Creating smart health solutions with biomedical informatics

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Adela Grando, a professor with the Department of Biomedical Informatics at ASU, collaborates with graduate students on their app, iDecide, a decision system that utilizes medical evidence in its processing.Credit: Denise Kronsteiner

Adela Grando is a new professor with the Department of Biomedical Informatics in the College of Health Solutions at Arizona State University. Trained in artificial intelligence with a background in computer science, Grando moved into the biomedical informatics field

because she felt it offered great applications in medicine, and exciting opportunities for innovation.

"It's a very cool area of research with so much impact," she says about the role of biomedical informatics in health care – especially in clinical practice. "And there is good synergy here at ASU, and many collaborations with the Mayo Clinic. They are willing to push the boundaries."

Research and teaching within ASU's Department of Biomedical Informatics takes place on the Mayo Clinic campus in North Scottsdale, where faculty and students are able to work closely with Mayo providers and patients to carry out research and develop new tools and interventions.

Biomedical informatics is a fairly new interdisciplinary field that incorporates knowledge and expertise from various fields, according to Grando. "Biomedical informatics doesn't always start with biomedical informatics," she said. Researchers and practitioners often start out in computer science, mathematics, statistics, imaging, psychology, medicine, public health and many other fields.

While the scope of biomedical informatics is broad in nature – and growing – ASU works within four distinct application domains: bioinformatics, imaging, public health and clinical. The end result for each is finding solutions and creating interventions for patients.

The interdisciplinary nature of the program is motivating for Grando and her students because of the constant learning that takes place and the focus on developing solutions by looking at the problem from multiple perspectives.

A clinician presents a problem, said Grando, and biomedical informatics

practitioners set out to solve it. Both, and oftentimes others, are needed to create the most effective solutions for health. "They don't know what we know, and we don't know what they know," she said. "I cannot do it on my own."

Collaboration is the foundation for a new smart phone application that Grando and three of her graduate students are developing for patients with diabetes. The app, iDecide, is a decision system that utilizes medical evidence in its processing – critical for a tool that will be trusted by patients.

Grando and her students spent months learning about diabetes to prepare for the project in order to build a safe and effective tool for consumers who will use it, starting with the patients from the Mayo who have been entrusted to her team.

"We benefited from the advice of an internist, an endocrinologist, a registered nurse working as a diabetes educator, an expert on human-computer interaction, two experts in decision support systems and a postdoctoral visitor trained on the development of smart phone apps for health care," she said.

The first prototype could help her determine if patient goals are realistic, such as health habits, exercise and nutrition. Artificial intelligence has been programmed into the application to remember user habits (and reinforce the good ones), calculate insulin requirements and recommend follow-up actions that are more realistic and tailored to the lifestyle of the patient.

Whereas clinicians understand the science, Grando said, patients typically do not. Artificial intelligence allows researchers to create tools that can anticipate and mimic human decisions. What would a clinician recommend? How will a patient best understand the instructions?

Working directly with patients to understand how they think and make decisions is a priority in order to create a tool that is user-friendly, Grando said. "Future users are guiding the development process."

Building resilient systems with cognitive science

Vimla Patel has been in the biomedical informatics field for years. Originally from the fields of cognitive psychology and biomedicine, she 'came in the backdoor' to technology, she said. Her desire to know how humans think and do things, and how to apply this field of research and inquiry to medical solutions, brought her to biomedical informatics.

Patel is a professor in the Department of Biomedical Informatics at ASU, an adjunct professor at Columbia University and a senior research scientist and director for the Center for Cognitive Studies in Medicine and Public Health at the New York Academy of Medicine. She does research, teaches and lectures widely in the areas of medical cognition, patient safety and decision systems – critical aspects of the discipline as practitioners develop safe and effective solutions for patients.

The original work in biomedical informatics was done by physicians, Patel said. How they thought impacted how biomedical informatics was approached. Yet, in medicine, physicians, nurses and patients each bring their mental models to the process. But there is a mismatch between these models and the designed system, she says.

"The mental model of the builder of a system is different than the user's mental model," she said.

This prompted Patel to focus her research on medical cognition and decision-making – especially in critical care, and understanding the nature of medical errors, the impact of technology on human cognition, and the importance of developing systems for the medical field that are

safe, flexible and resilient.

How do complex systems cope with errors? According to Patel, most current systems are not resilient.

"Humans make a range of errors," she said. "We cannot have a static definition of error. We need to build systems that consider the boundary of error, a flexible and adaptive system, rather than people adapting to a system."

"For example, people in trouble – you don't help them solve problems, you help them cope, recover and become resilient," she said. "You build a resilience system in them."

Linking cognitive science to the development of usable applications, and collaborating with well-trained practitioners with expertise from different fields, allows scientists to create systems that are more flexible and resilient, she said.

For Patel, cognitive science is the core of biomedical informatics.

"Human behavior is influenced by our thoughts and our social values, and these are not easy to change," she said. "This means we need to understand how health care professionals think and make decisions before we develop any intervention."

Pioneering biomedical informatics

Biomedical informatics at ASU may have Ted Shortliffe to thank for setting the stage for many of the innovations in this fast growing field. A pioneer in the use of artificial intelligence in medicine and clinical decision-making, Shortliffe is widely considered the founder of biomedical informatics.

While at Stanford University in the early 1970s, where he earned both his master's and doctorate degrees, Shortliffe was the principal developer of one of the first rule-based medical expert systems, called MYCIN. Expert systems have continued to evolve over the years, incorporating emerging technologies and new thinking about decision systems, cognitive science and health care delivery.

Shortliffe is a clinical professor in the Department of Biomedical Informatics at ASU, a scholar in residence at the New York Academy of Medicine and adjunct professor of biomedical informatics at Columbia University. He is the author of several books on biomedical informatics, medical artificial intelligence and rule-based expert systems.

As senior adviser to Keith Lindor, the executive vice provost and dean of ASU's College of Health Solutions, Shortliffe applies his knowledge and expertise to projects that provide useful insights and lead to large-scale improvements in the biomedical informatics department.

"He helped facilitate the program's relationship with the Mayo Clinic and other health providers, and his in-depth review of the Center for Health Information & Research resulted in the center becoming more integrated into the biomedical informatics organization," Lindor said.

While Shortliffe's depth of knowledge and experience keep him busy advising health leaders and facilitating system change and improvement, teaching remains especially rewarding.

"A major lesson of teaching is that true impact on one's students comes less from the knowledge you convey than from the passion and philosophy that you communicate, demonstrate and encourage others to adopt," he said. "As I see my generation move toward retirement, it is bright, young people entering our field as graduate students who will advance the science and its applications, and who will accordingly

determine its future."

Creating impact through personalized solutions

Back at the Mayo Clinic, Adela Grando has been planning her next steps. She and her students are set to recruit 20 patients to monitor their diets, alcohol consumption and exercise habits, and then determine the impact of iDecide on their ability to better adjust insulin to control glucose levels. Grando and her team will then compare their patients' use of the app with that of the insulin pump.

"It's a calibration process," Grando said. "It's very important to know the limitations."

Artificial intelligence translates the way people think into a computer to ensure the solution is safe, effective and user-centered. Biomedical informatics is about creating personalized health care solutions – often with the use of artificial intelligence – that empower patients, showing them the impact of their choices, Grando said.

It is also about building trust. "If you want to make a difference at the level of care, you must build trust and relationships," Grando tells her students. "It is the key to the success of every biomedical informatics practitioner."

Buffy Lloyd is one of Grando's PhD students. The iDecide app intrigued Lloyd from the start because it uses knowledge from computer science, artificial intelligence, biology, statistics and clinical informatics, she said.

"It is exciting to be a part of an innovative project that could potentially improve the methodology for insulin administration and dosage for patients with diabetes," she said. "I feel like we are pioneers paving a

new frontier for how this nation practices medicine."

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