SMARTPHONE APPS FOR TOXICOLOGY: WHERE ARE WE NOW?

Rais Vohra MD FACEP FACMT
UCSF Fresno Medical Center and California Poison Control System

Smartphone applications (apps) and related mobile health (mHealth) technologies have rapidly transformed the clinical encounter in certain sectors of healthcare, but a thorough understanding of their unique benefits for clinical toxicology is still needed. In the absence of well-designed clinical trials, a useful framework for assessing the benefits of these technologies is offered, and relevant examples of currently available app programs discussed.

Apps succeed when they facilitate one of three interdependent tasks related to clinical communication: *information, insight, and interaction*. Considering a case of aspirin overdose as an example, information is the raw data (e.g. vital signs and laboratory results comparable to well-defined normal ranges), insight is the interpretation of the raw data (e.g. mixed acid-base disorder due to severe salicylate poisoning) and interaction is the activity triggered by the insight (e.g nephrology consultation for emergent hemodialysis). In clinical toxicology, apps that provide and record information, and those that facilitate interactions among participants, are currently the most prevalent.

Depending on their design, *informational apps* can be subdivided into personalized apps or gadgets (vital signs monitors, sensors and physical detection equipment, and portable analytical lab devices) and general databases (online textbooks, journals, clinical score calculators, and chemical and pharmacokinetic archives). Examples of higher-level public health projects that are being built on a foundation provided by well-designed informational apps and devices include: electronic health records, geomapping emergent illness trends, and research registry projects. These may provide models for global clinical toxicology.

Apps can also facilitate *interactions*, particularly when there are geographic or language barriers. Healthcare providers have embraced many non-clinical apps that enhance interactions among patients, providers and consultants. These apps include mobile phone, text messaging, photo sharing, language translation, regulatory agency reporting, photography, and videoconferencing. Because these functions are frequently limited both by internet capability and issues related to patient privacy, interaction app use in toxicology has so far been limited to pilot projects, or delayed academic enrichment based on deidentified case records. In order to make the leap to real-time clinical use, the technical and medicolegal infrastructure for interaction apps needs to be further refined, with input from the toxicology community.

At this time, toxicology apps designed for clinical *insight*, such as clinical decision rules and integrative diagnostic aids, are limited to algorithms and flowcharts based on well-established nomograms; in other words, true insight is still the domain of human experts. However, software programs integrated into simulated patient encounters or games can assist with developing critical thinking skills in learners in a safer practice environment.

The smartphone revolution promises to change the practice of clinical medicine substantially, but many questions remain regarding the clinical utility of such advances. Despite the global reach for many of these products, there is a real risk of a "digital divide" as poisoned patients in under-resourced countries may not benefit as fully from smartphone advances. Toxicologists worldwide clearly have a unique role to play in the future of mHealth

development and clinical outcomes research. In conclusion, more real-world experience and high-quality evidence is urgently needed to help navigate the rapidly evolving landscape of mobile health (mHealth) technologies for smartphones.