ROBOTS TAKING OVER HUMAN JOBS IN HEALTHCARE

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		Ethical Issue: Cost
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***Abstract*— The rapid progress of robotic technology holds great potential to improve the field of healthcare. However, it also raises significant ethical considerations that must be carefully addressed to ensure the safe integration of robotic technologies. This study takes the perspectives of healthcare providers and patients to investigate the following ethical issues: privacy, safety, cost, unemployment, patient consent, and patient-robot interaction. To reach our goal, we conducted two surveys aiming to collect opinions and understand how patients and healthcare view these issues. Our findings revealed that although both groups saw more potential in robotics than expected, they still had their reservations and concerns regarding the ethical challenges. Overall, this study suggests that while robotics have the potential to improve healthcare, people have not yet reached a level of trust that would allow for robotics integration at our current time, highlighting the necessity of addressing ethical considerations first; to prevent any possible issues in the future.**

Keywords*— *healthcare, robot, ethical, privacy, safety, cost, unemployment, consent, interaction

I. Introduction

Technology has rapidly advanced in recent years, becoming the driving force behind societal progress and unprecedented levels of innovation, and this was particularly evident in the emergence of advances robotics technologies, where robots are increasingly capable of performing tasks that were previously confined for humans only in various sectors. While these developments enhance efficiency and productivity, they also raise significant challenges and ethical concerns. To understand the impact resulting from the work of robots in human jobs, we are addressing a delicate sector, which is healthcare, and in this research, we aim to answer the question: What are the ethical concerns of robotic technologies replacing human jobs in healthcare?

As updates and new features in robotics continue to emerge, the need for studies and research to address the impact of reliance on their capabilities, and the associated risks and concerns, has increased, which is going to create a knowledge gap to understand the effects of what we are experiencing. This paper focuses on studying and analyzing the ethical concerns resulting from replacing human jobs with robotic technology in the field of healthcare, and investigates its effects and society's.

To achieve these objectives, our study employs a research approach encompassing thorough reviewing the literature, preparing a questionnaire, collecting the data, and analyzing that information to achieve results that enhance our understanding of the full impact of robotics, we will analyze the associated risks and concerns, explore public perception, and people's opinion toward these technologies and their acceptance.

At the conclusion of our research, we will be able to determine the starting point of their concerns, and to examining how these ethical issues intersect with societal values and norms, particularly how its effects on healthcare providers and patients. This will lead us to clarify the sources of these problems and the potential effects of living around the context of technological progress, and achieving an environment characterized by clarity and transparency. We ultimately aim provide deeper insights into the implications of robotic technologies, which will hopefully lead to bridging the gap created by technologies as their impacts remain unclear.

II. Literature Review

The rise of robotics in the healthcare sector has brought about a new era of innovation and efficiency, introducing both promising advancements and critical challenges, impacting areas such as patient privacy, safety, cost, as well as unemployment, patient-robot interactions, and informed consent. Although robots enhance precision and operational efficiency, they also raise concerns regarding data security and privacy.

As robotic-assisted surgeries become more prevalent, their potential to improve patient outcomes is clear despite the high costs involved. Ensuring informed consent remains crucial to help patients fully understand the procedures and associated risks. The expansion of robotics in healthcare also brings ethical concerns, particularly regarding job displacement, leading to recommendations for upskilling healthcare workers to adapt to technological advancements. Furthermore, patient satisfaction increasingly depends on healthcare robot's ability to recognize and respond to emotional cues, highlighting the need for algorithms that support meaningful interactions. With this foundation, this literature review will explore the current and future implications of robotics in healthcare.

Patient information is the most sensitive and valuable part of the healthcare system. By using robots as an employee, the privacy issue can be increased by any external factor or attack. As Jayaramana et al. [1] discuss, most of the human community has concerns about using robots and sharing information with them since they can't trust them in different fields, such as social, psychological, physical and more

importantly, informational privacy. This takes us to an interesting term called "Privacy Paradox." This is a term used to explain the difference between user claims and behaviors. It states that when people obtain benefits from robots, they tend to not care about their privacy as much as they claim. This is a good example of how data privacy could be easily put at risk when dealing with robots, since people usually do not see themselves falling for such scenarios, yet they still do. This is why scales like (IUIPC), developed by empirical studies, are important since they can investigate the privacy paradox. Empirical studies have also developed a specific scale for social robots that addresses different privacy dimensions.

Furthermore, Elendu et al. [2] mention that there are many useful ways to protect the patient's data, such as applying effective encryption methods to protect data during transmission and storage, commitment with the legal rules and the global data security standards, for example HIPAA in the US, providing training programs for healthcare employees about the best ways to protect patients' data to avoid hacking resulted from human errors, and increase awareness about the possible dangers attached, it also helps make the employees learn how to identify fraud attempts, avoid unsafe passwords and handle sensitive patient information appropriately.

The growing use of robotics in healthcare also raises ethical concerns around patient safety. Taking the surgical field, one of the most promising fields for robot involvement, Korb et al. [3] focus on the importance of analyzing the safety of surgical robotic systems by applying a risk management process before any clinical trials, and that it's better to investigate any futuristic risks regarding the patients' or the healthcare workers' safety.

The process performed on the biopsy robot prototype (B-Rob II) took patients undergoing a percutaneous biopsy of the liver or kidney as its definition scoop, then applied different methods such as (FTA) and (FMEA) to evaluate the safety of this surgical robot. The results revealed many flaws in the system, from wrong positioning or unregulated movement of the needle to errors with image processing, and even robot controller failure.

The previous results were used later, along with other systems analysis to categorize the possible risks into seven Surgical Robot Risks (SRRs), providing a useful reference for future projects to test the safety of their robotic devices. The experiment results supported the suggestion that no robotic system is completely risk-free, but expressed that by performing iterative analysis, risks can be reduced to the lowest possible level, following on the ALARP (as low as reasonably practicable) principle.

On another discussion of the successful implementation of robotics within the healthcare field, Sahoo et al. [4] claimed that not enough investigations were conducted into the safety aspects, emphasizing that such technology cannot be achieved unless it has considered the potential challenges and ethical concerns it might encounter. They then proceed to identify the necessary elements to ensure the safe integration of robots into healthcare.

The previously mentioned elements were expressed as essentials for a mobile robot to perform its designed tasks. High-level technologies such as sensors and navigation algorithms should play a non-negotiable role in assisting their movement within the environment. While other strategies for safety-enhancing were recommended to better improve their safety rate, including testing and validation for performance, regular maintenance check-ups, following safety standards, and proper training for patients and healthcare workers.

This result indicate that the goal was not to provide an actual piece of experimental evidence but rather serve as a foundation for futuristic research and development, highlighting the importance of considering the challenges and concerns associated with robots, as well as providing the necessary measurements to ensure their safe application.

While ensuring the safety of robotic systems and preventing errors, significant investment in equipment and data security measures is also required. The healthcare sector can form a significant part of a country's economy, which is increasing rapidly and facing labor costs and shortages of workers, thus investing in robots around-the-clock labor without the demands for salary increases or improved working conditions and delivering highly precise outcomes. Qureshi and Syed. [5] discuss that the government is spending on an economy to thrive, while by contrast, more impetus is given to the introduction of robots in the healthcare system, it may face challenges of unemployment, which in turn may lead to a downward economic cycle.

They recommended that government institutions should start collaborating with the health sector to provide a special training course related to employment for human resources, who will have to compete not only among themselves but also with robots.

On the other hand, Chumnavej et al. [6] focus on the cost-effectiveness of Robotic-assisted spine surgeries (RASS) compared to non-robotic-assisted surgery for spine diseases, highlighting ethical concerns associated with the rapid use of robotic technology in healthcare. Such robotic equipment can reach up to a million dollars, which doesn't include maintenance costs, disposable costs, and staff training costs.

Moreover, they suggest that robotic surgery is generally more cost-effective than open surgery in various procedures when compared to laparoscopic and chemotherapy, an operating service contributing to nearly a third of total healthcare spending. According to reports, one minute in the operative room can cost between 7 and over 100 dollars, depending on the location and surgeon.

They also made a comparison between patients who underwent robotic-assisted surgery with those who had non-robotic-assisted surgery, the operation time and length of stay (LOS) were significantly longer for patients in the robot group. As a result, robotic-assisted surgery can offer improved health outcomes and cost-effectiveness compared to traditional surgery.

While the use of robotics can be cost-effective, it may also lead to workforce displacement, a significant ethical concern. This study by Pham et al. [7] discusses the societal impact of robotics on employment and emphasizes that while robots can improve efficiency and reduce health risks, their increasing use leads to layoffs, wage suppression, and intensified working conditions for those who remain employed.

Robotics are expanding globally from manufacturing into sectors like healthcare, where surgical and service robots are becoming more common. The paper raises concerns about the potential for a "jobless society" as automation progresses, particularly in low-skill and labor-intensive economies. A primary consequence is the displacement of workers, and even for those who remain employed, the introduction of robots can lead to wage reductions. The surgical assistant technician is among the healthcare roles most at risk from automation, as robots increasingly handle precise and repetitive tasks. The long-term impact of robotics on employment remains debated: some studies predict large-scale job losses, while others argue that new jobs could emerge. To address these challenges, the paper proposes solutions such as increasing worker education, implementing reskilling programs, and considering options like universal basic income (UBI) and robot taxes to mitigate the negative effects.

In response, Qureshi et al. [8] suggest strategies for addressing unemployment through upskilling and retraining programs, helping healthcare workers transition to roles where they complement robotic systems rather than compete with them. The study suggests that training and motivation strategies are essential for healthcare organizations to maintain a competitive edge while adopting robotics.

To further address unemployment caused by the rise of robotics, organizations should prioritize retraining and upskilling their workforce. By investing in human talent, they can ensure that employees are prepared to handle more complex, creative, and strategic tasks—those that machines cannot replicate. Additionally, governments, in collaboration with industries, should introduce forward-thinking educational programs that align with the evolving job market. This approach not only keeps workers competitive but also drives innovation.

Moreover, developing "human-friendly" robotics that assist rather than replace employees can help strike a balance between technological progress and job security, fostering a future where humans and robots collaborate seamlessly. By doing so, healthcare organizations can maintain operational efficiency while also preserving vital human roles that foster empathy and patient care.

Another issue that is accentuated by this advancement in technology is patients' informed consent. Ferrarese et al. [9] discuss how informed consent (IC) has been a longstanding issue in the medical field, specifically surgery. Procuring IC from patients was made even more difficult over time as advancements in technology were made; it was shown that this was the case due to two main reasons: the natural complexity of surgical operations, and the struggle in making the information understandable for the patient. Naturally, the same issues arose when robotic surgery was introduced to the medical field.

They also mention that the patient's understanding of the IC can be affected by several factors such as demographic, socio-economic aspects, clinical history and listening attitude. Although, recent literature data indicates that patients show insufficient understanding of ICs regardless of their varying characteristics. They primarily focus on the diagnosis and on understanding the organ that will be impacted by the procedure. Additionally, not all patients seek the same level of detail, so the surgeon should give them information in line with what they ask.

Patients also require the doctor to be aware of any possible complications. Even though that information doesn't ultimately influence the decision of whether to proceed with the procedure or not, it gives them a better understanding of what may occur. Finally, the environment in which the discussion is held-including when the IC is obtained and who explains the procedure- has a significant impact.

Also in terms of informed consent, Pai et al. [10] sheds light on the legal implications of robotic surgery, one of the problems they explore is the process of informed consent and how to guarantee that patients have a clear understanding of what the technology can do and what the possible risks are.

The process of informed consent is crucial for building trust and transparency between the doctor and the patient. It also serves as a medicolegal document that is important if malpractice claims arise. The law requires that patients are aware of the basic steps of the procedure they are to undergo. Therefore, it's required to get the patient's consent if robots are to be used in the procedure.

This is even more important in this case, as many patients have minimal understanding of the way robotic surgery works and may have some misconceptions about the process. For example, many patients believe that the procedure is performed solely by the robot, with no human interference, which is usually not the case. It has been shown that setting realistic expectations reduces the number of lawsuits after surgery.

Other than explaining the process of the procedure, other specifics must also be disclosed. For example, the risk of a malfunction, the exact ways in which robots are to be used, and other general risks, advantages, and alternative options to the process. Additionally, it's suggested by some authors that information about the surgeon should also be given to the patient, such as their experience, training, and the number of procedures they performed, though this is not legally required. In conclusion, informed consent in robotic surgery is similar to consent in any other surgery, in addition to disclosing the use of robotics and its risks.

In addition to their consent, focusing on patient satisfaction will lead to issues regarding the quality of robots' interactions with patients, emphasizing the need for features that ensure robots are emotionally adaptable and have both variable and non-variable behaviors. Cresswell et al. [11] aimed to explore reliable algorithms that classify a patient's emotional states to achieve adaptation to the behaviors of healthcare robots at interactions.

The researcher hypothesis followed Bartlett's test, examining age-related differences in emotional regulation and variance on physiological autonomic response data, using the Self-Assessment Manikin (SAM) scale to evaluate arousal. The study found no significant differences in emotional ratings across age groups.

However, physiological responses indicated that older participants exhibited higher variability in Galvanic Skin Response (GSR), while younger participants showed greater variability in Heart Rate (HR).

Additionally, there was inconsistency in emotional responses to robot stimuli, with variations in GSR and HR impacting the accuracy of emotional state classification, which highlighted the existence of effects that form variation and emotional responses, which leads us to the fact that there

are problems in the interactions between robots and patients and the urgent need to develop algorithms that help identify emotional states, due to the challenges that patients face when interacting with robots and the quality of care provided to them.

And to think of it in a more engaging perspective, a review by Johanson et al. [12] focused on the ability of robots to engage in appropriate and acceptable interactions with patients, emphasizing on communication behaviors that are essential for effective interaction and the impact on patients by modeling the interaction between healthcare professionals and patients themselves.

The review aimed to identify both verbal and non-verbal communication behaviors demonstrated by doctors or healthcare professionals, either individually or collectively, that are crucial for enhancing patient engagement. Three databases linking physician communication with patient behavior were utilized and examined to identify communication behaviors associated with positive patient outcomes.

The findings revealed key communication behaviors that could reflect a physician's empathy toward the robot to improve, including humor, self-disclosure, smiling, leaning forward, and gestures, which influenced patient perceptions and the social and healthcare context, given the scarcity of research in this area.

III. Methodology

A. Sample Population

My classmates and I conducted two surveys in this research, focusing on two primary groups: healthcare providers, and patients aged 18 to 65. Each group were questioned on specific ethical issues to understand their points of view. Questions targeting healthcare providers aimed to obtain their opinions regarding privacy, safety, cost, and unemployment, while questions targeting patients focused on their opinions regarding privacy, safety, patient consent, and patient-robot interaction.

B. Survey Format

The survey format was quantitative, consisting of closed-ended questions. Although some questions allowed participants to add an extra response.

C. Data Collection

Submissions were collected over a period of five days, resulting in responses from 60 patients and 47 healthcare providers. Patient participants were collected through online platforms, which allowed a diverse representation of different age groups. On the other hand, healthcare providers of different medical specialties received the survey directly and distributed it among their colleagues. All responses collected were only used for research purposes with consent from participants.

IV. Results

This section presents the results of our surveys, showing our findings regarding the ethical implications of robots taking over human jobs in healthcare.

A. Healthcare Providers

When asked about how they think the application of robots in healthcare affects the privacy of patients' health information, 48.9% responded that it depends on the implementation of the technology. 19.1% responded that it enhances patient privacy through better security of data. 17% think that it doesn't affect privacy. As for the rest, 10.6% agreed that the benefits outweigh the privacy concerns, and 4.3% think that it cuts down on patient privacy a lot as shown in Fig.1.

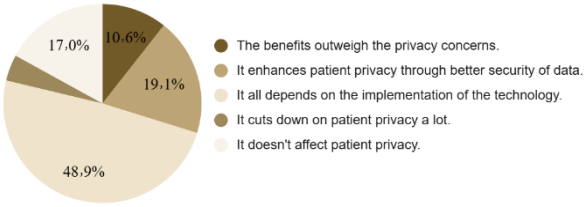

Fig. 1. Healthcare providers' responses about the effects of robotic applications in healthcare on the privacy of patients' health information.

As for the question asking their opinion on robots handling patients' information rather than a professional, 40.4% responded that robots can offer a level of security that might exceed that of human interaction. 25.5% responded that human interaction provides a level of security that is generally better than robotic systems. Also, 25.5% responded that human interaction provides a level of security that is generally better than robotic systems. 21.3% think that human interaction is significantly more secure than the use of robots. 10.6% see that the use of robots is often considered more secure than human interaction. Lastly, the least common response was that there is no strong distinction in security between human interaction and robots, in which 2.1% of healthcare providers chose this option as shown in Fig.2.

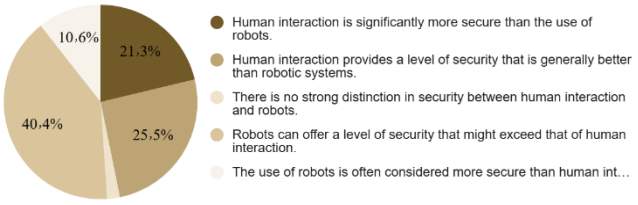

Fig. 2. Healthcare providers' opinion on robots handling patients' information rather than a professional.

When healthcare providers were asked about their biggest concern regarding the use of robots in the healthcare environment, the main concern, reported by 40.4% of respondents, was the risk of technical malfunctions or errors. The inability to understand patient needs followed that by 25.5%. While 17.0% of respondents choose potential harm during procedures, focusing their concern on the consequences of using robots during medical operations. Additionally, 14.9% expressed concern over delayed response to patient emergencies. A small portion of participants show no concerns about the use of robots in healthcare, considering it completely safe. See Fig.3.

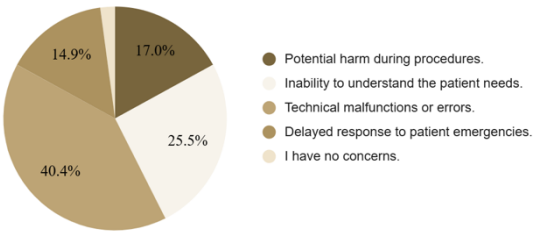

Fig. 3. Healthcare providers' concerns regarding the safety of using robots in healthcare.

Regarding the healthcare providers' opinions on the effect of robotics on the rate of medical errors, Fig.4 shows that nearly half 46.5% believe that robots would reduce errors by assisting them in their work. On the other hand, 23.4% of participants believed that robots would greatly increase errors by removing human judgment from the decision-making process. An equal percentage of 23.4% had the opposite opinion, believing that robots would reduce errors by ensuring accurate work. The rest of the respondents believed that robots could increase errors due to technical issues in their systems 4.3% or that robots would have no impact on the rate of medical errors at all 2.1%.

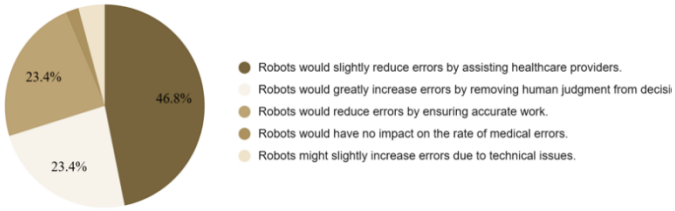

Fig. 4. Healthcare providers' opinions on the effects of robotics on the rate of medical errors in healthcare.

The results indicate a small confidence in robotics to safely work without human supervision. Most healthcare providers, at a percentage of 74.5%, believe that it's necessary to have constant supervision to ensure their patients' safety. More respondents 23.4% didn't oppose the idea, but rather agreed that not all tasks would require it, compared to more complicated procedures. Only a small percentage of respondents 2.1% believed supervision is unnecessary, feeling comfortable to allow robots to operate independently. See Fig.5.

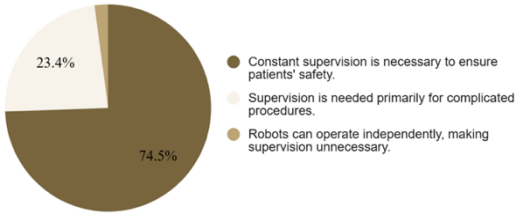

Fig. 5. Healthcare providers' views on the necessity of constant human supervision of robotics to ensure safety.

Healthcare providers' opinions on robots making independent decisions regarding patient safety during emergencies in Fig.6 showed that the majority 59.6% of respondents would only trust a robot if its decisions were supervised by a healthcare provider. Another 23.4% showed more caution, only allowing robots to make decisions in non-life-threatening situations. Only a portion of 17.0% completely accepted the idea of trusting robots to make independent decisions, regardless of the situation.

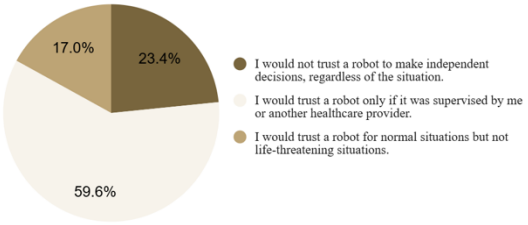

Fig. 6. Healthcare providers' views on allowing robots to make independent decisions regarding patient safety in the event of an emergency.

When asked to evaluate the initial investment costs of implementing robotic systems in healthcare, as shown in Fig. 7, the majority 72.3% perceived these costs as high and unjustified. A smaller portion 14.9% viewed the costs as high but justified in the long term. Meanwhile, 10.6% considered the costs moderate and consistent with technological development. Only 1.2% regarded the investment as relatively low compared to the potential benefits.

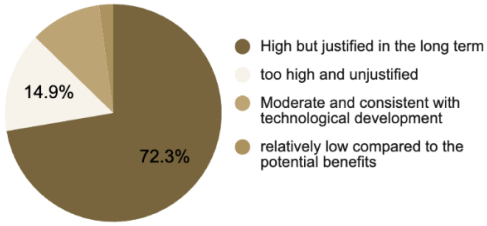

Fig. 7. Healthcare providers' perceptions of the initial investment costs of robotic systems in healthcare.

When questioned if robotic surgeries are more effective compared to traditional surgeries in terms of cost, as shown in Fig.8, over half 55.3% believe the health outcomes and recovery are faster, 14.9% agree in some cases, equal proportions of respondents 14.9% did not think there is a big difference in cost, while another 14.9% regard traditional surgeries as more cost-effective.

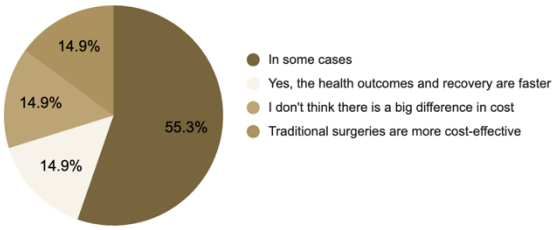

Fig. 8. Healthcare providers' opinions on the cost-effectiveness of robotic surgeries compared to traditional surgeries.

We also found that 44.7% of respondents think that using robots in hospitals will increase the cost of patient care, while 8.5% think it will have no effect on that, and 46.8% think it will reduce costs over time. See Fig.9.

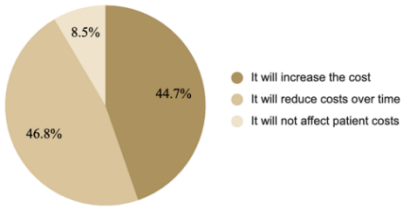

Fig. 9. Healthcare providers' views on how the use of robotics in hospitals may influence patient care costs.

As shown in Fig.10, 34% believe hidden costs may be greater than the benefits, 40.4% see that hidden costs can be addressed with parallel technology, 23.4% don't think the hidden costs are very high, while the minority 2.2% believe that there are no hidden costs of significant impact.

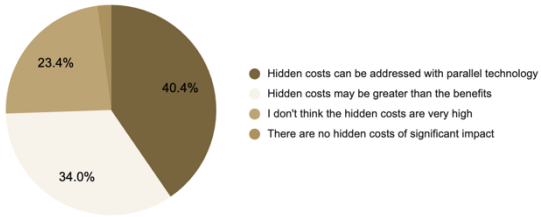

Fig. 10. Assessment by healthcare providers of the hidden costs associated with robotics in healthcare, including data security and technical failures.

In terms of their concern about robots replacing human doctors. 51.1% had moderate concerns but believed human doctors would still be needed. Meanwhile, 36.2% were unconcerned, trusting that robots could not fully replace doctors. Only 12.8% were very worried, fearing job loss due to robotics as shown in Fig.11.

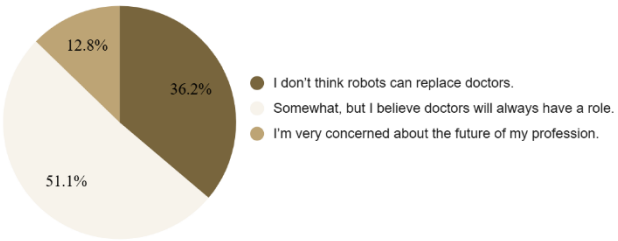

Fig. 11. Healthcare providers' concerns about robotic technologies potentially replacing human doctors in healthcare.

Respondents' opinions on whether robotics will create or eliminate jobs in healthcare vary. Approximately 29.8% of respondents believe that robotics will eliminate more jobs than it creates. On the other hand, 25.5% think that robotics will neither create nor eliminate jobs, as robots would handle tasks that do not directly impact job availability. A smaller group, 19.1%, believes robotics could create new jobs, albeit primarily for highly specialized role as seen in Fig.12.

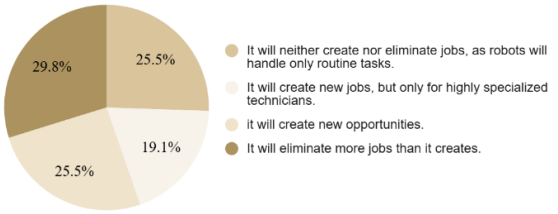

Fig. 12. Healthcare providers' perception of job creation vs. job elimination due to robotics in healthcare.

When asked about potential solutions for managing unemployment due to robotics, Fig.13 demonstrates that half of the respondents 48.9% supported the idea of providing alternative roles or retraining displaced workers, indicating an interest in proactive adaptation strategies. Additionally, 27.7% supported reducing reliance on robotic technologies. 12.8% favored avoiding the implementation of robotics in healthcare altogether to preserve existing jobs and 10.6% responded to offering early retirement to affected workers.

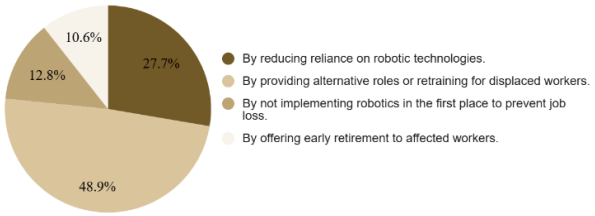

Fig. 13. Recommended solutions given by healthcare providers addressing unemployment caused by robotics.

In terms of specific healthcare roles at risk, a significant majority 59.6% indicated that administrative and support staff handling routine tasks are most likely to be replaced by robotics. Meanwhile, 19.1% pointed to doctors specializing in complex surgeries. 8.5% respondents felt that healthcare executives making strategic decisions and 12.8% responded nurses who are responsible for patient care and monitoring are at risk as seen in Fig. 14.

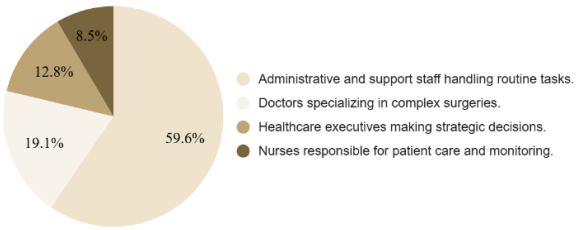

Fig. 14. Healthcare providers believes regarding roles at risk of replacement by robotics.

B. Patients

Regarding patients' opinions on how they think the application of robots in healthcare affects the privacy of their health information, 43.3% responded that it depends on the implementation of the technology. 18.3% think that it cuts down on patient privacy a lot. The same percentage they think that it doesn't affect privacy. As for the remaining respondents, 10% agree that the benefits outweigh the privacy concerns, in addition to another 10% who believe that it enhances patient privacy through better security of data as shown in Fig 15.

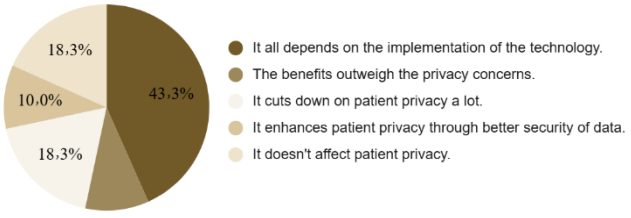

Fig. 15. Patients' opinions on how the application of robots in healthcare affects the privacy of their health information.

Regarding their opinion on robots handling their information rather than a professional, 33.3% responded that human interaction provides a level of security that is generally better than robotic systems. 25% think that human interaction is significantly more secure than the use of robots. Also, 25% responded that robots can offer a level of security that might exceed that of human interaction. 10% see that the use of robots is often considered more secure than human interaction. Lastly, 6.7% of patients think that there is no strong distinction in security between human interaction and robots. See Fig. 16.

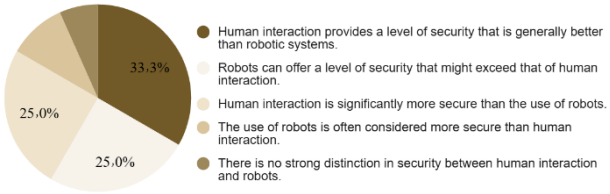

Fig. 16. Patients' opinion on robots handling their information rather than a professional.

When asked about how comfortable they are with the idea of robots having access to their health information, 40% feel somewhat okay, but they have some worries. 25% feel okay with the idea, but 13.3% don't have any strong feelings about it. Also, 13.3% feel a bit worried about it. Lastly, 8.3% don't like the idea of robots accessing their health information. See Fig.17.

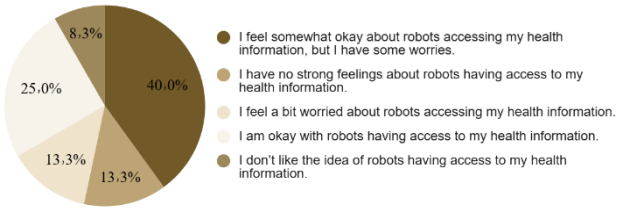

Fig. 17. Patients' level of comfort surrounding robots having access to their health information.

35% responded to the question 'How concerned are you that your personal health information will be shared with a robot?' with 'I have reservations but see potential benefits' and 25% need to know more information about how their data will be used. 20% of patients believe safeguards are in place, 13.3% trust the technology and privacy designed into it, and 6.7% do not trust robots at all when handling their health information.

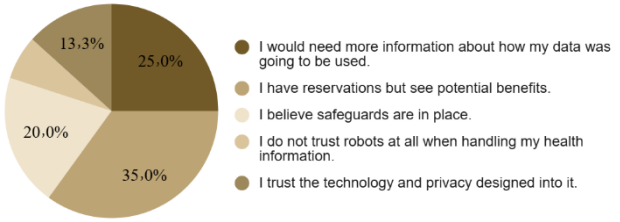

Fig. 18. Patients' concerns regarding their personal health information being shared with a robot.

Lastly, when asked how necessary it is that informed consent be provided before a robot can access their information, 68.3% responded that it's very necessary before a robot can access their information. 23.3% think it's necessary to have informed consent, but they're okay with some flexibility. 5% feel that informed consent isn't as necessary if there are safety measures, and 3.3% don't have strong feelings about needing informed consent for robots to access their information. There's no response choosing "I don't think informed consent is necessary for robots to access my information" as shown in Fig.19.

Fig. 19. Patients' responses when they were asked about how necessary it is that informed consent be provided before a robot can access their information.

Similarly to healthcare providers, when patients were asked about their biggest concern regarding the use of robots in the healthcare environment, Fig. 20 shows that the main concern was the risk of technical malfunctions or errors 33.3%, followed by the potential harm during procedures with 28.3% of the responses. While a close percentage of 16.7% and 15.0% resembled the concerns of delayed response to patient emergencies and inability to understand patient needs, respectively. 5.1% added an "all of the above option" as an extra typed response. Additionally, some patients 1.7% expressed the concern of cyber-attacks affecting robotics and exposing humans to danger. It was noticed that no patient expressed having "no concerns". See Fig.20.

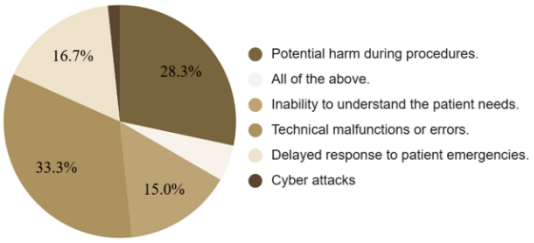

Fig. 20. Patients' concerns regarding the safety of using robots in healthcare.

Regarding the patients' opinions on the effect of robotics on the rate of medical errors, it shows that almost half 45.0% believe that robots would reduce errors by assisting healthcare providers in their work. Additionally, 23.3% of respondents also believed that robots would reduce errors by ensuring accurate and precise work. All other respondents either believed that errors would increase due to technical issues and the lack or humas judgment 6.7%, or that robotics would have no effect on the rate of errors 6.7%. See Fig.21.

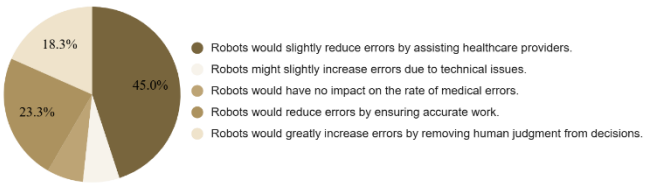

Fig. 21. Patients' opinions on the change of medical errors rate with robotics taking part in healthcare.

The results in Fig.22 indicate a small confidence in robotics to safely work without human supervision. Almost all patients believe that it's necessary to have supervision to ensure their safety, either by always applying supervision 68.3% or by applying it specifically to complicated procedures 30.0%. Only a small percentage 1.7% of respondents believed supervision is unnecessary, feeling comfortable to allow robots to operate independently.

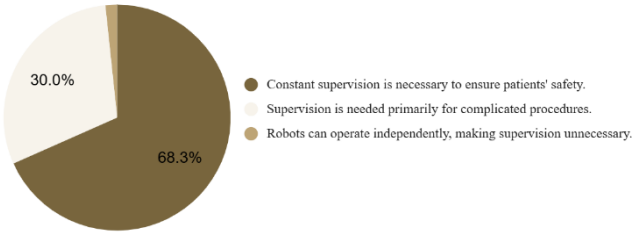

Fig. 22. Patients' views on the necessity of constant human supervision of robotics to ensure their safety.

Patients' opinions on robots making independent decisions regarding thier safety during emergencies, showed that the majority 55.0% of respondents would only trust a robot if its decisions were supervised by a healthcare provider. Another 20.0% showed more caution, only allowing robots to make decisions in non-life-threatening situations. Only a portion of 25.0% completely rejected the idea of trusting robots to make independent decisions, regardless of the situation. See Fig.23

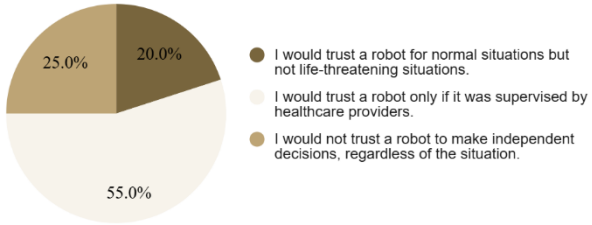

Fig. 23. Patients' views on allowing robots to make independent decisions regarding their safety in the event of an emergency.

When patients were asked when they would prefer being asked for consent, the majority 65% responded with "before any procedure." Meanwhile, 33.3% responded with "only before major procedures," and only 1.7% responded with "never." See Fig. 24.

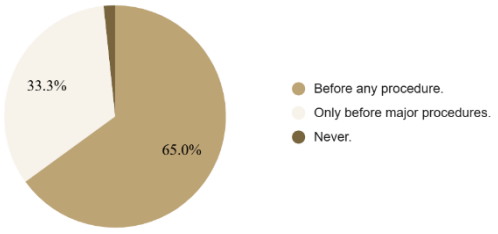

Fig. 24. When patients prefer being asked for consent if robots were to be used in their medical care.

In terms of the details, they would want to know about a medical service if a robot were the one offering it, Fig. 25 demonstrates that most patients 65% wanted to know every detail and risk, no matter how small or improbable. The remaining patients 35% only wanted to know the general idea and the most likely risks. No patient responded with "I trust healthcare providers without needing to understand the procedure."

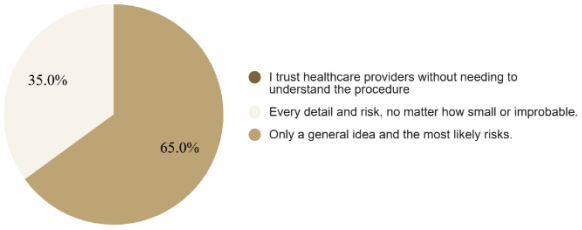

Fig. 25. Details patients prefer knowing about a medical service offered by a robot.

As for the comfort levels of patients regarding the idea of robots being used in their medical care, Fig.26 shows that they differ from one patient to another. 35% are neutral, 31.7% are somewhat comfortable, 21.7% are somewhat uncomfortable, 6.7% are very uncomfortable, and 5% are very comfortable

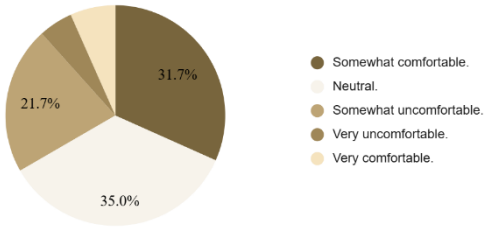

Fig. 26. Patients' comfort levels regarding robots giving them medical care.

Regarding patients' opinions on having a human healthcare provider supervise the robot during medical procedures, the greater part of responses 75% believed it is essential for a human to be there and oversee the entire operation. The remaining respondents 25% believed it depends on the procedure and whether it requires human intervention. No respondents believed that a robot can be programmed to work independently. This is shown in Fig. 27.

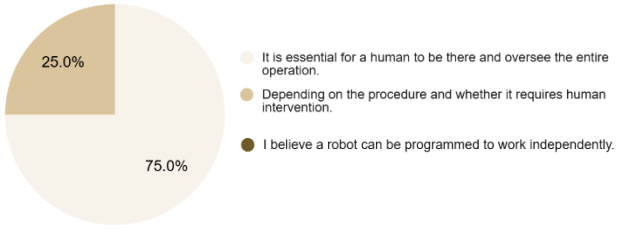

Fig. 27. Patients' opinions on having a human healthcare provider supervise the robot during medical procedures.

Building on the findings related to patient consent, the following questions responses provide further insight into patients' opinions and perceptions of robots' interactions, so we asked the patients how effective do they think robots communicate and understand emotions, as shown in Fig. 28, the vast majority that constitutes 35% thinks not effectively and 25% believe minimall effectivity. In contrast, a lesser

group that constitutes 18.3% thought somewhat effictively and 5% believe pretty much effictively. The remaining respondents 16.7% were not sure.

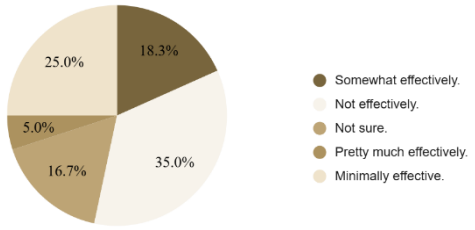

Fig. 28. Patients' opinions on the efficiency of robots in communicating and understanding emotions in patients.

Furthermore, we asked the patients about the boundaries that might cause lack of robot interaction, allowing the possibility of multiple answers in this part of the questionnaire, only to discover that most of them 70% felt it might be lack of emotional understanding while 45% believed that robots having no tone and emotional expressions, 31.7% chose inflexibility and 16.7% thought lack of a personalized care. Additionally, a patient also added the option "lack of trust" in robots as shown in Fig.29.

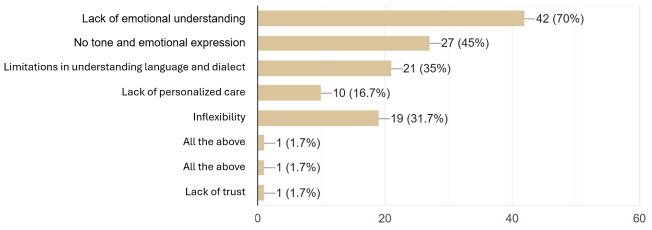

Fig. 29. Patients' opinions regarding boundaries that cause lack of robot-patient interactions.

Since our study primarily focuses on robots as substitutes for human caregivers, we framed our question to compare the quality of care provided by humans versus robots to see who do patients believe is better. As we can see in Fig. 30, 20% of them believed that humans provide much better care, and 41.7% of them preferred humans in some way, while quite the opposite 25% believed that robots may provide somewhat better care than humans, and 1.6% completely preferred robots, while the remaining 11.7% agreed on the qualities between them being the same.

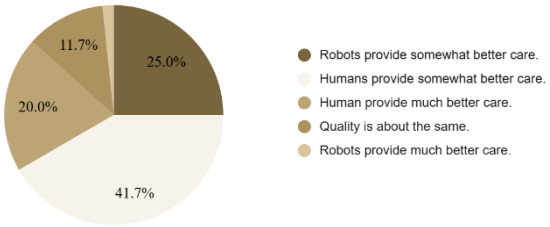

Fig. 30. Patients' opinios regarding the quality of care provided by robots compared to human.

Lastly, we asked the patients about the characteristics that they thought the robot would need to achieve the desired health care, allowing multiple answers. The largest number of patients agreed on its need for communication skills, constituting 75% of them, and 65% believed that it needed emotional intelligence and understanding feelings, as 43.3% of them believed that it needed a friendly user interface, as well as 43.3% for adaptability, and the percentages increased in most options depending on the patient choosing more than one capability or even all. Also 5.1% suggested their need to be faster, programmed by a high-profile health care provider, and its need for flexibility as shown in Fig.31.

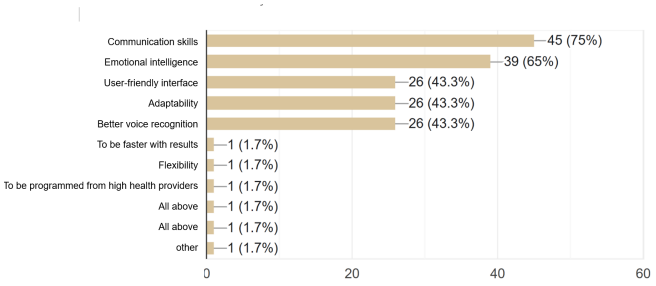

Fig. 31. Capabilities robots needs to be able to achive patient care service according to patients.

V. Discussion

The integration of robotics in healthcare presents significant ethical considerations, as evidenced by the findings of this study. While robotic technology promises improvements in efficiency, precision, and patient outcomes, it also raises critical challenges regarding privacy, safety, cost, unemployment, and patient interaction. The discussion explores these findings in greater detail, examining the perspectives of both healthcare providers and patients.

A. Healthcare Providers

Based on healthcare providers' responses, they show that they are open to robotics assisting in healthcare but have a strong belief in the unique qualities humans bring to medical care.

Taking the privacy issues, we see that when asked about how they think the application of robots in healthcare affects the privacy of patients' health information, the results showed that almost half of healthcare providers and patients responded that it depends on the implementation of the technology. This indicates that most healthcare providers and patients somewhat trust robots in terms of privacy if the technology is applied in an ideal manner. Healthcare providers also think that it enhances patient privacy through better security, as it received the second highest response; unlike patients, the second highest response was "it cuts down on patient privacy a lot," indicating that patients have a little more worry than the healthcare providers.

Most healthcare providers agree that robots can offer a level of security that might exceed that of human interaction. On the other hand, one-third of patients prefer human interaction and believe that it provides a level of security that is generally better than robotic systems. The difference between the patients and healthcare providers is significant, indicating that healthcare providers have much more belief in robotic systems than patients.

Another concern for healthcare providers is their safety. Conducted results expressed that most healthcare providers have major concerns and doubts regarding the integration of robotics in healthcare, especially when it comes to safety. The biggest concern was the risk of technical malfunctions or errors, which can lead to highly dangerous medical situations. Other major concerns include robots' inability to understand patient needs, the potential harm during medical procedures, and delayed responses to patient emergencies.

Regarding the impact of robotics on the rate of medical errors, we see more positive feedback from healthcare providers. Almost half of the participants believed that robots would reduce errors by assisting them in their work. Two equal percentages of 23.4% had a division in perspectives, one side agreed with the majority but with a different explanation, pointing out how errors could be reduced by ensuring precision and consistency at work within the environment, while the other proposed that errors would greatly increase due to the lack of human judgment. This shows that healthcare providers trust robots to certain level and are not completely opposed to working collaboratively with them.

Although when it comes to the idea of robots performing without human supervision, the findings reveal that healthcare providers do not trust that robotics are able to do that. Almost three quarters believing so during all tasks and a quarter only with complex procedures. Therefore, we can conclude that the majority are stressing the necessity of having human oversight when implementing robotics in healthcare.

These findings lead us to the conclusion that although robotics may play a valuable role in healthcare, they still have a long way to go before gaining the trust of professionals in the field, whose existence is still essential according to found results. This goal may be achievable, but it would require enforcing heavy safety measures.

In pursuing the idea of integrating robots in healthcare, concerns about cost may also arise. Healthcare providers have different opinions on this. Most healthcare providers — almost three quarters— believe that the initial investment costs of robotic systems in healthcare is justified in the long term, expressing confidence that these technologies will eventually bring significant value. This reflects a hopeful view that, although steep upfront expenses are involved, robotics could ultimately improve efficiency, precision, and patient care, supporting a longer-term vision for technology in healthcare. Regarding the cost-effectiveness of robotic surgeries, over half agreed that robotics could be beneficial in certain cases, suggesting that providers believe the true value of robotic surgeries might depend on specific patient needs or particular types of procedures rather than being universally applicable.

Regarding the impact of robotics on patient care costs, nearly half of the respondents expect that robotics will eventually reduce these costs, pointing to anticipated improvements in efficiency that could offset the initial investments. However, there are still concerns about hidden costs—like those related to data security or technical issues—in which the largest portion feel that these can be managed with parallel technologies, showing that while there is some caution, many feel these risks are manageable. These responses show a balanced view from healthcare providers, while remaining mindful of the practical and cost challenges.

In terms of job creation or elimination, the majority agreed that this will lead to the displacement of workers. This was expected and has been frequently mentioned, while others believe it will create more jobs, though the study shows their nature and distribution remain uncertain.

Regarding the risk of their roles being replaced, most of them agreed that the highest risk is perceived to be for roles involving routine tasks, showing that robots could be particularly beneficial in tedious tasks. On the other hand, only a small percentage agreed that roles specializing in surgeries are at risk, unlike the literature that believes the contrary as robots increasingly handle precise and repetitive tasks. When recommending solutions for addressing unemployment, nearly half of the respondents favored providing alternative roles or retraining for displaced workers. Which corresponds to our study "To further address unemployment caused by the rise of robotics, organizations should prioritize retraining and upskilling their workforce." This indicates that adaptation and retraining are seen as essential in ethically managing unemployment due to automation.

B. Patients

Based on patients' responses, although they see potential benefits in the use of robots in healthcare, they have significant concerns, confusing feelings, and a lack of understanding that need to be addressed to be more widely accepted.

Regarding how comfortable they are with the idea of robots having access to their health information, most feel somewhat okay about robots accessing their health information, but they have some worries. Only a small percentage don't like the whole idea, which highlights the worries that the patients have, but they want to give it a chance; the majority do not reject the idea. Concerning the same issue, another percentage have reservations but see potential benefits, and others need to know more information about how their data will be used. Based on the results, most patients can see the benefits, but they are concerned about the use of their data.

As for how necessary it is that informed consent be provided before a robot can access their information, the majority of patients feel that it's very necessary, while no one chose the option of it being not necessary. This leads us to the importance of informed consent for patients before a robot can access their data.

As we express the importance of data privacy as a way to help people trust robots in healthcare, addressing safety concerns is equally as important for the patients to feel comfortable and secure with having them in their environment.

The results show that patients have some concerns about using robots in healthcare. Like healthcare providers, most patients were concerned about the risk of technical

malfunctions or errors with robots. Another big concern was the possibility of getting hurt during procedures. Patients were also concerned about robots having a delayed response to emergencies and not being able to understand their needs in different situations. These concerns, along with the fact that none of the patients expressed having "no concerns" at all about robotics, suggest that patients don't fully trust robots to perform safely in healthcare situations.

When asked about the effect of robots on medical errors, almost half of the patients thought robots would help reduce errors by assisting healthcare providers. Another percentage felt that robots could also reduce errors by improving the accuracy of work, making work more precise. However, some patients thought robots could increase errors due to technical issues or robots lack human judgment. These mixed opinions show that while most patients have a positive view, there are still some who are worried about the possible risks.

The findings also found that most patients don't feel confident about robots working without human supervision. The majority of patients firmly believed that robots must always work under the supervision of humans. Similarly, others expressed that robots should at least be supervised during complex procedures. Only a small percentage thought that supervision wasn't needed. This need for human oversight shows that patients do not believe robots are capable of making the right decisions on their own.

Supervision played a bigger role than expected at first, even when asked about allowing robotics to make independent decisions in the event of an emergency, over half of patients said they would only trust a robot's decisions if a healthcare provider was supervising. The remaining believed in either allowing robots to make their own decisions, but only if the situation wasn't life-threatening or not trusting robots to make any decisions independently. This only supports our previous results, stressing once more how patients do not have enough trust in robots to make decisions without human involvement.

As for patients' informed consent, results indicate that most patients would want to know if a robot is to be used in their medical care before any procedure. This shows the importance of transparency in healthcare, especially when it involves technology that is more likely not fully understood by patients.

In terms of details surrounding their care, results show that the majority prefer to know comprehensive details surrounding it, including all potential risks, regardless of how improbable they are, as discussed in previous literature [10]. No patient chose not to understand anything surrounding the procedure. This leads to the belief that informed consent is important and that patients would want to make decisions based on the knowledge of what might happen.

When it comes to their comfort levels with robots being used in their care, there is a diverse response. This shows the need for healthcare providers to consider patients' preferences and address their concerns. The fact that only a small percentage were very comfortable indicates a wariness among patients about blindly trusting robots.

Regarding human supervision, the vast majority are in favor of having a human healthcare provider oversee the entire operation. This demonstrates the importance of human healthcare providers. The fact that no patient opted for believing that a robot can work independently further emphasizes the crucial role of human oversight when robots are used.

As for patients' feelings toward the interactivity of robots with them, we found that their opinions on the robots' communication and understanding of patients emotions were mostly negative, with over half perceiving no effectiveness or considering it only minimally effective, which led us to investigate of what patients think as the limitations of robots and what causes the interaction boundaries, a significant number agreed that robots lack an understanding of emotions, while others pointed to the lack of expressive communication and emotional expression that distinguishes robots, and this exactly aligns with our study's perspective that there is a need to develop reliable algorithms that can classify patients' emotional states, enabling robots to adapt and acquire behaviors that improve their interaction.

Afterward, we conducted a comparison between the quality of service provided by robots and humans to determine if there are human-specific factors that affect patient satisfaction, almost half agreed that humans provide somewhat better care, while a considerable portion believed that robots could offer certain types of care more effectively. This suggests that while robots may be able to match human capabilities in quality care service, they have not yet fully achieved this level, based on these findings, our final question addressed the qualities that could enhance robot caregiving standards. Most responses indicated that communication skills and emotional intelligence are necessary, and others highlighted the need for a user-friendly interface, among other features. This led us to realize the importance of focusing on developing capabilities that enable robots to engage and interact appropriately with patients, due to the current gap in the quality of robotic care.

The responses from healthcare providers and patients show cautious acceptance of robotics in healthcare, recognizing its potential to enhance efficiency while expressing significant concerns about privacy, safety, and the effect it might have on the economy. Healthcare Providers appreciate robotics for improved precision but believe that human intervention is still necessary. Patients, while seeing the benefits of robotic assistance, are also uneasy with robots acting independently, especially in sensitive situations, and stress the importance of clear communication, informed consent, and better emotional awareness in robotic systems. These perspectives suggest that while robotics can support healthcare, its ethical and effective integration depends on maintaining privacy, ensuring safety, and preserving the human touch in patient care.

VI. Conclusion

In conclusion, this study examines the ethical implications of robotics in healthcare, focusing on privacy, safety, cost, unemployment, and patient interaction. Our findings reveal that while robotic technology enhances efficiency and precision in healthcare, it brings crucial challenges,

particularly around protecting patient privacy, maintaining safety, and ensuring a balanced workforce.

To responsibly integrate robotics in healthcare, the study recommends developing systems that prioritize empathy in patient interactions and investing in workforce retraining programs to support affected workers.

Moreover, it is important for healthcare organizations and regulators to create clear rules for the ethical use of robotics. This includes protecting patient data, making sure someone is responsible for any mistakes made by robots, and being open about how robotic systems are used.

Overall, by addressing these ethical considerations, the healthcare sector can leverage robotics to improve care while respecting patient and provider needs.

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