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We shape our tools, and thereafter, our tools shape us.

-Marshall McLuhan

Introduction

In ancient times, the Oracle of Delphi was believed to be the greatest source of knowledge, wisdom and prophecy. In modern times, it is the internet, and in the future, it will be artificial intelligence (AI). In ancient times, one had to make an arduous trek. Nowadays, we merely access any connected computer, tablet or

The Internet and the Rise of Artificial Intelligence in Critical Care Medicine: Opportunities, Threats, and the Practitioner-Patient Relationship

This article explores how pervasive and persuasive the internet is in current critical care practice, offers insights into how healthcare professionals, patients and families can critically appraise where information comes from and its content producers and discusses the opportunities and threats posed by AI on the physicians/team-patient/family relationships.

phone. The internet, free online medical education (FOAMed), and AI are increasingly the dominant sources for medical data, medical education, medical opinion, and medical predictions. Unfortunately, the same is true regarding medical disinformation. We now all – patient and provider alike – live in a digital age. This means we all need a degree of digital literacy; perhaps even a degree in digital literacy.

The use of the internet and AI is a massive and increasingly important topic. The internet is both pervasive and persuasive, and yet accessing information and opinion is not the same thing as knowledge or wisdom. At the very least, we healthcare providers (HCPs) need to direct our patients and students (and ourselves) towards higher quality resources and away from half-truths and nonsense. This also should engage reflection on our own online presence: what is expertise vs mere opinion, and how might this influence our current and future relationships with patients and families.

Patients, families and HCPs want fast access to reliable information, and the internet has certainly revolutionised our collective ability to do so. AI has the potential to dramatically increase both the speed and the access to information and appears set to revolutionise how we care for patients and families. Yet, above

all, humans want to be seen, heard and cared for. There is an ever-present danger that, as technology grows, it becomes master rather than servant. The goals of this article are therefore: 1) to discuss how pervasive and persuasive the internet is in current critical care practice, 2) to offer insights into how HCPs, patients and families can critically appraise where information comes from and its content producers and 3) to explore the opportunities and threats posed by AI on the physicians/team-patient/family relationships.

Consulting Dr Google: Medical Information on the Internet

The enormous increase in online medical information can make it difficult for everyone to distinguish signal from noise. This digital revolution is especially profound and disruptive because there now is a single, albeit vast, portal for education, opinion, information, and disinformation. Unless there are internet firewalls and restricted journal access, we also have a single portal for HCPs, patients and families. When compared to traditional medical forums (i.e. textbooks or journals), online material can be disseminated faster, wider and cheaper. The downside is that there is often less time for expert review and contemplation.

While the old ways of disseminating medical information (textbooks, peer-review, expensive journals) were far from perfect, there are dangers with relying solely upon internet searches. For example, it is unclear who or how information is filtered and who or how they are monetising the process. In short, most search algorithms are proprietary, and many revenue streams are opaque. In the 1960s, the philosopher Marshall McLuhan argued that “the medium is the message” (McLuhan 1964). Accordingly, part of being a modern human - a member of “homo digitalis” - is understanding how the digital medium not only spreads messages but morphs them.

Health is one of the most searched topics online. There are at least 500 million daily tweets (Twitter Stats 2023) and four billion daily Google searches (Internet Stats 2023). This single search engine constitutes nine out of every ten searches, and the company is valued at over \$1.5 trillion. We live in an attentional economy, where more profit is made by keeping our attention rather than ensuring the truth. Moreover, anybody with a laptop, tablet or smartphone can now promote their ideas, regardless of whether these are grounded in science or mere opinion and regardless of whether or not they have any expertise.

Nowadays, medical information is less owned by HCPs or medical journals. Producers can game the algorithm using techniques like keyword stuffing and link-building, thereby making content look more relevant and more accurate than is warranted. An example during the pandemic was the Frontline Covid-19 Critical Care Alliance (FLCCC) website. This site promoted unproven, potentially harmful, therapies. The issue is that its professional appearance likely worsened relations because patients and families expected to receive harmful therapies such as ivermectin and hydrochloroquine. In the same vein, Google’s algorithms recently shifted from quality content to content optimised for advertising. The move from organic content to paid advertisements can make it harder to find useful, unbiased information. Search engines can also diminish diversity of opinion, given that over three-quarters of us never scroll past the first page of suggested

sites. In short, if a source is not ranked on the first page, then it is unlikely to be read or to influence the debate.

The internet not only makes it quicker to find resources but also easier to criticise and dismiss (Wilkinson et al. 2019). Medical information has been democratised, but the cautious, iterative, scientific method is under threat. Traditional crucibles of medical debate have less of a monopoly over what is considered mainstream or trustworthy. Journals also have fewer paid subscribers and, therefore, face unpredictable futures. Digital publication is now associated with over 30,000 journals on PubMed alone. This makes it harder for most of us to remain current or claim broad competence.

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Anyone with a significant online presence can have an influence disproportionate to their scholarly standing or clinical expertise (Cameron et al. 2017). Moreover, social media is playing an ever-increasing mainstream role. Accordingly, Facebook™, WhatsApp™, Wikipedia™, YouTube™ and X™ (formerly Twitter) are increasingly important sources of medical information for the public. Importantly, however, the same is true for HCPs. Blogs, podcasts and websites are increasingly recommended over textbooks and journals for teaching and learning (Cadogan 2014; Eysenbach 2011; Thoma 2015).

Because of the deluge of information, readers, HCPs or patients/families are, nowadays, more likely to scan, rather than fully engage, absorb and reflect. There may be less patience for nuance

or interest in ideas that challenge bias. Virtual communication also makes it easier for humans to be anonymous, rude, and dismissive. Accordingly, traditional publishers and academic institutions face an existential dilemma. Namely, to what degree should they embrace digital media to be popular or stay relevant? Websites, blogs and videos can receive thousands more views than journal articles and reach previously untapped audiences. In contrast, an excessive online presence can also tarnish standards, reputation and brand. Universities also face uncertainty regarding how best to recognise and reward non-traditional scholarly output from their faculty and whether they can (or should) censure online heretics. In other words, we must be cautious not to equate worth with ease of access or popularity (Cameron et al. 2017).

Returning to Marshall McLuhan, the digital revolution has affected not only how we report medical ideas but also whether they persist. Ideas (i.e. packages of information) can now spread like viruses (i.e. packages of genetic information). Similarly, memes (units of cultural information) compete like genes (units of genetic information). Regardless, the internet has dramatically affected how ideas are birthed, raised, and matured. It has also affected how we interact as humans.

Families Searching Doctors; Doctors Searching Patients

Many families of critically ill patients turn to internet searches when someone they care for is admitted to the ICU. They go online to better understand the disease and to seek out support. However, many also search for their physicians to understand who they are, their expertise (or lack thereof), their publications, and their ratings. Upon being introduced, it is not infrequent - though it can be disconcerting - to have family members inform HCPs that they have ‘read all about them’. Being the subject of internet searches by patients feels, well... awkward. Even if we have posted the information ourselves, it can feel like starting a conversation with a person whose name you have forgotten, or, once met but cannot place.

What is less well-known is that many physicians also “Google” their patients (Belisomo 2015; Brown 2019). Sometimes searches are performed at the patient’s request to understand their career (e.g. artist, photographer), to determine if that patient is delirious, or, more controversially, to look up details of their lives (Belisomo 2015; Brown 2019). Regardless, the reciprocal nature of these online searches shows how internet searches have profoundly affected how modern humans interact.

HCPs might go on ward rounds without a stethoscope now, but few of us are ever far from an internet connection. Along with looking up patient records and journals, HCPs also search the internet to better understand behaviours, fads or health crazes. These could range from beliefs in alternate drugs (e.g. ivermectin in COVID), dietary cleanses (e.g. high dose baking soda), or new illicit drugs (i.e. carfentanyl, xylazine) or eccentric practices (e.g. ingesting Tide pods). Of note, these Google searches usually yield faster results than traditional medical searches. They also show exactly what people are reading and exploring.

It can be challenging to answer every internet-related question a family has. Regardless, it is a way to show that we are eager to partner, maintain dialogue, and build trust. For patients and families, it is a way to feel empowered, but it can also result in misinformation, anxiety, and, at times, an exaggerated sense of understanding. The challenge for both parties is to navigate this landscape with trust, transparency, integrity, and patient-centredness. It starts with a basic understanding of what is quality online information and what is not.

Online Medical Information: It’s Popular, But Is It Any Good?

The term “Free Open Access Medical Education”, aka “FOAM” or “FOAMed”, reportedly originated in an Irish pub. Apparently, a doctor was preparing a talk and stared at a half-emptied beer glass. This individual wanted to encapsulate the proliferation of free online open access medical education, and FOAM was

coined (Shaw 2013). These online resources include blog posts, podcasts, online videos, Facebook groups, Twitter feeds, and Google Hangouts. To date, the largest proportion of FOAM comes from emergency medicine, with lesser amounts from critical care medicine and anaesthesiology. North American sources currently predominate.

While some have raised concerns with FOAMed and emphasised the need to wait for qualified experts, others argue that online medical material is now unavoidable. If so, the focus should be on whether digital resources are higher versus lower quality and higher versus lower influence. Ways to gauge the quality of online work include the Medical Education Translational Resources Impact and Quality (METRIQ) study collaboration (<https://metriqstudy.org/>) and the Critical Care Medical Education Website Quality Evaluation Tool (CCMEWQET) (Wolbrink 2019). Many scoring systems also exist and include the Social Media Index,

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the ALiEM AIR score, and the Revised METRIQ Score. Others (Ting et al. 2020) have also identified ten tools, categorised into those that help readers and those that rate producers.

In addition to assessing the quality of online products, we can assess producers (i.e. authors). The h-index is a traditional metric used to estimate the productivity of an individual scholar. It is the maximum value where a given author has published h-papers each cited h-times (Hirsch 2005). Albeit slightly tongue-in-cheek, a similar index was developed for the social media age. The Kardashian Index (KI) (Hall 2014) refers to Kim Kardashian, someone with innumerable online followers but

no official scientific credentials. The serious point is that in the digital age “influencers” (whether celebrities or academics) can have a greater impact- or lesser impact- than their academic standing warrants (Brindley et al. 2022).

AI and Big Data in Critical Care Medicine: Servant, Not Master

AI refers to computer systems that perform tasks that would otherwise require human intelligence. These include, but are not limited to, pattern recognition and decision-making. These are usually powered by big data, namely huge data sets that can be analysed computationally to reveal trends and associations. Critical care medicine is on the cusp of an AI explosion (Hong et al. 2022; Saqib et al. 2023; van de Sande 2021). Potential AI applications are currently limited only by our human imagination and programming power. In time, however, AI holds the prospect of devices updating their own algorithms and generating their own searches.

AI already has the ability to predict patient deterioration (Chen et al. 2022; Cho et al. 2020), diagnose/predict the development of sepsis (DeCorte et al. 2022; Pai et al. 2022), predict the development of surgical site infections (Hopkins 2022), prognosticate ICU outcomes from a variety of critical illnesses, predict the effectiveness of triage, determine the best time to initiate intubation (Im et al. 2023; Nopour et al. 2023; Siu et al. 2020), and predict weaning from mechanical ventilation, extubation and safe ICU discharge (Abad et al. 2021; de Vos et al. 2022; Fabregat et al. 2021; Liu et al. 2022). It can predict the impact of ICU surge on patient mortality (Greco et al. 2022), the time to death after withdrawal of life support, and the success of organ transplantation (Yu et al. 2022). It may soon be able to anticipate the factors that create ICU physician/team stress and strain, identify training needs and predict future outcomes. The potential implications for patient care and the HCP-patient/family relationship could be staggering.

Rather than blindly accepting everything AI purports to offer, we should embrace our traditional academic scepticism. In other words, we should insist on high-quality research and wise reflection before implementation. We should accept that AI's potential is virtually unlimited and, therefore, both exciting and scary. The anxiety surrounding AI includes what data it accesses/includes/excludes, and what algorithms are used. It matters what AI deems to be important/irrelevant (cost, quality of care, quality of life, etc.) in arriving at its results/predictions; an opacity often called its 'black box'. As with any decision-making algorithm, whether human or machine, there is concern regarding bias and discrimination (Hong et al. 2022; Lorenzini et al. 2023; Mittelstadt 2021). The ability of AI to predict and its quality of output depends on the quality of its input. Without good quality research (input) the effect of internet popularity may impair its usefulness (output).

There is also anxiety about how human values, beliefs and lived experiences will be taken into account, if at all (Hong et al. 2022; Lorenzini et al. 2023; Mittelstadt 2021). To date, relatively few research studies have explored the lived experiences of critical illness. While some are now including patients and families as co-researchers to better understand their needs and priorities (Douma et al. 2021; Douma et al. 2023), AI risks moving us further from such considerations due to the dearth of such research and the speed of its own development. The concern is that CCM will see an erosion of patient-centred care and a loss of its humanity.

Many have argued that HCPs do not need to fully understand how AI works to use it as a tool. We disagree. This is because AI may provide more than just data that we can choose to ignore. It may guide decision-making and be far more determinative, especially if used to prognosticate, and especially if/when AI exceeds human intelligence.

AI's Potential Effects on HCP-Patient/Family Relationships

While the potential of AI is not yet realised, discussions of its potential impact on HCP-patient/family relationships (Mittelstadt

2021; Nagy and Sisk 2020; Saqib et al. 2023; Sauerbrei et al. 2023) have begun. These have focused on AI's ability to expand knowledge and understanding of health and illness. It has also been suggested that AI may enhance HCP-patient/family relationships by freeing up HCPs from more administrative tasks, allowing them to spend more time with patients, though whether this is realistic is not clear.

AI could supplant physicians in core knowledge, could be better at generating differential diagnoses, and could be quicker with decision-making. It is anticipated that physicians who use AI as an assistive tool will outperform those who do not. In time, we may even be mandated to use AI. Its enhanced ability to prognosticate may also have implications for how we triage scarce resources. Families currently, and understandably, raise concerns if they believe physicians are making decisions based on imperfect prognosticators. They are not likely to be any happier when algorithms and computers decide, even if the prognostications are more informed. Fears have already been raised about a return to more paternalistic care, this time governed by machines (Lorenzini et al. 2023).

Alternatively, AI offers many putative advantages. For example, with better prognostication, we could spare families weeks of organ support if we know the outcome will be bad or increase their resolve if we know there is a good chance. For those wrestling with whether to offer organ donations after cardiac death, they could be spared the distress if we knew that the patient would not die in the necessary timeframe. AI predictions of survival post-transplant could also result in better matching of donors and recipients, thereby improving both the likelihood and quality of survival.

Whether its benefits will ultimately outweigh its risks, it seems certain that AI could challenge how trust is earned and kept within HCP-patient/family relationships. To maximise the potential of AI, perhaps the best way forward is to learn from our past. Rather than wait for patients and families to come to us, we should accept they will have searched the internet and are likely to have questions. This means that -like it or not- part of our modern job

includes reviewing AI searches/data together, translating what it means, and ensuring it is discussed in human terms.

Conclusion

AI's opportunities and its risks to the doctor-patient relationship were explored in the report, "The Impact of Artificial Intelligence on the Doctor-Patient Relationship"; commissioned by the Steering Committee for Human Rights in the field of Biomedicine and Health. In brief, these included: (1) Unequal access to this technology; (2) Insufficient transparency regarding inconclusive and misguided evidence; (3) The risk of social bias; (4) Diluting the patient's account of well-being; (5) The risks of automation bias, de-skilling, and displaced liability; and (6) A loss of privacy (Mittelstadt 2021). The report also questions what standards AI will be held to in relationship to professionalism and duty of care.

The use of machines and computers is central to critical care medicine, and these devices are becoming increasingly smart in their nature. While exploring technology's cutting edge, it is crucial to keep the focus on the relationship between provider and recipient. AI is a remarkable tool we should harness, yet its ultimate benefit or harm rests with how we control it. Patients and HCPs want reliable information, but above all, humans want to be seen, heard and cared for. We cannot forget that healthcare is, and should always be, about human connections, not just online connections. We just need to remember that with the tremendous power of AI comes great responsibility, and we need to apply it wisely.

Conflict of Interest

None.

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