

The Advancement of Medical Devices in the Future and Ethical Considerations in Healthcare

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Many organizations define the definitions of medical devices, which differ in details¹. However, the core concept is that any instrument, apparatus, implement, machine or application designed for medical purposes does not achieve its intended action by pharmacological, immunological, or metabolic means¹. The purposes could be diagnosis, prevention, monitoring, prediction, prognosis, treatment or alleviation of disease¹.

The development of medical devices has been reported since ancient times, with archaeological evidence proving that there were surgical instruments in ancient Egypt². The medical devices market size has been growing worldwide; therefore, we can expect more encounters with new medical devices in healthcare practice³.

In terms of ethical considerations, there are lessons we can learn from the past when new medical devices have been developed and launched into our practice. Additionally, points of consideration that we have to project while tailoring new innovations. The World Health Organization published a report entitled: "Medical devices: managing the mismatch," in 2010⁴. The report is intended to find an approach to address global access to appropriate medical devices. The report used the 4As approach: availability, accessibility, appropriateness and affordability. This framework can be adopted and applied for ethical consideration.

Availability in the report was described as: 'when a medical device can be found on the medical device market'⁴. In the context of an individual health care provider, we should ensure that our health care facility has appropriate medical devices available for use.

Accessibility was described as: 'people's ability to obtain and appropriately use good quality health technologies when they are needed'⁴. This aspect can be applied in a health care facility; for example, to a device that the facility has but is not allowed to use in certain situations. Good medical management can help enhance accessibility in health care facilities.

Appropriateness referred to: 'medical methods, procedures, techniques and equipment that are scientifically valid, adapted to local needs, acceptable to both patient and healthcare personnel as well as those that can be utilized and maintained with resources the community or country can afford'⁴. The examples could span a spectrum from using medical devices with wrong indications to using highly advanced medical devices, which may have a high cost in clinical scenarios where simpler solutions are sufficient. Appropriate staff training can help to minimize this problem.

Affordability was mentioned as: 'the extent to which the intended clients of a health service or product can pay for it'⁴. The strategies to overcome this aspect may need to involve larger stakeholders rather than an individual health care provider. Engaging community partners to develop funding sources or building infrastructures to address the social determinants of health may be helpful⁵. An individual health care provider may need to consider context and patient values, combined with evidence-based practice while choosing medical devices.

The 4As framework applied to medical devices in the past is still applicable for medical devices in the future. By addressing these 4As, we uphold the four principles of medical ethics, consisting of: autonomy, non-maleficence, beneficence and justice⁶. By considering patients' contexts and values, we certainly respect patients' autonomy. Through good management of medical devices, we address justice and beneficence, and by providing good training to medical staff, we can ensure non-maleficence.

Although, the 4As seem to be sufficient to address the ethical aspects of using medical devices, innovation has been growing in some areas far beyond the past. The future of medical devices may involve large data inputs; such as using artificial intelligence to predict clinical outcomes and make decisions. Ethical consideration should also encompass data security and patient confidentiality.

In addition to the ethical considerations applied in the past, ethical considerations should be adapted to different contexts in order to keep up with innovations.

REFERENCES

1. Aronson JK, Heneghan C, Ferner RE. Medical devices: definition, classification, and regulatory implications. *Drug Saf* 2020b;43:83–93.
2. Deyah W. History of medical devices [homepage on the Internet]. Hilla (Iraq): College of Engineering & Technology, Al-Mustaqbal University; 2024 [cited 2025 Jul 17]. Available from: <https://www.uomus.edu.iq/En/NewColl.aspx?colid=25&newid=63411>
3. Precedence Research Pvt Ltd. Medical devices market size to hit USD 1,146.95 Bn by 2034 [homepage on the Internet]. Pune (India): Precedence Research Pvt Ltd.; 2025 [cited 2025 Jul 20]. Available from: <https://www.precedenceresearch.com/medical-devices-market>
4. World Health Organization. Medical devices: managing the mismatch: an outcome of the priority medical devices project. *Dispositivos médicos: la gestión de la discordancia: un resultado del proyecto sobre dispositivos médicos prioritarios* [homepage on the Internet]. Geneva: WHO; 2010 [cited 2025 Jul 20]. Available from: <https://iris.who.int/handle/10665/44407>
5. Purnell TS, Fakunle DO, Bone LR, Johnson TP, Hemberger N, Jilcott Pitts SB, et al. Overcoming barriers to sustaining health equity interventions: insights from the national institutes of health centers for population health and health disparities. *J Health Care Poor Underserved* 2019;30:1212–36.
6. Page K. The four principles: can they be measured and do they predict ethical decision making? *BMC Medical Ethics* 2012;13:10.