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*Leslye Denisse Dias Duran*[*]

# Deskilling of medical professionals: an unintended consequence of AI implementation?

## Introduction

In the last decade, the development of applications powered by artificial intelligence algorithmic architectures, especially machine learning, has increased exponentially thanks to heightened computational power, the availability of digital data in large amounts, and more mature and sophisticated algorithmic models. As a result, there has been a surge in academic, scientific, and journalistic publications concerned with the benefits that AI could bring to a variety of sectors, including healthcare[1]. So far, we have seen the rise of models capable of making highly accurate predictions in radiology[2], detecting diabetic retinopathy[3], diagnosing the presence or absence of tuberculosis[4], as well as helping in diagnosing breast cancer[5] and detecting diabetes[6], among many other projects. Some research, fascinated by these results and other recent studies, sug-

[*] PhD Student in Philosophy. Ruhr-Universität Bochum.

[1] S. Castagno, M. Khalifa, *Perceptions of Artificial Intelligence Among Healthcare Staff: A Qualitative Survey Study*, in "Frontiers in Artificial Intelligence", 2020, pp. 1-7.

[2] J.H. Thrall, *et al.*, *Artificial Intelligence and Machine Learning in Radiology: Opportunities, Challenges, Pitfalls, and Criteria for Success*, in "Journal of the American College of Radiology", 2018, pp. 504–508 <https://doi.org/10.1016/j.jacr.2017.12.026>.

[3] V. Gulsha, *et al.*, *Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs*, in "JAMA", 2016, pp. 2402-2409 <https://doi.org/10.1001/jama.2016.17216>.

[4] P. Lakhani, B. Sundaram, *Deep Learning at Chest Radiography: Automated Classification of Pulmonary Tuberculosis by Using Convolutional Neural Networks*, in "Radiology", 284, 2, 2017, pp. 574–582 <https://doi.org/10.1148/radiol.2017162326>.

[5] Y. Liu, *et al.*, *Detecting Cancer Metastases on Gigapixel Pathology Images*, in "MICCAI Tutorials", Quebec, 2017 <http://arxiv.org/abs/1703.02442>; M.J. Cardoso, *et. al*, *Artificial Intelligence (AI) in Breast Cancer Care – Leveraging Multidisciplinary Skills to Improve Care*, in "The Breast", 56, 2021, pp. 110–113 <https://doi.org/10.1016/j.breast.2020.11.012>.

[6] N. Nnamoko, I. Korkontzelos, *Efficient Treatment of Outliers and Class Imbalance for Diabetes Prediction*, in "Artificial Intelligence in Medicine", 104, 2020, pp. 574-582 <https://doi.org/10.1016/j.artmed.2020.101815>.

gests that AI-powered applications have the potential to improve patient outcomes by a range of 30% to 40% while decreasing treatment costs by up to 50%[7].

However, hand-in-hand with the opportunities come risks and possible unintended consequences. Much has been said about problems of bias and discrimination[8]; the black-box issue stemming from the opacity of highly accurate models[9] and their lack of interpretability and transparency[10]; the potential risks to privacy[11] and informed consent, among others. These risks belong to the phases of conception and design of AI models; further down the line, however, there are also risks associated with deployment and supervision. In other words, risks present at the point when applications encounter direct and indirect end users.

In the case of healthcare, it is not yet clear if direct users are medical professionals, medical administrative staff, or patients themselves. For the purpose of this paper, I take physicians and other highly skilled medical personnel (radiology clinicians, nurses, etc.) as those whose skills and employment opportunities may be negatively affected and will attempt to consider ethical implications of technical and moral deskilling as an unintended consequence of the application of machine learning in healthcare.

## Labor displacement and the notion of deskilling

The question of whether artificial intelligence could replace humans in the workplace has been around since the early stages of the discipline's development. However, it seems to have gained particular relevance alongside increased research funding in academic and corporate settings. A survey from Gruetzemacher and others shows that, accor-

[7] A.S. Ahuja, *The Impact of Artificial Intelligence in Medicine on the Future Role of the Physician*, in "PeerJ", 7, 2019 <https://doi.org/10.7717/peerj.7702>.
[8] J.C. Weyerer, P.F. Langer, *Garbage In, Garbage Out: The Vicious Cycle of AI-Based Discrimination in the Public Sector*, in "Proceedings of the 20th Annual International Conference on Digital Government Research" (presented at the dg.o 2019: 20th Annual International Conference on Digital Government Research, Dubai United Arab Emirates: ACM, 2019), pp. 509–511 <https://doi.org/10.1145/3325112.3328220>.
[9] D. Castelvecchi, *Can We Open the Black Box of AI?*, in "Nature News", 538, 2016, pp. 20–23 <https://doi.org/10.1038/538020a>.
[10] W. Samek, *et al.* (ed. by), *Explainable AI: Interpreting, Explaining and Visualizing Deep Learning*, Springer Nature, Cham 2019 <https://doi.org/10.1007/978-3-030-28954-6>; J. Zerilli, *et al.*, *Transparency in Algorithmic and Human Decision-Making: Is There a Double Standard?*, in "Philosophy & Technology", 32, 4, 2019, pp. 661–683 <https://doi.org/10.1007/s13347-018-0330-6>.
[11] K. Manheim, L. Kaplan, *Artificial Intelligence: Risks to Privacy and Democracy*, in "Yale Journal of Law and Technology", 2018, pp. 106–189.

ding to AI practitioners, the median percentage of human tasks that are susceptible of being automatable is 22%, with the likelihood of an increase to 40% and 60% in five (by 2025) and ten years (by 2030), respectively. Accordingly, there is expected displacement of labor, with a median forecast of 50% in 25 years, as a consequence of widespread use of AI technologies[12].

In healthcare, the success of models capable of making predictions that surpass the overall accuracy of medical professionals in a variety of medical subfields has prompted projections of labor displacement that have caused backlash in the medical community[13], although, many physicians and medical researchers have raised their voices to debunk this, still unrealized, myth[14]. Nevertheless, even if the implementation of new technologies does not result in labor displacement, it has brought forward another concern about the negative repercussion of these technologies on the abilities of physicians and other medical professionals.

This phenomenon is known as 'deskilling', and in economic theory it describes the situation where skilled labor is reduced or even fully displaced by less-skilled labor due to the implementation of technological advancements. From a Marxist point of view, deskilling is a tool to reduce the investment in human capital (in terms of education and training), which in turn weakens the bargaining power of that human capital[15]. Conversely, from a Smithian view deskilling is a result of labor division that leads to a simplification of worker's tasks. However, a third standpoint argues that deskilling is the result of a complex and constant process of evolution and professionalization in many fields: "This trend exists because specialization permits efficiency, and with efficiency, energy is freed up for further, more sophisticated actions, in a self-reinforcing cycle"[16].

Concerns about the potential deskilling of medical professionals were considered early in the development of medical AI models. The notion of deskilling applied to healthcare as a profession appeared formally for the

[12] R. Gruetzemacher, D. Paradice, K. Bok Lee, *Forecasting Extreme Labor Displacement: A Survey of AI Practitioners*, in "Technological Forecasting and Social Change", 161, 2020, p. 13 <https://doi.org/10.1016/j.techfore.2020.120323>.
[13] C. Farr, *Here's Why One Tech Investor Thinks Some Doctors Will Be "obsolete" in Five Years*, CNBC, 2017 <https://www.cnbc.com/2017/04/07/vinod-khosla-radiologists-obsolete-five-years.html>.
[14] C.P. Langlotz, *Will Artificial Intelligence Replace Radiologists?*, in "Radiology: Artificial Intelligence", 1, 3, 2019 <https://doi.org/10.1148/ryai.2019190058>.
[15] P. Attewell, *The Deskilling Controversy*, in "Work and Occupations", 14, 3, 1987, pp. 323–346 (p. 323) <https://doi.org/10.1177/0730888487014003001>.
[16] B.P. Green, *Artificial Intelligence, Decision-Making, and Moral Deskilling*, in "Markkula Center for Applied Ethics", 2019 <https://www.scu.edu/ethics/focus-areas/technology-ethics/resources/artificial-intelligence-decision-making-and-moral-deskilling/>.

first time in 1970, when economic forces encouraged medical professionals and institutions to adopt measures of managed care such as provider profiling and notably, electronic medical records (EMRs)[17].

In 1996, Ruth Rinard published a paper that was concerned with the impact of a "technological changing environment" for nurses. According to her, each significant change in society causes a fair amount of distress and concern. She made a rough periodization of the story of the impact of technological innovation on nurses from 1950 and 1990 and concluded that it was a story of deskilling[18]. However, the question remains as to whether this conception of medical professional deskilling is indeed well-founded. If we were to consider deskilling as a structural problem, then we would need to question which skills would suffer, and how would it be possible to assess this decline in skill level? All this based on the understanding that skills are dynamic social constructs that evolve according to cultural, economic, and social demands. Moreover, assuming deskilling as a systematic decline in medical skills, what would be the negative consequences and who would be harmed? So far, there has not been a systematic account or study of this nature.

From a historical point of view, the application of technological innovations oftentimes triggers changes that presuppose advantages and disadvantages for societies and professions. These changes demand that the working and education sectors adapt. Industrialization led to the crisis and later elimination of certain skills of crafters and small producers; automation in large manufacturing companies decreased the need of manual workers and applications like GPS and mobile map apps have decreased our general sense of localization and spatial memory[19]. At the end, some modern techniques replace older ones, and some of the ancient wisdom is lost in the process.

[17] T. Hoff, *Deskilling and Adaptation among Primary Care Physicians Using Two Work Innovations*, in "Health Care Management Review", 36, 4, 2011, pp. 338–348 (p. 339) <https://doi.org/10.1097/HMR.0b013e31821826a1>.

[18] R.G. Rinard, *Technology, Deskilling, and Nurses: The Impact of the Technologically Changing Environment*, in "Advances in Nursing Science", 18, 4, 1996, pp. 60–69 (pp. 66–67) <https://doi.org/10.1097/00012272-199606000-00008>.

[19] I.T. Ruginski, *et al.*, *GPS Use Negatively Affects Environmental Learning through Spatial Transformation Abilities*, in "Journal of Environmental Psychology", 64, 2019, pp. 12–20 (pp. 18–19) <https://doi.org/10.1016/j.jenvp.2019.05.001>; L. Dahmani, V.D. Bohbot, *Habitual Use of GPS Negatively Impacts Spatial Memory during Self-Guided Navigation*, in "Scientific Reports", 10, 1, 2020, pp. 1-14 (pp. 11-12) <https://doi.org/10.1038/s41598-020-62877-0>.

## Technical and moral deskilling in healthcare

As mentioned previously, the shift of skills in the practice of medicine can be seen as a logical consequence of new technological developments. For instance, before the age of CT scans and X-rays, physicians had to rely on more rudimentary methods to assess external symptoms and signs of diseases such as pneumonia. They were well-versed in small changes in breathing patterns and how to recognize early side-effects. Thanks to the advent of scans and other tools, physicians displaced these abilities or at the very least, stopped relying entirely on them to diagnose acute lung problems, as a result, the human error factor decreased, and patients received better care[20].

It could be argued, then, that AI would not be too different from all other technological innovations that have triggered a change in professional skills throughout history. However, as further research suggests, AI has elements that sets it apart. According to Robbie Allen, AI has a low entry barrier for people to develop something useful, and that development is decentralized[21]. In other words, AI can be developed by anyone, and no company has a monopoly on the technology itself. These circumstances are set inside a world where hyper-specialization and efficiency have become the norm in most professional subjects, and AI brings the promise of automating repetitive tasks with an accuracy that surpasses those of human beings while maintaining efficiency and minimizing costs. AI, therefore, is not quite the same as other technologies, and its consequences might differ from those we have already seen happening from previous experiences.

I hold that the potential for unintended repercussions on the skills of medical professionals is a topic that requires attention, because only by acquiring a comprehensive understanding of these risks it is possible to make an informed decision about the suitability of a model in a specific clinical setting and afterwards, what decisions are required to prevent and/or minimize undesired effects.

Deskilling in healthcare can be understood from two angles: technical and moral. Technical deskilling describes the situation where medical professionals experience reduced opportunities to exercise particular skills. According to Timothy Hoff, this is presumed to be the result of

[20] A. Agrawal, *Medication Errors: Prevention Using Information Technology Systems*, in "British Journal of Clinical Pharmacology", 67, 6, 2009, pp. 681–686 <https://doi.org/10.1111/j.1365-2125.2009.03427.x>.

[21] R. Allen, *Why Artificial Intelligence Is Different from Previous Technology Waves*, in "Medium", 2018 <https://medium.com/machine-learning-in-practice/why-artificial-intelligence-is-different-from-previous-technology-waves-764d7710df8b>.

managerial demands to improve efficiency and reduce costs. As supporting examples, he names the adoption of electronic health records (EHRs) and clinical practice guidelines (CPGs). However, he also clarifies that this assumption has not found sufficient empirical support and that the problems associated are: (1) that this perspective presents a too deterministic view on deskilling and (2) does not consider the role played by human agency[22].

Hoff holds that the physicians' adaptation mechanisms to the introduction of new technologies can contribute to the process of deskilling[23]. For instance, while the adoption of EMRs was intended as a means to store patient medical data in a digitalized, easily managed tool, it actually turned out to harm the overall patient experience with their primary care physicians. This happened partly because the tool became a demand by organizational forces and because physicians adapted by adopting a completionism mentality where filling the records was top priority instead of spending quality time examining the patient.

In the case of the implementation of AI technologies, a similar situation may occur where the models become a requirement for diagnosis. This may lead physicians to progressively cease relying on their hard-honed skills, depending instead on the results provided by the model under the assumption that they are always far more accurate and therefore more reliable as the basis of a successful diagnosis. Here we encounter a fundamental issue: an unfounded certainty about the performance of AI models. While the promise of AI applications to revolutionize healthcare has indeed permeated recent academic and scientific debate, it is important to maintain a critical eye. Healthcare is a notoriously complex field to implement any technological innovation in, and AI does not work like magic.

In his study, Hoff concluded that deskilling due to the introduction of technological tools is a valid concer He explored the experiences of primary care physicians that started using EMRs and CPGs, and according to their perceptions:

> […] deskilling manifested itself in decreased clinical knowledge; lower levels of physician-patient trust; greater tendency to apply a 'one-size-fits-all' understanding across individual patients, especially those with chronic diseases; and decreased clinical decision-making confidence[24].

Moral deskilling is a phenomenon that occurs when a moral agent loses the ability to make appropriate moral judgements and lacks the

[22] T. Hoff, *op. cit.*, p. 339.
[23] Ivi, p. 340.
[24] Ivi, p. 347.

skills of moral decision-making due to overreliance on technological developments. Shannon Vallor argues that in the same sense that a skill that is not practiced is forgotten, like a language, the ability to make sound moral decisions can disappear if the individual stops exercising their judgement. From an Aristotelian theory, virtues must be cultivated, as they are not inborn traits. Cultivated virtues in turn constitute the necessary conditions for the acquisition of practical wisdom, or in other words, moral skill. Vallor points out that Aristotle's account of moral skills entails a concrete and conscious grasp of moral demands in specific contexts and the capacity to justify the reasoning behind them[25]. However, moral skill is a necessary condition for virtue of character but not sufficient as per Vallor's interpretation: "genuine virtue is something more than moral skill or know-how, it is a state in which that know-how is reliably put into action when called for and is done with the appropriate moral concern for what is good"[26].

With both moral and technical deskilling, the authors warn that the phenomena are highly disputed due to ambiguous empirical results. Vallor points out the way the internet revolution helped workers by automating repetitive tasks and opening opportunities for developing and enhancing other type of skills that require creativity[27]. Similarly, the promise of AI-powered systems is not only to provide tools that can enable medical professionals to provide better, faster, and more accurate diagnoses, and to automate menial and time-consuming tasks, but also to present a full diagnosis that surpasses the accuracy of human doctors. This is no mean feat, and one must stop at this enthusiastic undertaking and consider (1) how realistic is this from a technical standpoint, (2) if this would be something that we would prefer, and (3) if this would help the realization of medicine's goals as a human endeavor.

## Consequences of deskilling in healthcare

Human interaction and forming relationships among members of societies are likely one of the greatest strengths we enjoy as a species. From our daily interactions, we build bonds that are cemented in trust, companionship, mutual interest, beneficence, respect, etc. These bonds enable us to form communities, groups, and families, and act as the pri-

[25] S. Vallor, *Moral Deskilling and Upskilling in a New Machine Age: Reflections on the Ambiguous Future of Character*, in "Philosophy & Technology", 28, 2015, pp. 7–124 (p. 109) <https://doi.org/10.1007/s13347-014-0156-9>.
[26] Ivi, p. 110.
[27] Ivi, p. 108.

mary thread weaving together different aspects of the fabric of society. For example, as we drive a car on a busy street, we trust tacitly that other people will comply with the rules and that nobody will crash into our car on purpose. Our societies are able to function based on basic agreements of mutual beneficence. By introducing AI models into the equation, we are adding a new sort of foreign variable that, as of now, we cannot entirely trust.

Regardless of whether there will be a point in time where AI becomes a fully autonomous agent and this prompts a new era where humans and AI machines and systems develop a sort of relationship, the ethical question that arises now as we continue to research and deploy these technologies with their narrow capabilities is *how the implementation is changing and can further change who we are and how we interact with each other.* Even now, as we rely more and more on AI-driven recommendation algorithms instead of advice from friends and prefer to turn to customer service chatbots instead of calling a human representative, there is a marked trend of change where our moral skills might be negatively affected.

Vallor holds that moral skills are a necessary condition to cultivate a virtuous character, so in the case of physicians, it would be credible to presume that possessing a virtuous character or professional *arete* is essential to providing patients with outstanding care. Furthermore, there are already strong ethical value foundations in healthcare such as the Hippocratic Oath and the four principles of biomedical ethics (beneficence, non-maleficence, autonomy, and justice) that explicitly assert the bearing of moral skills in the practice of medicine. Gabel gives a further argument that strengthens this view; in his research, he argues that incongruence in values, i.e.: "when health care professionals sense a lack of alignment between their own values and those they perceive to be the values of various health care-related organizations or groups with which they are associated"[28], is related to professional burnout. Examples of this can be observed when physicians are forced to comply with for-profit policies in the detriment of deontological values, such as impartiality in treatment. Healthcare is, after all, a moral undertaking.

Having this present, the prospect of automated systems eroding the opportunities to develop an adequate set of moral skills that bestows the medical professionals with a solid professional *arete* can have negative repercussions on the quality of care delivered. In the case of diagnosis, an overreliance on automated results from AI-powered models could affect the confidence of physicians to give a full diagnosis without aid. Howe-

[28] S. Gabel, *Ethics and Values in Clinical Practice: Whom Do They Help?*, in "Mayo Clinic Proceedings", 86, 5, 2011, pp. 421–424 (p. 421) <https://doi.org/10.4065/mcp.2010.0781>.

ver, as it was hinted, the challenge might not lie solely on the AI systems themselves but in the way, related organizations manage them within the clinical setting.

Another consideration is the relationship between a patient and their physician and this is one of tremendous importance for the process of diagnosis, treatment, and care. It is by nature a fiduciary relationship because the patient implicitly or explicitly entrusts the physician to act on behalf of their health and have their best interests at heart. This has gained an even higher level of consequence as patients become more informed about their health and want to be involved in the management of their care. Hence, a potential consequence of technical and moral deskilling is the deterioration of this relationship. One practical illustration of this scenario is a diagnosis with complications.

The fiduciary nature of the patient-physician relationship within this context presumes that the physician possesses strong moral skills to deliver the information with compassion, to respect the right of the patient to be appropriately informed, and to act according to the beneficence principle of medical practice. When the utilization of technological tools such as AI proves to be detrimental to the exercise of this practical wisdom, causing double harm of moral deskilling and poor delivery of care, it is necessary to take a step back and analyze how this can be prevented. What mechanisms and strategies can be designed and integrated within the pipeline of development and deployment of AI models in clinical settings to prevent these harms? After all, it is not acceptable to wait until patients and physicians alike are affected to reflect and start preparing for it.

## Deskilling and upskilling

Having discussed the concept of deskilling, it seems relevant to also consider the alternative phenomenon: upskilling. As the name suggests in contrast, it refers to the process where economic or technological developments prompt the gradual increase of skill level requirements for certain jobs and the labor market becomes more skilled to meet that demand. In the case of healthcare, physicians and nurses have expanded the scope of their skills according to new methods and procedures, for instance, how to collect, manage and use patient data to add to EMRs.

On this same line of thought, Ulrich Heisig discusses that physical skills have been steadily replaced by intellective skills as a result of the introduction of computers and automation, and thanks to that, workers perform tasks that used to belong only to field specialists. However, he also concedes that new technologies can have an objective impact on skill

development, mostly due to how capitalism in different countries and contexts prompts different paths[29].

Here is perhaps the crux of the matter, or at least a highlight point to continue the discussion. Artificial intelligence, as any other tool at our disposal, is not *ontologically* harmful. It can be used to exacerbate discrimination, increase inequality, and erode human interactions, or it can be used to reach ethical goals and benefit people in many respects. In fact, for healthcare, it holds a great potential to significantly improve many of the wall-end limits that medicine has reached up until now. It is necessary, however, to first take a critical look at the way research is being done at different levels but also to prepare the ground for a smooth-as-possible deployment and implementation. We need to invest, not only in the development of AI models, but to try and take a few steps ahead and analyze the ethical and social repercussions. Ultimately, given the amount of attention AI in healthcare keeps garnering, it is the given responsibility of diverse actors across the field to devote time and effort, not only in improving the algorithms and computational capacity, but also in interdisciplinary work that includes robust ethical training and collaboration.

## Conclusions and recommendations

I have presented so far different accounts of what deskilling denote from technical and moral perspectives, and in both cases, it would be sound to conclude that an acute deskilling of medical labor could have harmful consequences for medical professionals and especially for patients.

As described in the first section, it is difficult to measure the decreasing quality of a skill (to the extent that it is by some accounts considered an "unresolvable" problem), because to objectively assess this, we would need to have a solid parameter that registers fluctuation in skills due to technological implementation but that is not influenced by other factors[30]. However, it is reasonable to presume that the implementation

[29] Heisig gives the example of Germany ands its post-war system for apprenticeships and vocational training that while it has proven to be somehow resistant to deskilling, it cannot completely avoid creating a gap between educated and highly-skilled workers and low skilled workers that are relegated to be employed as supermarket cashiers and other low-paid jobs. See: U. Heisig, *The Deskilling and Upskilling Debate*, in "International Handbook of Education for the Changing World of Work", ed. by R. Maclean, D. Wilson, Springer Netherlands, Dordrecht 2009, pp. 1639–1651 (p. 1646) <https://doi.org/10.1007/978-1-4020-5281-1_110>.

[30] F. Brugger, C. Gehrke, *Skilling and Deskilling: Technological Change in Classical Economic Theory and Its Empirical Evidence*, in "Theory and Society", 47, 5, 2018, pp. 663–689 (p. 674) <https://doi.org/10.1007/s11186-018-9325-7>.

of AI in healthcare can realistically produce an impact, at the very least, similar to the adoption of electronic medical records.

I hold that unintended consequences of AI are real risks not only because of design issues but also due to a marked imbalance between our epistemic grip about the realistic possibilities of AI, i.e., what it can *actually* achieve and how they integrate with existing work structures. The fear of deskilling reveals that we must give more thought to the question of how automated AI systems can change professional roles. That is not to say that we ought not to continue researching and exploring these technologies, instead, we should ground the over-inflated expectations and help navigate those consequences with robust educational programs, ethical frameworks, and interdisciplinary regulations.

Furthermore, it is also possible to conclude that the shift and actualization of professional skills is a process present in all occupations as techniques and methods evolve and become more accurate and efficient. In this sense, medical AI holds significant promise to benefit diverse subfields in healthcare including but not limited to applications for early cancer detection, improved diabetes detection, billing, outpatient management, telehealth, among others. From Eric Topol's perspective, AI has the potential to help humanize healthcare. He argues that the practice of medicine has lost much of his interpersonal touch, and this is not related to the advent of machine learning or deep learning. Even before that, there was already a crisis. The implementation of AI need not be the end of humane medicine, but instead, it can provide physicians and patients the tools to regain the connection that sustains the fiduciary bond between them[31]. Furthermore, AI can act as a motivator for a positive shift in medical skills that results in a better-managed workflow that, in turn, can help solve -or at least minimize- issues such as a human error in medical diagnosis and physician burnout.

To achieve these goals, it is imperative to establish a robust framework of interdisciplinary and collaborative work. While there must be serious updates to university curriculums and in-hospital training opportunities for medical students and interns that include education on the functioning of AI models and interpreting their results, it could be helpful to encourage inter-faculty and inter-departmental collaboration. Furthermore, given the disruptive potential of artificial intelligence and the sensitive character of medicine, especially the fiduciary relationship between physicians and patients, it is essential to include consistent and contextual ethical training for medical professionals and AI developers alike.

[31] E. Topol, *Deep Empathy*, in "Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again", Basic Books, New York 2019, pp. 309–310.

Finally, although this aspect was not covered in the paper, a potential but plausible risk of the deskilling of medical labor is the exacerbation of global economic inequalities. In strong economies, the process of automation may provide healthcare professionals with the opportunity to dedicate more time to innovation and creativity and to improve bedside manners and patient care, while in weaker economies automation as a cheaper alternative to the human workforce might contribute to further straining of the patient-physician relationship and worsen the situation of overworked medical professionals. This specific point calls for deeper analysis and investigation that will be carried in further research.

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