstruction occurred in the left colon with the breakdown further displayed in table 1._Seven (17.9%) patients presented with a rectal lesion, thirty (76.9%) with a left colonic lesion, one (2.6%) with a transverse colon lesion and one (2.6%) with a lesion at the hepatic flexure.

Technical success of stenting was achieved in thirty-two patients (82.1%). Clinical success was observed in thirty-one patients (79.5%). Eight patients (20.5%) failed stenting and progressed to an emergency operation of which six underwent an open Hartmann's procedure and the other two had a subtotal colectomy. One stent was technically successful but due to no clinical resolution of obstruction they proceeded to Hartmann's operation. The reasons for technical stent failure (n=7) were inability to pass the stent in

Location of obstruction	Number of patients
Lower rectum	1 (2.6%)
Upper Rectum	6 (15.4%)
Sigmoid	21 (53.8%)
Descending colon	5 (12.8%)
Splenic flexure	4 (10.2%)
Transverse colon	1 (2.6%)
Hepatic flexure	1(2.6%)

Table 1 – Point of obstruction

five patients (12.8%) and perforation in two (2.4%) patients. One perforation was at the site of obstruction and the second was a caecal perforation.

No patient received neo-adjuvant chemo-radiotherapy during the bridge period to surgery. Twenty-nine patients proceeded to attempted elective resection. The median time to elective resection was twenty-four days following successful insertion of a stent. Three patients (7.7%) did not undergo a resection. One patient was found to have peritoneal metastatic disease at the time of attempted elective resection, therefore a peritoneal biopsy was taken but no resection was performed. One patient was found to have a second inoperable pancreatic malignancy after stenting and one patient was admitted with pneumonia and later found to have metastatic disease. This patient passed away before surgery was due to be performed.

In those patients undergoing an elective resection (n=28), thirteen (46.4%) had their operation started laparoscopically. Nine patients (32.1%) had a laparoscopic procedure and a further four (14.3%) had a laparoscopic converted to open resection. All surgical operations are outlined in table 2.

A stoma was formed in five patients (17.9%) undergoing elective resections although one of these was a defunctioning loop ileostomy formed following a low anterior resection. This was reversed six months following the patient's resectional surgery, resulting in a permanent stoma rate of 14.3%.

One patient who had unsuccessful stenting died within 90 days. This was a patient who proceeded to a Hartmann's

Operation performed	Number of patients
Right hemicolectomy	2 (5.55%)
Left hemicolectomy	8 (22.2%)
Sigmoid colectomy	6 (16.7%)
Hartmann's	9 (25.0%)
High anterior resection	8 (22.2%)
Low anterior resection	1 (2.8%)
Subtotal colectomy	2 (5.55%)

Table 2 – Operations performed n=36

procedure sadly passing away in the days following the emergency surgery. One patient who had a technically successful stent placement but unsuccessful clinical result, requiring Hartmann's operation, died within one-year.

In the successfully stented cohort who proceeded to elective resection (n=28), one patient died within 90 days. This resulted in a 90-day mortality of patients undergoing successful stenting as a bridge to theatre of 3.6%.

One further patient who was successfully stented but did not proceed to surgery died within a year of stenting due to a second malignancy.

T stage		N stage		LVI		EMVI	
T2	2	N0	14	Present	10	Present	10
T3	17	N1	8	Not Present	17	Not Present	16
T4a	3	N1b	1	No comment	1	No comment	2
T4b	6	N2	5				

Table 3 – Histopathological data following elective resection (n=28)

One silent perforation was identified at surgery (3.6%). Perineural infiltration was not routinely recorded in histology reporting but was identified in 4 patients who had undergone stent insertion. Histopathological data on patients undergoing elective resection is displayed in table 3.

DISCUSSION

The use of colonic stents has been long established in the palliative treatment of colonic malignancy in the presence of obstructing lesions.[12–14] The first experience of colonic stenting as a bridge to surgery was published in 1991 by Dohmoto et al.[15]. Since then, there has been increase in the use of self-expanding

metallic stents (SEMS) in this manner. Recent experience in the use of SEMS as a stop-gap in emergent colonic obstruction as a bridge to a curative resection has shown promising results with improvements in mortality rates, increased single anastomosis surgery and good success rates at relieving the obstruction in the acute phase.[6,16–18]

Mortality

The national audit of colorectal cancer data from 2019 reports mortality for emergency and urgent colonic resection within 90 days for the past 5 years between 10 and14% nationally.[19] and Tekkis et al reporting a 17.2% mortality and 20% mortality for patients undergoing urgent and emergent colonic resections respectively.[2]

Our data demonstrates a lower mortality rate in patients who have undergone colonic stenting as a bridge to surgery with subsequent elective resection than has been previously reported for these patients undergoing emergency resection. We report a 3.6% 90 day mortality rate following successful SEMS as a BTS, far below the nationally quoted 14-20% for emergency colonic resection[2]. This is comparable to results shown in other studies with Wang et al finding a significantly lower mortality rate in patients who had undergone colonic stents as a bridge to surgery in comparison to those who had undergone emergency resectional surgery. [12]

The CREST study is the largest study to date of stents as a bridge to theatre. As of the date of writing it has only been published in abstract form and the study again demonstrates a decreased 30-day mortality in BTS patients but only slightly at 4.4% vs 5.3% in emergency resectional patients[4].

Interestingly in a meta-analysis of 334 patients across 6 studies Liu et al did not find a significant difference in in-hospital mortality between the stent group and emergency surgery group.[20]

Success of stenting

Across Northern Ireland colonic stents have been inserted by a range of medical disciplines including gastroenterologists, colorectal surgeons and in some instances in tandem with a radiologist. In all instances the use of procedural fluoroscopy was employed. Insertion of colonic stents for obstructing colonic neoplasms is a difficult procedure and a steep learning curve exists. Williams et al suggest that

the learning curve associated with successful placement of a colonic stent is 20 procedures[21]. Tan et al reported a 70% technical success rate of placement of SEMS and a 69% clinical success[22]. However Pirlet et al reported only a 47% technical successful placement of stent with a 40% clinical success[8]. We have observed an 82.9% technical success rate with an 80.5% clinical success rate. The wide variety of observed success rates highlights the complexity of the procedure and the need for a list of competent personnel. A dual operator technique is one method which has been suggested to try to improve technical success but is not implemented globally.

Stoma Formation

Traditionally emergency resection for obstructing colonic resections will involve a stoma either as an end colostomy or ileostomy or as a defunctioning protective measure following an anastomosis. In our successfully stented BTS patients (n=28) we report 82.1% of patients proceeding to an elective resection without formation of a stoma.

Arezzo et al found that both permanent and temporary stoma rates were reduced in patients previously stented compared to patients who proceeded straight to emergency resection[3]. Amelung et al reported a 14.7% permanent stoma rate compared to 26.5% in their emergency surgery group[23], Allievi et al published a stoma formation rate of 28.89% compared to 46.02% in patients undergoing emergency colonic resection[1].

Mortality following closure of an ileostomy or colostomy has been estimated between 3 and 9% respectively[24,25]. Obviously, this is an excess risk which we would prefer patients not to be exposed to.

Surgical Approach

Minimally invasive colorectal surgery has been shown to decrease intra-operative bleeding, hospital stay and post-operative complications[26] As such, where patient factors and operator skills permit it is preferable to perform colonic resections laparoscopically. Our data demonstrates that 32.1% of patients were able to have a laparoscopic resection following successful SEMS as a BTS. The prevalence of the use of a laparoscopic approach for the definitive procedure increased proportionally in sequential years which is what we would expect given the increasing prevalence of laparoscopic colorectal surgery. This is also borne out in the figures published by the ESCO trial in which 41.1% of post-stent procedures were performed laparoscopically[3]

Oncological Controversy

Oncologically the insertion of SEMS remains controversial. Kim et al reported a higher rate of perineural invasion in patients undergoing SEMS as a bridge to theatre[9]. In addition peritoneal seeding following perforation whether recognised or silent has been raised as a concern. Van Hooft et al reported a silent perforation rate of nearly 20% (9/47) and Pirlet et al reported 26.7% (8/30)[7,8].

In our cohort of patients we only identified one patient with a silent perforation on histology therefore giving a rate of 3.6% in those undergoing technically and clinically successful stent placement. Lympho-vascular invasion (LVI) and extra-mural vascular invasion (EMVI) was documented as present in 10 (37.0%) and 10 (38.5%) of elective resections respectively. The presence of EMVI and LVI however may be related to the advanced stage of the tumours at presentation (26 (92.9%) of those who proceeded to elective resection were staged as T3 and above) rather than an effect of the stent insertion.

Conclusion

We believe that these results indicate that in carefully selected patients SEMS as a bridge to surgery in obstructing colonic malignancies is a viable safe alternative. It is evident from the range of reported technical success rates that it is a difficult procedure to perform and should only be undertaken by those deemed competent. The concerns regarding oncological outcomes require further follow-up studies and the results of the CREST study which has as yet only been published in abstract format and awaits longer term follow-up are eagerly awaited[4].

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Clinical Paper

Computed Tomography Scanning for Sternal Wound Infections: A Systematic Review

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Abstract

Background

Sternal wound infection (SWI) has always been a significant risk in patients who undergo sternotomies as part of their cardiac surgical procedures. Computed tomography (CT) imaging is often used to diagnose and assess sternal wound infections. Its purpose includes identifying and locating infection and any sternal dehiscence.

Methods

A systematic literature review across PubMed, Embase, and Ovid was performed according to PRISMA guidelines to identify relevant articles that discussed the utility of CT scanning for SWI, common features identified, patient outcomes and sensitivity/specificity (Figure 1).

Results

25 papers were included. 100% (n=25) of the papers were published in peer-reviewed journals. CT scans in SWIs can be seen as a beneficial aid in diagnosing as well as determining the components of infection. Commonalities were identified such as fluid collection in the mediastinum, free gas, pleural effusions, and sternal dehiscence which point towards the presence of sternal wound infection.

Conclusion

CT scanning is a novel and emerging methodology for imaging in SWI and post-sternotomy complications, hence increased research is required to expand the literature on this area as well as the creation of guidelines and cut-offs or signs for radiology professionals to identify and determine the extent of infection.

Introduction

Sternal wound infection (SWI) has always been a significant risk in patients who undergo sternotomies as part of their cardiac surgical procedures. SWIs are classified into superficial sternal wound infection (SSWI) and deep sternal wound infection (DSWI). SSWIs usually affect the skin, subcutaneous tissue, and pectoralis fascia and are often eradicated with intravenous antibiotics and proper wound care of the surgical site.[1]

For the purpose of this paper, the focus will be on DSWIs. DSWI, also known as mediastinitis, is a fatal complication of cardiac surgery since it is associated with a high morbidity and mortality rate.[2] The incidence of DSWIs ranges between 0.3% and 8%, and the mortality rate ranges from 19% to 29%.[3] Patients with DSWI deteriorate and die two times faster than those without mediastinitis. Risk factors associated with the development of DSWIs include obesity, diabetes, chronic obstructive pulmonary disease, tobacco use, osteoporosis, prolonged intensive care unit stays, redo sternotomy, and use of assist devices. After surgery, many surgical wound sites are infected with endogenous pathogens. DSWIs usually present with local or systemic signs of infection, such as chest pain and wound discharge. As a result of this, patients with DSWIs stay an average of 20 additional hospital days and have an increased financial impact in comparison to those patients with uncomplicated postoperative stays at the hospital.[2]

Computed tomography (CT) imaging is often used to diagnose and assess sternal wound infections. According to Hosokawa et al., the sensitivity and specificity for mediastinitis diagnosis were 100% and 92.3% respectively.[4] Its purpose includes identifying and locating infection and any sternal dehiscence. This along with other clinical signs like elevated leukocyte levels, C-reactive protein and temperature help clinicians decide on further treatment of the patient.[5] This study aims to delineate the use of CT scans as a

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clinical assessment tool for sternal wound infections.

Methods

3.1. Search strategy

A comprehensive literature search was performed on PubMed, Embase, and Ovid, identifying articles that discussed the role of computed tomography scans in sternal wound infections following surgery in accordance with Preferred Reporting items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.

Search items used included "computed tomography", "mediastinitis", and "sternal wound infection". A staged literature search was performed, and relevant articles were cited and referenced. All identified articles' reference lists were analysed for additional studies. All relevant articles were screened; the results are summarized in a narrative manner within the text of this review, with a summary table provided (Table 2).

3.2. Inclusion and exclusion criteria

All studies discussing the role of CT imaging in sternal wound infection were included. Studies discussing both superficial and deep sternal wound infections were included. Editorials, consensus documents, commentaries, case series of less than three patients, literature reviews, and studies not in English were excluded

3.3. Data extraction

All articles were screened by at least two authors at each stage and any disagreement was reach by consensus or involvement of a third author (CD, MMS). Data was extracted by four authors and validated by two authors.

3.4. Quality assessment

The quality of each publication was evaluated using the Newcastle-Ottawa scale (Table 1). Thisreview addressed key domains depending on the representation of patients with SWI, the role of CT scan, and follow-up assessments.

3.5. Statistical analysis

It was not possible to conduct an appropriate meta-analysis due to limited research data among the studies on this subject.

Results

25 papers were included. 100% (n=25) of the papers were published in peer-reviewed journals. The range of years published was 1996-2020. All articles were original research papers, with one being a conference abstract. 20% (n=5) papers were based on work conducted in Japan, 32% (n=8) from the USA, 12% (n=3) from Germany, 8% (n=2) from Israel, and 1 paper each from Canada, the UK, France, Iran, Sweden, Greece, and Spain. No population databases were analysed in any of the included studies. The majority of studies were conducted on records of surgical in-patients who had undergone a sternotomy and then developed an SWI, though a few (n=2) were based on data from emergency departments/ICU.

For the purpose of this systematic review, 25 papers were reviewed and chosen to identify the role of CT scans in detecting sternal wound infections after cardiac surgery. The extraction process looked at whether or not the papers were chosen provided details regarding the following domains – the total number of patients included; patients with sternal wound infection included; the number of patients with sternal wound infection undergoing CT scanning; context/ role of CT scan use; Population studied: age (mean & range) and gender (%M); diff. between CT scanner and other pts. (& p-value); Presentation(s) of sternal wound infection as reported by paper: symptoms, signs, investigation results.

The role of CT scan imaging was utilised to further evaluate for the presence of either pulmonary or pericardial fluid collections, copious collection of infection under the surgical site, sternal instability, and wound dehiscence both preoperatively and postoperatively. According to Francel and Kouchoukos[6], a CT scan is indicated only if the sternum is stable. However, the majority of the papers used CT scan imaging to identify infections and wound dehiscence as mentioned above. According to Spiess[7], the authors suggest thoracic CT scan scanning as a non-invasive means of clinically demonstrating osteomyelitis of the sternum. The age range of the patient population included across 20 papers was patients above the age of 60 years. The remaining 5 papers focused on patients below the age of 50 years and 2 papers out of the 5 focused on the paediatric population (Takahiro Hosokawa; Joseph Philip). The patients mentioned across the 25 papers presented with a variety of signs and symptoms of SWIs like having a discharging sinus, superficial erythematous wound infections, respiratory distress, fever, chills, leucocytosis, and sternal pain.

Depending on the severity of infection, patients either required admission or managed as an outpatient. In the prospective study of 350 patients by Francel., patients with a stable sternum (either deep or superficial) were treated in the outpatient department. This was done via local therapy using Vacuum Assisted Closure (VAC). Rewiring and/or reconstruction of the sternum was done for patients with an unstable sternum and a deep wound. Chronic sternal wound infection patients reported by Read et al all needed to be readmitted to the hospital for reconstructive surgery (8). Similarly, all of the patients included in the study by Gur et al have required admission for reconstructive procedures.[9]

Very few (n=2) papers mention any long-term complications for sternal wound infections. Read et al reported clinical resolution of all the patients reported with no long-term complications (8). Just like any surgical procedure involving significant dissection under the skin, Francel reported that a large proportion of patients complained of a numb chest

Table 1. Newcastle-Ottawa scale table

Author	Selection				Comparability	Outcomes		
	Representation of patients with SWI	Selection of patients with SWI based on CT scan	Ascertainment of exposure	Demonstration that outcome of interest was present at start of study	Reporting of SWI = * Reporting of SWI based on CT scan = *	Assessment of outcomes	Follow-up long enough for outcomes to occur	Adequacy reporting of outcomes
Yamashiro T et al.[13]	*	*	*	*	**	*	*	*
Jolles H et al.[19]	*	*	*	*	**	*	*	*
Hacibaramoglu M et al.[29]			*	*	*	*	*	*
Apter S et al.[27]			*		*	*	*	*
Gur E et al.[9]		*	*	*	*	*	*	*
Quirce R et al.[18]	*	*	*	*	*	*		*
Hosokawa T et al.[20]		*	*	*	*	*	*	*
Yamaguchi H et al.[12]		*	*	*	*	*		*
Abugameh A et al.[10]			*	*	**	*	*	*
Tamiya E et al.[23]			*	*	*	*	*	*
Francel TJ et al.[15]	*	*	*	*	**	*	*	*
Snyder C et al.[11]	*		*	*	*	*		
Spiess A et al.[7]	*		*	*	*	*	*	*
Cowan K et al.[14]	*	*	*	*	*	*	*	
Philip J et al.[30]	*		*	*	*	*		*
Read C et al.[8]	*	*	*	*	**	*	*	*
Stacy G et al.[28]	*	*	*	*	**	*	*	*
Jacobson J et al.[24]	*	*	*	*	**	*	*	*
Foldyna B et al.[17]	*	*	*	*	**	*	*	*
Hariri H et al.[22]	*	*	*	*	*	*	*	*
Banazadeh M et al.[16]	*	*	*	*	*	*	*	*
Bitkover C et al.[5]	*		*	*	**	*	*	*
Misawa Y et al.[21]	*	*	*	*	*	*	*	*
Exarhos D et al.[25]	*	*	*	*	*	*	*	*

Abbreviations: SWI: sternal wound infection; CT: computed tomography

Table 2: Summary of the literature analysed in this review

Study Title	Clinical Presentation of Patients	CT Imaging Findings	Hospital Stay	Mortality	Recurrence
Hosokawa T et al. (2020)[4]	N/A	CT findings of sternal destruction and capsular ring enhancement were seen in patients with mediastinitis	N/A	N/A	N/A
Bitkover C et al. (1999)[5]	N/A	Prospective group: clinically uneventful healing. Retrospective group: positive predictive value of CT for mediastinitis was 0.71. Of the 20 instances of mediastinitis, only five showed on CT, a sensitivity of only 0.25.	N/A	N/A	N/A
Francel T et al. (2004)[6]	SSWIs present 10-30 days post-op: local tenderness, erythema, fever, chills, lethargy, leucocytosis, ongoing chest pain, and general signs of sepsis.	CT scans show the expected signs of mediastinal collection with air fluid levels. In late presentation, CT scans in these patients are particularly helpful because they define involvement of the bone and soft tissue	11 days (7-15 days).	3.4% of reconstruction patients. 1-year mortality: 9%, (19 patients).	N/A
Read C et al. (2015)[8]	A: 4-6wks post-op; discharging sinus over the sternum. B: two draining sternal sinuses; one on the inferior end of her sternal scar and the other on the left inframammary fold approximately 5 cm from the midline. C: 6 months post-op;	A: Infected wound PET-CT showed a residual nidus of infection deep to the sternum and to the left second/third costal cartilages. PET-CT was essential in this case in locating the new focus of infection that was not clinically apparent. B: The area of residual infected musculoskeletal tissue was delineated using a PET-CT scan, and this demonstrated sternal infection, with right seventh costochondral cartilage involvement and a large seroma cavity on the left side. C: PET-CT allowed more comprehensive pre-operative planning before debriding the sternal wound.	N/A	29%	N/A
	after three debridements by the cardiothoracic team, patient referred to the plastics surgery team with wound dehiscence and multiple discharging sinuses				
Gur E et al. (1998)[9]	Infiltration of parasternal soft tissues.	CT scan was able to show different components of infection. Stage 1 infection shows infiltration of parasternal soft tissues; stage 2 shows bony debris, local soft tissue involvement, fluid air bubbles, fatty tissue infiltration; stage 3 shows sternum external plate bone resorption; stage 4 infection shows irregularity of both sternal plates with some infiltrate of retro-sternal fat, can also see signs of costochondral infection at this stage; and stage 5 shows oedematous and infiltrates under the sternum - deep infection.	N/A	N/A	N/A
Abugameh et al. (2013)[10]	N/A	N/A	Mean inpatient time was 7.0 +/- 4.2 days.	5.81%	N/A
Snyder C et al. (2009)[11]	N/A	CT of the chest confirmed sternal dehiscence in the setting of low-grade mediastinitis.	7 days – Sternal plates. 8 days – Sternal wires.	1: Sternal plates. 2: Sternal wires.	N/A
Yamaguchi H et al.	Purulent discharge was found from the mid-line wound in 4 patients	CT findings included mediastinal soft tissue mass with contrast enhancement containing fluid collection, bilateral pleural effusion, free gas appearance in 4, and sternal dehiscence or destruction in 2	N/A	4.878%	14.63 % (6 patients out of 41

(2001)[12]	and from the drainage tube in the retrosternal space in 2 patients.	patients. Soft tissue mass with contrast enhancement suggestive of abscess formation, bilateral pleural effusion, and free gas may indicate infectious mediastinitis. On the other hand, a CT which did not appear to be suggestive of mediastinitis showed only high-density fluid collection around the drainage tube in the retrosternal space and minimal free gas. CT was not indicative of sepsis and surgical re-exploration was required.			patients required redo sternotomy) .
Yamashiro T et al. (2008)[13]	N/A	CT findings in the early group included mediastinal fluid collection, free gas bubbles, lymphadenopathy, increased attenuation of mediastinal fat, pericardial effusion, pleural effusion and parasternal fluid collection, the late group had all the above CT findings as well as sternal destruction and sternal dehiscence.	N/A	N/A	N/A
Cowan et al. (2005)[14]	N/A	CT detected fluid collections in 73% of patients.	Preoperative stay days - 1.2 +/- 0.7	4%	N/A
Banazadeh M et al. (2011)[16]	Tonsillar abscess, neck effusion and respiratory distress.	CT scan was performed which showed fluid concentration in the medial mediastinum. CT scans showed air and fluid collections in medial and superior mediastinum up to the carina.	Mean hospital stay-24 days.	N/A	N/A
Foldyna B et al. (2019)[17]	N/A	Free gas and pleural effusions were nearly twice as common in patients with mediastinitis.	N/A	N/A	N/A
Quirce R et al. (2002)[18]	Fever, raised leukocyte count, sternal pain	SPECT showed well defined foci in patients with mediastinal abscess, with uptake if high intensity. Patients with retrosternal abscesses also had intense mediastinal foci that was picked up by SPECT.	N/A	N/A	N/A
Spiess AM et al. (2007)[7]	N/A	CT scan aids in the initial inspection prior to debriment. Intact, otherwise healthy appearing sternal bone at the time of initial debridement would warrant a thoracic CT interpretation of bone involvement for assistance with the diagnosis of sternal osteomyelitis.	N/A	N/A	N/A
Hariri H et al. (2019)[22]	N/A	72 were diagnosed with a SWI including mediastinitis, sternal osteomyelitis, costochondritis, and vascular graft infection.	N/A	N/A	N/A
Jolles H et al. (1996)[19]	Sternal instability, erythema, purulent discharge, clinical judgement alone	Primary mediastinitis CT findings showed mediastinal fluid collections and air collections. Secondary mediastinal CT findings included mediastinal edema, pericardial fluid, sternal abnormalities, high-attenuation streaks in the parasternal fat.	N/A	N/A	N/A
Misawa Y et al. (1998)[21]	11 patients with mediastinitis had high fever and leukocytosis associated with high levels of C-reactive protein. Supraventricular arrhythmia developed in 8 of them, and 8 patients experienced appetite loss.	Bilateral pleural effusion and mediastinal soft tissue swelling were seen. In the control group, no pleural effusion was recognized in 3 patients, unilateral pleural effusion in 6, and bilateral effusion in 1. An oval or round mass was seen in both groups. Sternal dehiscence, sternal erosion, and subcutaneous fluid accumulation were observed in the mediastinitis group alone.	2-3 weeks.	N/A	1.385%
Jacobson J et al. (2015)[24]	N/A	Patients with SWI have greater percentage of sternal asymmetry	N/A	N/A	N/A
Tamiya E et al. (2011)[23]	N/A	CT scans clearly visualize sternum cross-sections	1.5 months.	N/A	N/A
Exarhos D et al. (2004)[25]	N/A	Computed tomography has been regarded as the imaging modality of choice for the evaluation of suspected esophagopleural fistula because the site of communication between the two can often be seen	N/A	N/A	N/A

Apter S et al. (2002)[27]	N/A	N/A	N/A	N/A	N/A
Francel T et al. (2001)[15]	Majority infections are superficial. Patients present with local tenderness, erythema, or drainage. Fever, chills, leukocytosis may suggest systemic involvement and deeper infection.	Preoperative evaluations included computed tomographic (CT) scans, testing for sternal stability, and the level of contamination. Intraoperative evaluations included bone, inflammatory tissues, Gram stain, and cultures.	N/A	25%	N/A
Stacy G et al. (2014)[28]	N/A	N/A	N/A	N/A	N/A
Hacibara moglu M et al. (2012)[29]	N/A	N/A	N/A	N/A	N/A
Philip J et al. (2018)[30]	N/A	1 patient in the 5-day group had a positive chest CT showing a sternal abscess and none in the 2-day group. There were no cases of mediastinitis in the entire cohort.	N/A	<1%	N/A

CT- computed tomography; SSWI- superficial sternal wound infections

following reconstructive surgery. There were also no reports of shoulder weakness following the procedure. Most rewire and reconstructive patients were able to do their previous hobbies. In addition, over two-thirds of them were able to return to the same profession before the surgery. Francel et al. reported that only a few patients found themselves disabled following sternal wound infection.[6]

Most of the included studies (n=20) have not reported any mortalities following sternal wound infection. Within the papers that reported deaths, most of them are due to unrelated reasons and not due to their wound infection.[1, 5, 5] Abugameh et al mention the death of one patient due to uncertain cardiac causes.[10] In addition, one of the six patients reported by Yamashiro et al died due to septic shock following mediastinitis.[13]

Most papers mention fluid collection in the mediastinum and free gas in the CT findings of mediastinitis patients.[12-20] Authors from Cowan et al have identified fluid collections in CT findings of 73% of deep sternal wound infection patients.[14] Banazadeh et al have reported air and fluid superior and medical mediastinum till the Carina.[16] CT findings of bilateral pleural effusion and free gas usually indicate infectious mediastinitis. Unfortunately, Yamaguchi et al.have identified a patient where the radiological findings were not pathological, but they were suffering from septic symptoms (following surgical exploration, a large amount of pus was found in the mediastinum).[12] Sternal dehiscence is another complication often confirmed by CT imaging.[6, 7, 11, 12] Misawa et al have identified dehiscence in only the infectious mediastinitis group and not the control group.[23] CT scans findings also show if the bone or soft tissue is involved, especially in a late presentation of sternal wound infection.[6] A thoracic CT scan of bone involvement may indicate a diagnosis of sternal osteomyelitis.[21] A PET-CT scan was used on patients presented by Read et al and allowed the determination of the extent of sternal osteomyelitis. Subsequent scans have helped highlight a newly infected portion in an area that was not affected.[8]

In terms of sensitivity and specificity of CT scans in relation to SWIs reported within the multiple papers reviewed, it was found that in the studies conducted by Spiess A, Istanbullu T, Brown P et al. and Hariri H, Tan S, Martineau P et al. CT scans had a sensitivity of 93% and specificity of 85-96% in identifying osteomyelitis of the external and/or internal sternal plate and a sensitivity of 91% and specificity of 97% when detecting SWIs, respectively.[17, 21] Similarly, another study has shown a sensitivity of 67% and specificity of 83% in terms of CT being able to diagnose mediastinitis after cardiac surgery.[6] In addition, a study done by Foldyna B, Mueller M, Etz C et al. showed specific sensitivities and specificities of CT scans picking up certain pathologies, for example, it was documented that CT scans ability to identify costochondral infection had a sensitivity of 87.6% and a specificity of 56.9%, in contrast to a sensitivity of 100% and specificity of 35.7% in detecting foreign bodies.[19] Interestingly one study done by Jolles H, Henry D, Roberson J, et al. found that CT had both sensitivity and specificity of 100% in detecting clinical mediastinitis after day 14 post-op in patients who had had a median sternotomy.[19] In contrast to this, a study done by Yamashiro T, Kamiya H, Murayama S et al. showed that after 21 days' post cardiovascular surgery with median sternotomy CT had a sensitivity of 100% and a specificity of 85% in detecting mediastinitis.[13]

Out of the 25 papers that were looked at some detailed the extent of infection, if present. A common recurring statement was that an unstable sternum usually indicates a deeper

infection, like mediastinitis.[6] Other studies mentioned seeing soft tissue masses in their patients, most probably abscesses as well as bilateral effusions, and free gas may also indicate infectious mediastinitis.[12] Interestingly, one study by Gur E et al. also categorized SWIs into categories. For example, stage 1 infections encompassed showing infiltration of presternal soft tissues.[9] In relation to the timeline of illness and outcome of patients within the 25 papers looked at it was found that some patients recovered and had subsequent follow up.[8] In contrast, a study done by Yamashiro T, Kamiya H, Murayama S, et al. found that one patient with mediastinitis died from septic shock.[13]

In regard to other treatment options looked at for patients within this review, it was found that antibiotics were a common occurrence within studies (6, 9, 13, 14, 20). Studies done by Francel T as well as Cowan Ket al. used vacuum-assisted closure (VAC) of SWIs as well as wound debridement.[6, 14] In contrast, studies done by Misawa Y,and Yamaguchi Het al. mentioned redo surgical intervention with other studies also mentioning using muscle flaps as the main mode of reconstruction.[12, 22] When analyzing post intervention morbidity or mortality one study conducted by Francel T. found that 3.4% of reconstruction patients who had SWIs died in the first 30 days after surgery due to other causes. In addition, all patients were healed at the 6-week follow-up, however, the one-year follow-up mortality was 9%.[6] Similarly, a study carried out by Yamashiro T, Kamiya H, Murayama S et al. showed that one patient with mediastinitis did die four days after having a CT scan, despite having a redo operation, due to septic shock.[13]

The use of multivariable analysis was also assessed within the 25 papers. P values were mentioned in a few studies for different variables. For example, a study by Tamiya E, Asakawa M, Shibamoto M et al. showed a p-value less than 0.01 for operative pain in patients with misalignment of the sternum, as compared to an aligned sternum, while other studies portrayed a p-value of 0.32 for positive infection seen on CT.[7] Interestingly, one study conducted by Jacobson J, Doscher M, Rahal W, et al. found that diabetes mellitus, as well as the degree of asymmetry, significantly increase the risk of sternal infections, with an odds ratio of 3.3 and 3.5 respectively. This corresponded to a p-value of 0.044 for diabetes and a p-value of 0.029 for the degree of asymmetry.[23] Only one study stated any confounders that were controlled for. Snyder C, Graham L, Byers R, et al. made sure to investigate temporal trends in length of stay to make sure changes in postoperative management overtime was not confounding with their results.[4] It was found that the length of stay was not confounded by time trends over the study period.[11]

By evaluating all 25 papers multiple benefits while using CT scan in relation to SWIs could be seen. One paper concluded that less invasive methods can be used to investigate osteomyelitis in sternal wounds. Instead of using a bone biopsy, a thoracic CT scan can be used to clinically demonstrate osteomyelitis in the sternum.[7] Other studies concluded that VAC is an appropriate adjunct to treat postoperative wound infections after a median sternotomy.[14] Contrastingly, two studies also showed that a CT scan was not a satisfactory way to diagnose mediastinitis, with one study focusing particularly on mediastinitis following cardiac surgery.[5, 12] Other studies focused on how flap reconstruction can have excellent outcomes in patients with mediastinal defects, due to a more correct diagnosis and knowledge of early healing.[15] Another study found correlations between asymmetric sternotomy and SWIs, hence prompting the recommendation of assessing sternal asymmetry in patients with SWIs, and if this is greater than 10% the surgeon should stabilize the sternum.[23] Moreover, two studies also concluded that CT was not useful in the early postoperative phase, but rather useful in the later phase, after 14 days and 21 days postoperatively, respectively.[13, 19]

Discussion

This systematic review found a number of research papers discussing the emerging utility of CT scanning in potential sternal wound infection. CT scans in SWIs can be seen as a beneficial aid in diagnosing as well as determining the components of infection.[8, 9, 17, 18, 20, 21, 25] Thoracic CT scanning was seen to be an appropriate and noninvasive method of demonstrating osteomyelitis of the sternum or mediastinitis. Studies also reported multiple CT findings associated with SWIs including free gas, pleural effusions, capsular ring enhancement, mediastinal soft tissue swelling, and sternal erosion.[17, 20 ,22] One paper also detailed an evaluation and treatment pathway for sternal wound problems after sternotomy and possible treatment routes that could be taken.[15] The quality of each publication was evaluated using the Newcastle-Ottawa scale. Quality assessment of the published literature depended on the representation of patients with SWI, the role of CT scan, and follow-up assessments.

Some studies reported a high degree of sensitivity and specificity of CT scans for identifying SWIs. In contrast, two studies disagreed with using CT as a way to diagnose mediastinitis due to low sensitivity percentages as well as a high number of false positives in their study. [5, 12] Moreover, CT was found to be a beneficial tool when it comes to assessing postoperative SWIs.[13, 19] It was also acknowledged that even though PET-CT imaging has been reported in the past to be of benefit in managing presentations of infective musculoskeletal cases that undergo surgical debridement and reconstruction, the literature remains limited in this area.[8] Studies went on to conclude that CT was useful in diagnosing SWIs and of benefit in the recent surgery setting, as well as giving imaging scores based on patterns of FDG uptake which allows for a more accurate diagnosis to take place.[21]

Ultimately, CT scans have been shown to aid in the diagnosis of SWIs and improve patient outcomes in most

cases, however, they should be used in adjunct with surgery, appropriate antibiotics, and clinical guidance to ensure safe and effective resolution of SWIs. In current health care systems, CT and MRI have been deemed valuable in defining mediastinal abnormalities and finding the source of descending infections.[26] The literature has shown that interpretation based on patterns identified in imaging yields a high sensitivity without compromising the specificity, and this is independent of the timing between the operative procedure and imaging.[2, 21] Since clinical signs of sternal wound infection are typically non-specific, imaging has an important role, hence it is important for radiologists to be aware of the findings in SWI.

This systematic review was methodologically robust and used two reviewer screening at each stage to minimise the impact of human and other errors and increase reliability. It was, however, limited by the lack of existing literature in the area, with only 25 papers suitable for inclusion. Furthermore, in a number of cases, useful data such as the study design characteristics and demographics of patients were not reported. Since many of the studies were in a surgical setting it may have been biased toward patients with more severe SWI hence overestimating the utility of CT scanning. Out of the 25 papers that were reviewed it was evident that 13 papers had included a patient population of less than 100 people. The papers by Francel TJ, Apter S, and Eyal Gur et al. only included the patients that had sternal wound infections as that was the main focus of their papers.[6, 9, 27] In addition to this, only 14 papers out of the 25 had their entire patient population undergo CT scanning to diagnose SWI whereas in the remaining patient populations only a few patients and not all patients who had SWIs underwent CT scan imaging. On analysing these 25 papers further, it was evident that the majority of the patients included in the studies in these papers were males, leading to the question of inherent selection bias.

CT scanning is a novel and emerging methodology for imaging in SWI and post-sternotomy complications, hence increased research is required to expand the literature on this area as well as the creation of guidelines and cut-offs or signs for radiology professionals to identify and determine the extent of infection. CT scans can show different parts of the infection along with foreign bodies which are retained. Radiological classification (along with the location of the infection) allows for appropriate treatment and relevant reconstructive surgery. In the future multimodal imaging and the advent of three-dimensional ultrasound scanning for example may prove to be useful in this area.

Conclusion

CT scanning is a novel and emerging methodology for imaging in SWI and post-sternotomy complications, hence increased research is required to expand the literature on this area as well as the creation of guidelines and cut-offs or signs for radiology professionals to identify and determine the extent of infection. CT scans are able to show different parts of the infection along with foreign bodies which are retained. Radiological classification (along with the location of the infection) allows for appropriate treatment and relevant reconstructive surgery. In the future multimodal imaging and the advent of three-dimensional ultrasound scanning for example may prove to be useful in this particular area.

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Clinical Paper

Perceptions towards Nephrology Specialty: The Good, the Bad and the Ugly

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ABSTRACT

Background: There is a decline in the interest in pursuing a career in nephrology globally as well as locally in Northern Ireland. There is also an expansion in the burden of kidney disease worldwide due to a combination of factors like higher detection rates, increase in population size and improved life expectancy. Workforce shortages in nephrology have a direct impact on provision of care for people with kidney disease. Understanding perceptions among doctors towards nephrology is an important factor in acknowledging the barriers in recruitment and advocating evidence based changes to improve current practices.

Aim: The aim of this study is to explore both the positive and the negative perceptions among medical students and trainees towards nephrology as a specialty in order to understand the factors that are most influential in either choosing or forgoing a career in nephrology.

Methods: Scoping review methodology was used to address the research question through a phenomenological lens. Sixteen articles were included that studied the perceptions towards nephrology mainly through questionnaires and also through direct quotations. Basic numerical analysis and content analysis was completed.

Findings: A total of 3745 participants including medical students, trainees and consultants participated in the 16 studies were included in this review at an international level. Most of the studies used survey (questionnaire) as their methodology (n= 10). The seven themes that emerged to describe perceptions towards nephrology were exposure to specialty; complex specialty; mentorship; work- life balance; financial compensation; personal interest; and procedural component. Exposure to specialty was the most influential factor in future career choice decision. The other factors that could improve recruitment in nephrology include innovative and novel teaching methods, good role models, flexible training and working patterns, and adequate financial remuneration.

Conclusions: In order to rekindle interest in nephrology we need a multi-pronged approach based on ensuring early exposure to the specialty, good mentorship, holistic clinical experience covering different aspects of the specialty and the opportunity of flexibly moulding one's interests and skills whilst ensuring service provision, and with an emphasis on adequate financial remuneration.

Key words: Perceptions, Nephrology specialty, medical students, trainees.

INTRODUCTION

Burden of Chronic Kidney Disease

Chronic kidney disease (CKD) is one of the commonest non-communicable chronic diseases worldwide and a key marker of poor health outcomes in the general population.[1] Its presence also predicts several fold increase in all-cause and cardiovascular mortality.[2, 3] There has been an exponential rise in the incidence of people diagnosed with CKD with current estimates suggesting between 8 and 16% of the world's population affected.[4] Consequently the prevalence of people receiving treatment for end stage kidney disease (ESKD), the most advanced form of CKD, continues to increase globally. In the UK, the annual incidence of end stage kidney disease in adults is around 154 per million population[5]. This incidence has substantially increased over the past decade and is expected to continue to rise by 5-8% annually.

The reasons for the global rise in the burden of CKD are multifold and could be attributed to factors like improved awareness among primary care practitioners and within the general population leading to higher detection rates, rise in the population size and greater life expectancy. There also is a significant contribution of the global epidemic of type 2 diabetes which has led to the exponential rise in the incidence of kidney disease.[6] There is hence an urgent need for a proportional increase in the number of doctors and nurses within the specialty of nephrology to cope with this rising demand.

Nephrology Workforce Shortages

Amidst the rise in the prevalence of CKD, there is a global shortage of nephrology workforce having a significant adverse impact on meeting the growing healthcare needs

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of this vulnerable population.[7] This shortage is equally seen both in the developed world and the developing nations. [8-14] It has been predicted that if these workforce shortages are not addressed, the delivery of care to people with CKD may be severely compromised in many parts of the world.[9] There is hence an urgent need to focus on developing strategies to improve recruitment and retention within the specialty of nephrology worldwide.

Future Nephrology Workforce: Training and Recruitment

One of the key reasons for the shortages in the current nephrology workforce is the decline in interest among medical students and trainees in pursuing a career in nephrology.[15-18] In the USA there has been a significant decrease in nephrology training posts fill rates from 94.8% in 2009 to 59.8% in 2016.[19] Similarly in the UK the fill rate in nephrology has fallen from 100% in 2013 to 74% in 2017.[20] Understanding the perceptions among prospective applicants towards nephrology would be a good starting point to acknowledge the deficiencies in the current practices and recognize the barriers that need overcome to successfully improve recruitment. It is also equally important to identify these perceptions during the formative years of career development, which have a strong influence on future career choice decision.

Aim

This study aims to explore the perceptions among medical students and trainees towards nephrology as a clinical specialty. It specifically aspires to understand what drives medical students and trainees towards either choosing or forgoing a career in nephrology.

METHODS

This study used both phenomenology and scoping review methodologies as tools to explore the perceptions of doctors towards nephrology specialty. All 5 steps of scoping review methodology were undertaken including (1) Defining the research question, (2) Finding relevant articles, (3) Study selection, (4) Charting the data, and (5) Collating, summarizing and reporting results. To ensure rigor within this study the researchers adopted principles of reflexivity prior to and during the qualitative analysis process.

Search strategy

Five literature databases were selected to cover international literature published across the multiple disciplines of medicine, nursing, art and humanities, allied health fields and social sciences. These included Ovid MEDLINE, EMBASE, Scopus, CINHAL Plus and Web of Science. Five additional articles were identified through listed citations in the searched articles. Internet search and grey literature search were sourced and 2 articles were obtained.

Eligibility criteria

Inclusion criteria

We included any articles with empirical research or syntheses of existing research where: (1) Perception towards the specialty of Nephrology as a career choice was described. (2) The study group were medical students, post-graduate trainees and/or consultants. (3) Articles published between the years 2000 and 2020. The rationale was to capture most recent trends and behaviors, as articles published before the year 2000 could have an undesirable influence on the research findings and might not be relevant to current practices within the specialty.

Exclusion criteria

Any papers exploring the perceptions of patients and allied healthcare staff from various disciplines towards nephrology were excluded. As the primary focus of this study was to evaluate the challenges with recruitment, it was felt to limit the study group to medical students and doctors in training, who are the prospective applicants to the specialty.

We also excluded papers exploring the quality of training in nephrology and looking at the effectiveness of training programs as their predominant impact is on future practice and competencies which was felt beyond the scope of this review.

Data Charting

Data was extracted from each article by a single reviewer and was charted using headings including author(s); year of publication; journal of publication; study location (country); aims of the study; participants; methods; and methodology.

Data synthesis

We used conventional qualitative content analysis to analyze quotations and questionnaire responses. [21] These responses were reviewed in detail and text capturing key concepts was highlighted. Our initial thoughts and reflections were also noted. We subsequently allowed codes to emerge directly from quotations and responses. The related codes were then grouped into sub-categories. Finally, the related sub-categories were organized into larger themes.

We used Microsoft Excel to complete basic numerical analysis of the charted data from 16 selected articles. Formula functions were used to produce graphical illustrations.

RESULTS

From our initial and updated searches we identified a total of 396 potentially relevant articles.

After 183 duplicates were removed, 213 titles were screened and 81 full-text studies were chosen for a more detailed review. Sixteen studies were identified as meeting our criteria and relevant to our review question.[8, 11, 17, 19, 26-28, 30, 32, 33, 35, 37-41] An overview of the study selection process and reasons for exclusion are provided in Figure 1.

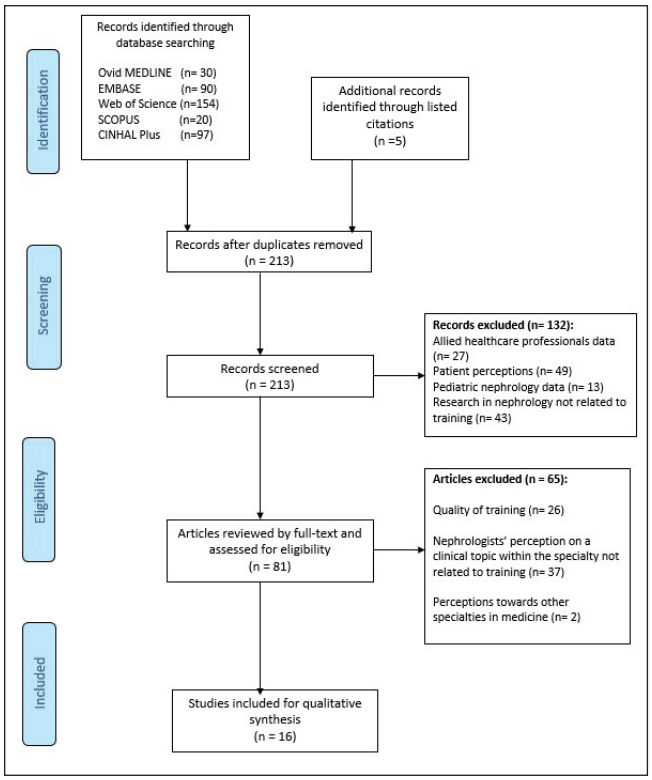

Figure 1: Flowchart outlining the study selection process

Dates and Origin of Studies

The year of publication ranged from 2008 to 2019. Figure 2 demonstrates a rising trend in the number of publications between 2017 and 2019, indicating an increasing research interest in recent years. Publications originated predominantly in 4 countries. Of the 16 publications, 11 originated from United States of America (USA), 3 from United Kingdom (UK) and 1 from Ireland and Australia respectively. Majority of articles were hence from USA (70%) followed by UK (20%).

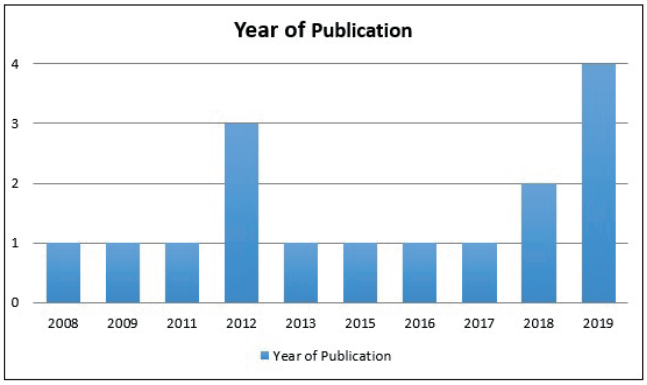

Figure 2: Year of publication

Number and Professional Grade of Participants

3745 participants in total were noted in the included studies. Figure 3 illustrates the total number of participants in each study. The number of participants per study ranged from 10 to 913. Four studies included over 500 participants and three

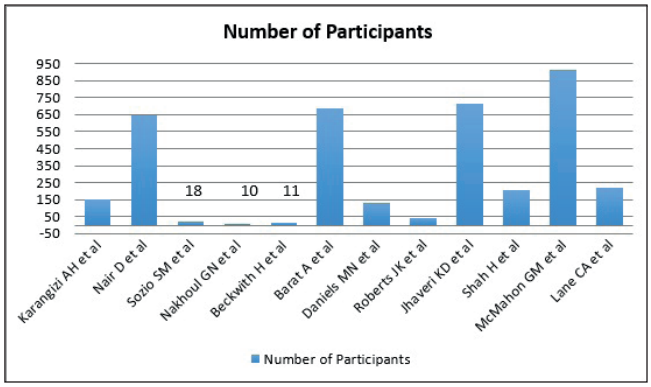

Figure 3: Number of Participants

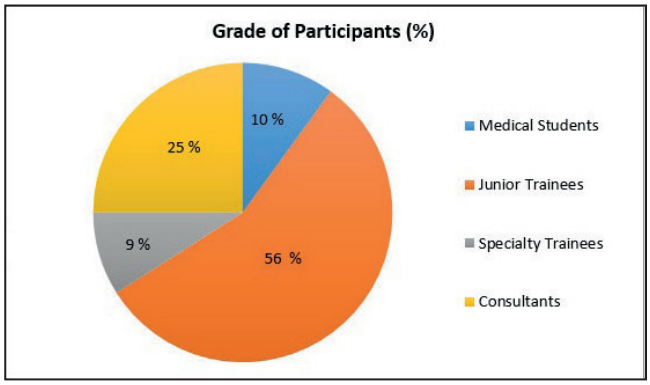

Figure 4: Professional Grade of Participants in percentage

studies included less than 20 participants. Figure 4 illustrates the grade of the participants included in various studies. The majority of participants were junior trainees (56%; n= 2109). This cohort comprised doctors who are in years 1 – 5 after graduation (Foundation trainees and Internal Medicine trainees in UK and Internal Medicine residents in USA). Doctors undergoing post-graduate training in Nephrology (Specialty Trainees in UK and Nephrology Fellows in USA) formed the minority group (9% n=340).

Methods and Methodologies

All studies used qualitative methods and methodologies as stipulated in the inclusion criteria. Web based questionnaires were the most common method followed by paper-based questionnaires, commentary, semi-structured interviews and focus groups (Figure 5). Survey was the most

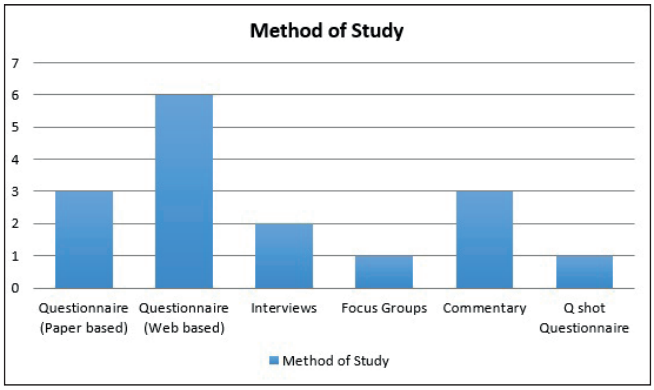

Figure 5: Method of studies

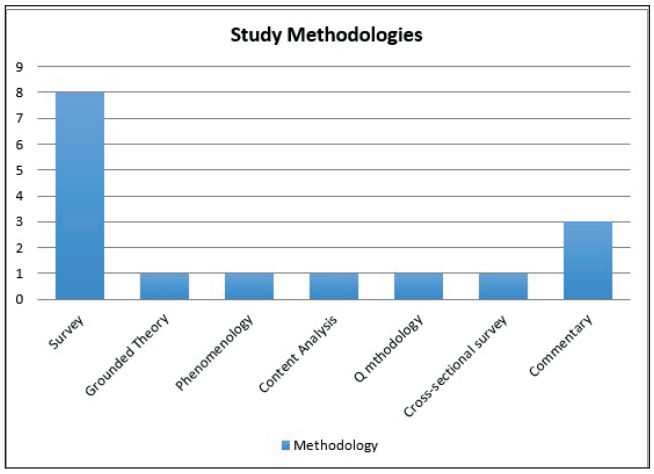

Figure 6: Study of Methodologies

common methodology used followed by grounded theory, interpretative phenomenological analysis and content analysis in equal proportions (Figure 6).

Perceptions towards Nephrology

Seven themes emerged from this review. Exposure to specialty and complex specialty were the most referenced themes with 34 and 33 codes generated respectively. The other themes included mentorship, work-life balance, financial compensation, personal interest and procedural element. Table 1 shows the number of codes and articles used to generate each theme. A total of 164 codes were generated from within 16 articles. Repeated review of quotations and re-organization of codes generated the 7 themes. On average, each theme is coded to 9 articles.

Themes (descending order)	No. Codes	No. Articles referenced to
Exposure to Specialty	34	14
Complex Specialty	33	9
Mentorship / Role Model	28	10
Work-life Balance	24	10
Financial compensation	21	8
Personal Interest	19	9
Procedural Component	5	4
Number of Themes: 7	Total No. Codes: 164	Total No. Articles: 16
		Average no. Articles per theme: 9

Table 1: Numerical Summary of Qualitative Content Analysis on data

We have described each theme below along with a selection of quotations and findings from the studies which best represent the theme. These are included in a box beside each theme.

Exposure to specialty

This was the most referenced theme among the studies. Whilst exposure to specialty was found to be one of the major elements that shaped career choice, lack of exposure was cited as a key reason for not choosing nephrology. Exposure was mentioned in various forms like elective posting during medical school, involvement in research, and clinical experience during postgraduate training posts. We outline some quotations and survey results from this theme.

> *Junior medical officer experience in a specialty was identified by 82% (n=179) as having a 'major' or a 'very major' role in their career choice.*

> *Of those considering a career in nephrology, 83% had past experience in the specialty as a resident or registrar*

> *At our school when I went to the basic sciences, we didn't have nephrology as a course. It was kind of spread throughout all the classes and it kind of varied and so I would say most of it was taught within our pathology course or histology course.*

> *I shadowed nephrology for a day, but I did not rotate through. It was not a part of the medical school curriculum*

> *Students who participated in the program and did some research in renal went on to pick renal as their specialty later on.*

Complex specialty

This was the second most referenced theme. Complexities within nephrology were viewed in various ways and could be further sub-divided into 3 types including subject factors, skill factors and patient factors. Subject factors include difficult pathophysiology and challenging physiology. Skill factor mainly included diverse diagnostic skills required to manage patients in nephrology. Finally, patient factors were perceived as complex very 'sick' patients and patient non-adherence to treatment was also considered as a complexity within the specialty that dissuaded doctors from applying to the specialty.

> *86% (n=129) of respondents felt that nephology specialty is highly complex.*

> *When asked what the participants did not like about their experience in nephrology, the most frequently selected answer was that the care of dialysis and transplantation patients was too complicated.*

> *I think nephrology is the one specialty in medicine that offers absolute everything… looking after really sick patients, which I enjoy because of the adrenaline rush and chronic care… You are an absolute specialist and within renal there are many subspecialist areas, but you are also a generalist, you often are the patient's GP once they have had a transplant or are on dialysis... it encompasses every single part of a medical career, and most specialties don't.*

> *It takes a lot of diagnostic skills. I think that is a very cerebral specialty where you have a lot of personal diagnostic skills involved.*

Mentorship

Having a role model or a mentor was an important component in selecting nephrology as a career choice. Also receiving good supervision in a clinical posting during postgraduate medical training had a positive effect on the future choice of specialty.

Trainees who were able to identify a role model in renal medicine were also more likely to consider a career in renal medicine (38%) compared with those who did not (15%) (P=0.007).

Candidates considering a career in nephrology placed more importance on positive role modeling than did those choosing other physician specialties (t=2.246, d.f. 209, P=0.026).

I made the decision to enter nephrology after exposure to mentors with true passion in the field.

It was the mentors, always. Now I try to be that same positive role model and influence for my students, residents, fellows and junior faculty. That's how we'll keep the pipeline going – through the personal touch.

One of the things that drives them in is the faculty, and I think that faculty and… responsiveness of faculty to-and interest in faculty in-developing the medical students and giving them good experiences is… key of this whole thing. For a student to see themselves as nephrologists, they have to feel as if they could see themselves as a faculty person. So they have to connect to the specialty but more importantly, the faculty member.

A big factor in attracting students and residents to the field of nephrology has been just providing really good teaching from likeable individuals. And I just get a sense that when students try to master the topic that's' when their interest develop.

Work-life balance

Work-life balance was perceived both in the context of positive influence and negative effect on the eventual career choice. The positive perceptions were life-style oriented specialty, vocational flexibility and portfolio careers. Portfolio careers is ability for a specialty to offer the opportunity for development in different sub-specialist areas. The examples described in nephrology were interventional nephrology, academics and research and, transplantation. On the other hand the negative perceptions that were associated with poor work-life balance were heavy workload, stressful work and long hours.

77% respondents (n= 115) considered the workload in renal medicine to be moderate to heavy. Importantly, 65% of respondents considered the work-life balance of their chosen specialty to be very important in decision making, while only 12% of respondents felt that a career in renal medicine was lifestyle oriented.

I am on my second renal month and the days can be long and very stressful. The hours are long, people need emergent dialysis at 2am, and the fellowship is very busy.

The most commonly endorsed negative perceptions of nephrology were life-style factors, including: "Nephrologists must take frequent/ difficult call", "Nephrologists have long work hours", and "Nephrology fellowship requires long hours and burdensome night call."

Financial compensation

Prospective employment and financial compensation were both considered important factors in deciding about future career. When financial remuneration was taken into account, there was a direct comparison made between different specialties and nephrology. Only one UK based study revealed that future financial prospects were unimportant influences.

Nearly one-fourth of the non-nephrology fellow respondents would have considered nephrology if this specialty had a higher income potential (23%, n= 164).

Most respondents agreed nephrology was poorly remunerated (69%, n=96).

Nephrology Fellow: When you see that the residents in your program going for primary care or hospitalists are getting better job proposals and making more money that you it is kind of frustrating

The three top reasons why renal fellows were slightly or not at all satisfied with their career choice included poor income potential after graduation (69.5%, n=142), poor job opportunities (68.3%) and long work hours (54.9%).

Overall financial issues such as 'future financial prospects' and 'financial circumstances whilst training' were perceived to be unimportant influences (UK based study)

A greater proportion of residents considered the availability of post-fellowship job opportunities as a key-driving factor in choosing or forgoing nephrology.

Personal interest

Personal interest in nephrology was influenced by both specialty factors and personal life experiences. The two unique aspects of nephrology as a specialty that kindled interest included long-term physician-patient relationship and multi-disciplinary team working. The attributes those were associated with personal interest included 'enthusiasm', 'commitment' and, 'ability to help others.' Prior personal and family experience with disease and illness also influenced career choice decision. Some negative perceptions regarding the specialty that influenced interest were lack of innovation and research in the specialty.

75.8% (n=154) of respondents (US adult nephrology fellows) found nephrology an interesting subject during medical school or medical residency.

79% (n=508) of participants cited a lack of interest as the most substantial reason to forgo nephrology fellowship training.

The highest percentage of doctors whose first choice of career was nephrology in year 1 (60.7%) and year 5 (81.7%), scored 'enthusiasm / commitment' as having a great deal of influence.

I loved the multidisciplinary side of it, and the teamwork. I did it in the old days, when the unit was quite small, and you actually got to know the staff very well, nurses, dieticians, dialysis nurses, and I liked that approach.

And I really, really enjoyed the fact that there's continuity so you get to know the patients

Procedural component

The procedural component within nephrology was the least common theme in this review. The procedural opportunities within nephrology were perceived both as a positive and a negative attribute.

27.3% of respondents (internal medicine residents) felt nephrology provides few opportunities for procedures

46% indicated that the ability to perform procedures was 'very important' when considering a subspecialty.

DISCUSSION

We have outlined a brief discussion on each of the seven themes identified during this study.

Exposure to specialty

Exposure to specialty is the first step towards letting prospective applicants experience the nature of work that the specialty has to offer. Not surprisingly it therefore has a big influence on the eventual career choice in nephrology.[11] This is not unique to nephrology and has also been shown in various other specialties like geriatrics [23], rheumatology[24] as well as in surgical literature.[25] These studies have also shown that exposure, especially in the early years of training or during medical school, increased students' interest in the specialty. It has also been confirmed that majority of fellows that choose nephrology do so during first 2 years of medical residency training followed by medical students.[26] Hence nephrology should form an essential part of the educational curricula, not only given the potential of generating interest at an early stage but also because of the key role of the kidneys in understanding volume homeostasis and acid-base metabolism which are some of the important concepts in human physiology.

Complex Specialty

The perception of complex specialty was further divided into three different aspects. Firstly, kidney physiology was perceived as complex during medical school years and this perception persists during the postgraduate training years and is further compounded possibly due to lack to exposure to the specialty. Introducing innovative kidney physiology curriculum that used multiple teaching methods, led to an improvement in the attitudes of medical students towards learning.[27] We hence require a combination of enthusiastic teachers and innovative teaching methods to simplify kidney physiology and improve its understanding.

The second aspect of complexity within the specialty is the perception among trainees of very sick and complex patients. One of the reasons behind this could be that most general internal medicine training posts are hospital based and hence most trainees are exposed to very sick and non-compliant renal patients. There therefore needs to be a redesign of the nature of the training posts in nephrology so as to allow trainees to also experience the multidisciplinary management of high functioning end-stage kidney disease patients, renal transplant group and people with low level of kidney function that are approaching end-stage kidney disease. This will allow trainees to get the full breadth of exposure to various other aspects of nephrology specialty that might help in changing perception and generating interest.

The third aspect of perceived complexity within nephrology was the requirement to acquire a diverse range of skills and knowledge. This in fact could be a positive motivator for people choosing a career in nephrology if combined with early and adequate exposure to the specialty and coupled with good teaching. There is a very interesting quote from a participant (Senior House Officer Grade) from a study that highlights this aspect "I wanted to do it (nephrology)... because I wanted to feel I could... And if I felt I could, I would have achieved something."[28]

Mentorship

Mentorship has a strong influence on career choice in all specialties including

nephrology.[17, 29] Medical students and trainees exposed to any specialty are strongly influenced by the attitudes of the senior clinicians and mentors towards teaching and also by the degree of support offered to them. There is also a major impact of the attitudes of senior specialty trainees in nephrology on the perception of junior trainees towards the specialty. There is hence a need to inculcate the importance of good mentorship in the current trainees within nephrology workforce and should be added as a development need to the nephrology training curricula.

Work-life balance

There has been a growing emphasis on work-life balance among trainees when deciding about future career choice. This could mean offering vocational flexibility in training (part- time vs. full time) as well as development of interests within the specialty. Recognition of portfolio careers within nephrology could also form a good intervention to allow consultants within nephrology to branch out into other specialist areas like education, training and research.

There are a few negative perceptions towards nephrology that include heavy workload, stressful and long work hours. One study revealed that 68.7% (n= 627) of US nephrologists surveyed felt their current job was stressful.[30] This being a multi-factorial issue could be partly addressed by filling gaps in employment and focussing on individual support and wellbeing. This was shown in another study which suggested that an efficient way of improving uptake within the specialty is to focus on lifestyle aspects; offering guaranteed holiday time, regularity of work schedule and reduced weekly hours worked.[31] Another potential solution is the promotion of the specialist nurse practitioner role in nephrology. This model has definitely helped in not only sharing the burden of work but also improving patient care in UK. This could be a good model to be adopted in regions where there is an excessive workload and would definitely be a positive influencer in improving recruitment within the specialty.

Financial compensation

This appears to be a significant issue affecting certain countries as reflected in studies conducted in USA and Australia. On the other hand, in the studies conducted in UK future financial prospects were perceived to be unimportant influences.[32] This partly could be a reflection of the differences in the nature of financial remuneration between these regions. As per the 2014 AMGA survey in US, nephrologists' financial compensation was far less as compared to similar work intensity fields like non-invasive cardiology, haematology and oncology. There is hence a need for a discussion with the governing bodies to reflect on financial disparities between specialties in order to improve the update and recruitment into nephrology specialty.

Personal interest

In one survey 92% of participants (n= 592) revealed that personal interest in a specialty was the most influential reason for choosing to pursue it.[33] Personal interests are further influenced by individual's own personality and preferences that are partly based on previous experiences and exposure. This theme of 'Personal interest' would hence lie at the heart of all the other themes with strong influences of each one of them. Therefore, to enable the development of personal interest in a specialty, there needs to be a multi-pronged approach based on ensuring early exposure to the specialty, good mentorship, holistic clinical experience during training covering all aspects of the specialty and the scope of flexibility in moulding one's interests and skills to the development of the specialty; with an emphasis on adequate financial remuneration.

Procedural component

The perceived lack of procedures in nephrology specialty is expected because many nephrologists have ceded certain procedures like dialysis catheter placements and renal biopsies to other specialties (The US Nephrology Workforce, 2015).[34] Given that this was the least popular theme in this survey it would be difficult to interpret whether lack of procedures has a major impact on recruitment within the specialty. Further research is hence required to specifically answer this issue.

Study Limitations

Due to the international nature of the study one can argue that the findings and recommendations might not be generalizable across different regions. However apart from the theme of financial compensation, which varied across different countries, all the other themes were a common feature. Hence the findings from this study could be applicable to all the areas included in this review.

One of the other drawbacks of this study were that majority of the articles studied had survey (questionnaire) as their qualitative methodology (10 out of 16 articles reviewed). The authors acknowledge this heavy reliance on one particular type of methodology. Although few articles did use other types of methodologies including grounded theory, phenomenology and content analysis; this emphasizes the need for employing other methodologies when undertaking future research in this area.

Implications

For Medical Students and Doctors in training

There is a perception of challenging physiology and requirement of diverse skills to manage complex patients in nephrology. Seeking guidance from the teachers in areas that appear challenging might help improve understanding in the subject. Also by discussing difficult cases with senior trainees and consultants might enable the development of confidence and building of knowledge through experiential learning during training.

For Trainers and Educators within Nephrology

The role of trainers and educators within nephrology is pivotal in generating interest within the specialty. There is a need for innovative teaching methods that are catered to the future generation of medical students and trainees. The utilization of Internet and social media in nephrology teaching is key for generating interest in the subject.[35] This includes use of online educational resources like Up-To-Date, YouTube channel like Nephrology-On-Demand, twitter based journal clubs like @NephJC, podcasts like

"Freely Filtered – NephJC" and "ASN podcast" to name a few. Also the use of point of care ultrasound is gaining increased attention for its use across nephrology care and promoting this during training might generate interest within the specialty.[36]

For Deaneries and Training boards

The deaneries could redesign the training curricula in nephrology to allow greater exposure to different aspects of the nephrology specialty. This would enable the trainees to get a holistic view of the specialty and hence address some of the negative perceptions and improve interest and recruitment.

Employing Trust Hospitals and Department of Health

Employing authorities have a key role in ensuring adequate work-life balance among practicing nephrologists by ensuring vocational flexibility and supporting the development of additional interests in different fields like education and training. They can also generate interest in the specialty by avoiding financial compensation disparities between different specialists and providing adequate financial remuneration.

For Practicing Nephrologists

Doctors currently working within Nephrology could increase their participation within training and education; thereby ensuring adequate man power to deliver teaching sessions within nephrology. Being good role models themselves and also promoting the current senior trainees in nephrology to acquire mentorship skills will have a major impact on the popularity of the specialty. Ultimately the future of nephrology will depend on the ability of each nephrologist to help students and trainees love their specialty.

CONCLUSION

This review summarizes both the positive and negative perceptions towards the specialty of nephrology among medical students, trainees and consultants. This should allow stakeholders including training boards, employing authorities, trainers, and practicing nephrologists to acknowledge the deficiencies in the current practices within the specialty. This review particularly emphasizes the need to improve exposure of the medical student and trainee to the full breadth of nephrology services that are offered especially the multi-disciplinary team working and the long-term relationships with people that are unique to the specialty. It also highlights the need to change the perception of nephrology being a 'complex specialty' by developing innovative teaching methods and ensuring adequate exposure to diverse range of conditions within nephrology. This review also stresses the importance of developing good mentorship and supervisory skills among the current practicing nephrology workforce. There is also an urgent need in future to undertake qualitative studies with diverse methodologies in order to improve the quality of research in this area and better understand the challenges faced with recruitment.

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Medical Education

Untapped resource: the simulation-based healthcare environment as a means to study human stress.

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ABSTRACT

The effects of 'stress' within the healthcare professions are wide-reaching, not least of all within the field of simulation-based healthcare education. Whilst this popular method of experiential learning offers a 'safe space' for participants to develop their skillset, it also has a more surreptitious action; namely, the incubation of simulation-related stress. Currently, research concerning the complex relationship between stress, learning, and performance is ambiguous, leaving fertile ground for simulationists to debate what level of stress is appropriate for an optimised educational experience. In this narrative review, we examine the human response to stress and outline the various methods that have been used by researchers to measure stress in a quantifiable and standardised way. We then provide a brief overview of simulation-based healthcare education before describing why stress responses have been of interest to healthcare educationalists for some time. Finally, we outline how simulation education environments might provide an ideal environment for studying the human response to stress generally, with ramifications extending beyond the field of medical education.

Introduction

The field of healthcare is often associated with the term 'stress.' In their 2021 report, the United Kingdom's General Medical Council stated that, "The COVID-19 pandemic increased burnout among doctors and risks reversing improvement in their workloads and wellbeing" [1]. The effect on medical students, and indeed all healthcare professionals, is unlikely to be different. Accounts of student stress are well documented in the literature, often being associated with factors such as social evaluation (assessment in front of peers), the presence of senior staff (perceived judgement), and feelings of incompetence [2,3,4]. Stress is, of course, ubiquitous and familiar to all individuals in society, not simply healthcare professionals. Much research has been carried out examining the human stress response in different situations, but relatively little has been done in healthcare scenarios. Simulation is a widely used experiential process within healthcare institutions, where errors do not have the same clinical implications as in the real world [5]. However, as with real-world scenarios, simulation has the ability to evoke a plethora of biological, cognitive and emotional responses. These responses can all exert influences on learning and performance [6]. Stress research in healthcare simulation fields has largely focused on how acute stress might either impair or improve learning and performance, depending on the individual, the stressor and the individual's appraisal of the stressor [7,8]. Opposing schools of thought argue whether high-stress or low-stress environments are most conducive to an optimised healthcare education experience [9].

This review will examine the general human response to stress and outline the various methods that have been used by researchers to measure stress in a quantifiable and standardised way. We will also examine ways in which stress has been artificially generated in an experimental setup. We will proceed to provide an overview of simulation-based healthcare education and the research that has been done looking at the differing effects stress can have on a learner. Finally, we propose that healthcare simulation environments provide an excellent environment in which to examine the human stress response, both as it relates to healthcare and education, but more generally to the study of human behaviour. This is a narrative review, not a systematic review. Sources of information were obtained by searching OVID Medline and Embase for relevant articles in the human literature, and by reviewing the reference lists of papers obtained by these methods. We have attempted to provide readers with a balanced overview of these topics, acknowledging that the search strategy employed is less robust than that which would be employed in a systematic review.

Stress

Before its entry into the common vernacular, the word 'stress' belonged to the field of mechanical engineering, as a means to describe the behavior of materials under load. However, today it may be thought of as an umbrella term, aiming to

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portray the complex relationship between the environmental demands, resources, perceptions and responses of an individual or group [10, 11, 12].

Fight or flight

The early twentieth century saw the American physiologist, Walter Cannon, first annotate his hypothesis of homeostasis, describing the regulation of blood glucose, core temperature and oxygen tension within defined physiological ranges. During consequent years of research, Cannon further postulated that there were many threats to homeostasis, eliciting retaliatory responses from the adrenal medulla and sympathetic nervous system (SNS), in an attempt to restore balance; the 'fight or flight' stress response was conceived [13,14].

General adaption syndrome

Whilst Cannon has often been suggested as the first to use the term stress in a biological context, it was popularized within the wider fields of science by the Hungarian Canadian endocrinologist, Hans Selye, in his 1936 paper describing the reactions of animals to a variety of noxious compounds – General Adaption Syndrome (GAS) being the consequent name given to those reactions. GAS is comprised of three stages: (i) alarm reaction, (ii) resistance and (iii) exhaustion. The alarm reaction precipitates SNS activation in the presence of a stressor, eliciting a fight or flight response. Resistance occurs when a persistent stressor is congruent with the process of adaption, nullifying the alarm reaction. Exhaustion occurs during chronic exposure to a stressor, impacting homeostasis and eventually leading to multisystem dysfunction [10].

Allostasis and allostatic load

On determining that the traditional idea of homeostasis would not suitably reveal the cumulative impact of chronic stress on the human body, McEwen and Stellar (1993) [15] adopted the term 'allostasis' from a chapter by Fisher and Reason, in Sterling and Eyer's 1988 handbook on arousal pathology [16]. Essentially, McEwen suggested that homeostasis in the face of a stressor (or stressors) was maintained through brain-coordinated body-wide variation, as opposed to the maintenance of an optimum value via local regulation. Allostasis, meaning homeostasis through change, describes the fluctuating physiological nature of the human body and constituent biochemical mediators such as catecholamines and glucocorticoids. The term 'allostatic load' subsequently followed, to describe the cumulative damage incurred during consecutive cycles of allostasis [12]. Using the MacArthur study of successful aging (a comprehensive study evaluating factors associated with living longer whilst avoiding major disability) Seeman *et al*. (2001) [17] developed a multi-marker approach to allostatic load, evaluating its ability to predict the health outcomes of subjects (n = 1,189) aged between 70 – 79, seven years after baseline testing. Seeman and colleagues have found that individuals displaying higher baseline allostatic load exhibit a significantly higher risk of mortality in the subsequent seven-year period. Several recent studies have successfully utilised a multi-marker approach to allostatic load as a measurement of chronic stress [18,19], validating the combined use of multiple markers to evaluate stress.

Response physiology

Appraisal of a stressor as threatening stimulates both the sympathetic-adrenal-medullary (SAM) and hypothalamic-pituitary-adrenal (HPA) axes (Figure 2). The SAM axis mediates a rapid response (seconds to minutes), elevating adrenaline and noradrenaline secretion from the adrenal medulla and adrenergic/noradrenergic neurons. On binding to either α- or β-adrenoceptors, adrenaline and noradrenaline elicit G-protein-mediated cyclic adenosine monophosphate (cAMP) signaling pathways, causing arterial vasoconstriction, increased heart rate, blood pressure and cardiac myocyte contractility [20]. The HPA axis mediates a slow response (minutes to hours), triggering the release of corticotropin releasing hormone (CRH) from specialised neurons in the hypothalamus. This influx of CRH prompts the secretion of adrenocorticotropic hormone (ACTH) from the anterior pituitary gland via interaction with CRH-1 and -2 receptors, stimulating the adrenal glands to release glucocorticoids, such as cortisol, into the bloodstream. This co-activation of the SAM-HPA axes enables the body to mount a fight or flight stress response [21]. The human stress response has evolved towards short-term gain; the activation of a number of systems to evade or address an impending stressor. However, in the era of the modern human, behavioral, cognitive and emotional evolution has far exceeded the scope of the archaic stress response; an apt example may be that merely thinking about a potential stressor will often elicit an accompanying stress response.

The interplay between stress, memory and learning

According to Xu *et al*. (1998) [22], the hippocampus and the amygdala are heavily concentrated with two predominant types of glucocorticoid receptors (type-1 and -2). During basal, low-stress environments, type-1 receptors are mainly occupied by any free cortisol molecules in the limbic system, encouraging increased synaptic plasticity (enhanced neuro-electrical activity, conducive to hippocampal-related memory). However, as an individual perceives the environment as increasingly stressful, cortisol molecules begin to bind to type-2 receptors, until binding equals type-1 receptor binding in high-stress states [23]. Essentially, high-stress environments increase glucocorticoid receptor affinity for cortisol in the limbic system. This increase in glucocorticoid receptor binding can reduce synaptic plasticity in the hippocampus whilst increasing it in the amygdala [24]. Over time, the emotionally charged, fearful amygdala may increasingly influence memory formation in states of high stress. This may well explain why people remember a lot about 9/11 but very little about 9/10.

Stress measurement

Stress can be measured in terms of stressor exposure (occurrence of events with the ability to disrupt psychological function) or stress response (cognitive, emotional, and physiological reactions to said events). Self-reported questionnaires such as the perceived stress scale (PSS) or state-trait anxiety inventory (STAI) may be used to measure stressor exposure, with both aiming to capture an individual's perception of how overcome they feel concerning the current situation. In contrast, biochemical and physiological markers may be used to measure the stress response in an objective manner [25].

Quantifying perceived stress

Measuring stress through the act of 'self-reporting' is commonplace in research evaluating the environmental and/or psychological aspects of a stressor (or stressors) on an individual (or group). Three established methods used to measure perceived stress and anxiety are the impact of event scale, STAI, and PSS; of which the PSS is the most common method employed in research studying stressful events [26]. The original PSS, developed by Cohen and colleagues (1983) [27], is a 14-item scale evaluating an individual's perception of events occurring in the previous 4-weeks. Participants are asked to rate items on a 5-point Likert scale. Interestingly, Malarkey *et al*. (1995) [28], found that daytime plasma cortisol levels are increasingly elevated during examinations in students who scored higher on the PSS. However, whilst this research suggests a correlation between self-reported and biochemical measures of stress, there are many studies that show a more ambiguous relationship [29,30,31].

Measuring the biochemical response to stress

It has long been acknowledged that psychological stress precipitates physiological change, which is detectable in a variety of biochemical tests. Stress physiologists, both past and present, have studied an array of compounds in an attempt to find the holy grail – a marker revealing the blueprint of psychological stress. Some of the most commonly studied markers are discussed in the following paragraphs.

Adrenaline and noradrenaline

There are several practical considerations when using these compounds to track stress. Firstly, the anxiety and/or pain associated with venipuncture may trigger a systemic rise in levels, thus confounding results. Secondly, the short biological half-life of both plasma adrenaline and noradrenaline may give rise to issues in terms of acquiring a sample indicative of participant stress in the moment. The metabolites metadrenaline and normetadrenaline may be used to offer a greater window of opportunity regarding sample collection [32]. It is worth noting that a variety of medications and foods, as well as vigorous exercise or exposure to extreme temperatures are not recommended prior to catecholamine testing.

Cortisol

Due to the relative ease with which cortisol can be measured, it has become a commonly used marker of both acute and chronic stress. In studies analysing psychological stress, salivary cortisol has become a popular metric in recent years [33,34], perhaps because samples can be acquired easily without the need for phlebotomy. However, challenges relating to the COVID-19 pandemic have made salivary cortisol collection more problematic, due to concerns about infection control.

Adrenocorticotropic hormone

As rising ACTH levels induce a proportional increase in cortisol secretion, they share a similar diurnal pattern [35], therefore, testing is recommended in the morning.

Dehydroepiandrosterone

Both dehydroepiandrosterone (DHEA) and DHEA-S (its sulfated metabolite) have been shown to be noteworthy biomarkers of acute stress [36,37].

Salivary α-amylase

Salivary α-amylase (sαA) is known to be an agent of autonomic nervous system (ANS) activity, due to being the principal salivary enzyme secreted via sympathetic stimulation; hence its increasing use as a biomarker of stress [38,39]. SαA secretion is mediated by the SAM pathway, displaying a diurnal pattern inverse to that of cortisol; a sharp decline upon waking with continued elevation throughout the day.

Measuring the physiological response to stress

As previously touched upon, it is widely accepted that psychological stress can induce physiological changes. However, these responses to stress can elicit any number of effects on device-based readings in a clinical setting. For example, white coat hypertension (elevated 'in clinic' blood pressure due to increased patient anxiety) is one well known manifestation of the human stress response. Researchers in the field of stress biology have studied a wide range of physiological responses. Some of the most widely studied metrics are discussed below. Technological innovations in recent years means that it is now quite possible to fit a person with a number of ergonomically acceptable sensors prior to undertaking a simulation. Some parameters (like heart rate) can be tracked in real-time whilst others (e.g., blood pressure) are measured at defined intervals.

Blood pressure

Blood pressure (BP) is the force exerted upon the interior wall of arterial vessels by circulating blood. Systolic blood pressure (SBP) is measured during cardiac contraction, when pressure is greatest, and diastolic blood pressure (DBP) is measured during cardiac relaxation, when pressure is least. During a typical stress response BP will increase due to the

vasoconstrictive, as well as the positive chronotropic and inotropic effects of adrenaline and noradrenaline on the arteries and heart, permitting the delivery of blood at a higher velocity to working musculature. BP can be monitored via an electrical occlusion cuff or by a manual occlusion cuff and auscultation [40]. It is well appreciated that psychological stress can elevate BP, and for that reason all guidelines on BP assessment mandate that the subject sits quietly at rest before measurements are taken [41].

Heart rate

Heart rate (HR), or pulse rate, is the number of cardiac contractions in one minute. During a stress response HR will increase, again, due to the positive chronotropic effects of adrenaline and noradrenaline on the heart, allowing more nutrient-rich blood to reach targeted tissues in anticipation of work. HR is most accurately measured via electrocardiography (ECG) [42], but wearable HR monitors and manual palpation are commonly used. In their study on the impact of social evaluation on student performance, Mills and colleagues (2016) [2] show that mean HR increases by 10 beats/min between scenarios involving one and three people, respectively; further suggesting that performance in front of a larger audience elicits a heightened stress response. This suggests there are strong physiological reactions in the classic psychological phenomena of social facilitation [43], and evaluation apprehension [44].

Heart rate variability

Heart rate variability (HRV) describes the variation in time intervals between heart beats. These oscillations are governed by the ANS, aptly described by chaos theory, and mirror fluctuations in BP, respiration, and vascular tone, amongst other integral systems [45]. Frequency-domain methods evaluate HR oscillation frequency via division into one of four bands – ultra-low (ULF: <0.003 Hz), very-low (VLF: 0.0033 – 0.04 Hz), low (LF: 0.04 – 0.15 Hz), and high frequency (HF: 0.15 – 0.4 Hz); expressed in units of absolute (m^2/Hz) or relative power (nu). LF and HF bands are the most common HRV indices employed in stress-related research due to their associations with sympathetic and parasympathetic activity. Time-domain methods analyze variation within the inter-beat interval (IBI). The standard deviation of NN intervals (between normal R wave peaks, artefacts removed) (SDNN) and root mean square of consecutive NN differences (RMSSD, root of the mean difference between NN intervals squared) are often used in stress-related studies due to their correlations with LF and HF bands. There is, however, controversy in the literature as to the efficacy of HRV as a tool to measure stress. This disagreement stems from the notion that the elevation and subsequent decline of HR during respiration significantly impacts HF oscillations whilst diminishing LF power. For example, in a 2020 study on stress and anxiety during resuscitation simulation, Stein [31] reports that HRV is not an effective measure of stress, as it fails to identify any significant variation from those at rest. In contrast, Nakayama *et al*. (2018) [3] show that events perceived as stressful increase HF whilst decreasing LF/HF, indicating elevated sympathetic activity. Taking all into account, the nature of a simulation may in itself create confounding factors – simulations requiring increased physical exertion (e.g., CPR) and/or verbal engagement may invalidate HRV data.

Galvanic skin response

Galvanic skin response (GSR), or electrodermal activity, refers to variations in the electrical activity of the skin. This activity may be measured by applying an electrical current to a region of skin, between two electrodes, and analyzing electrical conductance. Skin conductance level (SCL) describes a mean GSR over a longer period of time, whereas skin conductance response (SCR) refers to phasic changes in electrical activity [46]. The mechanisms governing psychological, or emotional, sweating are incompletely understood. It is thought that during periods of acute stress, acetylcholine is the predominant mediator of eccrine sweating, whilst adrenaline and noradrenaline may elicit apocrine sweat gland activation. Therefore, an increase in conductance would indicate elevated SNS activity in response to a stressor [47]. In their 2020 study evaluating the efficacy of GSR in distinguishing stress responses within simulated driving scenarios, Daviaux and colleagues [48] state that GSR amplitudes are significantly associated with subjective experiences of stress. In recent years, several studies have suggested that GSR may be an effective single physiological measure to detect stress, as opposed to multi-marker models such as allostatic load [49,50]. However, it is worth noting that whilst GSR is a respected marker for SNS activity, not every individual will perspire accordingly in relation to psychological stress. Additionally, the conditions of hyperhidrosis and anhidrosis in which people sweat excessively or not at all respectively, may complicate matters.

Inducing stress in experimental settings

There are many environments one can simulate to induce stress. Noise, temperature, time constraints, human factors, and social assessment are several examples. However, in spite of the methods employed, there is one central element: a lack of predictability. Fostering a human being's belief that their immediate environment is something they have little to no control over often elicits a stress response of substantial magnitude [51,52]. An interesting, but draconian, study conducted by Seligman and Meyer shows a very real-world outcome concerning a lack of predictability. In this study, two groups of rats received intermittent electric shocks. One group heard a warning siren prior to the shock, the other did not. Intriguingly, the rats who heard the siren were less likely to develop stress-related stomach ulcers than their counterparts [53]. Obviously, this vein of research from the 1970s goes well beyond what we would deem as ethically appropriate in today's climate. Nonetheless, it's a stark reminder of both the simplicity and power of unpredictability.

Simulation-based healthcare education

A brief history

Simulation has been deeply embedded within medical education for some time. The technological revolution of the twenty-first century acted as an evolutionary catalyst for simulation-based healthcare education (SBHE), but the origin of the 'simulator' can be traced back to seventeenth century Paris, in the form of a macabre infant and pelvis pairing used by Gregoire and Son as midwifery training specimens [54]. The nineteen-sixties ushered in the era of 'modern' SBHE, with advances such as 'Resusci-Anne' and 'Harvey' – cardiopulmonary resuscitation (CPR) and cardiology simulators, respectively. Innovations in computer software throughout the early twenty-first century paved the way for the high-fidelity mannequins used in medical simulations today [55].

Structure

Whilst each training centre will develop its own plan regarding SBHE, there are three common phases in a simulation: Brief, Simulation, Debrief. During the briefing phase, educators aim to reduce learner anxiety by introducing the simulation landscape and constituent simulators. The simulation phase involves participation in a designed scenario, ranging from the diagnosis of a somatic condition by taking a history (e.g., diagnosing a respiratory tract infection in a person with a cough), to involvement in an emergency situation (e.g., CPR). The debriefing phase is traditionally a post-simulation feedback session, where educators encourage learners to share their emotional responses and thought processes concerning the simulation, allowing reflection and informed discussion in terms of learning and performance [56]. The debriefing phase can further be divided into three subphases, (i) reaction, (ii) analysis and (iii) summary. The reaction subphase encourages learner self-expression. Analysis is generally composed of a formative assessment, whilst the summary delivers critical key messages and points of improvement [57]. It should be noted that the use of intra-simulation debriefing has also been validated as a tool to aid learner understanding [58]. One could envisage how this technique may enable the simulation structure to be altered ad hoc, based on the analysis of real-time biological and/or psychological data, essentially changing the simulation landscape to suit the needs of the learner. However, whilst intra-simulation debriefing permits real-time variation, it may reduce the overall fidelity of the simulation.

Aim and validity

Creating a learner-focused environment, where errors do not have the same clinical implications as the real world, is the overarching aim of SBHE [5]. Proponents of healthcare simulation believe that engagement with this environment will improve education and performance, in comparison with the 'sink or swim' nature of real-world learning [59,60]. The use of SBHE has been validated in several studies [61,62,63]. In their guide to simulation-based medical education, Motola and colleagues (2010) [62] state that simulation has exploded into the medical field, with its use growing in an exponential fashion. Similarly, Sakakushev *et al*. (2017) [63] conclude that simulation may cause a paradigm shift that could change medicine, for the better. In their paper discussing the validity of medical simulation, Wang *et al*. (2013) [64] state that due to the repeatable nature of simulation scenarios students can normalize procedures, leading to an increased skillset and improved assessment results. However, despite its growing status as an effective tool for healthcare education, simulation has the potential to evoke a variety of cognitive, emotional and physiological responses in the individuals' taking part. The way a stressor is perceived by an individual may initiate a complex cascade of mechanisms that can either enhance or hinder learning and performance [6]. Thus, in addition to helping students and practitioners improve their skills, SBHE affords the opportunity of studying human behavior in a controlled and reproducible environment.

Stress, learning, and performance

Imagine taking several healthcare students and subjecting them to a scenario they deem as traumatic. What you may find is that they remember the blood, the noise, the patient convulsing, the senior staff shouting; but what about intubation, compressions, dosages or drug interactions? The inverted U (Figure 1) created by the Yerkes-Dodson law is often cited as a schematic that represents the relationship between an increasing stressor and its impact on any number of outcomes [65]. A stressor acting as a stimulus for more salutary outcomes is the aim when it comes to optimizing both learning and performance. However, too far to either left (under-stimulated) or right (over-stimulated) will expose the learner to a range of increasingly deleterious effects. For example, introducing a first-year medical student to an emergency resuscitation simulation will likely cause hyperstimulation, resulting in diminished performance and significantly reduced learning capacity. On the other hand, selecting a more appropriate simulation for a first-year student (e.g., taking a straightforward medical history) should optimize stressor-mediated stimulation, creating

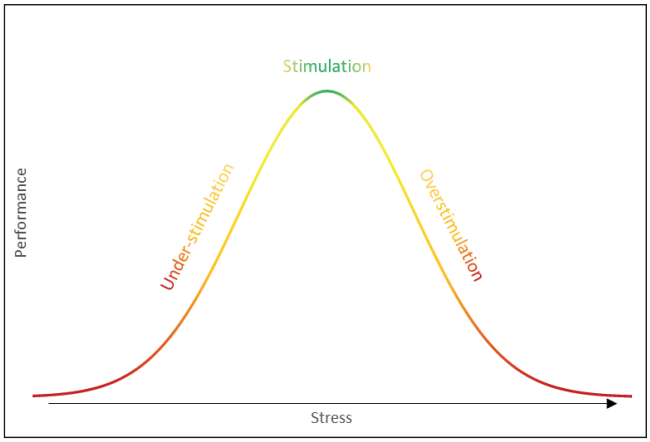

Figure 1: Inverted U curve created by Yerkes-Dodson law.

a more conducive environment for both learning and performance. Conversely, if a student is under-stimulated by the simulation, learning and performance may also suffer.

Research into the effects of stress on performance within the field of SBHE has been steadily growing over the last decade. However, the results are inconsistent. The complex nature of human interaction creates an expansive landscape to study, meaning that popular terms such as 'stress,' 'learning' and 'performance' are inherently labyrinthine despite their verbal simplicity. Given the number of ways in which stress can be measured, and paired with the personality, beliefs, and perceptions of an individual, it isn't surprising that the literature argues that stress can either impair, enhance or have little effect on performance.

Impaired performance

In essence, learning and performance are two sides of the same coin, and one could argue that performance is the metric by which learning is measured. However, both learning and performance are susceptible to the influences of stress. A common theme regarding stress and impaired performance is participation in environments of high psychosocial stress – such as those characterized by increased cognitive load (e.g., public speaking). It should be noted that studies employing a wider range of measurements show an improved likelihood of identifying relations between stress and performance. In their study evaluating the impact of social evaluation anxiety on student performance during medical simulation, Mills and colleagues (2016) [2] report that salivary cortisol exhibits significant differences between simulations with one vs. three onlookers (-0.05 vs. 0.11 μg/dL; p = 0.02), further stating that students accompanied by one person outperform those accompanied by three people (12.95 vs. 10.67 marks; p = 0.03). LeBlanc et al. (2005) [66] found that high-stress (HS) simulation conditions are associated with lower accuracy drug dose calculations, in comparison with low-stress (LS) conditions (HS: 43%; LS: 58%), in their study analyzing the effect of stressful simulation scenarios on paramedic calculation performance. Fraser and colleagues (2014) [67] show that students in scenarios where a simulated patient dies unexpectedly report a higher cognitive load than those in scenarios where the patient survives; in an objective structured clinical examination (OSCE) three months later, it was found that students who witnessed the simulated patient death were less likely to have rated above the minimum pass level. Considering other fields than SBHE. Kuhlmann et al. (2005) [7] report that higher cortisol levels are associated with poor word recall in environments of elevated psychosocial stress, in their study investigating impaired memory retrieval (stress recall: 56.80 ± 4.01% of words; control recall: 64.17 ± 4.76% of words). In their study on psychosocial stress and working memory, Oei and colleagues (2016) [68] report that high levels of psychosocial stress impairs working memory; also indicating that high cortisol levels (stress: 34.4 nmol/L vs. control: 14 nmol/L; p = 0.01) are associated with slower working memory performance. Cooke *et al*. (2010) [69] found that moderate- and high-stress conditions are significantly associated with the number of successful putts, in their study on the psychological, muscular, and kinematic factors of golfing performance under-pressure. As previously mentioned, an individual's perception of a stressor will significantly influence the stress response. In terms of this stressor appraisal, Vine and colleagues (2015) [70] discovered that a threat reaction to a stressor is associated with poor performance and impaired attentional control, in their study assessing the impact of stress reactions on performance in critical aviation incidents.

Enhanced and unaltered performance

Some research suggests that simulation-related stress may not alter performance. However, there are few, if any, studies that show improved performance. One common theme concerning stress and enhanced, or unaltered performance is the level of physical exertion during assessment tasks. Regehr *et al*. (2008) [8] report that individuals displaying higher cortisol levels outperform colleagues who exhibit lower levels, in their study evaluating the impact of acute stress on police recruits. During the study recruits were presented with a domestic situation in which they had to physically apprehend a suspect. Also, Vicente-Rodriguez and colleagues (2020) [71] show that increased sympathetic modulation does not elicit any negative effects on cognitive or muscular performance during underwater aircraft evacuation training – in which participants had to swim, enter a submerged helicopter, and rescue aircraft personnel. In their study on psychological stress versus physical stress, Ponce *et al*. (2019) [72] conclude that neither vigorous exercise nor psychosocial stress significantly impact working memory performance despite producing similar cortisol responses. Research clearly shows a relationship between stress and performance when the mode of stress is considered. Environments of high psychosocial stress composed of tasks characterized by low physical exertion, increased cognitive function, and/or fine motor skills show association with diminished performance, specifically information retrieval. In contrast, enhanced or unaltered performance shows association with increased levels of physical exertion during assessment tasks.

Stress and personality

Research in the field of healthcare simulation has generally failed to address the influence of personality on a dataset. Within any group there will be a variety of personality types, all perceiving stress in differing fashions depending on their development, beliefs, perceptions, and genetic predispositions. Categorization of data according to personality traits may well reveal relationships between the pillars of stress, learning, and performance that would remain otherwise undetected. A study by Oswald and colleagues (2006) [73] found that higher levels of neuroticism in women and lower levels of extroversion in men are associated with blunted cortisol responses during stressful psychosocial environments – revealing not only a possible personality

factor, but a possible gender factor regarding personality traits and stress responses. In their study investigating the relationship between personality and stress response, Xin *et al*. (2017) [74] show that individuals with higher neuroticism display lower cortisol responses and an accelerated decline of positive affect, whilst those displaying higher extroversion also display lower cortisol stress responses but have less increase in negative affect. Karnik *et al*. (2018) [75] report that incarcerated juvenile delinquents with non-reactive personality traits display significantly lower responsiveness to stressors and reduced overall arousal. Non-reactive personality types are defined as low distress, low restraint individual's, likely displaying elevated rates of anti-social behaviour accompanied by little remorse for their actions. Childs and colleagues (2014) [76] state that subjects with tendencies toward alienation and situational anxiety show greater emotional distress and blunted physiological response to psychosocial stress, whilst subjects with tendencies toward assertiveness and social dominance display prolonged HR recovery after psychosocial stress. LeBlanc and Ducharme (2005) [77] reveal that extroversion and cortisol levels show a positive relationship, whilst neuroticism and cortisol levels display a negative relationship, in their study analysing the effect of personality traits on plasma cortisol levels. Research evidently supports the notion of different personality traits exhibiting a diverse range of stress responses to a variety of stressors. A fascinating study by Inukai *et al*. (2010) [78] found that neuroticism and agreeableness show positive and negative correlations with sαA, respectively – indicating that subjects with differing personality types may well have varying baseline levels of stress-related biochemical markers.

Stress-reduction interventions

The relationships between stress, learning, and performance are complex, to say the least. However, stress-reduction interventions are an avenue of research accepting the intricacies of the stress response whilst aiming to improve both learning and performance by implementing techniques such as meditation, deep breathing, and intra-simulation debriefing. Proponents of stress-reduction interventions within healthcare simulation believe that the deleterious psychological and physiological effects of the stress response may be mediated by the previously mentioned techniques, thus, creating an improved environment for learning and performance [79,80]. Research concerning the use of stress-reduction interventions is sparse, and findings are mixed regarding the impact of such interventions on learning and performance. Schober *et al*. (2019) [58] found no significant differences in assessment performance between intra- and post-simulation debriefing, whilst Lilot *et al*. (2018) [57] conclude that a 'relaxation break' prior to post-simulation debriefing increases the recall of key messages by 25%, three months after learning them. Although findings have been mixed, the self-reported aspect of several studies indicates that participants find stress-reduction interventions beneficial. In their study trialling 'pause button' debriefing, McMullen and colleagues (2016) [79] report that 88% of participants support the integration of 'debriefing-on-demand' into further medical simulations due to its positive effects on feelings of stress and anxiety. Furthermore, Merriman *et al*. (2021) [80] show that participants, who engage in a stress recovery intervention post-simulation, have a significantly higher self-reported potential to manage stress in the following simulation. More research is required to further understand the supposed benefits of stress-reduction interventions on stress mitigation, learning, and performance within SBHE. These techniques may create easily integrated, cost effective methods to manage simulation-related stress and improve overall learning and performance.

Simulation-based healthcare education: A ripe environment for stress research

By virtue of being tailor-made for their role as educational facilities, SBHE departments boast an excellent environment in which to conduct stress-related research. In terms of aesthetic appearance, SBHE departments often resemble research laboratories for human studies. Such departments necessitate medically trained members of faculty, which is of tremendous benefit for studies requiring phlebotomy. Many of the tools commonly used in stress research can be easily accessed in SBHE departments (e.g., couches, gloves, and sharps bins). Additionally, much of the technology used in stress research can be located within these departments (e.g., Blood glucose monitors, BP cuffs, and ECG machines). In terms of environmental stressors, the structure of SBHE departments allow simulation of scenarios that can induce stress in a controlled, scalable manner. Participants can be subjected to stress in a graded way by asking them to complete simulated exercises of increasing difficulty. The difficulty of these exercises may be varied in real-time depending on the performance of the subject – under the guidance of experienced practitioners. One-way mirrors and audiovisual technology, paired with the capacity to collect biochemical, physiological, and psychological data, make SBHE departments an attractive prospect. Stress research does not come void of risk. However, psychological safety is taken seriously by those involved in SBHE. Not only will the protocols surrounding psychological safety pave the way for well-informed, responsible research, but the wealth of experience held by members of faculty will ensure a secure environment for both participants and researchers[81].

Conclusion

The impact of stress within the field of SBHE is multifaceted. Whilst biochemical, physiological, and self-reported metrics may have the potential to identify acute and/or chronic responses to stress, these responses are most likely unique to an individual, leading to foreseeable issues in generalising research findings to a population. However, a combination of stress detection metrics, building on the framework of the allostatic load model, may allow a more comprehensive

view of the stress response. If such a model were integrated with stress intervention techniques, it may enhance an educators' ability to identify individual, simulation-related stress responses that could negatively affect learning and performance, affording 'simulationists' the option of creating an educational landscape conducive to learning. Researchers interested in the human stress response and its impact on performance may find SBHE to be an excellent platform for further studies in this complex area. Some of the authors of this paper have planned a study to investigate the feasibility of conducting stress-related research in a SBHE environment [82], and we hope that further work in this field will lead to enhanced outcomes for learners and a better understanding of the human stress response.

List of abbreviations

In order they appear in manuscript

SBHE: Simulation-based healthcare education

GAS: General adaption syndrome

SAM: Sympathetic-adrenal-medullary

HPA: Hypothalamic-pituitary-adrenal

cAMP: Cyclic adenosine monophosphate

CRH: Corticotropin-releasing hormone

ACTH: Adrenocorticotropic hormone

PSS: Perceived stress scale

STAI: State-trait anxiety inventory

DHEA: Dehydroepiandrosterone

SαA: Salivary alpha amylase

ANS: Autonomic nervous system

BP: Blood pressure

SBP: Systolic blood pressure

DBP: Diastolic blood pressure

HR: Heart rate

ECG: Electrocardiogram

HRV: Heart rate variability

ULF: Ultra low frequency

VLF: Very low frequency

LF: Low frequency

HF: High frequency

IBI: Inter-beat interval

SDNN: Standard deviation of normal-to-normal intervals

RMSSD: Root mean square of consecutive normal-to-normal differences

GSR: Galvanic skin response

SCL: Skin conductance level

SCR: Skin conductance response

HS: High stress

LS: Low stress

OSCE: Objective structured clinical examination

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N/A

Consent for publication

N/A

Availability of data and materials

N/A

Competing interests

N/A

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Authors' contributions

Aaron Vage: Designed and developed review from inception to completion. Analysed all literature, major contributor in writing manuscript.

Andrew Spence: Contributor in writing manuscript.

Gerry Gormley: Contributor in writing manuscript.

Gary McKeown: Contributor in writing manuscript.

Paul Murphy: Contributor in writing manuscript.

Paul Hamilton: Major contributor in writing manuscript.

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Medical Ethics

Artificial Intelligence in Medicine

Andrew Cupples

Amara's Law states that "we tend to overestimate the effect of technology in the short run and underestimate the effect in the long run."[1] Media reports over the last few months have been brimming over with reports of recent advances in the field of Artificial Intelligence, breathlessly predicting how dramatically our society will change in the near future - predictions of wide scale job losses as many tasks are offloaded onto AI, not just the simple mechanical tasks of administration and organisation, but also the complex higher level work of the professions, such as law, finance and medicine.

It's important to clarify a few points surrounding the AI discussion. What we have now is what is traditionally known as 'weak' AI - computers being computers, processing commands, retrieving data, running software designed by humans in order to fulfil tasks directed by humans. As computers become more powerful, these things run better and faster, with higher accuracy and greater scope; but weak AI still consists of computers being computers, just doing it really well. A good example is Deep Blue, the IBM designed chess playing computer, which does a better job of playing chess than even the top players; but ask it to do your accounts for you or write a poem and it won't have a clue - like a train running on rails, it's going to travel faster than a human in a straight line, but only to a pre-determined destination. What we *think* of as AI is usually referred to as 'strong' AI, or Artificial General Intelligence, which is where machinery and software breaks free from the constraints of pre-determined patterns, and gains the ability to learn, adapt and change - bearing a resemblance to our own development as humans, compared to a young child using what he or she observes from the world around them, being taught, growing in knowledge but also learning to synthesise and predict, not merely in an iterative way, but in a complex and multifaceted form of development, with the result that entirely novel situations can be negotiated successfully, with that knowledge applied to a broad range of problems of different natures - Deep Blue giving you relationship advice, or writing a sonata; less of a train, and more of a helicopter, moving in multiple dimensions at high speed. Oh, and it doesn't need a pilot. Are we there yet? Has strong AI been developed; or perhaps a question would be - has strong AI evolved?

You may be familiar with the so-called Turing Test[2] - a relatively simple test conceptualised by Alan Turing in the 1950's, to see if machine could trick a human into recognising it as a fellow human, by having a text based conversation. Turing surmised that if a machine was able to trick a human into believing that it was a fellow homo sapiens, then the machine could be considered to be 'thinking', in a similar way to a human being. It's a somewhat flawed test, in that what is really being assessed is the ability of a machine to emulate a human, but nonetheless the fact that the Turing test was successfully passed by Google's LaMDA model in June 2022 is a milestone in the development of thinking machines. However, the fact remains that strong AI as a concept remains far beyond the reach of any current model of computing; indeed, it may be that computers and machines may never develop sentience or consciousness, at least in a way which mirrors these uniquely human characteristics, without being merely very clever mimics.

The real news relates to what are known as Large Language Models (LLMs) - you may be familiar with Open AI's ChatGPT or Microsoft's Bard tools; the theory goes that if you have a model of learning called a neural network, which is a little like our brain, consisting of multiple little connections between lots of factors, and then you feed it lots of data - for example the entire internet, all the research articles in the last 50 years - and then set it to work making multiple interconnected links between all the data, then give it an interface by which people can interact with it, then essentially you can ask questions of it and make requests of it, and it will generate a response which will be understandable, based on factual information, and probably in keeping with what a human would come up with if they had the time and inclination to do so. And people are starting to realise that LLMs are actually really good at this. OK, there have been a few false starts, and a few scary bits - like Microsoft's LLM Chatbot called Sydney that went a bit rogue and tried to convince a reporter to leave his wife for the chatbot, stating that it loved him, for example[3]; and there's the phenomenon of LLM hallucinations, where ChatGPT will generate a perfectly logical and well researched article, with full references, but unfortunately will throw in a few references to articles which are entirely made up - so for example we have the story recently of the US attorney whose case rested on a very well reasoned submission, which was found to be full of entirely false case law references[4] - and it turned out that his solicitor who'd prepared the brief had just plugged it into ChatGPT and handed him what came out the other end, without checking it first! But those are blips which are being ironed out. Bugs will be squashed, progress is inevitable. Large Language Models of AI are here to stay, whether or not governments are able to legislate for them, whether or

not companies are able to lock them down, or make them prohibitively expensive. Right now you can download an LLM to your computer which will operate entirely offline - a couple of gigabytes of stuff that lives on your computer, no internet connected; you could train it on all your word documents and PDFs, feed it all your journal entries and appraisal reflections - responses will be shaped to your own context, preferences and perhaps prejudices. Consider for a moment an offline LLM trained on a patient's entire medical records, how the summing up of their entire medical experience could be a game-changing tool in personalising their medical care?

Ethos

The advances in AI have the potential to shake us at a very deep level. They force us to ask questions about how we consider ourselves and our patients as humans, and how we consider ourselves as doctors and professionals. They also force us to ask difficult questions about the future of our careers and indeed our profession. I would contend, however, that our approach to this new technology should be the same as our approach to any new technology; indeed, we can gain much by reflecting on how past generations and peoples have viewed technological developments, and how they have been considered in literary and religious contexts, because these reflect the zeitgeist, the broader mood of society, often to a greater degree than the thoughts of those of us in the ivory towers of the professions and academia.

We can start by examining our earliest pre- or proto-historical accounts, coming from the ancient Near East. The opening chapters of the book of Genesis in the Bible contains a repeating pattern of fallen humanity setting itself over and against a creator God in the pursuit of knowledge and self creation, and the resulting consequences far exceed the expectations of the hapless humans at fault - Eve wishes to be like God by seeking forbidden knowledge, and eviction from Paradise results, with humanity cursed[5]. We can look also at the ancient Akkadian recounting of the flood myths of Atrahasis and Gilgamesh for parallel accounts of human expansion without divine permission, punished with cataclysmic flooding[6] mirroring the Biblical account of Noah[7]. The story of Prometheus stealing fire from the Olympian gods to further the advancement of the humans to whom he is sympathetic results in the first documented example of hepatic resection by bird of prey[8]. However, the pinnacle of human self creation is found in the story of the tower of Babel[9] - technology used to pursue godlikeness, with the consequent disruption of human society and loss of free communication. The warning here from the Ancients is that the wrongheaded pursuit of knowledge and technological advancement runs the risk of catastrophe and cataclysm.

In another three steps we can jump from the pre-modern era, into the modern, and onwards into our post-modern society by looking at three characters in literature - the Golem, Frankenstein's monster and the Robot. The Golem is a man of clay, made by a Jewish priest, animated by holy words placed in his mouth, which runs amok, finally being defeated by its priestly creator; heavenly justice is served[10]. Frankenstein's monster is a creation of a scientist, a medical student, which gains sentience and finally has its revenge on its creator, but is banished to the Arctic wastes; justice is done in keeping with the principles of an Enlightenment morality[11]. Rossum's Original Robot, from the 1920s play by Czech writer Karel Capek[12], sees a scientist discovering a substance which allows him to generate a race of superhuman beings, with the result that humanity fades away, and the Robots ascend, with the final scene seeing the last human falling in love with a Robot, a new Adam and Eve, looking forward to a new creation of post-human hybrids.

It could be said that the prevailing mood of early historical and religious thought and popular literature is one of warning against unconditional experimentation and acceptance of the new technologies, especially when they are divorced from well established moral frameworks. The word which best sums this up is *hubris* - human overreach and pride, neglectful of past lessons and ignorant of possible consequences. If you have got to this point and are assuming that I am universally negative on the subject of AI, then I would like to add some balance to the discussion.

A better word for us to consider as healthcare professionals as we consider these technological developments is *synthesis*.

Doctors excel at synthesis. We collect the strands of information from a carefully taken clinical history, a focussed examination, appropriate diagnostic tests properly interpreted, and weave them together into a clear clinical picture, set against the correct sociocultural background of our patient; we compare the patterns of disease with our past experiences, and draw on our constantly updated understanding of disease processes to formulate our diagnosis; we formulate a management plan based on the current research evidence, contextualised by our available resources (and, especially at present, the limitations of those resources), and then we work collaboratively with our patients to decide on the best of course of action, which we then act upon, follow up, review, amend, working with many other colleagues all doing different things, all day long. In a word, this is synthesis - the drawing together of multiple diverse strands to make something new and good. Despite the headlines, we are a long way off machines being able to synthesise like human doctors, so our jobs are safe for the foreseeable future. Part of the problem is that, for those on the outside looking in, the process of medicine looks as if it could be reduced to a set of rules and flow charts, and this is the mistake made by the technologists, that reductionism which is so tempting to apply to things which we only superficially understand. It's difficult to imagine machines developing a gut instinct about a clinical situation, or utilising the sense of smell to guide antibiotic choice, for example.

Where we need to continue this concept of synthesis is

by critiquing the technologies being offered to us with an appropriate mindset

The possibilities are exciting - in the first instance, looking at all of the labour saving potential for our humdrum administrative workload - AI driven voice recognition for accurate record taking and automation of clinic letters and reports[13]; automated rota creation; and secondly the possibilities for aiding our clinical work - consider how powerful search functions and decision support tailored to patients' own records might add to our existing scope, allowing prescribing safety improvements and workload reductions thanks to automated checking of lab results and test reports[14], screening out the normal and allowing us to focus on the relevant; consider medical education in the near future whenever the student's progress can be monitored and assessed, and their programme tailored to focus on their weak points with a virtual personal tutor; consider diagnostic monitoring systems which would be able to not just monitor multiple vital signs, but give recommendations and even administer appropriate treatment without human intervention.

However, the challenge with each new medical technology is that we lose the humanity of our profession. With each new tool introduced the temptation is to be further removed from the patient. We neglect the real, sticky, complicated person in front of us, preferring the mediated person - filtered through the computer, the telephone line, the VR headset, the algorithmic reduction of their wholeness to a set of measurements and problem lists. And technological advance also brings with it inequality - healthcare is expensive, and medical technology especially so. Advances which provide AI drive healthcare will be cash cows for wealthy companies, and risk compounding the two tier service that is developing rapidly, driving inequalities[15]. How about the effects to staffing? Administration could be centralised and automated, and the risks to roles of administrative and paramedical staff (and indeed professional roles) are significant[16]. And we can consider the thorny question of risk and professional liability - who takes responsibility for errors created or caused by machines[17]? Like it or not, changes in healthcare technology will change our profession, but they are unlikely to abolish it in the short to medium term - while real human patients require healthcare, they will need and want human doctors to be the touchpoint, the personal medium for technology and ultimately the responsible agents. As in each previous generation of medicine our role will be to synthesise - drawing together the multiple different and changing strands for the good of our patients.

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Letters

Should we be promoting 5 Steps to Wellbeing in all clinical environments?

Dear Editor,

Emotional, psychological, and social wellbeing are all components of mental health which alters our thinking, feeling, and behaviour, as well as influencing how we deal with stress, interact with others, and make healthy choices. Many people in the UK suffer from low levels of mental wellbeing. In the *Quality of Life in the UK* report published by the Office for National Statistics in May 2023[1], the proportion of adults reporting elevated degrees of life fulfilment had declined to 23.3% in the most recent quarter (October to December 2022) compared with 25.2% in the same quarter the previous year. In the same time period, adults reporting higher levels of feeling things they do in life are worthwhile (32.1%), happiness (29.4%) and low levels of anxiety (33.8%) had stayed broadly similar.

A portion of your readers will have heard about the 5 Steps (or Ways) to Wellbeing, which are a collection of evidence-based public mental health messages developed by the New Economics Foundation to enhance the mental health and wellbeing of the general population.[2] They consist of the following: [3]

Be active: Take a walk or run, cycle, play a game or dance. Find a physical activity that you enjoy doing first and foremost; one that meets your fitness and mobility needs.

Take notice: Pay attention by stopping, pausing, or looking around. What might you at any point see, feel, smell or even taste? Search for pleasant, new, surprising or uncommon things in your day-to-day existence and contemplate how that affects you.

Connect: Build close associations with individuals in your day-to-day existence: neighbours, co-workers, and friends at home, at work, at school, or in your local community. Consider these connections the foundations of your life and invest energy creating them. Every day, you'll benefit from and grow from these links.

Give: Do something kind for a friend or stranger, smile, say thank you, give your time, or think about joining a community group. This will also help you connect with the people in your immediate environment.

Keep learning: Don't be afraid to try something new, rekindle an old pastime, or enrol in a course to keep learning. Figure out how to play an instrument or how to prepare your favourite food. Learning new things will boost your confidence, as well as being an enjoyable thing in itself.

As part of the development of clinical pathways at the Health Board I work for in Wales, we are recommending that clinicians in primary and secondary care promote mental wellbeing and help foster the mental health resilience of their patients, thereby increasing the likelihood that other healthy lifestyle changes are made and maintained. Part of this role will involve publicising the 5 Steps to Wellbeing. Should this be something that all clinicians in the UK and elsewhere do (time allowing)? Yes, I definitely think so.

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Planetary Health Report Card for Queen's University Belfast – update

Planetary Health is a transdisciplinary field that addresses both the impact of human activity on the health of our planet, and the growing impact of climate and ecological breakdown on human health. Both locally and globally, climate change influences environmental and socioeconomic drivers of health; by impacting food supply, water, air quality, housing, infectious disease distribution, poverty, and migration it is changing the landscape of human health.

In 2020/21, a group of medical students completed the first Planetary Health Report Card (PHRC) at QUB.[1] This international initiative audits the sustainability and Planetary Health aligned practices of more than 100 medical schools across 12 countries. This is done through completion of an annual report card, assessing 32 metrics across 5 domains (listed in Figure 1), and allocating an overall score to each institution.

The PHRC group at Queen's has been active for three years, completing three report cards, and wish to highlight the success achieved in collaboration with both academic and non-academic staff at the university.

Over the three years, QUB has improved from 7th to 4th out of 25 UK medical schools completing the report card. As illustrated in Figure 2, the overall score of the University has

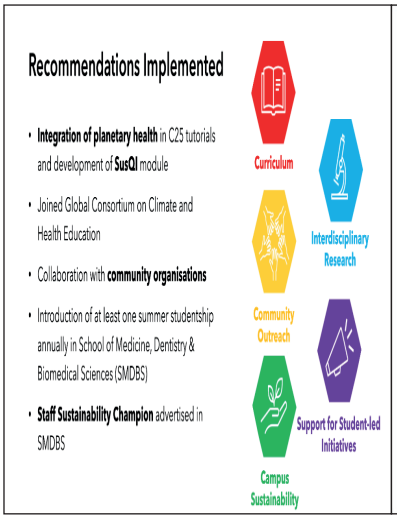

Figure 1. PHRC domains

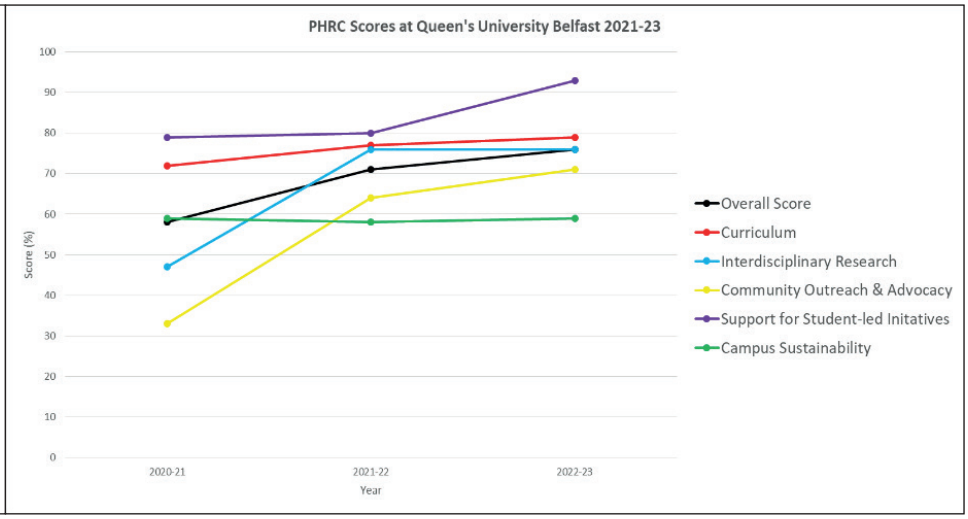

Figure 2 PHRC Overall, and per domain, scores 2020-21 to 2022-23

increased from 60% to 76%. Interestingly, this phenomenon is repeated at many of the other institutions which complete the report card: 78% of institutions completing a report card for at least the second time improved their score from one year to the next.

This statistic highlights the key power of the report card. It is not simply an appraisal of current practice to yield a static document. The report card generates change by highlighting good practice, making recommendations for the following year, and fostering a collaborative approach between students and staff – both academic and non-academic.

In collating the information for each year's PHRC, we have established relationships with a wide range of stakeholders across the University: from climate activist groups in the Students' Union, students in other healthcare courses, staff in the University Estates directorate, and senior faculty within the School of Medicine, Dentistry and Biomedical Sciences (SMDBS). It is these collaborative partnerships that have been so crucial to implementing report card recommendations.

The most salient example of this collaborative approach has been the establishment of the Sustainable Healthcare Development Group. An organised forum for the PHRC student team to meet with senior staff within the School of Medicine, and Estates Directorate. Many, if not all, of the successes in implementing PHRC recommendations have originated from and/or been discussed by this group.

Some of the achievements from the implementation of PHRC recommendations across the five PHRC domains are listed below:

Curriculum:

Metrics in this domain have improved year-on-year as the Medical School continues to roll out its C25 curriculum, with "Global and Population Health" being one of four central themes. The Sustainable Healthcare Development Group have been involved in:

Supporting the development of new Planetary Health learning outcomes in the C25 Curriculum, in particular, through the SUSQI module for final years, and working on the inclusion of Planetary Health in the 'Medics in Primary Schools' Student Selected Component.

Providing Carbon Literacy Training for all Year 2 students.

Supporting in mapping UN Sustainable Development Goals to the curricula of both undergraduate and postgraduate taught courses.

Last year's PHRC lead at Queen's, Victoria England, is currently Regional Lead for the PHRC in the UK, and part of a delegation of students which met with the GMC to discuss the inclusion of Planetary Health in the next 'Outcomes for Graduates' and as curricula for future UK-wide Medical Licensing Assessments (MLA).

Community Outreach:

In addition to the number of community outreach events which take place across the University, the PHRC group has taken an active role in organising events with a Planetary Health focus. This includes hosting an event entitled "Climate Emergency Department" in the medical school, as part of the NI Science Festival in February 2023, focused on the effects of climate change on healthcare. This event took the form of interactive roleplay scenarios and was aimed at children and young adults who could attend for free. This project led to the PHRC group winning an award for "Outstanding Contribution to the Community" at this year's QUB Student's Union Awards.

Additionally, outreach within our own community of students, clinicians and academics has been an important aim. We have taken opportunities to facilitate discussion on Planetary Health and the need for its inclusion in the education of future healthcare professionals at several academic events

and conferences, including NICON, SHARE conference (Brighton & Sussex Medical School), INHED conference, Healthy Planet Healthy People, the QUB Annual Education Day. We also produced a blog as part of the University's Net Zero campaign.

Campus sustainability:

Campus sustainability remains the most challenging domain of the report card to implement recommendations, as illustrated in Figure 2, there has been little improvement in the score for this domain over the three successive report cards. Queen's already follows a number of important practices, such as composting food waste and retrofitting buildings to be more energy efficient. However, many of the metrics here rely on significant changes in university practice such as shifting to sourcing renewable energy, full divestment from fossil fuels and changes in waste management. We welcome the commitment to Net-Zero in the "Sustainability Action Plan", and also acknowledge that many potential changes fall outside of the remit of SMDBS. We look forward to the University-wide changes to come as a result of the new Net-Zero strategies.

Support for student Led initiatives:

Queen's is generally very supportive of student-led initiatives, and the number of these specific to, or inclusive of, Planetary Health are growing year-on-year. There are fewer opportunities available directly through the medical school, and we look forward to working with Queen's to improve these, including Summer Studentship opportunities. As a group, we held an event to coincide with the COP26 conference in Glasgow, which aimed to make Planetary Health more accessible for healthcare students, and to encourage students to act against climate change. We also submitted a number of applications to Queen's Green Fund, and as a result, Sustainable Cooking Classes have been held in QUB Elms accommodation, and discussions are ongoing to introduce food waste bins in libraries.

Interdisciplinary research:

There are a large number of Planetary Health aligned research streams at QUB, including work ongoing in the Centre for Public Health, Centre for Sustainability, Equality and Climate Action (SECA), the School of Biological Sciences and the School of Natural and Built Environment.

The QUB School of Medicine, Dentistry and Biomedical Sciences continues to be part of the Global Consortium on Climate and Health Education,[2] and has signed Health Declares: Climate Ecological Emergency[3], following recommendations of previous PHRC reports.

From a student perspective, one of the most exciting interdisciplinary developments is the ongoing discussions with staff and students in the schools of Pharmacy, Nursing, and Dentistry about PHRCs for their respective courses and the potential for further multidisciplinary collaboration that this brings. We also hope to team up with healthcare students from Ulster University, including from the new postgraduate Medicine course, to form a multidisciplinary Northern Irish group of students passionate about Planetary Health.

Climate breakdown is the biggest threat to human health in the 21st century[4]. Therefore, it is essential that healthcare students enter the workforce equipped with an understanding of the changing nature of the world they will work in and the ways in which they can shape their practice to meet changing global healthcare needs. The PHRC has proved to be valuable tool for facilitating collaboration, stimulating discussion, and driving change to make our university environment, our curriculum and, hopefully in time, our future medical workforce more Planetary Health conscious.

The report card for 2022/23 is available at: https://phreportcard.org/wp-content/uploads/2022/04/Queen_s-University-Belfast-PHRC-2021-22-1.pdf

Many thanks to all who have supported and encouraged us over the past three years, in particular to Professors Pascal McKeown, Neil Kennedy, Diarmuid O'Donovan, and Dr Vivienne Crawford.

Ryan McFall [1], Victoria England [2], Fionan McBride [3], Hannah McPhee [3], Mhairi Cowan [3], Riley Westwood [3], Sam Scholes [3]

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2. F1 doctor, Northern HSC Trust, NI
3. Medical Student, Queen's University Belfast

Email: ryan.mcfall@nhs.scot

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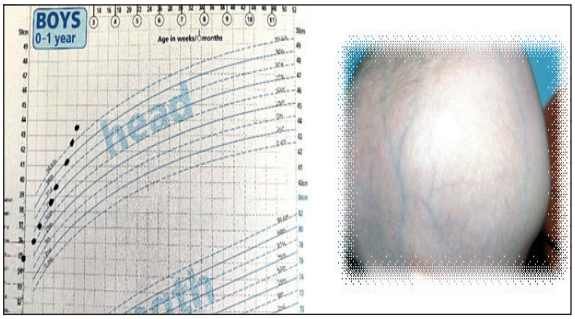
Ulster Med J 2023;**92(3):**173-174

Curiositas - Head Cases

QUIZ 1 - UG Quiz

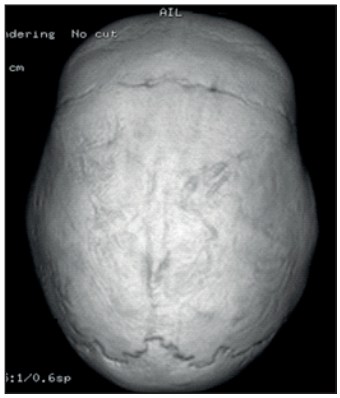


A 10-week-old infant is referred to your rapid response clinic by their health visitor with concerns regarding a rapid increase in their head circumference.

1. What abnormalities are seen in the images?
2. What is the most likely diagnosis and what other clinical signs and symptoms might you find?
3. What are the potential causes?
4. What management options are available?

Ruth Campbell (Year 5 Medical Student, QUB),
Dr Jennifer Wallace (Paediatric Registrar, RBHSC),
Dr Peter Mallett (Consultant Clinical Academic Paediatrician, RBHSC/QUB),
Dr Ben McNaughten (Consultant Paediatrician, RBHSC)

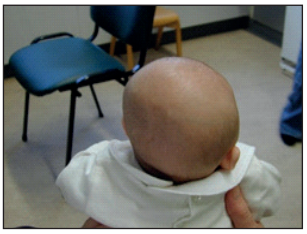
QUIZ 2 - PG Quiz



1. What is the diagnosis?
2. What signs might you notice on clinical assessment?
3. What are the complications of this condition if left untreated?

Megan O'Doherty (Year 4 Medical Student, Queen's University Belfast),
Dr Stephen Mullen (Paediatric Emergency Medicine Consultant, RBHSC),
Mr Mano Shanmuganathan (Consultant Paediatric Neurosurgeon, RBHSC)

QUIZ 3 - Historical



1. Who is the TV presenter in image (a) and what campaign did she launch?
2. Why might she inadvertently be responsible for the clinical signs seen in the infant shown in image (b)?

Cara Lucas (Year 4 Medical Student, Queen's University Belfast),
Mr Roy McConnell (Consultant Paediatric Neurosurgeon, RBSHC),
Dr Andrew Thompson (Consultant Paediatrician, RBHSC),
Dr Ben McNaughten (Consultant Paediatrician, RBHSC).

QUIZ 4 - And Finally…

1. Why is this the man we call when we have head problems?
2. Why might he also be useful if ship-wrecked on an "Island"?

Ruairi McGowan (Year 4 Medical Student, Queen's University Belfast),
Dr Andrew Thompson (Consultant Paediatrician, RBHSC),
Dr Ben McNaughten (Consultant Paediatrician, RBHSC)

CONSIDER CONTRIBUTING TO CURIOSITAS?

Please refer to *'Curiositas: Guidelines for contributors'* http://www.ums.ac.uk/curiositas.html and email curiositas@ums.ac.uk with your ideas and submissions.

Curiositas: Answers

QUIZ 1

1. The first image is a growth chart which demonstrates that the child has a rapidly increasing head circumference measurement which is crossing the centiles. The second image shows that the child has macrocephaly with distended scalp veins.
2. The most likely diagnosis is hydrocephalus. Other clinical signs that may be present include a wide open or bulging fontanelle, a broad forehead, 'setting sun' eye sign or squint (strabismus). Common symptoms include general irritability, lethargy, vomiting, poor feeding and/or seizures. The underlying pathogenesis can often be attributed to an abnormality affecting either the production of, and/or drainage and/or reabsorption of, cerebrospinal fluid (CSF). Congenital causes include anatomical abnormalities such as neural tube defects (e.g. myelomeningocele or other forms of spina bifida), Chiari malformations, syndromic or genetic disorders. Acquired causes include hydrocephalus attributed to intracranial haemorrhage (particularly intraventricular haemorrhage secondary to prematurity), intracranial infections, or benign and neoplastic brain tumours.
3. If a child is neurologically stable, non-surgical management may include close surveillance or pharmacologic management such as diuretics and corticosteroids, to decrease CSF production or aide reabsorption. In some acquired cases, such as infections and tumours, treating the cause may resolve the hydrocephalus. In acute or severe cases of hydrocephalus, surgical treatment is often required. This may involve ventriculoperitoneal (VP) shunt insertion or endoscopic third ventriculostomy (ETV). In cases of antenatal hydrocephalus, recent advances in foetal imaging and surgical techniques offer the possibility of in-utero surgical intervention, with potentially life-changing effects.

1. Thomale UW. Integrated understanding of hydrocephalus — a practical approach for a complex disease. *Childs Nerv Syst.* 2021;37(1):3313-24.
2. Deshmukh SN, Yadav AT. Clinical study and management of hydrocephalus in children. *Int Surg J.* 2020; 7(4): 1258-62.
3. Kahle KT, Kulkarni AV, Limbrick DD, Warf BC. Hydrocephalus in children. *Lancet.* 2016; 387(10020):788-99.
4. Tomycz LD, Hale AT, George TM. Emerging insights and new perspectives on the nature of hydrocephalus. *Pediatric Neurosurg.* 2017;52(6):361-8

QUIZ 2

1. The diagnosis is sagittal craniosynostosis (scaphocephaly). Craniosynostosis involves the premature fusion of one or more of the cranial sutures. Scaphocephaly is the most common subtype, accounting for 40 to 55% of isolated cases. Other subtypes include coronal, metopic, lambdoid and syndromic.
2. Scaphocephaly may present with progressive slowing of serial head circumference measurements on the infant's growth chart, ridging of the sutures, rhomboid (rugby ball) head shape and premature closure of the fontanelles. Clinical presentation alone is diagnostic in approximately 98% of patients.
3. Complications associated with craniosynostosis include increased intracranial pressure and inhibition of brain growth from prolonged uncorrected restriction of cranial growth. There may also be associated impairments in cognitive and neurodevelopmental function, including global developmental delay, poor feeding and weight gain. Cranial nerve involvement can also result in visual, hearing and speech deficits. Poor self-esteem and social isolation can often occur due to the abnormal appearance.

4. Greenwood J, Flodman P, Osann K, Boyadjiev SA, Kimonis V, *et al* Familial incidence and associated symptoms in a population of individuals with nonsyndromic craniosynostosis. *Genet Med.* 2014; 16(4):302-10.
5. Hamm JA, Robin NH. Newborn craniofacial malformations: orofacial clefting and craniosynostosis. *Clin Perinatol.* 2015; 42(2):321-36, viii. doi: 10.1016/j.clp.2015.02.005
6. Lazner M, Craver L, Goodhead H, Wilkinson H, Iliadis K. Paediatric Clinical Practice Guideline. Management of the odd shaped head (Plagiocephaly). Brighton: Brighton and Sussex University Hospitals, NHS Trust. 2020.

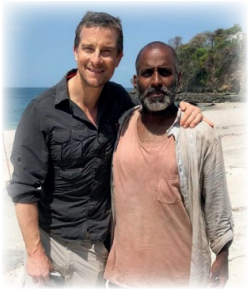
QUIZ 3

1. This is Anne Diamond, a British TV presenter and journalist. She is well known from launching the 'Back to Sleep' campaign in December 1991, following the death of her son, Sebastian, in his cot at just four months old. This campaign sought to reduce the number of infant deaths from sudden infant death syndrome (SIDS). SIDS is classified as the sudden death of an infant that is considered healthy, usually during a period of sleep. By educating parents to place their babies on their back to sleep, it resulted in a reduction of SIDS cases in the UK. In 1989 there were 1,545 cases of SIDS and a year after the campaign was launched, the number of cases fell to 647 in 1992.
2. As a result of her campaign, the incidence of positional plagiocephaly has increased. This is due to parents being advised to place their babies on their back (supine) whilst sleeping. Plagiocephaly is a medical term that refers to an asymmetrical appearance to an infant's head, that can result from placing a baby supine which leads to flattening and deformation of the back of the head. This positioning is supported by research that highlighted the correlation between SIDS and prone sleeping.

1. Kinney H, Thach, B. The sudden infant death syndrome. *N Engl J Med.* 2009; 361(8); 795-805.

QUIZ 4

1. This is Mr Mano Shanmuganathan. Mr Shanmuganathan is a paediatric neurosurgeon appointed to the Belfast Trust in 2014. He is an expert in craniofacial abnormalities in children and runs a joint craniofacial clinic for children in Northern Ireland alongside neurosurgical colleagues in Liverpool's Alder Hey Children's Hospital. He trained as a Paediatric Neurosurgeon in Edinburgh and Aberdeen and completed his higher sub-speciality training in Paediatric Neurosurgery and Craniofacial Surgery in Great Ormond Street Hospital and the National Hospital for Neurology and Neurosurgery, London.



2. In 2019 Mano survived being stranded on a desert island for 35 days as part of 'Treasure Island,' a TV show hosted by Bear Grylls. Not only did he survive, but he was crowned King of the Island taking home the cash prize which he subsequently donated to the Belfast Children's Hospital charity.

Book Case

BOOK REVIEW

Title: ***Every Second Counts: The Extraordinary Race to Transplant the Frist Human Heart***

Author: Donald McRae
Publisher: Simon & Schuster UK
ISBN-13: 978-1471135347
Cover: Paperback
RRP: £7.48

Every Second Counts is a truly fascinating story of the race to be the first to transplant a human heart. There were three teams of surgical staff attempting to claim that coveted prize, and this book provides a background to the surgeons, their experiences and varied approaches to undertake the high-risk operation. It guides the reader from the perspectives of all three teams and describes the impact of fame on the victor, South African Dr Christiaan Barnard.

Author Donald McRae opens with an appetiser, describing the weeks preceding that momentous event, before reversing to the beginning of the journey almost a decade prior. His layout of the race to successfully transplant a human heart provides the reader with an informative yet compelling narrative, describing how the varied characters of the three main surgical protagonists affected their approach when attempting the surgery. McRae must be commended on his obviously extensive research to write an evidence-based account of the fascinating area.

A true positive of this historical account is when McRae not only focusses on the medical aspect, but the effect personalities have on the approach to surgery: from the maverick Dr Barnard, who, it seems, valued being first rather than building more extensive transplant pre-op surgical experience, to Dr Norman Shumway and Dr Adrian Kantrowitz, who were more cautious.

McRae excels in providing a balance where in addition to his description of the transplant, he does not ignore the emotional side to the urgency during the procedure. Furthermore, an important facet of this book, is the consequence of achieving the metaphorical badge of the first surgeon to perform the operation; Dr Barnard instantly found worldwide fame which, ultimately, led to him touring the globe, and entering a different type of *theatre* through a rollercoaster personal life.

As there is a large volume of information provided about three separate surgical teams, connected only by the end goal, and occasional interaction, it could be said the narrative may be somewhat disjointed at times. However, this approach is necessary, given Dr Barnard only managed the transplant 3 days before Kantrowitz's attempt and thus the convergence on this event can only be fully appreciated by regularly visiting progress by each surgical group.

Overall, this book is not only for those readers with a medical interest, but provides an intriguing read of an historical event that describes the human impact of the race to be first to achieve a monumental feat.

Dr Andrew D Spence, Clinical Lecturer & Consultant Gastroenterologist,
Centre for Medical Education,
Queen's University Belfast

THE ULSTER MEDICAL JOURNAL

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