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Editorial

Artificial Intelligence as an Extension of Pharmaceutical Care

Luiz Cláudio DA SILVA

Artificial Intelligence (AI) has evolved from a futuristic concept into a transformative force in highly complex sectors. In health care, and more specifically in hospital pharmacy, its applications are shaping a new model of operation and care, redefining the boundaries of efficiency, safety, and personalization. Although discussions about AI often evoke images of robots replacing humans, the emerging reality is one of symbiosis, in which technology amplifies the pharmacist's strategic and clinical capacity, strengthening safety and efficiency throughout the entire medication cycle.[1,2]

The initial impact of AI is felt at the operational core of hospital pharmacy, where supply chain management, traditionally reactive and prone to failures, is being transformed into a predictive model. Machine learning can analyze vast volumes of data to optimize inventory levels, considering factors such as historical demand, seasonal patterns, the epidemiological profile of diseases, and even external factors such as weather events or health crises. This not only prevents shortages of critical items that can jeopardize patient lives but also minimizes resource waste, reducing operating costs and the disposal of medications nearing expiration.[3] Furthermore, this same analytical capacity extends to combating counterfeit and adulterated drugs. AI can assess product authenticity, trace their origin, and detect anomalies in the distribution chain, strengthening safety barriers before any suspicious product reaches the patient. Such operational optimization frees up financial resources and, crucially, time, allowing the pharmacy team to focus on its most vital and impactful function: direct patient care.[1,3]

It is in the realm of clinical services that AI's potential becomes even more evident and revolutionary. Automation, powered by intelligent and robotic systems, is already a reality in many leading hospitals. Dispensing robots, for example, drastically reduce human errors inherent to repetitive tasks and streamline internal logistics, ensuring that the right drug reaches the right patient, in the right dose, at the right time. However, this automation is not intended to make the pharmacist obsolete, but rather to reposition them at a higher strategic level. Freed from mechanical and repetitive tasks, the professional can devote their expertise and time entirely to higher value-added and more complex health care services: the careful validation of complex prescriptions requiring deep knowledge of drug interactions and patient conditions; bedside pharmacotherapeutic follow-up, monitoring the patient's response to treatment and adjusting it as needed; active pharmacovigilance, proactively detecting and reporting adverse drug reactions; and specialized consulting for the multidisciplinary team, contributing insights into pharmacotherapy management. In addition, AI tools can act as highly sophisticated clinical decision-support systems, analyzing the patient's full medical history, genetic data, laboratory results, and scientific literature to identify potentially dangerous drug interactions, suggest personalized therapeutic adjustments based on pharmacogenomics, or even predict treatment responses, elevating pharmaceutical practice to a new level of precision and individualization.[1,3,4]

However, the robust and ethical implementation of artificial intelligence (AI) in the pharmaceutical setting, despite its immense potential, faces complex challenges that require a meticulous approach. Two critical pillars for the successful integration of AI are machine learning and professional qualification. Effectively addressing these factors is essential to ensure that AI becomes a truly transformative and safe tool in health care.[2]

With regard to machine learning, the use of robust data to train algorithms is an ongoing and central concern. By nature, AI algorithms are trained with vast volumes of historical data, which can, paradoxically, become a source of vulnerability. Any biases inherent in these training datasets, whether due to unequal demographic representation, incomplete data, or inadequate records, can be perpetuated and even amplified by the algorithms. This may lead to subtle or overt discrimination, resulting in erroneous decisions that directly affect patient health.[3]

The explainability of algorithms (or "explainable AI" [XAI]) is another fundamental component. In a context where human lives are at stake, it is imperative that health care professionals and patients understand how AI-based decisions are made. This does not necessarily mean understanding every line of code, but rather the reasoning behind the model's predictions, the most influential factors in a given decision, and the limits of its applicability. The challenge lies in creating models that are not only effective in their predictions but also fair and transparent, reconciling the inherent complexity of many AI models with the need for clarity and trust. A lack of explainability can generate distrust and hinder the adoption of AI, especially in critical scenarios.[5]

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At the same time, the professional qualification of pharmacists and other health care professionals is a critical issue. Having access to technology is not enough; these professionals must be prepared to use it effectively and ethically. This extends beyond a conceptual understanding of AI to include practical skills such as prompt engineering and the integration of database knowledge. Prompt engineering is an emerging and vital skill in the use of language models and other generative AIs. It involves the ability to formulate effective commands and questions that enable the extraction of relevant information and the generation of accurate and reliable insights from AI models. A poorly formulated prompt can lead to inaccurate, irrelevant, or even dangerous responses. Therefore, investment in training and capacity building is necessary so that professionals develop the accuracy and precision required to interact productively with these tools. Qualified professionals must be able to validate AI outputs, recognize their limitations, and ensure that the generated information is applied safely, ethically, and clinically appropriately in practice. This includes the ability to cross-check AI information with clinical knowledge and patient data, ensuring a holistic and human-centered decision-making process.[2,5]

The need for clear and agile regulation is another barrier that must be responsibly overcome, ensuring that innovation does not compromise safety and quality of care. Global regulatory agencies, such as the FDA in the United States and the EMA in Europe, are already actively working to create comprehensive guidelines that guarantee the safety, efficacy, and transparency of these tools. In this constantly evolving scenario, the pharmacist's role is shifting toward technical information curation, critical supervision, and technology interpretation, ensuring that the final decision remains human, informed by artificial intelligence, but always centered on the patient's best interest and well-being.[1,3-5]

In summary, the integration of AI into hospital pharmacy is not a question of 'if', but of 'how' and 'when' it will be fully realized. We are facing a historic opportunity to redesign workflows, exponentially improve patient safety, and, fundamentally, redefine the scope and quality of pharmaceutical care. It is up to us, health care professionals, and particularly pharmacists, to lead this transition with proactivity and responsibility, equipping ourselves to use these new tools not as substitutes for our intelligence and humanity, but as powerful allies in the mission to safeguard patient health and well-being, building a smarter, safer, and more humanized future for pharmacy.

About the author

Luiz Cláudio DA SILVA is a pharmacist, PhD in Pharmaceutical Sciences, and professor at the Federal University of Rio de Janeiro.

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