MEDICAL PHYSICISTS IN THE AGE OF AI: FROM QUALITY ASSURANCE TO GOVERNANCE ASSURANCE

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Abstract – **Artificial intelligence (AI) is increasingly integrated into healthcare and is reshaping how medical technologies are developed, deployed and monitored. Unlike conventional medical devices, AI-enabled systems may evolve, creating new challenges related to validation, performance monitoring, cybersecurity and governance. Drawing upon current global evidence and emerging international guidance, this article explores how the role of medical physicists is expanding beyond traditional quality assurance towards broader governance assurance. It highlights key responsibilities in AI validation, post-market monitoring, bias assessment and governance leadership, while emphasising the importance of workforce development and international collaboration. The article argues that medical physicists are uniquely positioned to support the safe, effective and trustworthy adoption of AI-enabled medical devices and to serve as future stewards of AI governance in healthcare.**

Keywords – Artificial Intelligence; Medical Physics; AI Governance; AI-Enabled Medical Devices; Quality Assurance; Lifecycle Governance; Patient Safety; Healthcare Technology Management .

I. THE AI REVOLUTION HAS ALREADY ARRIVED

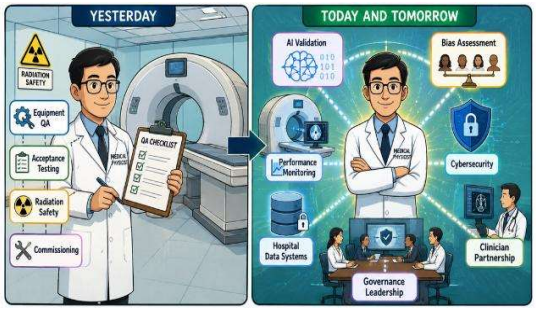

Figure 1. The Evolving Role of Medical Physicists in the Age of AI (AI-generated)

Artificial intelligence (AI) is rapidly transforming healthcare. Across radiology, radiation oncology and nuclear medicine, AI-enabled medical devices are increasingly being integrated into clinical workflows, supporting image reconstruction, clinical decision-making and operational efficiency [1, 2].

Unlike conventional medical technologies, many AI-enabled systems do not remain fixed after deployment. Their performance may be influenced by software updates, evolving datasets, changing patient populations and local clinical environments. As a result, ensuring that these technologies remain safe and effective over time presents new challenges for healthcare organisations [2, 3].

Medical physicists have long played a central role in the safe implementation of healthcare technology through equipment commissioning, quality assurance, performance evaluation and patient safety oversight. However, the emergence of adaptive and data-driven technologies is expanding these traditional responsibilities. Beyond ensuring that technology functions correctly, medical physicists are increasingly being called upon to support the governance, monitoring and safe integration of AI throughout its clinical lifecycle [4].

As AI becomes an increasingly important component of healthcare delivery, the profession has a unique opportunity to help shape how these technologies are implemented, monitored and governed in real-world clinical practice.

II. AI IS DIFFERENT FROM CONVENTIONAL MEDICAL DEVICES

To understand why AI governance has become such an important issue, we must first recognise how AI-enabled medical devices differ from the technologies we traditionally manage.

Consider a familiar example, such as a CT scanner. Once commissioned and placed into clinical service, its core operating characteristics generally remain stable over time. AI-enabled technologies are different. Their performance may be influenced by software updates, evolving datasets, changing patient populations and local clinical workflows. As a result, a system that performs well today may not necessarily perform identically in the future [2, 3].

This creates a new challenge for healthcare organisations. While considerable attention is given to regulatory approval and initial clinical deployment, much less attention is often paid to what happens after implementation. Yet AI systems continue to operate within dynamic clinical environments where data, workflows and practice patterns constantly evolve. Recognising this

challenge, international regulators have increasingly emphasised the importance of continuous monitoring, performance evaluation and lifecycle oversight for AI-enabled medical devices [4, 5].

As AI adoption expands, ensuring that these technologies remain safe, effective and trustworthy requires ongoing oversight rather than a one-time assessment. This highlights the growing importance of post-market monitoring, continuous performance evaluation and lifecycle governance throughout routine clinical practice [3, 6].

III. LESSONS FROM A RECENT REVIEW

A recent review of 355 studies from around the world revealed several important lessons about how AI-enabled medical devices are currently governed (unpublished). Although healthcare systems differ across countries, many of the same challenges continue to emerge.

One of the findings was that governance efforts remain heavily focused on the early stages of the technology lifecycle, particularly regulatory approval and clinical deployment. Considerable attention is devoted to how AI tools are introduced into practice, yet far less attention is directed toward what happens after implementation. Despite the adaptive nature of many AI systems, post-market surveillance and long-term performance monitoring remain relatively underdeveloped.

A second observation concerns the use of international standards. Frameworks such as ISO 14971 [7], IEC 62304 [8], and IEC 81001-5-1 [9] are widely recognised and frequently referenced. However, their practical implementation within healthcare organisations appears much less common. This highlights an important gap between regulatory expectations and everyday clinical practice.

The review also showed a significant geographical imbalance. Most governance evidence originates from high-income countries, while comparatively little is available from low- and middle-income settings. This raises important questions about local validation, infrastructure readiness, workforce capacity and governance maturity.

Perhaps the most important lesson is that governance does not end when an AI system receives regulatory approval. In many respects, governance only begins once the technology enters routine clinical practice. As AI adoption accelerates, hospitals and healthcare organisations will increasingly need local expertise to ensure these systems remain safe, effective and trustworthy over time.

IV. THE MEDICAL PHYSICIST AS THE AI SAFETY STEWARD

AI governance is often viewed as the responsibility of regulators, software developers, and healthcare administrators. However, as attention shifts toward local accountability and post-deployment oversight, it becomes clear that medical physicists already possess many of the skills needed to support the safe and effective use of AI in healthcare [4, 10].

For decades, medical physicists have been responsible for managing complex clinical technologies. We routinely assess risk, investigate incidents, validate performance and implement quality assurance programmes designed to protect patients and support clinical decision-making. Through activities such as acceptance testing, commissioning, performance evaluation and audit, we help ensure that healthcare technologies perform as intended throughout their operational life [4].

Importantly, medical physicists also work at the interface between technology and clinical practice. We regularly translate technical concepts into practical clinical applications, collaborating with clinicians, engineers, information technology teams, and hospital leadership. This ability to bridge technical and clinical domains is particularly valuable in the era of AI, where safe implementation depends not only on algorithm performance but also on how technologies interact with people, workflows and healthcare systems [4].

These existing competencies align closely with many of the challenges associated with AI-enabled medical devices. As healthcare organisations seek stronger approaches to AI validation, safety monitoring and post-market oversight, medical physicists are well-positioned to contribute to local governance efforts and support responsible implementation [4, 10].

Rather than viewing AI as a disruption to the profession, we should see it as an opportunity to extend our contribution to healthcare. The skills that have long underpinned quality and safety in medical technology can also help support the safe, effective and trustworthy use of AI in clinical practice.

V. FIVE EMERGING RESPONSIBILITIES FOR MEDICAL PHYSICISTS

As AI becomes part of routine clinical practice, many of the traditional responsibilities of medical physicists are naturally evolving. Rather than representing entirely new roles, these responsibilities build upon competencies that already exist within the profession (Table 1).

Table 1. From Quality Assurance to Governance Assurance

Traditional Responsibility	Emerging AI Responsibility
Equipment Quality Assurance	AI Performance Monitoring
Acceptance Testing	Algorithm Validation
Radiation Safety	AI Safety Assurance
Device Commissioning	Lifecycle Governance
Technical Advisor	AI Governance Advisor

One important area is AI validation. Just as new imaging equipment requires local acceptance testing and commissioning, AI systems should be evaluated within the clinical environment in which they will be used. Performance demonstrated elsewhere may not always translate directly to local patient populations, workflows, or data characteristics. International guidance increasingly emphasises the importance of validation within the intended context of use and throughout the product lifecycle [5, 6].

Medical physicists can also contribute to bias assessment by helping identify variations in algorithm performance across different patient groups. Ensuring that AI systems perform consistently and equitably is becoming an increasingly important aspect of patient safety and trustworthy AI implementation [2].

Another emerging responsibility is post-market monitoring. Unlike many conventional technologies, AI-enabled systems may change in performance over time because of evolving data, clinical practices, or software updates. Ongoing monitoring can help detect performance drift before it affects patient care. Regulatory agencies and international organisations have increasingly highlighted post-market surveillance and continuous performance monitoring as critical components of AI governance [3, 6].

As healthcare technologies become increasingly interconnected, cybersecurity awareness is also becoming part of the broader safety landscape. Medical physicists should work closely with information technology and cybersecurity teams to support the safe deployment and operation of AI-enabled systems. Cybersecurity is increasingly recognised as a key element of maintaining the safety, effectiveness and trustworthiness of software-based medical technologies [2, 11].

Finally, medical physicists can play an important role in governance leadership. As healthcare organisations assume greater responsibility for the oversight of AI-enabled technologies, many may establish multidisciplinary AI governance committees involving clinicians, information technology specialists, data scientists, administrators and medical physicists. Such committees can support local validation, performance monitoring, risk management and post-market oversight. Within these structures, medical physicists are well-positioned to contribute expertise in quality assurance, safety assurance and lifecycle management of AI-enabled medical devices [4, 10].

Together, these responsibilities reflect an important evolution of the profession, from technology assessment toward continuous stewardship of AI-enabled healthcare technologies throughout their lifecycle.

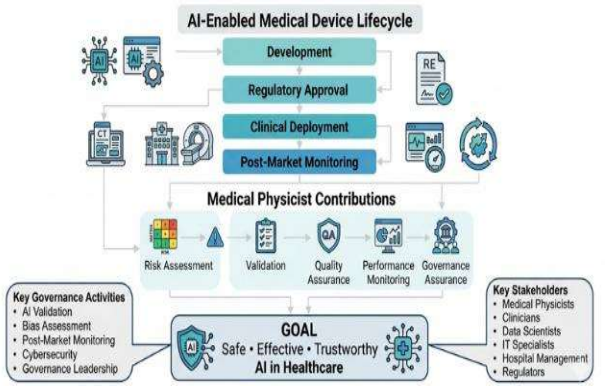

Figure 2. Medical physicists as AI safety stewards across the AI lifecycle. (AI-generated)

VI. BUILDING GLOBAL CAPACITY FOR SAFE AI ADOPTION

The IOMP encompasses healthcare systems with diverse levels of infrastructure, workforce capacity, regulatory maturity and access to technical expertise. As AI-enabled medical devices become more widely adopted, ensuring their safe and effective use will require more than technology acquisition alone. It will also require governance capability, professional competency and institutional readiness [2].

For many years, IOMP has supported professional development through its schools, workshops, scientific meetings and regional educational initiatives [12]. These established platforms provide a strong foundation for building awareness and competency in emerging areas such as AI governance, validation, safety monitoring and lifecycle management.

Beyond education, IOMP has facilitated regional collaboration and knowledge sharing among member organisations facing similar challenges. By exchanging experiences, developing practical guidance and promoting best practices, the medical physics community can help ensure that AI is implemented responsibly across a wide range of healthcare settings [4].

The challenge we are facing is not whether AI will be adopted, but whether the healthcare workforce will be adequately prepared to govern it. Through continued collaboration and professional development, IOMP can help build a community of practice that supports safe, effective and trustworthy AI adoption throughout the world.

VII. PREPARING THE NEXT GENERATION OF MEDICAL PHYSICISTS

As AI becomes increasingly embedded in healthcare, the competencies required of future medical physicists will continue to evolve. In addition to traditional expertise in clinical physics, quality assurance and patient safety, the next generation will need a broader understanding of AI literacy, data governance, cybersecurity, regulatory science, human-AI interaction and ethics [2, 4].

Developing these competencies will require ongoing education, professional development, and lifelong learning. Universities, training programmes, professional societies and healthcare organisations all have an important role to play in preparing the workforce for an increasingly digital healthcare environment [10]. Beyond technical competencies, future medical physicists will also need to cultivate ethical judgement, professional wisdom, stewardship and a strong sense of responsibility in the use of emerging technologies, particularly artificial intelligence.

Importantly, these new skills should complement and not replace the core scientific and clinical foundations of the profession. As healthcare becomes more dependent on data-driven technologies, medical physicists will be uniquely positioned to help ensure that innovation remains safe, effective and patient-centred [4].

Future medical physicists will increasingly become the trusted guardians of safe, effective and trustworthy AI across the healthcare ecosystem.

VIII. CONCLUSION

AI-enabled medical devices are reshaping healthcare, creating new challenges that extend beyond traditional regulatory approval and into routine clinical practice. Medical physicists already possess many of the skills needed to support this transition, including expertise in risk management, quality assurance, validation and clinical implementation.

As healthcare increasingly adopts AI-enabled technologies, the profession has an opportunity to expand its contribution from quality assurance to governance assurance. This action ensures that AI remains safe, effective and trustworthy throughout its lifecycle. Medical physicists can play a central role in shaping the future of healthcare.

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