# Advancements in digital pharmacy post COVID-19

## Report from the FIP Technology Advisory Group

2023

20 DIGITAL HEALTH

7 ADVANCING INTEGRATED SERVICES

16 COMMUNICABLE DISEASES

FIP Development Goals

International Pharmaceutical Federation

# Colophon



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# Acknowledgements

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This report is based on discussions at a FIP digital event titled “How digital health is changing care delivery for pharmacists and improving public health”. This was led by the FIP Technology Advisory Group and exposed an array of topics related to digital services in pharmacy, the challenges and benefits of digitisation in pharmacy, and the impact on pharmacy education and training.

# 1 Introduction

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The International Pharmaceutical Federation (FIP) Technology Advisory Group (TAG) is a new platform within FIP that explores global initiatives in technology and pharmacists' involvement. The TAG will explore new technologies and their possible impact, and how pharmacy can embrace new trends, new technologies and new logistic models and integrate them into our everyday work in the service of our communities. It will also be tasked with outlining technological trends and their potential impact on pharmacy, and providing guidance for FIP members on technology matters, including digital trends, artificial intelligence and big data, medical devices, the digitalisation of pharmacy and mobile health (mHealth).

The FIP TAG has the following objectives:

- To provide ad-hoc technical expertise on technology;
- To provide ad-hoc technical expertise for FIP's collaboration with partners, namely the World Health Organisation (WHO) in the area of technology;
- To explore global initiatives in technology and explore pharmacists' involvement;
- To outline trends in technology and their effects on pharmacists in different settings; and
- To provide guidance for FIP members on technology (e.g., through a publication, leading to a statement, or a project focused on technology)

## 1.1 Digital health and telepharmacy

Digital health and telepharmacy have gained increasing importance in the delivery of pharmaceutical care, largely due to the coronavirus disease 2019 (COVID-19) pandemic, which has placed enormous pressures on healthcare systems globally. There are some innovative models of telepharmacy services aimed at optimising and improving access to pharmaceutical care, resulting in improved patient safety and outcomes.

Pharmacists play a critical role in healthcare delivery today. The local pharmacy is a mainstay of the community, serving as a convenient, accessible destination for a wide range of healthcare services and wellness needs.

Technology allows community and hospital pharmacists to do more purpose-driven, patient-centred work. Telepharmacy and digital services will help drive clinical outcomes and prioritise outreach to patients who need additional support in managing their medicines.

The FIP TAG brings together experts from within FIP's membership to exchange views on current activities, problem areas, best practices, and more, in technology. It also serves as a networking platform for finding new contacts among fellow pharmacists and allows members to work together on joint projects that bring added value and are aligned with FIP's Strategic Plan.

In this report, readers will learn more about the activities led by FIP TAG as well as be exposed to an array of topics related to digital services in pharmacy, the challenges and benefits of digitisation in pharmacy and the impact on pharmacy education and training.

## 1.2 Embracing digital health

Digital health has become increasingly common practice in pharmacy, and in other sites of pharmaceutical care delivery, and pharmaceutical research and development. The pharmacy sector is utilising technology to improve access and affordability for consumers, breaking down geographical barriers to accessing pharmaceutical services and medicines, and empowering pharmacists to manage medication risks for consumers and to be more accountable and responsible for medicines safety and efficacy. Inputting into digital health records, the use of electronic prescriptions and real-time prescription monitoring, as examples, also provide opportunities for pharmacists to ensure the safe and quality use of medicines. This has been accelerated and focused due to the COVID-19 pandemic.

# 1.3 FIP Development Goal 20 (Digital health)

FIP Development Goal (DG) 20 (Digital health) includes three elements, namely, workforce & education, practice and science.

The workforce & education element sets a goal for countries to have enablers of digital transformation within the pharmacy workforce and effective processes to facilitate the development of a digitally literate pharmaceutical workforce.

The practice element sets a goal for countries to have systems and structures in place to develop and deliver quality digital health and pharmaceutical care services through digital literacy, the utilisation of technology and digital enablers, and configuration of responsive digital services to widen access and equity.

The science element sets a goal for countries to apply digital technology in healthcare delivery and development of innovative medical products.

FIP recommends mechanisms to support countries in implementing each element of FIP DG 20.

Some of the mechanisms to implement the workforce & education element of FIP DG 20 are:

- To develop courses, training materials and experiential learning opportunities in initial education and early career training to prepare a digitally literate workforce; and
- To incorporate digital health and literacy competencies and skills in pharmaceutical competency, advanced and specialist frameworks.

Some of the mechanisms to implement the practice element of FIP DG 20 are:

- To demonstrate digital literacy and understanding of governance issues surrounding data ownership, ethics, privacy and quality information, and to have policies in place to support the development of the workforce as managers of health data; and
- To recognise digital health as a mechanism for widening access and equity, including access to digital pharmaceutical care.

Some of the mechanisms to implement the science element of FIP DG 20 are:

- To promote the use and interpretation of digital technology and information during training and education of pharmacists and pharmaceutical scientists; and
- To enable integration of “data science” solutions to improve patient care.

The United Nations’ 2030 Agenda for Sustainable Development highlights that the spread of information and communications technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies.

With the recognition that information and communications technologies present new opportunities and challenges for the achievement of all 17 of the United Nations Sustainable Development Goals, there is a growing consensus in the global health community that the strategic and innovative use of digital and cutting-edge information and communications technologies will be an essential enabling factor towards ensuring that one billion more people benefit from universal health coverage, that one billion more people are better protected from health emergencies, and that one billion more people enjoy better health and well-being (WHO’s triple billion targets.)

Digital transformation of health care can be disruptive; however, technologies — such as the internet of things, virtual care, remote monitoring, artificial intelligence, big data analytics, blockchain, smart wearables, platforms, tools enabling data exchange and storage and tools enabling remote data capture and the exchange of data and sharing of relevant information across the health ecosystem creating a continuum of care — have proven potential to enhance health outcomes by improving medical diagnosis, data-based treatment decisions, digital therapeutics, clinical trials, self-management of care and person-centred care as well as creating more evidence-based knowledge, skills and competence for professionals to support health care. This is the future pharmacy landscape.

There is evident that digital transformation impacts health care through technology. Telepharmacy is set to become one of the most important aspects of telemedicine in the years to come with its ability to provide patients with: increased and more timely access to pharmaceutical care; reduced costs for individuals and health systems; improved patient satisfaction, experience and convenience; and better health outcomes.

Technology, such as robotics, automation, machine learning and artificial intelligence (AI), will also help power our approach to dynamic workload sharing, where certain parts of pharmacy workflow can be completed virtually and where pharmacists can have more direct interaction with patients, and can serve our patients, where and when they need us most.

The future of pharmacy, pharmacy education and pharmaceutical sciences is digital and it is exciting. A digitally enabled and agile pharmaceutical workforce will capitalise on the benefits of digital health, by employing them to reach their full potential in providing good health and well-being for all, leaving no one behind.

# 2 FIP resources on technology

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Digitisation brings unprecedented transformation to the healthcare landscape and compels us to fully rethink healthcare for the digital age. This is a challenging exercise.

The COVID-19 crisis has provided circumstantial evidence on how information technology (IT) developments in interoperability and the use of e-Health and m-Health technologies allow systems and processes to be more fluid, more transparent, more accessible and closer to patients and health professionals' expectations. The use of such technologies as e-prescribing, electronic health records, telehealth, telecare and telemedicine, as well as the use of mobile health, wearables, remote monitoring sensors and artificial intelligence through screening chatbots has demonstrated a better continuity of health care for patients that would not have been possible otherwise due to lockdown travel restrictions. This finally resulted in more patients being treated.

As technological advances and innovations are expanding, applications of digital technologies in health care is a trend which is not going to stop. An important aspect is that these new technologies are becoming more and more complex and difficult for health professionals to embrace, particularly in the case of convergence of digital technologies with other technologies — future 3D printing combined with genomics technology being one example. Moreover digital solutions continuously need to be updated regularly, sometimes requiring alignment of their potential impact on the digital environment.

In the light of these considerations, there is a risk that the rate of technology innovation and its complexity may outpace healthcare providers' ability to implement and adopt it. This will be particularly true in the case of a disruptive technology — a technology which changes the work process model used so far.

Here lies the purpose of this FIP report. Here is the concern of FIP in the workforce element of FIP DG 20 (Digital health) and here is one of FIP TAG's major reflections — incorporating digital health into pharmacy education is key for future pharmacists and for the future of pharmacy, and willingness to adopt digital health technologies is addressed within this report. Technology readiness, open mindedness and adaptability will be decisive personality qualities for future generations of pharmacists providing value to healthcare systems and patients. Not only must they be competent in their knowledge and skills, they must also feel open, secure, comfortable and confident about technology in order to be creative and innovative as they enthusiastically usher pharmacy towards its digital future.

FIP is recognised as the leader of pharmacy at a global level. We continue to expand our presence, within pharmacy and pharmaceutical sciences, and influence through partnerships with some of the world's leading health, policymaking, education and science institutions.

**Regarding digital health, FIP commits to:**

1. Advocate — to the World Health Organization, the United Nations, the World Health Professions Alliance, other international healthcare professional associations, patients' associations, international digital health solution consortia and other relevant international stakeholders — the adoption of common digital standards and common terminologies to enhance interoperable e-health solutions within health information systems and to facilitate health information exchange among countries at a global level.
2. Develop international strategies to promote among its member organisations the importance of interoperable digital technology in providing high-quality, patient-centred digital pharmaceutical care to ensure accessible, safe and rational use of effective medicines.
3. Support its member organisations to develop educational resources and standards covering appropriate digital health literacy. These resources should outline good practice and affordable solutions, and be a support for digital health education.
4. Advocate, collectively with other healthcare professionals at national and international levels, the digital advancement of the profession. Focus should be given to digital breakthroughs and other emerging technologies and applications so as to prepare the pharmacy workforce to champion and lead the profound reshaping these will bring to healthcare delivery in the near future.

5. Advocate the pharmacy profession's ability to embrace digital technologies, and pharmacists' capabilities as agents of change in leading projects of high magnitude to optimise healthcare.
6. Promote a positive attitude towards digital health and the possibilities digital transformation can bring to enable safe, efficient, accessible and cost-effective healthcare.
7. Support its member organisations to challenge the pharmacy profession, policymakers and regulators in their countries to resource and harness the potential of pharmacy via the full scope of pharmaceutical care. While welcoming and embracing digital technologies, remain a strong advocate and supporter of patient data privacy, personalised care and patient safety.
8. Support the exchange of experiences and success stories among its member organisations and countries, with an emphasis on developing countries.
9. Identify and celebrate its member organisations and countries that have successfully developed and implemented value-adding digital technologies, where there have been demonstrable benefits to patient and health system outcomes.
10. Encourage international collaboration for further research in digital health to increase the level of understanding of digital health technologies. Implement a FIP-dedicated platform for sharing the research results.
11. Provide tools and support to develop digital health curricula for pharmacists and pharmaceutical scientists. Support national implementation of the digital literacy competencies through the FIP Global Competency Framework at global level.
12. Promote evidence-based practice that can be adapted to the national level, thus supporting evidence-based policies.

FIP provides a wide range of resources to its members and the pharmacy profession. These resources include recorded webinars with experts in the field, congress posters and sessions, FIP reports, *International Pharmaceutical Journal* articles, statements, and more. Through these resources, FIP aims to support the advancement of pharmacy practice, education and science, and to promote the role of pharmacists as essential healthcare providers. The webinars cover a diverse range of topics, including medication safety, digitalisation of pharmacy, pharmacy services and pharmaceutical care, and provide a valuable opportunity for members to learn from experts and exchange ideas. Congress posters and sessions showcase the latest research and developments in pharmacy practice and education. FIP reports and *International Pharmaceutical Journal* articles provide in-depth analysis and commentary on key issues in pharmacy, while FIP statements offer guidance on important policy issues affecting the profession. Overall, these resources are an invaluable asset for FIP members and the wider pharmacy community, helping to advance the profession and improve patient care.

# 3 Health apps for blended pharmaceutical care

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Blended care is a healthcare delivery model that combines traditional face-to-face care with digital health tools and services. It offers patients the benefits of both in-person care and technology-enabled care, providing a more comprehensive approach to health care.

The digital part of blended care can, for example, be provided by health apps. A health app is a mobile application, designed to help users manage their health and wellness, track their symptoms and medication, access health information, and connect with healthcare providers and services.

There are thousands of health apps available in the app stores which offer patients increased access to health information, improved health and wellness management, convenience and accessibility, personalisation, and sometimes even cost savings. They can be accessed from anywhere, at any time, making them a convenient and accessible resource for individuals who are unable to visit healthcare providers in-person.[1]

Blending care in a pharmacy is a vital component for a sustainable future care model, as the number of patients that require care is increasing, whereas the number of personnel able to provide the care is declining in many countries. It is the obligation of the pharmaceutical profession to warrant the provision of required information and care, in order to avoid user mistakes that can have serious consequences like avoidable hospitalisation or addiction.

Pharmacists can use health apps for different purposes:

- Clinical and diagnosis assisting;
- Remote health monitoring;
- Clinical reference tool;
- Productivity and logistics supporting; and
- Wellness and healthy lifestyle tracking.

This chapter focuses mainly on the impact pharmacists can have when supporting patients to use health apps (blending care).

Pharmacists can educate patients on the benefits and risks of using health apps and help them understand how these apps can help them manage their health more effectively. Patients may be unaware of the various types of health apps available, or they may be hesitant to use them due to concerns about data privacy or app effectiveness. By explaining the benefits of health apps, verifying the accuracy and addressing patients' concerns, pharmacists can help patients make informed decisions about using health apps.

As with any healthcare technology, privacy is one of the key concerns when it comes to health apps. Pharmacists must ensure that patient privacy is protected and can advise patients on the importance of using secure apps and password protection, as well as reminding patients to read an app’s privacy policy before using it. Pharmacists can also help patients understand how their data will be used and shared, and can provide guidance on how to manage app permissions and data sharing settings.

The accuracy of an app can for instance be checked by a number of growing certification tools for health apps, for example, the upcoming ISO 82304 certification for health apps. ISO 82304 provides quality requirements for health apps and defines a health app quality label in order to visualise the quality and reliability of health apps.[2] When reviewing the status of an app, the pharmacist can give informed advice to patients on the usefulness of a certain app.

When patients use adequate app support tools, pharmacists can use these to monitor patients’ progress and provide feedback to help them achieve their health goals. This can involve reviewing data generated by the app and providing recommendations on medicines use, diet, exercise or other lifestyle factors. By monitoring patient progress using health apps, pharmacists can identify potential issues early on and help patients make adjustments to their health management plans.

By sharing data generated by an app with the healthcare system players surrounding the patient, healthcare providers can work together to develop a comprehensive care plan that addresses all aspects of a patient's health. Therefore, a crucial element for using health app data is that systems are interoperable and data can be shared safely and in a standardised way between different systems.

Finally, pharmacists have an important ethical role in helping patients use digital health apps safely and effectively. As healthcare professionals, pharmacists are responsible for protecting patients' health and well-being, including their privacy and confidentiality and avoiding conflicts of interests. For example, if patients are not willing to share data or insist on talking to a human instead of to a digital tool, the pharmaceutical profession allows wise consideration of the different aspects of this moral dilemma and reach a balanced decision in providing care in which the patient benefit is always central.

In summary, patients can benefit from health app use and the pharmacist can use these tools to make care more accessible, sustainable and reliable.

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# 4 Digital services in the community pharmacy

**Author:** Paul Fahey, member of the FIP Technology Advisory Group, Ireland

## 4.1 How COVID-19 disrupted community pharmacy

The COVID-19 pandemic resulted in significant disruption to the personal and working lives of populations worldwide. Community pharmacy was no exception, and it has been argued that of the many services that make up modern health care, community pharmacy was the quickest and most successful at adapting to the new working reality.

Most pharmacies worldwide remained open to the public during lockdowns while other elements of primary care moved to a telehealth-only model.

The success in community pharmacy's adaptation can be attributed to disruptive innovation by pharmacies and their staff. Most of the innovations and new services were facilitated by new or improved digital solutions to allow for the planning, provision and recording of services.

Examples of such innovations include:

- New or expanded pharmacy vaccination services;
- Electronic transfer of prescriptions from prescribers to pharmacies and also electronic prescribing;
- New and increased use of pharmacy apps to facilitate click-and-collect services for prescriptions;
- Vaccination appointment scheduling;
- Vaccination pre-screening of patients to reduce customer contact time;
- Integration of pharmacy systems with vaccine registries to allow for production of digital vaccination certificates;
- Polymerase chain reaction testing and the issuing of related digital certificates;
- Managed access programmes to facilitate the dispensing (and prescribing) of oral antiviral medicines to treat COVID-19 infection under strict protocols in pre-determined patient groups;
- Increased use of digital therapeutics (also referred to "software as a medical device") to monitor or treat certain conditions, e.g., ambulatory blood pressure monitoring, continuous blood glucose monitoring; and
- Continuing education and continuous professional development moved to online.

## 4.2 The future

The migration to a digital-only model for new services has transformed community pharmacy and has, in many cases, resulted in efficiencies and may facilitate expanded roles going forward. Pharmacy staff will want to continue to use digital tools that optimised workflows and reduced patient contact time.

Many health systems have also seen the benefits of managed access programmes and in some cases are expanding them to allow for the provision of hi-tech medicines (e.g., anticancer drugs and biologics) through community pharmacies and also to verify veracity of claims and compliance with protocols for certain medicines, e.g., glucagon-like peptide-1 agonists.

There is an increasing prevalence of legislation worldwide to prevent falsified and substandard medicines from entering the supply chain. Laws have been enacted in the European Union and will shortly be introduced in the United States. Digital solutions have been rolled out in the EU and several other jurisdictions. For example, Ghana has introduced its National Electronic Pharmacy Platform, which aims to verify the supply chain.

# 4.3 Challenges and opportunities

Migration to digital services is not without challenges and opportunities. For example:

- There is a need to re-engineer existing workflows to facilitate service innovations.
- As more information is shared, there will be a need for interoperability between diverse technology systems and platforms, document standards and terminologies (e.g., Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT), Health Level Seven (HL7), Integrating the Healthcare Enterprise (IHE), Logical Observation Identifiers Names and Codes (LOINC), International Organization for Standardization (ISO) standards and terminologies).
- Electronic health records, electronic patient record systems and clinical decision support systems (CDSSs) will need to be optimised to deal with real world data that will result from increased use of digital therapeutics.
- Artificial intelligence (AI) may be used as an information source by consumers going forward. Will it be accurate? Will it be misleading? Will pharmacists be called upon to curate the information on behalf of consumers?
- AI may prove useful in reducing the administrative burden on pharmacies in navigating reimbursement and eligibility rules.
- In the digital age, more data and information are being shared, which increases the risk of security and privacy breaches. This may result in an increased regulatory burden due to legislation proposed in many jurisdictions which aims to increase the regulation of access to digital platforms and also of the provision of digital services, especially with respect to health care.
- Payment and reimbursement models need to be developed to reflect the new service delivery models, i.e., from a “dispense and supply” model to a hybrid “dispense, supply and digital services” model.
- Pharmacogenetics is becoming an ever more important area and will lead to greater personalised medicine provision by community pharmacy, this will require new CDSSs to support pharmacists.
- The plethora of information and data coupled with more sophisticated CDSSs risks the generation of significant “noise” or large amounts of non-actionable prompts and interruption to existing workflows. If CDSSs are not engineered to optimise user experiences, there may be a risk of critical actionable prompts being ignored which may negatively affect safe provision of services.
- As pharmacy services become more digitised there will be a need for informatics pharmacists who will develop the workflows with software developers and pharmacists and facilitate the journey from paper to digital.

The *Economist* magazine recently quoted research by Gartner in the United States which showed an almost 400% increase in consumers who consulted a doctor online, but only a 66% increase in consumers who managed prescription medicines online.[1]

This research suggests that as of May 2020, almost 26% of United States consumers managed their prescription medicines online and therefore it might be inferred that almost 74% of US consumers opted for a physical face-to-face or hybrid pharmacy experience.[1] This would suggest that the future model of community pharmacy will be omni-channel, not just online or in person but a blend of both that will vary with consumer preferences. The future looks interesting.

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# 5 Benefits of technology in hospital pharmacy

**Author:** Robert Moss, member of the FIP Technology Advisory Group, immediate past president of the FIP Hospital Pharmacy Section, The Netherlands

## 5.1 Introduction

The FIP Hospital Pharmacy Section's Strategic Plan 2022[1] identified technological advancements as a key trend that will shape the future of hospital pharmacy practice. These innovations promise to impact various aspects of hospital pharmacy, from automation to personalised medicine. This chapter highlights some of these promising developments.

One such development is that technological advancements in automated dispensing and closed-loop administration systems are replacing manual, error-prone tasks in logistics and medication management with automated systems.[2] Using data generated by these systems and integrating these with electronic health records (EHRs) streamlines workflows and reduces administrative burdens on pharmacists, technicians and nurses. This allows healthcare providers to focus more on direct patient care, leading to better patient outcomes and improved satisfaction among care providers.

## 5.2 Data-driven hospital pharmacy: A paradigm shift

With access to a wealth of real-world data from automated systems and EHRs, hospital pharmacists can move away from relying solely on clinical trial data and traditional static guidelines. They can now develop short-cycle improvements of treatment protocols based on reliable, real-world data of outcomes. AI will increasingly play a role in facilitating rapid and reliable improvements.

Hospital pharmacists taking the lead in these developments will enhance the role hospital pharmacists within multidisciplinary care teams.

## 5.3 Virtual reality for training

Virtual reality offers a more realistic and immersive training experience for healthcare providers than traditional classroom or paper-based instruction. By practising in simulated complex hospital environments, healthcare providers can be better prepared for real-life situations, and this will enhance patient safety.[3]

## 5.4 Clinical decision support systems

Intelligent clinical decision support systems (CDSSs)help healthcare providers navigate the vast amounts of data generated by integrated hospital systems. By providing context and focusing attention on events that require action, these systems aid doctors, nurses and hospital pharmacists in making informed clinical decisions at the point of care.

Therapeutic drug monitoring will be enhanced by using intelligent systems to predict and adjust dosages directly related to changes in relevant patient parameters. Linking this dose optimisation with EHRs and smart infusion pumps will allow the direct adjustment of flowrates to make sure there are no manual actions required thereby limiting error-prone manual adjustments.

## 5.5 Personalised medicine

Advancements in genotyping and phenotyping enable tailored treatments that improve drug efficacy and reduce adverse events. Adding this information to intelligent CDSSs helps hospital pharmacists and other healthcare professionals to easily optimise therapy for patients. Techniques such as 3D printing allow hospital pharmacists to create personalised dosage forms and can also be used to develop unique dosages for specific patient groups, such as paediatric patients.[4]

## 5.6 Health ecosystem

The trend in health care is shifting from "sick care" to preventive or early-stage interventions. Hospital health care providers will play an important role in this transformation, offering specialised care at any stage of a disease whenever needed, regardless of location and in collaboration with other healthcare providers outside of the hospital, creating true seamless care. Utilising data from wearables and point-of-care testing, pharmacists will be able to provide patients with tailored advice and treatment.

Care will be organised in specialised networks, e.g., diabetes networks or Parkinson's networks. These specialised networks will help optimise care by connecting specific patient groups with the right information, the right healthcare providers and the right care. Thus, the treatment outcomes and satisfaction of these groups will be enhanced. Hospital pharmacists should and will be important contributors in these networks.

## 5.7 Conclusion

Technological advancements have the potential to revolutionise hospital pharmacy by streamlining processes, improving medication safety and enhancing patient care. As technology continues to evolve, its impact on hospital pharmacy will only grow, paving the way for a more efficient and effective healthcare system.

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# 6 Is digital education the first step to develop digitally enabled pharmacists?

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We are living in a rapidly changing world. New technologies that have been brought by the wave of digital revolution are transforming the way we live, learn and work. Pharmacists, like many other professionals, are under pressure to follow up recent developments and to align their knowledge, skills and competencies with the requirements of a new working environment. A digitally enabled pharmaceutical workforce is required to properly respond to new roles in the fast-shifting, digitalised health landscape.[1]

This is recognised as a priority by the FIP, as exemplified by FIP DG 20 (Digital health).

One of the first steps to facilitate the development of digitally literate pharmacists is to transform the education process towards implementation of more digital health-related topics. This holds true for both academic formal education and various continuous professional development courses within the lifelong learning process. Besides content-related changes in the curricula, a transformation is needed in teaching methodology through adopting various digital tools in the teaching process. Nowadays students prefer a more "entertaining" and efficient way of learning enriched with the tools so familiar to digital-native generation Z.[2]

Furthermore, the outbreak of the COVID-19 pandemic forced changes in the teaching process towards adoption of various digital technologies. During lockdown periods education went online and it became obvious that digitalising teaching processes is doable and possible. The benefits were obvious: without digital education, we would have faced immense delays in education of the necessary workforce at a time when society needed them most.

Many technologies have been available to help a shift to remote learning. These include various platforms to stimulate group work, virtual collaboration, knowledge sharing, community building, interactive simulation via virtual/augmented reality, apps or chatbots, AI adaptive course delivery for customised lessons based on student progress, classroom interactions with polls, chats, learning games etc. Recent research showed that more support is needed by institutions to continue using the new classroom learning technologies adopted during the pandemic.[3]

Lack of awareness was one of the five top reasons why new learning tools are not completely adopted in high-education institutions. Lack of information was also the main reason why most pharmacists are still not comfortable with using digital health technologies in daily practice as shown in a survey among pharmacists in Serbia.[4]

Pharmacy students and pharmacy professionals are ready to be educated and trained with new technologies and new content. To make it happen all relevant stakeholders should be involved in the process of digital transformation, discussing various issues and considerations. These include: how to maintain equity and accessibility to technologies for everyone; how to enable proper training of teaching staff and technical support to keep up with the novelties in the fast-changing IT sector; and what the optimal teaching model is — online only or a smart mix of virtual and face-to-face learning?

Also, it is important to enable continuity in exchanging knowledge, best practices and sharing resources.

All the above should be considered to provide proper education for a digitally enabled pharmaceutical workforce.

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# 7 Considerations for artificial intelligence in pharmacy

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Chapter 7 provides a brief overview of the information covered in the "AI considerations in pharmacy" presentation during the FIP Technology Advisory Group Digital Event that is the basis of this report.

## 7.1 Defining artificial intelligence and machine learning

Artificial intelligence (AI) is anything that mimics human intelligence. This includes both rules-based programmes, as well as machine learning algorithms. Machine learning (ML) is a subset of AI that involves algorithms that recognise patterns and infer information from data which can then be applied to data the algorithm has never seen before. Getting even more specific, deep learning is a type of ML that borrows from the architectural design of the neural pathways in the human brain.

ML is a spectrum, depending on the degree of feature engineering and manual coding required. At the far end of the spectrum sit deep neural networks (DNNs), a type of deep learning. A DNN model reduces the need for manual feature engineering because the model detects which features it should use and applies them to the given task. DNNs are based on the theory of representation learning, where simple representations are used as the building blocks for more complex concepts, until a model can complete complex tasks beyond the skill of traditional programming, such as image recognition.

## 7.2 Challenges and opportunities

There are already numerous applications of AI/ML in pharmacy, within both research and practice domains. Within research, AI has been used for drug discovery, drug repurposing and clinical trial enrolment and participant identification. AI in clinical practice can be categorised into five general types of applications: (1) diagnostics; (2) data collection and measurement; (3) workflow automation and administrative tools; (4) patient triage and risk stratification; and (5) treatment and therapy recommendations.

When it comes to workflow and administrative tools, AI has been leveraged to improve supply chain management, identify clinical fraud and detect opioid diversion, to name a few examples. AI use in diagnostics has centred mostly on image recognition models that detect the presence of disease from clinical images, such as x-rays, computerised tomography scans or retinal images. Conversely, there have been very few successful AI applications within the domain of treatment recommendations. Treatment recommendation and optimisation is a particularly challenging task for AI, especially in the context of medication optimisation.

It is important to understand what AI can and cannot do. Deploying AI in clinical applications for medication management is hindered by several key limitations, which are important for pharmacist to understand. Recognising AI's limitations will help pharmacists know how best to use and interact with AI in real world settings. Three key AI algorithmic limitations include model drift, algorithmic bias and black box algorithms.

**Model drift:** Deep learning models rely on pattern recognition and learning associations between variables in a fixed environment. However, the world is not a fixed environment. Parameters are constantly changing. As they change, the world looks less and less like the environment in which the model was trained. The patterns the model learned may no longer be applicable. The faster an environment changes, the faster a model's performance will degrade over time. However, not every domain is affected equally. For example, using AI to recognise lung disease in a chest x-ray is less susceptible to drift, because the quality of x-ray images is not likely to change at an excessively accelerated rate; moreover, when they do change, model developers can anticipate the change and plan for it by retraining the model. Pharmacy, however, is one of the fastest and most dynamically changing domains within health care: new medicines are constantly being released, new evidence is being generated, treatment guidelines are being changed, and previously accepted best practice recommendations can be reversed. All these contribute to a model's accuracy beginning to degrade as soon as it is deployed. A great example is the use of large language models such as ChatGPT. When Generative Pre-trained Transformer-3 (GPT-3) was released, it was only trained on data up until 2020. Therefore, if one were to ask GPT-3 "What is paxlovid?", it would provide an accurate-sounding but false answer, such as "Paxlovid is an antipsychotic medication used to treat schizophrenia and bipolar disorder".

**Algorithmic bias:** There are many examples of models encoding bias due to the pre-existing biases that live in the data used to train the model. Models can also be biased if the data they are trained on are not representative of the population in which the model will be deployed. However, there are also much more subtle ways a model can be biased that we may not immediately recognise. For example, looking at GPT-3 again, if you were to ask GPT-3 to list the most important questions a patient should ask their pharmacist before starting a new medicine, the model responds with different types of questions depending on whether you specify the patient as being male or female. Even something as simple as suggesting a list of questions for a patient to ask can lead to downstream impacts on health outcomes because the level and type of information each patient receives could be different based on the questions they are prompted to ask.

**Black box algorithms:** Deep learning models are opaque, meaning that one cannot intuitively know how a model made its decision. This is concerning when models are allowed to make decisions in high-risk environments where the consequences could be detrimental to an individual's health. Having a model that performs well is only part of the challenge. You must also ensure the model is learning the right way. Models love to take shortcuts whenever possible. For example, a company building a model to classify chest x-rays as "normal" or "abnormal" noticed that its model stopped performing well when deployed on real patient data. After investigation, the company realised that the model was not using what it assumed it was when making its decision. Instead of looking at lung features, the model was only scanning for presented text or annotations overlaid on the image. This was because all the images it was trained on were already annotated by a radiologist. When deployed on images that had not yet been examined by a radiologist, the model assumed all images were "normal" due to the absence of presented text on the image.

In addition to algorithm limitations, there is also a lack of pharmacy expertise in AI. This can have profound effects on the development of fit-for-purpose AI applications. It is critical to have all stakeholders at the table when building responsible AI. We need both data scientists and clinical experts. For example, when medication experts are not involved, this can lead to language models being less accurate in answering medication-related questions than when answering questions from other domains in health care. Lack of pharmacy expertise is also evident when examining the quality of training data used in a large portion of AI/ML research in health care. Many open-source datasets of EHR data used commonly in AI research only contain partial drug administration data. This can lead to models that are misleading in their claims. Without complete medication data, any conclusions that could be drawn from the research are limited and the model's output has minimal value in real-world applications.

# 7.3 Summary

AI/ML is ultimately a tool, and the value of any tool depends on how it is utilised. The future value of AI in health care will be determined by the choices we make now in how we implement it. We need pharmacists involved in every part of the AI model development lifecycle to ensure we are solving the right problems and minimising unintended consequences.

**Resources for further reading**


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