Creating the future of artificial intelligence in health-system pharmacy

Is artificial intelligence (AI) about to reinvent healthcare, or are its applications to the field not yet ready for prime time? The answer is yes on both counts. In the realm of pharmacy, for example, AI is already being used to predict adverse drug events, including drug–drug interactions, as well as to power mobile platforms that aid patients in boosting medication adherence. But as ASHP's Commission on Goals[1] points out in its report on AI in this issue of *AJHP*, the most dramatic potential applications lie ahead—and the prospects are both exhilarating and unsettling. When developed and used appropriately, AI will enable far superior diagnosis and treatment, as well as greater efficiency in operational aspects of pharmacy care. Used inappropriately, however, AI could lead to great harm—for example, if algorithms based on genomic studies of a relatively narrow patient cohort were used to make flawed diagnostic or treatment decisions for an altogether different population of patients.[2]

Given both the possibilities and the potential pitfalls, leaders in health-system pharmacy should create a robust research agenda for determining how best to reap AI's potential to achieve beneficial outcomes and drive toward the Triple Aim. In so doing, they would follow a wise old dictum: The best way to predict the future is to create it.

Use-case identification. As the Commission on Goals proposed, compiling this research agenda would start by identifying various use cases in which AI-enabled applications, particularly those based in machine learning, could make significant contributions to improving patient care. Such use cases could include actual clinical decision-making and operational changes in pharmacy management, such as the broad array of activities inherent in optimizing medication delivery and use. This complex area is overripe for vast improvement, given estimates that the annual cost of drug-related morbidity and mortality resulting from nonoptimized medication therapy totaled more than $528 billion—a staggering 16% of U.S. healthcare expenditures—in 2016.[3]

The broad capacities of machine learning in particular—to detect patterns, categorize like people and processes, predict outcomes based on patterns, identify unknown patterns and relationships, and detect anomalies—can help to address the myriad ways that medication use goes awry, as well as to pinpoint multiple opportunities for better clinical care and pharmacy process improvement. By specifying these and other key research areas that AI and machine learning could shed light on, health-system pharmacy could signal for both academia and the commercial sector where to place their efforts to make inroads in an area of healthcare that produces tremendous waste and human harm.

Data standards framework. Because much of AI—and indeed, all of machine learning—is at root about processing, analyzing, and learning from data, how these data are gathered, used, labeled or tagged, and otherwise stewarded will determine AI systems' ultimate utility and effectiveness. As a result, a second item on the research agenda for health-system pharmacy should be devising a set of "best data practices" to govern the development and use of AI applications related to pharmacy. Creating what amounts to a "data checklist" for health systems and others to use is essential. In particular, detailing how systems should follow appropriate consent procedures for gathering data on individuals that will be used to train machine learning systems, as well as observing any applicable privacy or security laws and regulations, is essential.

Algorithm transparency and accountability. AI is built on algorithms, which as Topol[4] has described, now exist along a "continuum from those that are entirely human guided to those that are entirely machine guided." An example of the former is "rules-based" software that analyzes an array of symptoms to arrive at a particular cancer diagnosis; an example of the latter, machine-guided algorithms, is software that trains itself to perform tasks, such as categorizing cancers into new subtypes based on ever-increasing volumes of data.[5] Yet, it isn't always clear why or how these machine-guided algorithms actually work—a "black box" problem that could grow worse with time. Health-system pharmacy should team with other leading healthcare groups to define minimum acceptable standards for transparency and "explainability" of algorithms, especially those that could affect clinical pharmacy practice.

Workforce and systems preparedness. Almost every sector within healthcare lacks the people, skills, and knowledge to both gain the most from AI and avoid the pitfalls. What's more, shockingly enough, no existing set of healthcare workforce projections takes account of AI or any other information technology. Today, it may only be possible to guess at what the future may look like, but sound decisions about investments in education and training can't be based on such a flimsy foundation. A research agenda that carefully considers these investment decisions as they pertain to the future pharmacy workforce is essential—and arguably well within the bounds of even human intelligence to achieve.

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Medication reconciliation studies: High quantity, low quality

Maintaining and communicating accurate medication information across the continuum of patient care is a National Patient Safety Goal. The primary reason for this goal is that "there is evidence that medication discrepancies can affect patient outcomes."[1] Over the past decade, tremendous financial and personnel resources were invested in pursuing this goal. Correlatively, published literature has increased, including medication reconciliation systematic reviews and meta-analyses. Still, little is known about the overall effects of medication reconciliation on direct patient outcomes.

In this issue of *AJHP*, Anderson et al. provide a systematic overview of medication reconciliation systematic reviews. This type of study design is usually intended to provide a summary of the highest level of evidence available.[2] The study's primary outcome focuses on the most important patient-centered question: What is the effect of medication reconciliation programs on morbidity, mortality, and healthcare use? Using standardized and validated systematic review tools, the authors narrowed the medication reconciliation studies performed over the past decade to 9 peer-reviewed manuscripts meeting stringent inclusion criteria. The included reviews varied in patient population, including the elderly, adults, and children. While the majority of systematic reviews analyzed transitions in and out of the hospital setting (i.e., medication reconciliation at admission and discharge), 1 review focused on primary care.

The overall quality of evidence of included systematic reviews was poor, with only 3 meeting moderate evidence criteria. The reviews suffered from poor study quality, nonrandomized design, and conflicting and varied outcome effects. Overall, medication reconciliation was found to be effective in reducing medication discrepancies; nevertheless, studies with such conclusions were based on low-quality evidence. Of the studies that examined clinically significant discrepancies, mortality, and adverse events, most yielded mixed results, with positive results usually suffering from poor-quality evidence.

Study designs such as this are not easy, and the authors should be commended on taking on a challenging question with this methodology. As the authors mention, only 1 similar study reporting similar results is currently available.[3] Some limitations of the overview are the inclusion of heterogeneous settings, patient populations, and broad definitions of medication reconciliation activities. While medication reconciliation discrepancies occur commonly, errors and patient harm from such discrepancies are uncommon. Finding adequately powered studies for the detection of rare events is a limitation of the included systematic reviews, which inherently limited the researchers' ability to make patient-specific conclusions.

What to make of the results of this study? Should hospitals decrease investments in improving medication reconciliation processes, as they have no effect on ultimate patient-specific outcomes? The study suggests that stakeholders should not expect to improve patient-specific outcomes solely with medication reconciliation. While this study raises important questions about effect, it also shows that the latest quality evidence about effect is still lacking. Additionally, the heterogeneity of settings and patient populations analyzed represent distinct cohorts with unique medication history requirements. As such, drawing overarching conclusions about medication reconciliation effect should be done with caution. Further, stakeholders should not conflate low-quality evidence with no evidence of benefit.

The authors recognize the dilemma between medication reconciliation "face validity" (i.e., clinical importance) and their results. Anyone who has performed a detailed medication history at a transition of care can likely attest to catching discrepancies that may have led to catastrophic consequences.