

The Influence of Medical Informatics on Improved Patient Outcomes: The TIME System

As President of AMI Healthcare Systems and co-creator of the AMI TIME® (Total Information for Managing Effectively) System, I have been asked on several occasions to explain how information technology—that is, “medical informatics”—can improve patient care. Candidly, I have refrained from doing so. The reasons for this hesitancy are twofold.

First, I cannot prove without a doubt that medical informatics does improve patient care. I can do so only in very controlled and circumscribed situations that are provable only after the fact and not necessarily during the dynamic process of care.

Second, while I *can* focus on how information technology optimizes more correct and timely intervention, doing so puts me in the unenviable position of implying that appropriate clinical intervention can occur only with information technology. I have preferred not to do so, fearing that my good intention then becomes the sword upon which I will fall.

I prefer instead to assume a conceptual approach to the question, “Does information technology improve patient care?” My argument is that *strategically deployed* medical informatics does improve patient care via automated real-time analysis of information—an analysis fragmented in content and by time in current paper processes.

Overcoming an Information Disadvantage

The truth of the matter is that medical decision-makers, such as physicians and nurses, are many times at an information disadvantage during the patient care cycle. They often do not have the data necessary to provide optimal patient care *in real time*. The necessary data may still be in the lab, at the hospital, and/or in a satellite office. Sometimes the data are fragmented among these locations, as well as buried among other data. As a result, the

medical decision-makers run the risk of making decisions based on an incomplete set of facts.

My position is that the strategic deployment of real-time information is also strategic to the practice of medicine. The science of information clears away mental clutter by organizing data. It collates large volumes of data at the patient level—as well as at the disease and global levels—in real-time, both prospectively and retrospectively. It reveals meaningful relationships that large volumes of fragmented paper medical records often obscure. These relationships are crucial to medical decision-making and, therefore, to optimizing the effectiveness of care. Without them, each patient care event is isolated from its context and that of historical perspective.

By deploying information within a real-time context and prospectively, the science of information literally empowers medical decision-makers to be students of their patients in the immediate present, similar to a researcher using tools at a research center. In effect, the science of information expands the art of medicine with the practice of information.

Tapping Into “Now”

Reflect on how information technology has improved financial management in the U.S. and around the world. When market news breaks, the data are almost instantaneously downloaded into the appropriate databases. An investor can then pull up his or her account, research its status, link to financial databases, and do online, real-time research. The data must be available and immediate.

No one doubts that the data will get into the database. Further, the investors expect that information technology will organize it into meaningful relationships—graphs, statistics, decision-points,

Elizabeth Evans is President of AMI Healthcare Systems Group, a Richmond, Virginia-based developer and distributor of integrated clinical and financial computer software for use in dialysis centers and nephrology practices.

forecasts—using current and historical data in conjunction with information tools such as artificial intelligence. Investors can make a valid decision only when they use an up-to-date, complete set of current and historical facts. We should manage patient care in a similar fashion.

Imagine that a medical information tool could be as immediate as the financial tool described above. Visualize the tool as if it were a medical assistant. You would have this tool at your disposal 24 hours a day, 7 days a week. It would monitor your patients according to your specific directions based on current medical science, practice guidelines, and clinical pathways.

Case Study

Dr. James M. Cox, MD, is a practicing nephrologist with Lynchburg Nephrology, Inc. (LNI), Lynchburg, VA. He is a user of the TIME System—AMI's real-time, integrated clinical, financial, and data warehouse system for dialysis centers and nephrology practices—and agrees with the investor analogy made above.

As expressed by Dr. Cox: "How would you feel if you didn't know your checking account balance as you wrote a check for \$100? Did you or didn't you deposit your last paycheck? Did you enter the last ATM withdrawal in your checkbook ledger?"

"From the bank's perspective, these aren't concerns, because each deposit and withdrawal is automatically placed into an accounting program, where your account balance is accurately determined. The same principle can be applied to patient data.

"A 'clinical ledger card' would serve to identify problems in a patient's 'account' and would then guide each diagnostic or therapeutic intervention in order to reduce any problems to their lowest 'outstanding balance.' The patient's account balance would be the sum of each outstanding balance, i.e., the sum of the individual acuities."

From this vantage point, Dr. Cox asks these questions:

- What specific factors will prompt better treatment decisions?

- How does one know when all of the correct clinical interventions have been taken in a pre-defined time interval?

- How do we know that the interventions prevent or limit in severity patient clinical events and improve quality of life?

- Does quality care only mean treating and/or preventing negative clinical events, or does it also mean maximizing health to increase quality of life?

These questions are at the heart of medical informatics and central to the TIME System design strategy.

Background

LNI has used the TIME System in its nephrology practice and dialysis unit since March 1991. Dr. Cox is, therefore, in a somewhat unique position to respond to the above questions and to substantiate his responses with data.

Dr. Cox believes that the system has broadened the decision matrix at LNI with real-time information. Multiple users—the LNI care team—can use data/information at the same time and review up-to-date facts and observations. This can be done at the point of care, where clinical decisions often need to be made. The care team can do this regardless of the data's source, i.e., the physician's office, the dialysis facility, the hospital, or the lab.

Armed with the appropriate clinical facts at the point of decision, the LNI care team is, according to Dr. Cox, in a better position to make informed treatment decisions. He maintains, for instance, that the team is better able to incorporate and effectively control multiple and discrete medication dosing for their patients because of the increased quality of the available clinical documentation and data.

The ubiquitous and interrelated nature of the data, regardless of the source, has reinforced the importance of the observation and the person who makes the observation. "This has created a greater awareness that each member of

the team plays a pivotal role in the care of the patient," said Dr. Cox. "This awareness has had the synergistic effect of encouraging greater and more effective teamwork at LNI."

Clinical Application

Imagine a 64-year-old patient who progressed to end-stage renal failure due to hereditary nephritis. He has been an LNI patient since March 1978—13 years before the AMI TIME System was operational, and 7 years following its installation. He has been maintained on in-center hemodialysis, but did have a short experience with a kidney transplant that was rejected very quickly a number of years ago.

Through the years, this patient has been a member of a group of patients that grew from 10 to 210. In this same interval, there has been an evolution of the care delivered—going from one physician with a staff of less than 10, to four physicians and a total staff of more than 100.

Over the years, treatment was directed toward dealing with acute problems while attempting to prevent further problems from occurring. Prior to the TIME System, patient care was based on a traditional hierarchical medical system. Today, the care of the patient is spread across the team. The team is empowered with the appropriate real-time clinical facts and protocols to make informed treatment decisions.

For example, authorized staff can access a patient's most current laboratory results from the TIME System. They can also see, in tabular form, the results going back to 1991 (and further), or they can see the results displayed graphically on the screen. The LNI staff can also see the effect of medication dosing over time on the patient's chemistries.

As explained by Dr. Cox: "The appropriate use of EPO has improved with our ability to make smaller dose changes more frequently to avoid the swings in hematocrits. We are able to do this better than before because we now have graphical representation of data, a strong focus on teamwork, and protocols.

"With the TIME System, we can graphically look at multiple data elements dating back to June 1991. It would be particularly disturbing, for instance, to see a distinct but very slow decrease in a patient's serum albumin and creatinine over time while that patient had been maintaining a constant weight.

"In the past we would look at flow-sheets, with their under-documentation, that might be very difficult to read because they were illegible or because critical information was missing. We would look for data/information and perhaps not find it, or again it was illegible. Now we have laser-crisp observations and progress notes. The entire LNI team can read them easily."

Observations and progress notes are immediately accessible and facilitate the longitudinal EMR (electronic medical record) by virtue of the direct entry of data on the patient's record (including transcriptions of input from nephrologists,

surgeons, and interventional radiologists); typed abstracts of input from other consulting or treating physicians; and straightforward string-searches of progress notes that have already been categorized and sub-categorized.

Searching progress notes electronically allows access to information that heretofore had been buried in hand-written progress notes. The entire care team's documentation in those notes and observations allows the physician to more easily and quickly determine the critical clinical events occurring in a patient's life, thereby facilitating problem definition, diagnostic or therapeutic intervention, and outcomes.

Comparative Medicine

In addition to micro-managing patient care in this way, the TIME System becomes a 'round-the-clock "medical assistant," comparing each patient's statistics against a data bank of patterns that the physician has entered into the

system and wants the system to monitor. Dr. Cox corroborates this analogy.

"The system alerts us immediately when a patient's treatment pattern is *becoming* out of range and advises us about which symptoms/results contribute to the out-of-range pattern. At the point of alert, it allows us to link to data as we need them. The transfer of knowledge is, therefore, controlled by the set of our need-to-know criteria and the patient-specific set of problems, results, and trends.

"The TIME System keeps our list of need-to-address and potential clinical events. It anticipates and advises us when to focus on a specific patient, based on an analysis of the patient's status in real time, though we may do so at any time. It triages our attention to patient issues. It keeps us focused on what we consider to be the most important issues."

In a sense, strategically delivered medical information creates an envelope of sanity. By collating and automatically analyzing and reporting important, ongoing patient data, medical decision-makers are in a better position to take care of their patients at the appropriate time.

As expressed by Dr. Cox: "Real-time information comes from an observation or observations which, by their magnitude, warrant action, or which, when processed with medication history or other observations, yield information that requires action that the single observation might not warrant in isolation. This is the beauty of the real-time reporting of clinical events."

Dr. Cox believes the LNI team is increasingly doing a better job of identifying clinical events and, as a result, of taking action earlier, as is the case, for example, with the auto-reporting of venous pressures at a blood flow rate of 200 ml/min. "This alert feature of the system is in real time," says Dr. Cox, "so we are able to identify, in real time, those patients who have had three consecutive venous pressures over 150 mmHg, without waiting."



FYI

Clinical events are filtered by an electronic protocol and then followed-up appropriately with an electronic “tickler” or reminder file message. The completion of the tickler message represents the completion of a feedback loop in which all clinical events have been addressed. As a result of this information- and teamwork-rich environment, action on the lower-level clinical events is allowed to take place sooner. To return to the earlier analogy, the patient’s “clinical ledger card” shows a “zero balance” for each resolved clinical event.

Conclusion

While medical informatics is more complicated than financial informatics, their conceptual foundations are similar. In a medical sense, the patient care can be triaged through use of the right information (reflective of past and current data) at the right time—which is pre-, during, and post-clinical event.

Medical informatics can anticipate evolving patterns of potential morbidity, allowing the healthcare team to provide as much preventive care as possible or feasible. The right care can be scheduled for the right reasons.

While I cannot prove that strategically deployed information necessarily improves patient care, several ongoing longitudinal studies are beginning to indicate that it does. Medical informatics is a young science, one in which the scope of knowledge expands as our enthusiasm for its possibilities grows.

In the not-too-distant future, I believe we will not be able to imagine patient care without medical informatics. In fact, we already find ourselves saying that the delivery of medicine will be based on the practice of information.

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(AMI Healthcare Systems Group is located at 7231 Forest Ave., Ste. 301, Richmond, VA 23226; 804/285-9090; fax 804/285-9167; www.amihealthcare.com) **D&T**