Since the introduction of the personal computer in the early 1980s, there has been a dramatic evolution in computing power, database technology and infrastructure for quickly transmitting and receiving large amounts of data. The goals of this paper are to review the development of these technologies, to describe how they have been applied to the current delivery of healthcare and to explore how they may impact healthcare delivery in the future.

Advances in computing power. Computer processing speeds have increased a thousand-fold since the first microprocessor was introduced. The size of dynamic memory, which is used for active storage of the program code that is being executed, has reached capacities that exceed what used to be the standard for physical storage of data on a disk. These advances in processing speed and capacity have been paralleled by equally dramatic gains in permanent storage space. Computer workstations are commonly shipped with 40 gigabytes of hard disk storage capacity. The wide dissemination of this powerful computing technology at a reasonable cost has revolutionized the world of data processing and storage.

Advances in database technology. The existence of powerful computing combined with advances in programming have led to equally dramatic gains in the field of database technology. With large disk storage systems available, there is virtually no limit to the size of database that can be created. Powerful computer processing has dramatically increased the speed of information retrieval, allowing instantaneous access to large amounts of data. Modern databases utilize relational database structures rather than older hierarchical structures, providing enhanced capacity to combine data with very complex relationships. With the increased availability of dynamic memory, data processing can be made even more efficient through the use of caching technology. The increased sophistication of software operating systems has led to the development of client/server configurations that split the processing and storage functions of a database between a local workstation and a server. Another important development is Open Database Connectivity, known as ODBC, which provides connectivity between different databases by linking them together with a software driver that allows the tools from one database to access data from an entirely different data source. The user does not need to know the programming techniques of the other data source and is able to use tools to which he or she is accustomed. Another important database advance has been the development of object-oriented databases, which are capable of storing and accessing images. Finally, many databases are now “internet-enabled”, meaning that they can be accessed through the internet and users can perform database functions through standard internet tools.

Benefits and impact of the internet. The advent of the internet has provided the link allowing high speed, transmission of data and access to data stored on disparate computers anywhere in the world. These developments in technology have significant applications to healthcare. Historically, advances in information technology in healthcare have occurred in isolated areas, often driven by unique needs for image and textual data. With the advent of browser programs and powerful programming languages, it is now possible to link systems together and move data from isolated systems
The advances in database technology are making a “complete” and “interactive” patient medical record a reality. Powerful databases and advanced programming tools provide quick access to information and security that protects sensitive patient information. The interconnectivity that is possible with databases facilitates the use of large databases for clinical benchmarks that can be utilized online to aid in clinical decision-making.

**Challenges.** Although the potential gains in applying these advances in technology to healthcare are enormous, the challenges to fully implement these approaches are significant. There are a number of technical challenges that are unique to healthcare. As mentioned before, information systems that have been developed in healthcare have tended to be isolated and focused on a narrow task. Systems like these can present difficult challenges in the back-end integration that is required before internet tools such as web browsers can be used to gain access. With tighter controls on storage and transmission of data that will be implemented in new HIPPA (Health Insurance Portability and Accountability Act) regulations, the task of maintaining patient confidentiality will often be at odds with systems that are focused on increasing access to medical information. In addition to the balance between security and access, another struggle will be to balance ease of use with systems that capture the complexity that is often associated with the delivery of healthcare. Finally, one of the greatest technical challenges will be to move the information system as close as possible to the point of healthcare delivery.

There are also many non-technical challenges that impact the application of computing power and the internet on healthcare delivery. Many physicians were trained long before these technologies were available, and physician acceptance of these new approaches is sometimes lacking. Many of these tools radically change the way care is delivered and alter the traditional relationship between physician and patient that places the physician as the sole determiner of care. The use of these systems also demands that healthcare professionals agree on standard definitions, codings and practices. Another non-technical challenge is getting patients to accept these new approaches and utilize them for their healthcare. There is a great deal of education required to realize the full potential offered by these new technologies.

**Summary.** Advances in computing power and database technology combined with the internet are changing the way healthcare is delivered and evaluated. These systems may provide solutions to many of the critical problems that have caused the healthcare system to be inefficient and expensive. There are, however, a number of technical and non-technical challenges that must be addressed before these technologies can be implemented in the delivery of healthcare. The potential impact of these technologies on the delivery of healthcare is significant and will ultimately provide a system where efficiency and quality are integrated in the daily practice of medicine.