

Collaborating to Create Personalized Medicine

Three Major Organizations Work
Together With IT to Integrate
Clinical Delivery and Research



Executive Summary

The mapping of the human genome has launched a revolution in healthcare: Personalized medicine is becoming a reality. Physicians are now beginning to treat individual patients based on their unique genetic makeup. This case study reveals how Partners HealthCare, the Harvard Medical School–Partners Healthcare Center for Genetics and Genomics (HPCGG), and HP have developed an innovative, collaborative model, using information technology to:

- Improve patient care;
- Make important research discoveries;
- Accelerate the field of clinical genomics;
- Advance personalized medicine worldwide.

A New Frontier in Medicine

Personalized medicine offers the potential to transform healthcare and dramatically improve clinical outcomes. This new approach to medicine allows physicians and clinical researchers access to information about each patient's genetic or hereditary background to:

- Identify the most beneficial treatment for a particular patient,
- Predict susceptibility to common diseases,
- Determine the prognosis for those diagnosed with a particular disease,
- Develop strategies to prevent disease.

Pioneering this new area of personalized medicine is Partners HealthCare in Boston, an integrated health system founded by Brigham and Women's Hospital and Massachusetts General Hospital in 1994.

Partners HealthCare, a world-class patient care and biomedical research organization and principal teaching affiliate of Harvard Medical School, is working with the Harvard Medical School–Partners HealthCare Center for Genetics and Genomics (HPCGG) to accelerate the realization of personalized medicine by discovering and integrating genetic knowledge into the healthcare system.

The goal: to enable healthcare practitioners to treat individuals proactively, rather than reactively, through genetic- and genomic-based personalized medicine. The use of genomic information, which matches the genetic make up of the individual with its appropriate treatment, provides a way to personalize medical care. Such personalized treatment is useful for diagnosis, prevention, prognosis and treatment of disease.

The IT challenge: Delivery, management, and integration of healthcare information, including genetic and genomic data for medical researchers and physicians. Among the issues:

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- Maximize return on investment with the right solution, at the optimal performance for your research and budget

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1. How to facilitate collaboration among researchers and clinicians at its member institutions comprised of two academic medical centers, community hospitals, specialty hospitals, community health centers, a physician network, home health and long-term care services, and other health-related entities;
2. How to access, process and integrate clinical, genetic and genomic data from many different sources, including care delivery and laboratory systems across this large network;
3. How to enable computer processing of an uneven quality of clinical data, ranging from unstructured text to conflicting diagnoses.

Partners Healthcare has successfully overcome these challenges. Its collaborative model and innovative IT infrastructure have introduced a new era in personalized medicine.

A Pioneering Initiative

Since 2003, the Partners HealthCare Information Systems Department, the Harvard Medical School-Partners HealthCare Center for Genetics and Genomics and HP have collaborated to enhance the Partners HealthCare's IT infrastructure to integrate with Partners' electronic medical record and research systems. They set out to address the needs of personalized medicine today and accelerate future global adoption by enabling faster, better collaboration among researchers and clinicians.

Partners and HPCGG began seriously considering the potential of incorporating genetic and genomic data into electronic medical records. HP, its long-time systems provider, was simultaneously researching how the health and life sciences IT domain could enable innovation.

"We decided to join forces and learn together about how to collect genetic information from patients to make it a part of electronic medical records," explains Dr. Raju Kucherlapati, Scientific Director of HPCGG and the Paul C. Cabot Professor of Genetics at Harvard Medical School.

The three organizations soon tapped into their specific expertise:

- **Partners IS:** research and clinical applications and knowledge infrastructure;
- **HPCGG:** genetics and genomics;
- **HP:** computational/hardware/software/consulting.

Together they have created a collaborative, multi-year life sciences project that integrates genetics, genomics and imaging into clinical research and patient management. Team members meet regularly to review the project status and determine future requirements that will support imaging, research, and clinical support for personalized medicine.

Their five-year goal is to develop a model system for (a) research into the genomic bases of disease and (b) incorporating genetic data into electronic medical records (EMRs) and ensuring that physicians can access these records and apply this information to patient care. The challenge is to create a computational infrastructure capable of supporting the huge volumes of genetic and genomic information required for analysis.

Among the project's technical achievements:

- Structuring and digitizing genetic and genomic information
- Creating applications to support genetic discovery and research
- Identifying computational, storage and software requirements
- Building the right IT infrastructure

Genetic research and clinical laboratory operations have now gone live. The collaboration has also become a catalyst for similar types of biomedical projects, the development of research tools and funding opportunities, such as the National Institutes of Health National Centers for Biomedical Computing.

"Important discoveries are being made and that is why it is important to have a close relationship between medicine and IT," says Dr. Kucherlapati. "We are interested in exploring this with HP—how to export this information around the world."

The following significant, pacesetting healthcare benefits are now being realized at Partners HealthCare hospitals and affiliated institutions today.

- Genetic information is included in the medical record. Partners Healthcare is now in the early stages of providing physicians with tools to use massive amounts of genetic data.
- Physicians can make more informed and cost-effective

choices about drug treatments. Electronic records can now be coded with electronic flags with contra-indicators to show precisely which patients are likely to respond positively to specific drug prescriptions based on genomic data. For instance, using the results of genetic discovery and research conducted at Harvard and Partners, physicians can now determine which lung cancer patients will respond positively to certain medications, based on their tumor samples and genetic characteristics.

"We are beginning to conduct cost-benefit analysis with what we are doing. The ultimate benefits are not just to the medical center but to the society as a whole and how we take care of populations," says Dr. Kucherlapati.

The IT Foundation: Transforming Personalized Medicine

The right IT foundation is essential to support Partners HealthCare and HPCGG's goals for personalized medicine today and for the future. To this end, Partners and HPCGG collaborated with HP to design an IT infrastructure that would facilitate the sharing of medical research.

The IT infrastructure supports this vision for personalized medicine to:

- Improve the quality and efficiency of research and clinical operations,
- Integrate genetic test results into electronic medical record systems,
- Ensure the data integrity of the personalized medicine information flow,
- Manage costs.

"The complexity of genetic and bioscience information requires us to step back and think about the core foundation of the health and life sciences IT domain," says Jeff Miller, vice president, Health and Life Sciences, HP. "We have learned that this is truly a step function forward, not a simple progression along a curve as we introduce some of these new science disciplines into informatics models."

The HPCGG IT infrastructure includes core applications developed to support clinical and research uses of genetics, genomics and proteomics. Built-in security measures protect patient privacy and safeguard researcher confidentiality, including secure archiving and backup.

At the core lies a new informatics system developed by the three collaborating organizations: GIGPAD (Gateway for Integrated Genomics-Proteomics Application and Data).

GIGPAD, developed by HP in conjunction with Partners, is a platform for consistently managing the process of creating, organizing, and accessing genetic, genomic, and proteomic data. It processes, stores and shares research results, manages workflows from individual or multiple laboratories, and

Personalized Medicine Terminology

Genetics is the study of resemblances and differences of related organisms resulting from the interaction of their genes and the environment.

Genomics refers to the study of organisms in terms of their full DNA sequences or genomes.

Proteomics is the study and analysis of proteins in a cell to determine how they function.

seamlessly integrates with laboratory information management systems. It supports sequencing, micro-array analysis, genotyping, mass spectrometry, and 3-D imaging technologies.

GIGPAD enables a wide variety of genetic/genomic research, so research findings can be rapidly transformed into clinical tests that physicians can use to better manage a patient's disease or predisposition to disease. It incorporates tools for technicians and geneticists, a knowledge management and reporting infrastructure that supports the genetic testing process, and tracks structured genetic and genomic data for integration into electronic medical record systems.

source components such as Systemimager, SLURM and Nagios into a single, supported environment

- Open source and Linux solutions with support services enable researchers to share resources and data for proteomic and genomic analysis, using the computing and storage resources and databases distributed across the Partners healthcare system
- In March 2007, HP delivered an XC3000BL with cluster gateway file system, which greatly expands Partners' research compute capability. The system is now actively used and characterized under research loads.

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Additional key infrastructure elements of GIGPAD include:

- **Genelnsight:** A database for maintaining clinical annotations associated with genetic and genomic variations or mutations. This helps identify the interplay of different genetic and physiological observations relative to the diagnosis of a disease or predisposition to a health condition.
- **Genetic Variant Interpretation Engine (GVIE):** Assists clinical geneticists in the generation of patient reports on identified variants. GVIE integrates with Genelnsight and the Partners EMR infrastructure through the Partners pathology systems.

This centralized solution consolidates data so researchers from different research centers can more easily:

- Access information from many sources and locations;
- Share information with their peers quickly and securely;
- Place orders, receive results from multiple laboratories;
- View order history and status;
- Track financial information.

The computational infrastructure developed by HP includes:

- High-performance HP 64-node HP Cluster Platform 4000 with Linux-based XC System Software: HP ProLiant DL145 and DL585 nodes, with two AMD Opteron™ 2.2-gigahertz processors and 4 gigabytes of memory per node, and Gigabit Ethernet connectivity
- A cluster managed by HP XC System Software integrates Linux, Platform Computing's LSF software, HP's MPI (message passing interface), as well as open

Says HP's Miller, "We have approached it [infrastructure design] in a business-like process, with goals and measured against goals for a better understanding of how information can be used to enhance business and health outcomes through the application of genomic sciences."

The Future: A New Era in Healthcare

Partners HealthCare is revolutionizing healthcare with its innovative use of technology to achieve its goal of advancing personalized medicine. Genetic tests now guide treatment in clinical areas such as cancer and heart disease.

John Glaser, Partners CIO, attributes success to several factors, including strong CEO support, the right leadership, talented team members, and an excellent collaborative partnership. "The relationship with HP has been one of the most effective relationships we have ever had," he says.

Vision has also played a key role. "There are times when you take on IT initiatives where there is no formal ROI analysis to guide you, but you have a raw belief and vision," says Glaser.

The stakes are high. "In some ways, this work is not about today's care," Glaser says. "The majority of the payoff is in five or 10 years. For our kids and our grandkids, there will be a remarkably different level of care and many diseases will be curable and no longer fatal, and that is a valuable contribution we are making to people who succeed us. Our obligation is to give to those who follow us."

To learn more about the complete set of solutions available from HP for the Health and Life Sciences industry, please contact your HP representative today or visit: www.hp.com/go/healthandlifesciences

