The future of AVS, dizziness, and vertigo in emergency departments Part V: Rise of the machines – The role of science and engineering in medicine

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In the final article of this five-part series, Dr Millie Nakatsuka discusses emerging technologies relevant to acute vestibular syndrome (AVS) in the emergency healthcare setting

Telemedicine, artificial intelligence (AI), and smartphone technology play a key role in healthcare, especially in the wake of the COVID-19 pandemic. We focus on the current trajectories, potential opportunities, and foreseeable barriers.

1. Telemedicine

The history of remote delivery of medical services through telecommunications technology dates back to the 1860s, when the telegraph was used during the American Civil War. Even so, governments worldwide were reluctant to publicly fund and adopt telehealth services before the pandemic.

Telemedicine (i.e., the specific provision of remote medical consultations) is now vital for virtual emergency departments (EDs) and 'early discharge' hospital-in-the-home. Mobile medical devices providing remote diagnostics have increased accessibility and quality of care, e.g. portable video-oculography (VOG) for remote subspecialist support in EDs for AVS. Remote diagnostics operating via smartphone (without the need for dedicated mobile medical devices) shows great promise, with small studies showing smartphone eye-tracking algorithms and apps can perform similarly to VOG. (1) The major barriers to telemedicine are cost, accessibility, delays in regulatory approval, and privacy and cybersecurity concerns.

2. Artificial intelligence

The use of AI in emergency healthcare for clinical decision-making lags far behind its experimental research successes, due to previous failures and unresolved issues. The reputation of medical software was tarnished by the deaths caused by the computer-controlled radiation therapy machine Therac-25 (1985-1987), which resulted from poor design and development practices due to overconfidence and lax regulation. Although AI differs from older software, it is still vulnerable to data bias, inaccurate analysis, and misleading predictions, with ongoing public fear of unreliable and unaccountable machines that confidently make unexplainable errors (i.e. 'hallucinations' and the 'black box' problem).

The current application of AI in EDs is thus mainly limited to non-clinical decision-making roles: administrative and logistics, safety netting, and data collection (e.g. triage and dispatch in disasters, medical drones, and transcription). Meanwhile, research for clinical decision-making AI primarily focuses on 'proof of concept' diagnostic aids, with promising small studies of AI-powered VOG for AVS, including early stroke detection. (2) However, these may have limited scope for emergency physicians (without telemedicine), not being subspecialists capable of verifying the results produced.

The significant barriers to clinical decision-making AI in EDs are cost, acceptability, and professional liability. While past failures have resulted in increased regulation of medical devices and refinement of AI systems (e.g. human-controlled, 'white-box' or 'explainable'), legal frameworks for the safe and responsible use of AI remain inadequate. For instance, in Australia, there is no specific legislation for AI; it falls under the jurisdiction of other laws (e.g., the Privacy Act). Mandatory guardrails have merely been proposed. Some software and AI-enabled products used in healthcare are also exempt from regulation, not being a 'therapeutic medical device' (e.g. AI-powered medical transcription).

3. Smartphone technology

Medical apps for smartphones are popular and frequently used by emergency physicians, especially juniors. The primary functions of such apps include:

- Point-of-care diagnostic and treatment references.
- Medical calculators.
- Portable diagnostic tools (e.g., visual acuity charts).
- Aids for medical devices (e.g., digital stethoscopes).

More recently, there has been an uptrend of apps facilitating telemedicine and remote access (working from home).

Remote diagnostics operating via smartphone (without needing dedicated mobile medical devices) is a promising development, including eye-tracking algorithms and apps that can perform similarly to VOG for AVS in the ED. (1) Likewise, video-ophthalmoscopy via smartphone (and condenser lens) may be useful to identify patients with a central (and more sinister) cause of AVS. (3,4) Previously, high-quality digital images were difficult to capture on smartphones without expensive devices, such as the iExaminer Pro System app, which requires the iExaminer SmartBracket Accessory and PanOptic Ophthalmoscope Plus.

The major barriers to smartphone technology are similar to those affecting telemedicine. Another concern is that some users are still unable to use certain apps, as advanced and high-performing 'native' type apps were expensive to develop and maintain, being built specifically for a particular operating system and platform (e.g. Mobile MIM, a U.S. FDA-approved app exclusive to iOS for portable diagnostic imaging).

There is an urgent need for an appropriate legal framework for all three of these exciting developing fields. Federal agencies and regulatory authorities must strike a balance between the lack of regulatory oversight, and over-governance, which would hamper the potential benefits of innovative emerging technologies. However, technology is not a panacea, and we cannot ignore the issues and reforms we have discussed previously.

Summary of the series

- I.

  The HINTS exam, a simple three-step bedside physical examination, is a cost-effective and sustainable approach to AVS in the ED with high diagnostic accuracy when used by a subspecialist. New research has shown that emergency physicians can also use the exam after education and training, without relying on VOG and telemedicine.
- II.

  Systemic barriers serve as perverse incentives that result in the overuse of unnecessary neuroimaging for AVS in EDs, despite the harms and long-term consequences of doing so. Restructuring medical education and training is one of the strategies to pave the way for systemic reform.
- III.

  The health inequities and systemic barriers hospitals and physicians face in rural and remote areas are overlooked and underestimated. Medical education and training must consider local resources and economic realities to provide feasible clinical guidelines that do not assume patients have privileged access to mainstream healthcare.
- IV.

  Coherent and coordinated health policies, and rationally planned, cost-effective care based on population health priorities, are required to address overcrowding of EDs and achieve the vision of universal healthcare. Public health interventions to improve health literacy are essential to achieve a population-wide paradigm shift, and reorientate our healthcare systems towards primary healthcare.
- V.

  An appropriate legal framework is urgently needed to protect public trust and ensure beneficial medical technologies can be adopted quickly, safely, and effectively.

References

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