Medical Robotics

OPINION

Ergonomics in colonoscopy: Its critical role in shaping future practices

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INTRODUCTION

Regular screening of the large bowel is crucial for identifying pathology at an early stage, particularly for colorectal cancer, the third most common cause of cancer deaths worldwide.[1] Early detection can drastically reduce mortality rates, improve quality of life for patients,[2] and decrease healthcare costs associated with treating diseases,[3] Several non-invasive screening methods are cost-effective and are valuable solutions for early detection,[4] such as the Fecal Immunochemical Test (FIT), which can be done at home at very low cost.[5] Other new solutions are emerging, such as DNA liquid biopsies.[6] However, they are more expensive and have not yet been proven as effective as FIT.

If any of these non-invasive tests result in a positive finding, an optical colonoscopy, a visual inspection of the large bowel, is required since it can take biopsies and remove polyps before they may become cancerous.[7] Colonoscopy is a complex procedure that relies heavily on the technical skills of the operator and requires extensive training.[8] It can cause pain and discomfort for the patient and incur high costs for healthcare, including upfront costs to purchase expensive equipment and ongoing costs for cleaning and maintenance within a dedicated reprocessing unit. Additionally, this procedure poses challenges for healthcare professionals due to the lack of ergonomic design, often resulting in musculoskeletal injuries.[9]

CHALLENGES IN ERGONOMIC DESIGN

The modern colonoscopy was introduced in 1969 with Dr. Hiroshi performing the first electrosurgical polypectomy.[10] At that time, the main goal in the design of the colonoscope was to perform optical inspection of the entire large bowel and remove polyps. Poor attention was given in its ergonomic design. Since then, research institutes and companies have attempted to introduce various design solutions to the market. To date, none have achieved success. This is attributed to both engineering and commercial challenges.[11,12] Ergonomic challenges for professionals are primarily related to posture and handling, following the "one-size-fits-all" approach in the design of the handle.[13] This poses significant challenges, especially for women, who, on average, have smaller hands and less grip strength than men. Some add-on tools have been designed, but they fall short of solving the issue. The study by Kamani *et al.*[14] demonstrates that musculoskeletal injuries are highly prevalent among endoscopists, representing a significant occupational health issue. With research indicating that up to 95% of endoscopists experience musculoskeletal injuries, the data underscores an urgent need for advancements in ergonomic practices within the field of endoscopy.[14]

Ergonomics must be considered in the design of new instruments, addressing several limitations of current optical colonoscopy device. This includes standing in front of the patient in an uncomfortable position, watching a monitor that may require neck bending, exerting constant force on the control wheels with the left hand, and gripping, rotating, and advancing the instrument with the right hand. The procedure involves two phases. In the first phase, the clinician endures

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physical stress while reaching the cecum, the distal part of the bowel. Then, in the second phase, the colonoscope is withdrawn, marking the beginning of the inspection, which involves mental stress in analyzing any abnormalities and performing polypectomy if required. Reducing physical stress could lead to increased performance during the procedure and, consequently, better clinical outcomes.

Ergonomics has recently risen as a concern, and a recent publication from the American Society for Gastrointestinal Endoscopy has reported recommendations on the role of ergonomics in preventing endoscopy-related injuries (ERIs).[15] The guidelines provide an evidence-based approach to strategies aimed at reducing ERIs in gastrointestinal endoscopists, such as formal ergonomics education, the adoption of neutral posture during procedures, taking microbreaks and scheduled macrobreaks, and utilizing supportive devices for those with predisposing risk factors for ERIs. This publication is a significant step in addressing the musculoskeletal injuries that can arise from the physical demands of endoscopic procedures, promoting both clinician well-being and procedural efficiency. Incorporating ergonomics into the design of new medical technologies presents a significant challenge, especially in the context of demonstrating a direct impact on clinical outcomes and human error reduction. The process of substantiating such benefits often necessitates lengthy and expensive clinical trials, which can be a stumbling block for obtaining approval from healthcare authorities. In the UK, the National Institute for Health and Care Excellence (NICE) assesses new healthcare technologies primarily for clinical and cost-effectiveness. Given its structured approach focused on evidence-based medicine and health economics, NICE may not recognize the ergonomic benefits of a device unless they are shown to lead to a clinical advantage for patients. This is because NICE's remit is to ensure that health and social care provisions offer the best value for the public. As a result, without clear evidence linking ergonomic improvements to measurable patient outcomes or healthcare efficiency, such features may not influence NICE's recommendations or funding decisions.

ROBOTICS AND ARTIFICIAL INTELLIGENCE (AI): THE NEW FRONTIER IN COLONOSCOPY TECHNOLOGY

Technology, and particularly medical robotics, has been established as a significant ergonomic aid in various medical disciplines, such as keyhole surgery. Several companies have contributed to this field by providing robotic solutions that incorporate improved ergonomic consoles, which alleviate physical strain for surgeons and facilitate precise control of medical instruments.[11] This ergonomic innovation in keyhole surgery paves the way for similar advancements in colonoscopy technology.

Following the path forged by medical robotics in surgery, colonoscopy is now undergoing a similar transformation. Companies like Endotics (Era Endoscopy), recognized with CE (Conformité Européene) mark and Food and Drug Administration (FDA) 510 (k) approval, are at the forefront of this evolution.[16] These pioneers are replacing traditional, manually-intensive procedures with new technologies that leverage mechatronic interfaces. These interfaces could do more than just enhance control; they serve as data hubs to feed and refine AI algorithms, potentially leading to semi-autonomous or even fully autonomous tasks,[17,18] by gathering intricate data, they enable improved monitoring of procedural performance. Furthermore, the synergy between AI and medical robotics stands to substantially elevate ergonomic standards. By reducing the need for physical exertion during specific tasks, the incidence of musculoskeletal disorders among practitioners may be significantly diminished, bringing the benefits of robotics full circle from keyhole surgery to the future of colonoscopy. The introduction of new technology often comes with significant cost challenges. To mitigate these, it is crucial that cost considerations are integrated from the very beginning of the design process. This proactive approach ensures that cost-effectiveness is a fundamental aspect of the solution, rather than an afterthought.

CONCLUSIONS

In conclusion, the field of ergonomics, while often overlooked in the practice of colonoscopy, holds the key to enhancing clinician well-being and revolutionizing the work environment. Just as the automotive industry has seen dramatic improvements in worker safety and efficiency through ergonomic design, so too can the medical field reap similar benefits. Training programs that focus on ergonomic awareness are critical—they educate clinicians on how to minimize physical strain and collateral effects during procedures. The integration of ergonomic principles can transform the high-stress environment of colonoscopy into one that prioritizes the health and efficiency of the clinician, much like the advancements seen in sectors such as aviation, where pilot cockpit design advancements have markedly improved operational safety and comfort.[19]

However, the journey toward integrating new, ergonomically enhanced technologies in colonoscopy is laden with challenges. Demonstrating a direct link between improved ergonomics and clinical outcomes necessitates

a considerable investment of time and resources. Despite these hurdles, the pursuit is commendable and necessary, for the well-being of clinicians is inextricably linked to the quality of care they provide. In embracing the ergonomic evolution, the medical field stands to not only enhance patient care but also to foster a more sustainable and conducive work environment for clinicians, paralleling the strides made in industrial fields such as automotive, aviation, and technology manufacturing.

DECLARATION

Author contributions

LM: Conceptualization, Writing—Original draft preparation, Writing—Reviewing and Editing, Project administration.

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Conflict of interest

Luigi Manfredi is an editorial board member of the journal. The article was subject to the journal's standard procedures, with peer review handled independently of the editor and the affiliated research groups.

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No additional data is available.

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