Seven ways predictive analytics can improve healthcare

Everyone is a patient at some time or another, and we all want good medical care. We assume that doctors are all medical experts and that there is good research behind all their decisions.

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For 23 years, Dr. Miner directed academic programs for Southern Nazarene University-Tulsa, Oklahoma, including direction for undergraduate research projects. She has worked as a statistical research consultant for second-year medical residents for the In His Image Family Medical Residency program in Tulsa.

She authored many of the tutorials in the original two predictive analytic books published in 2009 and 2012 by Elsevier. She now teaches predictive analytics online for the University of California, Irvine and is a co-author on the third text, *Practical Predictive Analytics and Decisioning Systems for Medicine*, just released by Elsevier.

In this article, she highlights key principles she explores in more depth in her book.

Q&A with authors on the Direct2Dell blog

With the healthcare industry now a major focus of the analytics work being done at Dell following its acquisition of StatSoft and the STATISTICA platform, Stephen Phillips sat down with three of the authors — lead author Dr. Linda Miner, Dr. Gary Miner and Dr. Tom Hill — to discuss the book, its desired impact, and the potential for predictive analytics to revolutionize the healthcare industry. Read the interview here.

But that can't always be the case.

Physicians are smart, well trained and do their best to stay up to date with the latest research. But they can't possibly commit to memory all the knowledge they need for every situation, and they probably don't have it all at their fingertips. Even if they did have access to the massive amounts of data needed to compare treatment outcomes for al the diseases they encounter, they would still need time and expertise to analyze that information and integrate it with the patient's own medical profile. But this kind of in-depth research and statistical analysis is beyond the scope of a physician's work.

That's why more and more physicians – as well as insurance companies – are using predictive analytics.

Predictive analytics (PA) uses technology and statistical methods to search through massive amounts of information,
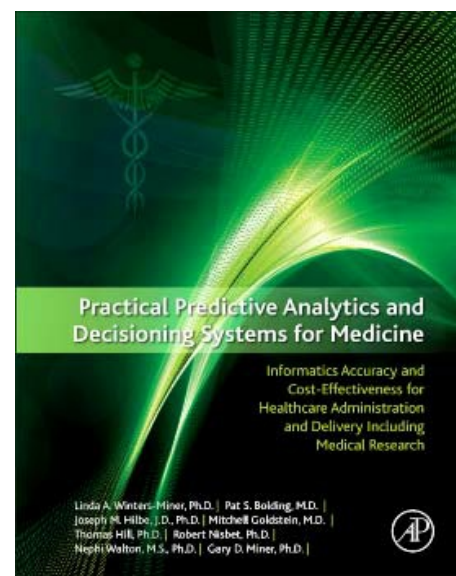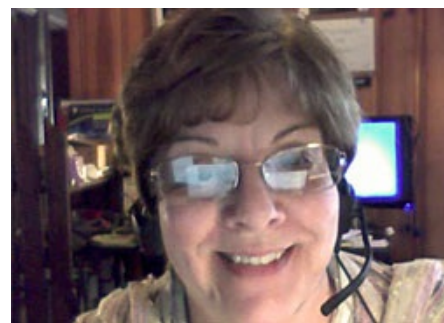
analyzing it to predict outcomes for individual patients. That information can include data from past treatment outcomes as well as the latest medical research published in peer-reviewed journals and databases.

Not only can PA help with predictions, but it can also reveal surprising associations in data that our human brains would never suspect.

In medicine, predictions can range from responses to medications to hospital readmission rates. Examples are predicting infections from methods of suturing, determining the likelihood of disease, helping a physician with a diagnosis, and even predicting future wellness.

The statistical methods are called *learning models* because they can grow in precision with additional cases. There are two major ways in which PA differs from traditional statistics (and from evidence-based medicine):

- First, predictions are made for individuals and not for groups
- Second PA does not rely upon a normal (bell-shaped) curve.

Prediction modelling uses techniques such as artificial intelligence to create a prediction profile (algorithm) from past individuals. The model is then "deployed" so that a new individual can get a prediction instantly for whatever the need is, whether a bank loan or an accurate diagnosis.

In this post, I discuss the top seven benefits of PA to medicine – or at least how they will be beneficial once PA techniques are known and widely used. In the United States, many physicians are just beginning to hear about predictive analytics and are realizing that they have to make changes as the government regulations and demands have changed. For example, under the Affordable Care Act, one of the first mandates within Meaningful Use demands that patients not be readmitted before 30 days of being dismissed from the hospital. Hospitals will need predictive models to accurately assess when a patient can safely be released.

1. Predictive analytics increase the accuracy of diagnoses.

Physicians can use predictive algorithms to help them make more accurate diagnoses. For example, when patients come to the ER with chest pain, it is often difficult to know whether the patient should be hospitalized. If the doctors were able to answers questions about the patient and his condition into a system with a tested and accurate predictive algorithm that would assess the likelihood that the patient could be sent home safely, then their own clinical judgments would be aided. The prediction would not replace their judgments but rather would assist.

In a visit to one's primary care physician, the following might occur: The doctor has been following the patient for many years. The patient's genome includes a gene marker for early onset Alzheimer's disease, determined by researchers using predictive analytics. This gene is rare and runs in the patient's family on one side. Several years ago, when it was first discovered, the patient agreed to have his blood taken to see if he had the gene. He did. There was no gene treatment available, but evidence based research indicated to the PCP conditions that may be helpful for many early Alzheimer's patients.

Ever since, the physician has had the patient engaging in exercise, good nutrition, and brain games apps that the patient downloaded on his smart phone and which automatically upload to the patient's portal. Memory tests are given on a regular basis and are entered into the electronic medical record (EMR), which also links to the patient portal. The patient himself adds data weekly onto his patient portal to keep track of time and kinds of exercises, what he is eating, how he has slept, and any other variable that his doctor wishes to keep track of.

Because the PCP has a number of Alzheimer's patients, the PCP has initiated an ongoing predictive study with the hope of developing a predictive model for individual likelihood of memory maintenance and uses, with permission, the data thus entered through the patients' portals. At this visit, the physician shares the good news that a gene therapy been discovered for the patient's specific gene and recommends that the patient receive such therapy.

2. Predictive analytics will help preventive medicine and public health.

With early intervention, many diseases can be prevented or ameliorated. Predictive analytics, particularly within the realm of genomics, will allow primary care physicians to identify at-risk patients within their practice. With that knowledge, patients can make lifestyle changes to avoid risks (An interview with Dr. Tim Armstrong on this WHO podcast explores the question: Do lifestyle changes improve health?)

As lifestyles change, population disease patterns may dramatically change with resulting savings in medical costs. As Dr. Daniel Kraft, Medicine and Neuroscience Chair at Stanford University, points out in his video *Medicine 2064*:

During the history of medicine, we have not been involved in healthcare; no, we've been consumed by sick care. We wait until someone is sick and then try to treat that person. Instead, we need to learn how to avoid illness and learn what will make us healthy. Genomics will play a huge part in the shift toward well-living.

As Dr. Kraft mentions, our future medications might be designed just for us because predictive analytics methods will be able to sort out what works for people with "similar subtypes and molecular pathways."

3. Predictive analytics provides physicians with answers they are seeking for individual patients.

Evidence-based medicine (EBM) is a step in the right direction and provides more help than simple hunches for physicians. However, what works best for the middle of a normal distribution of people may not work best for an individual patient seeking treatment. PA can help doctors decide the exact treatments for those individuals. It is wasteful and potentially dangerous to give treatments that are not needed or that won't work specifically for an individual. (This topic is covered in a paper by the Personalized Medicine Coalition.) Better diagnoses and more targeted treatments will naturally lead to increases in good outcomes and fewer resources used, including the doctor's time.

4. Predictive analytics can provide employers and hospitals with predictions concerning insurance product costs.

Employers providing healthcare benefits for employees can input characteristics of their workforce into a predictive analytic algorithm to obtain predictions of future medical costs. Predictions can be based upon the company's own data or the company may work with insurance providers who also have their own databases in order to generate the prediction algorithms. Companies and hospitals, working with insurance providers, can synchronize databases and actuarial tables to build models and subsequent health plans. Employers might also use predictive analytics to determine which providers may give them the most effective products for their particular needs. Built into the models would be the specific business characteristics. For example, if it is discovered that the average employee visits a primary care physician six times a year, those metrics can be included in the model.

Hospitals will also work with insurance providers as they seek to increase optimum outcomes and quality assurance for accreditation. In tailoring treatments that produce better outcomes, accreditation standards are both documented and increasingly met. (Likewise, predictive analytics can support the Accountable Care Organization (ACO) model in that the primary goal of ACO is the reduction of costs by treating specific patient populations successfully. Supply chain management (SCM) for model hospitals and insurance providers will change as needs for resources change; in fact when using PA, those organizations may see otherwise hidden opportunities for savings and increasing efficiency. PA has a way of bringing our attention to that which may not have been seen before.

5. Predictive analytics allow researchers to develop prediction models that do not require thousands of cases and that can become more accurate over time.

In huge population studies, even very small differences can be "statistically significant." Researchers understand that randomly assigned case control studies are superior to observational studies, but often it is simply not feasible to carry out such a design. From huge observational studies, the small but statistically significant differences are often not *clinically* significant. The media, ignorant of research nuances, may then focus on those small but statistically significant findings, convincing and sometimes frightening the public. Researchers also are to blame as sometimes they themselves do not understand the difference between statistical significance and clinical significance.

For example, in a TEDxColumbiaEngineering talk, Dr. David H. Newman spoke about the recent recommendation by the media that small to moderate alcohol consumption by women can result in higher levels of certain cancers. Many news programs and newspapers loudly and erroneously warned women not to drink even one alcoholic drink per day.

In contrast with predictive analytics, initial models in can be generated with smaller numbers of cases and then the accuracy of such may be improved over time with increased cases. The models are alive, learning, and adapting with added information and with changes that occur in the population over time.

In order to make use of data across practices, electronic data record systems will need to be compatible with one another; interoperability, or this very coordination, is important and has been mandated by the US government. Governance around the systems will require transparency and accountability. One program suite, STATISTICA, is familiar with governance as it has worked with banks, pharmaceutical industries and government agencies. Using such a program will be crucial in order to offer "transparent" models, meaning they work smoothly with other programs, such as Microsoft and Visual Basic. In addition, STATISTICA can provide predictive models using double-blind elements and random assignment, satisfying the continued need for controlled studies.

On the other hand, some programs are proprietary, and users often have to pay the statistical company to use their own data. In addition, they may find that the system is not compatible other systems if they need to make changes. When dealing with human life, the risks of making mistakes are increased, and the models used must lend themselves to making the systems valid, sharable and reliable.

6. Pharmaceutical companies can use predictive analytics to best meet the needs of the public for medications.

There will be incentives for the pharmaceutical industry to develop medications for ever smaller groups. Old medications, dropped because they were not used by the masses, may be brought back because drug companies will find it economically feasible to do so. In other words, previous big bulk medications are certain to be used less if they are found not to help many of those who were prescribed them. Less used medications will be economically lucrative to revive and develop as research is able to predict those who might benefit from them. For example, if 25,000 people need to be treated with a medication "shotgun-style" in order to save 10 people, then much waste has occurred. All medications have unwanted side effects. The shotgun-style delivery method can expose patients to those risks unnecessarily if the medication is not needed for them. Dr. Newman (above) discussed the probably overuse of statins as one example.

7. Patients have the potential benefit of better outcomes due to predictive analytics.

There will be many benefits in quality of life to patients as the use of predictive analytics increase. Potentially individuals will receive treatments that will work for them, be prescribed medications that work for them and not be given unnecessary medications just because that medication works for the majority of people. The patient role will change as patients become more informed consumers who work with their physicians collaboratively to achieve better outcomes. Patients will become aware of possible personal health risks sooner due to alerts from their genome analysis, from predictive models relayed by their physicians, from the increasing use of apps and medical devices (i.e., wearable devices and monitoring systems), and due to better accuracy of what information is needed for accurate predictions. They then will have decisions to make about life styles and their future well being.

Conclusion: Changes are coming in medicine worldwide.

In developed nations, such as the United States, predictive analytics are the next big idea in medicine –the next evolution in statistics – and roles will change as a result.

- **Patients will have to become better informed** and will have to assume more responsibility for their own care, if they are to make use of the information derived.

- **Physician roles will likely change to more of a consultant** than decision maker, who will advise, warn and help individual patients. Physicians may find more joy in practice as positive outcomes increase and negative outcomes decrease. Perhaps time with individual patients will increase and physicians can once again have the time to form positive and lasting relationships with their patients. Time to think, to interact, to really help people; relationship formation is one of the reasons physicians say they went into medicine, and when these diminish, so does their satisfaction with their profession.

- **Hospitals, pharmaceutical companies and insurance providers will see changes as well.** For example, there may be fewer unnecessary hospitalizations, resulting initially in less revenue. Over time, however, admissions will be more meaningful, the market will adjust, and accomplishment will rise. Initially, revenues may also be lost by pharmaceutical and device companies, but then more specialized and individualized offerings will increase profits. They may be forced to find newer and better solutions for individuals, ultimately providing them with fresh sources of revenue. There may be increased governmental funds offered for those who are innovative in approach.

All in all, changes are coming. The genie is out of the box and, in fact, is building boxes for the rest of us. Smart industries will anticipate and prepare.

These changes that can literally revolutionize the way medicine is practiced for better health and disease reduction.

I think about the Bayer TV commercial in which a woman gets a note that says, "Your heart attack will arrive in two days." The voiceover proclaims, "Laura's heart attack didn't come with a warning." Not so with predictive analytics. That very message could be sent to Laura from her doctor who uses predictive analytics. Better yet, in our bright future, Laura might get the note from her doctor that says, "Your heart attack will occur eight years from now, unless …" – giving Laura the chance to restructure her life and change the outcome.