

Medical Device & AI Regulations

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Revolutionising Medicine: The Power of Digital Algorithms in Healthcare

Medical digital algorithms are computer programs that use complex mathematical equations to analyse data and make predictions about medical conditions.

These algorithms have the potential to revolutionise healthcare by improving accuracy, reducing costs, and providing personalised treatment plans. Despite their potential benefits to transform healthcare, medical digital algorithms also raise concerns about privacy and bias. It is important to approach them with caution and careful consideration.

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key points

- An algorithm is a step-by-step procedure or a set of instructions that is designed to perform a specific task or solve a problem.
- Algorithms in health care can automate many (routine) tasks, freeing up medical professionals to focus on more complex cases.
- To ensure the long-term reliability and effectiveness of AI/ML-based clinical algorithms, it is crucial that we establish systems for regular monitoring and maintenance.

Enhancing Diagnostics, Treatment and Patient Outcomes through Innovative Technology

Introduction

An algorithm is a step-by-step procedure or a set of instructions that are designed to perform a specific task or solve a problem.

It consists of a series of well-defined and finite steps that can be followed to achieve a particular goal or objective. Algorithms are used in computer programming, mathematics, and many other fields.

In computer programming, algorithms are used to solve problems and automate tasks. For example, an algorithm might be used to sort a list of numbers or to search for a specific item in a database.

Algorithms can be expressed in various forms, such as natural language, flowcharts, pseudocode, or programming languages. In addition, digital algorithms can be used in a wide variety of applications, such as computer programming, data analysis, cryptography, and digital signal processing. They are typically written in a programming language and can be executed by a computer or other digital device.

Machine learning (ML) and artificial intelligence (AI) algorithms have the potential to derive insights from clinical data and possibly improve patient outcomes. The use of artificial intelligence (AI) and machine learning (ML) in the clinical arena has developed tremendously over the past decades, with numerous examples in medical imaging, cardiology, and acute care (Choudhury and Asan. 2020). Indeed, the list of AI/ML-based algorithms approved for clinical use by



the United States Food and Drug Administration (FDA) continues to grow at a rapid rate (Benjamens et al. 2020).

Well-constructed algorithms are efficient, accurate, and easy to understand. They should be designed to work correctly on all possible inputs and should produce the desired output. Digital algorithms are essential for many modern technologies and have revolutionised the way we process and analyse information. They have enabled us to solve complex problems quickly and efficiently, making them an integral part of the digital world.

Despite the accelerated development of these medical algorithms, adoption into the clinical space

real-time patient data from sensors and wearable devices.

Medical digital algorithms use machine learning techniques to “learn” from the data they analyse. They can identify patterns and correlations in the data that would be difficult or impossible for humans to detect. By doing so, they can help healthcare providers make more accurate diagnoses, develop more effective treatment plans, and monitor patient progress more effectively.

For example, an algorithm trained to detect breast cancer might analyse mammograms from thousands of patients to identify common patterns and features that indicate the presence of cancer. The algorithm can then use this knowledge to analyse new mammograms,

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has been limited. The challenges encountered on the way to successful integration go far beyond the initial development and evaluation phase. Because ML algorithms are highly data-dependent, a major concern is that their performance depends heavily on how the data are generated in specific contexts, at specific times. It can be difficult to anticipate how these models will behave in real-world settings over time, as their complexity can obscure potential failure modes (Feng et al. 2022).

What Are Medical Digital Algorithms?

A medical digital algorithm is a step-by-step procedure or set of rules that is designed to help healthcare professionals diagnose, treat, or manage a specific medical condition or disease. These algorithms are typically created using computer-based models that are programmed to process large amounts of data and provide recommendations based on specific criteria.

In simple terms, medical digital algorithms are computer programs that use mathematical models to analyse patient data and provide healthcare professionals with diagnostic or treatment recommendations. These models are then trained on large datasets of patient information, such as medical records or imaging data. The algorithm then uses this training to identify patterns and correlations in the data that might be indicative of specific medical conditions. These algorithms can process vast amounts of data, including medical images, electronic health records, and

indicate the diagnosis to healthcare providers and even suggest recommendations for further testing or treatment, all based on the data analysis.

Medical digital algorithms can be used for a wide range of purposes, such as:

- **Diagnosis:** Algorithms can be used to identify potential diagnoses based on a patient’s symptoms and medical history.
- **Treatment:** Algorithms can help healthcare professionals determine the most effective treatment plan for a patient based on their individual characteristics and circumstances.
- **Monitoring:** Algorithms can be used to track a patient’s progress over time and provide recommendations for adjustments to their treatment plan if necessary.

One example of a medical digital algorithm is the Framingham Risk Score, which is used to assess a patient’s risk of developing cardiovascular disease based on various risk factors such as age, gender, blood pressure, cholesterol levels, and smoking status. Another example is the Modified Early Warning Score (MEWS), which is used to predict the likelihood of a patient experiencing clinical deterioration in a hospital setting based on their vital signs and other clinical data.

Medical digital algorithms have become a critical tool in modern healthcare, providing doctors and healthcare professionals with a powerful way to analyse and interpret complex patient data. These algorithms are designed to help healthcare providers make better



decisions, improve patient outcomes, and reduce healthcare costs.

automate many routine tasks, freeing up medical professionals to focus on more complex cases. This can lead to faster diagnoses, shorter wait times,

Algorithms in health care can automate many (routine) tasks, freeing up medical professionals to focus on more complex cases

The Benefits of Medical Digital Algorithms

Algorithms can also automate many routine tasks, freeing up medical professionals to focus on more complex cases.

Medical digital algorithms thus can offer a range of benefits in healthcare.

Here are some of the most significant advantages they provide:

- **Improved Diagnostics:** Medical digital algorithms can help healthcare providers make more accurate diagnoses by analysing patient data and identifying patterns that may be difficult or impossible for humans to detect. This can lead to earlier detection of medical conditions, more accurate diagnoses, and better treatment outcomes.
- **Personalised Treatment:** By analysing patient data, these algorithms can provide healthcare providers with personalised treatment recommendations tailored to each patient's unique medical history, genetic makeup, and other factors. This can lead to more effective treatments and better patient outcomes. For example, algorithms are being developed to analyse a patient's genetic information and identify which medications are most likely to be effective for that individual, or what disease they might be more prone to.
- **Reduced Costs:** Medical digital algorithms can help reduce healthcare costs by improving the efficiency of healthcare delivery. By providing healthcare providers with more accurate diagnoses and treatment recommendations, these algorithms can help reduce the number of unnecessary tests, procedures, and even hospitalisations, leading to cost savings for patients and healthcare providers alike.
- **Improved Patient Outcomes:** By providing healthcare providers with more accurate and personalised treatment recommendations, medical digital algorithms can improve patient outcomes and reduce the risk of adverse events. Algorithms can

and reduced costs. For example, algorithms are being developed to automate the triage process in emergency departments. These algorithms can quickly analyse a patient's symptoms and medical history to determine the level of urgency and prioritise treatment. This can lead to better patient satisfaction and improved overall health.

- **Real-time Monitoring:** Medical digital algorithms can monitor patient data in real-time, providing healthcare providers with instant alerts when a patient's condition changes or deteriorates. This can help healthcare providers respond quickly and effectively to changes in a patient's health, improving patient outcomes and reducing the risk of complications.

Challenges and Concerns

While medical digital algorithms offer many benefits, there are also challenges and concerns associated with their use. Some of these include:

- **Data Privacy:** Medical digital algorithms rely on large amounts of patient data to function effectively. As such, there are concerns about data privacy and security. Healthcare providers must take steps to ensure patient data is protected and used only for its intended purposes.
- **Bias:** Medical digital algorithms are only as unbiased as the data they are trained on. If the data is biased or incomplete, the algorithm may also be biased. Healthcare providers must ensure that algorithms are trained on diverse datasets to prevent bias. For example, if an algorithm is trained on data that primarily includes white male patients, it may not be as accurate in diagnosing or treating medical conditions in patients who are not white or male.
- **Errors or Misinterpretations in the Data.** Another limitation of medical digital algorithms is the potential for errors or misinterpretations in the data. While algorithms are designed to be highly accurate, they



can still make mistakes if the data is incomplete or inaccurate. Additionally, the interpretation of the data can be influenced by the individual who programmed the algorithm, which can lead to errors or bias in the output.

- **Transparency and Accountability:** Algorithms can be complex and difficult to understand, which can make it challenging to identify and correct errors or biases. To address this challenge, medical professionals

Conclusion

In conclusion, medical digital algorithms are already revolutionising the healthcare industry.

They can improve patient outcomes, increase efficiency, and provide personalised care. However, there are also challenges that need to be addressed, including data privacy and security, transparency and accountability, and the need to safeguard a human connection in healthcare.

To ensure the long-term reliability and effectiveness of AI/ML-based clinical algorithms, it is crucial that we establish systems for regular monitoring and maintenance

must work to ensure that algorithms are developed with transparency and that patients have access to information about how algorithms are being used in their care.

- **Lack of Human Touch:** Medical digital algorithms may not take into account the nuances of a patient's individual situation or provide the same level of empathy and emotional support that a human clinician can.
- **Reliance on Technology:** Medical digital algorithms rely on technology to function. Healthcare providers may become overly reliant on technology and algorithms, potentially leading to reduced critical thinking skills and a lack of judgment.

Finally, there is a concern that reliance on algorithms may lead to a loss of human touch in healthcare. Medical professionals must strike a balance between using algorithms to improve efficiency and accuracy while also maintaining a human connection with patients.

As the use of medical digital algorithms continues to grow, it is essential that medical professionals work to address these challenges and ensure that algorithms are used in a responsible and ethical manner.

To ensure the long-term reliability and effectiveness of AI/ML-based clinical algorithms, it is crucial that we establish systems for regular monitoring and maintenance.

Simply put, AI-based algorithms achieve high predictive accuracy by detecting correlations between patient variables and outcomes. However, when the clinical environment is highly dynamic and patient populations are heterogeneous, a model that works well in one-time period or one hospital may fail in another. To bring clinical AI into maturity, AI systems must be continually monitored and updated (Yoshida et al. 2018).

Conflict of Interest

None. ■

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