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Medical Machines: The Expanding Role of Ethics in Technology-Driven Healthcare

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Article abstract

Emerging technologies such as artificial intelligence are actively revolutionizing the healthcare industry. While there is widespread concern that these advances will displace human practitioners within the healthcare sector, there are several tasks – including original and nuanced ethical decision making – that they cannot replace. Further, the implementation of artificial intelligence in clinical practice can be anticipated to drive the production of novel ethical tensions surrounding its use, even while eliminating some of the technical tasks which currently compete with ethical deliberation for clinicians' limited time. A new argument therefore arises to suggest that although these disruptive technologies will change the face of medicine, they may also foster a revival of several fundamental components inherent to the role of healthcare professionals, chiefly, the principal activities of moral philosophy. Accordingly, "machine medicine" presents a vital opportunity to reinvigorate the field of bioethics, rather than withdraw from it.

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Medical Machines: The Expanding Role of Ethics in Technology-Driven Healthcare

Canadian Bioethics Society / Société canadienne de bioéthique
Concours de rédaction / Writing Contest

Connor T.A. Brenna[a]

Résumé
Les technologies émergentes telles que l'intelligence artificielle révolutionnent activement le secteur des soins de santé. Si l'on craint généralement que ces progrès ne remplacent les praticiens humains dans l'ensemble du secteur des soins de santé, il existe plusieurs tâches – dont la prise de décisions éthiques originales et nuancées – qu'ils ne peuvent remplacer. En outre, la mise en œuvre de l'intelligence artificielle dans la pratique clinique devrait susciter de nouvelles tensions éthiques autour de son utilisation, même si elle élimine certaines des tâches techniques qui sont actuellement en concurrence avec la considération éthique concernant le temps limité des cliniciens. Un nouvel argument émerge donc pour suggérer que si ces technologies perturbatrices vont changer le visage de la médecine, elles peuvent aussi favoriser un renouveau de plusieurs composantes fondamentales inhérentes au rôle des professionnels de la santé, notamment, les principales activités de la philosophie morale. Par conséquent, la « médecine des machines » offre donc une opportunité vitale de revigorer le domaine de la bioéthique, plutôt que de s'en retirer.

Mots-clés
intelligence artificielle, apprentissage automatique, technologies émergentes, bioéthique, principes éthiques, rôles traditionnels, soins de santé

Abstract
Emerging technologies such as artificial intelligence are actively revolutionizing the healthcare industry. While there is widespread concern that these advances will displace human practitioners within the healthcare sector, there are several tasks – including original and nuanced ethical decision making – that they cannot replace. Further, the implementation of artificial intelligence in clinical practice can be anticipated to drive the production of novel ethical tensions surrounding its use, even while eliminating some of the technical tasks which currently compete with ethical deliberation for clinicians' limited time. A new argument therefore arises to suggest that although these disruptive technologies will change the face of medicine, they may also foster a revival of several fundamental components inherent to the role of healthcare professionals, chiefly, the principal activities of moral philosophy. Accordingly, "machine medicine" presents a vital opportunity to reinvigorate the field of bioethics, rather than withdraw from it.

Keywords
artificial intelligence, machine learning, emerging technologies, bioethics, ethical principles, traditional roles, healthcare

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DISRUPTION AND ROLES IN MODERN MEDICINE

The landscape of medical practice is continuously and rapidly evolving, as are the roles of modern practitioners. The etiology of this transformation is multifactorial, involving phenomena such as a swell in the pool of medical knowledge that must be integrated into educational curricula (1), growing attention to "patient-centred care" driven by advancements in clinical research which have afforded patients the possibility of more (and more meaningful) decisions in their treatment (2), and an increasing focus in North American healthcare on providing efficient and high-value care within the constraints of a limited financial and temporal budget (3). Together, these present many actionable targets for disruption and advancement, and individual technologies have demonstrated the capacity to revolutionize a liminal healthcare industry. Recent history provides several examples: the considerable advantages of electronic medical records (logistically, economically, and environmentally) over paper charts are changing the way that providers create, store, and share information (4,5); advances in telecommunication services have generated the field of telemedicine, which can instantaneously connect providers to patients formerly without access to healthcare (6,7); "telerobotics" (remotely-controlled surgical robots) allow surgeons to perform minimally invasive operations on patients in different time zones (8); and genetic sequencing technology is ushering in an era of personalized medicine in which individual physiological markers can predict clinically-significant responses to tailored therapies (9). Presently, artificial intelligence (AI) is bringing extraordinary computational models of intelligent behaviour to healthcare, which are able to operate independently from human intervention (10). Although AI is still an evolving innovation, there is considerable evidence to suggest that machines can augment or even outperform human beings in several domains of healthcare (10-14). This development has prompted a high degree of speculation as to which roles future providers will cede and which ones they will retain, when working in parallel with AI (15,16). The present article offers a novel perspective to this discussion, arguing that AI may revolutionize many aspects of medical practice, perhaps even making some obsolete, but that the role of bioethics in practice will endure and flourish through this transformation.

While some innovations, such as surgical simulation, have been identified as helping to relieve ethical tensions extant within the healthcare system (17), the advancement of AI is instead expanding the ethical spaces occupied by clinical

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bioethicists (18,19). New diagnostic and treatment options prompt novel thought surrounding the potential for misuse and the burden of responsibility in the context of erroneous decision making (20): the development of AI has been closely followed by questions around data stewardship (21,22), implicit discrimination (18), and legal liability (15). It is not yet clear who – if anyone – ought to be accountable for errors made by AI, nor are we fully able to predict all of the consequences which would follow from its displacement of human beings from jobs we now perform. These care-altering advances also necessarily pose questions of who will have access, who will pay, and who is entitled to their use, but it is uncertain how we could ensure that they benefit all patients equitably. In parallel with the new ethical challenges presented by AI, it can be expected to change the role of individuals working in healthcare just as other technologies before it have done. How many – and which – of the litany of healthcare professional roles will be altered remains unclear.

Chang (12) offers a starting point for an analysis of this concern by dividing the core tasks of a physician into three categories: *perception*, the interpretation and integration of visual phenomena such as an x-ray film or a skin rash; *operation*, the physical procedures such as a surgery or a biopsy; and *cognition*, the creative problem-solving and complex decision-making such as that which is required for diagnosis and management. The author continues by stating that AI promises improvement in perception tasks but has not yet demonstrated ability in the other two areas (12). This claim continues to find validation in the emerging applications of AI: moral philosophy, which is incited by this new technology, remains an exercise of the cognitive domain which AI has not yet accomplished.

ARTIFICIAL INTELLIGENCE IN HEALTHCARE

Artificial intelligence is signalling toward a transformative role in healthcare, leveraging an unprecedented availability of digital healthcare data and modern advances in processing power and analytic technique in order to find new applications in areas such as oncology, cardiology, and neurology (23). These technologies show undeniable promise as a near-future tool in healthcare, particularly for certain pattern recognition tasks such as the diagnosis of disease from visual inputs (12). These include, for example, the assessment of radiologic scans or photographs of dermatologic lesions.

The frontiers of medical research provide several examples of this promise. In a recent study by Bejnordi *et al.* (23), deep learning (a form of machine learning which employs hierarchical layers of data processing to “train” and modify its own algorithms) demonstrated a greater ability to discriminate normal and metastatic lymph nodes than a panel of expert pathologists working in a simulated setting. Haenssle *et al.* (24) reported that a deep learning convolutional neural network was comparable to a panel of dermatologists when it came to the task of detecting melanomatous lesions in dermoscopic images. A recent clinical trial organized in the United States demonstrated an AI system’s ability to detect diabetic retinopathy with specialty-level skill from ophthalmological images of real patients’ eyes (25). Watson, a supercomputer developed by IBM Corporation, uses semantic technology and deep learning to find applications in (among other places) the healthcare system, applied across spheres of research, diagnosis, and therapeutic decision making (26-28). Watson for Oncology, a collaboration between Memorial Sloan Kettering Cancer Centre and IBM, applies machine learning to existing data sets in order to determine how it can best recommend treatment for a variety of cancers; recently, this technology has demonstrated remarkable concordance with professional tumour boards (29).

Given these encouraging manifestations of AI in medicine, it is evident why healthcare AI is securing more global investment than research in any other sector (30,31). However, this enthusiasm (or nervousness) for a new era of healthcare must be tempered with an understanding of the limitations of AI. Although several of these technologies have demonstrated promise in the diagnosis of disease through pattern recognition, there are certain tasks inherent to medical practice which AI has not yet shown any indication that it can replace. Among these are the “cognitive” tasks identified by Chang (12), as well as the innately human contributions to medical care. Central to these are the ethical responsibilities of clinicians which, as many other facets of healthcare are revolutionized or replaced by AI, will not be diminished. Rather, these human roles which AI cannot perform will persist and flourish as increasingly critical parts of our practice.

ENDURING PRINCIPLES OF HEALING

Underpinning healthcare are several competencies that necessarily fall under the umbrella of human enterprise. These include the “soft skills”, i.e., components of medical practice that transcend applied science, such as empathy, integrity, and therapeutic listening. This group also includes ethical practice, because moral reasoning and decision making are necessarily matters of private conscience. Computers can offer assistance in clinical decision making, but they cannot balance the ethical principles surrounding care which are constructed and explored by human minds (32,33). Although the primary strength of AI is to learn and train from datasets to identify similarity in new inputs – for instance, correctly marking a tissue sample as likely neoplastic due to its resemblance to other samples it has seen which are known to be neoplastic – there are presently no comparable sample sets in ethics. The field of bioethics is constantly reinvigorated with new questions that emerge from our evolving environment, including from these technologies themselves, as well as new ideas and interpretations put forward by bioethicists. There is no threshold of processing power past which a computer could synthesize and weigh new moral ideas in the absence of previous cases of similar moral judgement, and so healthcare professionals’ intrinsic commitment to bioethics is therefore not replaceable by AI.

The role of bedside bioethics is, in fact, one of the increasingly few things that the future of healthcare has in common with its own historical nature. The evolution of medical ethics as a component of clinical practice dates back to the Hippocratic Oath,

sworn by physicians for more than two millennia, which is fundamentally a commitment to ethical care (34). Subsequent forms of medical ethics materialized in Thomas Percival's Code of Ethics, and ultimately, in Canada, in the CanMEDS roles (17,35,36). Across these various manifestations, the core values of professional medical ethics are largely unchanged. Each of these renderings is united by a fundamental concern for patient wellbeing, and the provision of high-quality, non-biased care (37). These enduring ethical values in medicine highlight a uniquely parabolic nature of past, present, and future practice. The last several centuries have seen an increasingly rapid uptake of new technologies managed by healthcare professionals (for example, improvements in imaging and the invention of the balloon catheter helped to create the field of interventional medicine and therefore the demand for interventional radiologists), and the next several centuries can be expected to yield a decreasing role for these same professionals in operating forthcoming technologies like AI (which are lauded for, among other reasons, the expectation that they will be able to function independently from human operation). Before the popularization of modern medical advances, which promoted highly-specialized and siloed patient care (for instance, the true "general practitioner" has been subdivided into some physicians who read scans or stain tissue samples, and others who rely on their services to discern and treat difficult diagnoses), the role of the physician bore a greater focus on the myriad aspects of holistic care: the historical role of "healer" had less depth, but greater breadth, in its interactions with patients (38). Although many of these aspects have been sidelined by a growing focus on evidence-based medicine (39), the medical experience continues to be greater than the assignment of treatment to ailment. Patient values and clinical judgment bear their own weight in this analeptic exchange, beyond statistical and probabilistic evidence in clinical decision-making, and with the replacement of those parts of healthcare which are thought to be replaceable by machines (such as the latter), it can be anticipated that there will be a resurgence of the traditional, therapeutic, and moral roles of the "healer" (38).

Even within an environment dominated by technology, healthcare professionals retain these uniquely human roles. While other aspects of their work are being replaced by operating machines or following algorithms (for example, trauma teams now perform an ultrasound scan to look for internal abdominal bleeding where they once would have done a diagnostic peritoneal lavage, a much more time-consuming and risky procedure to look for blood), their focus on ethical care remains. As technologies increase the efficiency of – or altogether replace – other time-consuming tasks, the focus of human practitioners on these other, purely-human aspects of therapy may logically and reciprocally increase.

AN ARGUMENT FOR THE EXPANSION OF ETHICS IN MODERN MEDICINE

The historical outcomes of previous disruptive medical technologies, in concert with early evidence on the efficacy of AI for performing certain diagnostic tasks, support a sentiment that the role of all healthcare professionals can be expected to change with the implementation and full integration of these new emerging technologies in medicine. The degree of change is likely to be variable, as present AI technologies are demonstrating more ready replacement of medical specialties reliant on pattern recognition (for example, the diagnosis of pathology from a scan or tissue sample), while there is a paucity of AI technologies able to perform more procedural tasks (for example, the removal of a tissue sample by a surgeon) (12). Even as the role of healthcare providers changes to better suit a new clinical environment, however, the ethical duties which they uphold remain intrinsically and exclusively within the purview of human providers. These materializing technologies can also be expected to challenge bioethicists by producing a new division of original ethical tensions (18), thereby augmenting their role and workload with new questions surrounding if and how AI can be used to provide ethically robust care. This can be observed in real time, in the field of genome editing, where embryonic DNA modification is becoming increasingly practical and concurrently illuminating new frontiers in synthetic genomics and the bioethical distinction between therapy and enhancement (40). Simultaneously, new technologies are anticipated to decrease the demands of occupations reliant on skills such as pattern recognition, thereby redistributing the focus of those working within the healthcare industry away from "replaceable tasks" and towards those things which cannot be replaced, such as bioethics. In a future where diagnosis and management may be more adeptly performed by AI, the other cognitive skills of clinicians and bioethicists will have an expanded role. The full integration of blossoming AI applications in clinical medicine will place demands on this role both in experimental settings, which necessitate facilitators and regulators (exploring and safeguarding issues like confidentiality and responsibility), and at the point of care (where it encompasses moral decision making, bedside manner, the development of trust in the therapeutic alliance, and the sharing of narratives and empathy).

Perhaps counterintuitively, a combination of these two consequences of disruptive technologies like AI in healthcare – the production of novel ethical problems and the reduction in demand for more concrete, technical tasks – will nourish the field of medical ethics. In stark contrast to concerns that emerging technologies are going to dehumanize healthcare, it is reasonable to believe that appropriate systems-level planning can, by redistributing professional roles (towards ethical tasks and the other "soft skills" of clinical practice), ensure that it will do exactly the opposite. The unification of bioethicists and technologists on endeavors of policy creation around the development and application of AI will further reinforce the roles of both professions in the future of clinical medicine. The coming era of machine medicine, wherein disruptive technologies will remold the healthcare arena and the roles of its providers, presents a unique opportunity to safeguard bioethics as the enduring cornerstone of quality healthcare.

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