

# Advancing Healthcare through the Application of Predictive Knowledge Management

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A White Paper examining how the healthcare industry can **proactively support patient-focused care** through the use of technology services that enable predictive analysis

## Executive Summary

As a practicing physician, I often wished there was a way to look into a crystal ball and foresee the obstacles that would keep me from providing the best care for every patient. Every day, providers are faced with situations that could have been predicted—the shortage of flu vaccine, adverse drug events that become clear when distributed data are pulled together following the widespread use of a medication, or predictable changes in surgical outcomes associated with the use of particular techniques in caring for trauma patients. As the granularity of clinical information becomes more dominant in healthcare, we can anticipate that clinicians will need—and, in the future, demand—the use of predictive knowledge management as a tool for supporting the care process.

The purpose of this white paper is to provide a high-level overview and analysis of the evolving field of data warehousing, mining, and analytics known as *Predictive Knowledge Management* (PKM), which is an approach for proactively understanding the essentials of the care delivery process and its outcomes in order to improve care delivery.

PKM provides value-added capability and service for clinicians as a resource for more effectively managing the process, safety, and outcomes of care. It combines operational, business, and clinical data into a common platform so that healthcare organizations can more effectively manage a variety of processes and address critical issues that impinge on their ability to provide care and adjust to market challenges.

The important point to understand is that PKM is not a quick-fix solution. Rather, it is a strategic change in thinking and an approach to providing care within the healthcare industry. It can be compared to an overweight, diabetic person making “life changes” versus going on a “diet.” Life changes are long-term commitments to behavioral changes that not only affect our eating habits, but also fundamentally alter our living habits. Companies who make the quantum leap into a PKM mindset or strategy must look at information as a corporate asset and not simply gather data that is pertinent to the accounting, basic reporting, or operational functions of the organization.

Beyond the four walls of any given organization, PKM takes information management a step further by providing reliable data and projections on the upstream and downstream effects of any given issue, trend or strategy within the overall healthcare continuum. PKM could be an important element in creating and maintaining directed and cogent thinking among the disparate healthcare ecosystem constituents (payers, CMS, providers, life sciences) within a given ecosystem creating a basis for consensus driven benefit and cost balancing. From the outputs of reliable PKM could eventually come documented plans that lend credibility and conviction as it relates to potential and actual investment in new reimbursement or care delivery programs.

On January, 31, 2007, in an interview with *The Press Enterprise* Kaiser Permanente’s chief medical information officer announced that “all of Kaiser’s 84 Southern California clinics will be able to check medical histories, lab results, progress notes, and order prescriptions for 2 million patients with the push of a button by the end of the year.” The article also stated that Kaiser Permanente will, ultimately, spend about \$3 billion to create its national medical records database and provide a significant foundation for future PKM efforts. The Kaiser effort—like all true PKM efforts—is focused on integrating operational, financial, clinical, and community-based healthcare data to create a truly person-centric view of healthcare services.<sup>1</sup>

Kaiser Permanente is not the only organization making these types of massive investments with the intent of shifting their information utilization toward a predictive understanding of the patient. From a healthcare payer perspective, Harvard Pilgrim Health Care, Humana, and the Blue Cross Blue Shield Association are additional examples of

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<sup>1</sup> The Press Enterprise, Inc., (Riverside, CA.), SECTION: A SECTION; Pg. A01, HEADLINE: HEALTH CARE: TECHNOLOGY DRIVE HITS COST, PRIVACY CONCERNS; Paperless Medicine Makes Waves; Records: Predictions Of A Computers-only Approach Abound, But Some Doctors And Patient Advocates Balk, BYLINE: LORA HINES, THE PRESS-ENTERPRISE.

companies using data mining and medical informatics to identify early indicators of serious disease to help address patient healthcare needs before they become seriously ill.<sup>2</sup>

I anticipate that PKM will serve as a core differentiator for healthcare organizations in the not-too-distant future as they engage in work to enhance safety, drive efficiency, reduce cost, and effectively manage outcomes. PKM will become, over the next decade, the requisite platform for healthcare organizations that are seriously pursuing an agenda to drive immediate value in the care delivery process and to focus future investments in healthcare.

This document provides:

- An **assessment** of the environment and market pressures that the healthcare industry faces today.
- An **overview** of the state of Predictive Knowledge Management solutions, as well as the technologies and processes that support this evolving tool.

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<sup>2</sup> Blue Cross And Blue Shield Plans Unveil Blue Health Intelligence; Resource Will Enhance Knowledge Sharing, BlueCross BlueShield Association Press Release, Aug. 4, 2006; Data Mining: Solving Care, Cost Capers – Humana, Data mining, along with predictive modeling apps, helps payers unravel patient mysteries., By Greg Gillespie, Managing Editor, Health Data Management, SECTION: SPECIAL REPORT; Vol. 12; No. 11; Pg. 52; Harvard Pilgrim is country's top-rated health plan for Member Satisfaction and Quality of Care according to National Committee for Quality Assurance report, Harvard Pilgrim Health Care Press Release, September 23, 2004

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## Background

**What is Predictable Healthcare?** A predictable healthcare organization is one that has progressed from rote data capture and regurgitation to one that uses, reuses, and massages information to identify probable outcomes, enabling the healthcare entity to “act” in a more predictive fashion throughout the care process (before, during, and after a patient care experience). One primary driver fostering the development of Predictive Knowledge Management (PKM) is the move toward transparency within the industry. Transparency is pushing the migration of healthcare organizations from simply collecting independent data events to creating coherent interdependent information environments that must actively support increased quality and patient safety, improve health outcomes, and enhance the patient experience across the entire healthcare continuum.

**Where is Healthcare Today?** In many respects, the move toward PKM in healthcare is an inevitable outcome of the move toward creating electronic databases. Other industries (e.g., retailing, finance, automotive) have adopted predictive modeling techniques as a standard practice. The platform for moving in this direction across all of these industries has clearly been the adoption of electronic information capability related to core functions within the specific organizations of the industry.

For healthcare, the core functions related to clinical care are the foundation for the evolving PKM capabilities of the industry. Unfortunately, due to the historically paper-based medical environment and the backlog of nonintegrated information residing in healthcare organizations, the move toward implementation of effective PKM will be both costly and time-consuming.

To meet the needs of predictive modeling, healthcare information must evolve from the simple sequential capture of discrete pieces of data to a model that facilitates the gathering of integrated data into information packages. Such an approach supports the creation of knowledge, which can eventually be used for driving improvements in the care process.

**How Do Healthcare Organizations Achieve PKM?** Enabling this PKM evolution requires a delivery platform that assimilates several information technology stages that include the transition from disconnected applications with independent functions and capabilities.

The stages include the following:

- Connecting business strategy where visibility into specific applications, people, and partners is feasible
- Integrating business and information models where the end-to-end processes are managed
- Eliminating time delays of real-time operations in handoffs associated with the processes
- Modeling on a predictive basis the process requirements and acts that will optimize care delivery opportunities and prevent the occurrence of problems

A number of environmental forces are precipitating the need for adoption of a predictive modeling capability by healthcare organizations. The following is a brief overview of the forces that are contributing to the development of PKM.

**What is the Future of PKM in Healthcare?** Many forces commonly addressed today—such as globalization of healthcare services, public dissatisfaction, the move to consumerization, clinical workforce shortages, as well as outcomes reimbursement and other financial issues—are precipitating a notable requirement for new discovery within the healthcare industry. With the advent of the electronic health record, new opportunities for uncovering patterns of care—patterns of care we did not even know were in existence—will come to the forefront of medical knowledge. As the healthcare industry continues its drive toward enhanced quality of care, promotion of better service, and reduction of cost, these undiscovered patterns of care will become increasingly transparent, first for physicians, nurses and other clinicians, and ultimately for all consumers of healthcare.

**Provider Community.** While global trends will be influential on all segments of the healthcare industry, several key factors are evident for the provider community.

The approach and venue for delivering care will change:

- A much deeper understanding of the actual care process—along the entire continuum—is required to support change efforts.
- Consumers will have a much larger voice in healthcare and demand more and better information on the outcomes of care.
- Businesses will no longer tolerate annual increases in healthcare expenditures that exceed general inflationary trends.
- Healthcare providers will shift their focus from the back office to the clinical setting to extract value.
- Demand for services will increase as the population ages.

For providers, these factors are driving an increasing recognition that more and better information is required to manage the “care process.”

Why? First, in today’s healthcare world, much of the inference extrapolated on the quality of care is derived from secondary data. Secondary data is interpretive in nature and consists primarily of financial information and billing code data. Essentially, the ability to derive good information on care delivery patterns is extremely limited and, from a clinical perspective, nonexistent. While such an approach to data extrapolation has been acceptable in an era of paper-based systems, in an era of available real-time, integrated, granular clinical and business operations information systems, such an approach is not only unacceptable, it is deemed archaic. Therefore, the growing digitalization of clinical data and deployment of Clinical Information Systems (CIS) creates a requirement for a deeper understanding of the care process and demand for more detailed analytic services.

Second, extracting such clinical information from disparate legacy healthcare information systems can be extremely difficult. Issues related to lexicon, semantics, normalization of data, and a host of other technical and standards-derived considerations must be managed to effectively compare data sets between disparate systems.

Third, from a pragmatic perspective, it is the rare healthcare organization that has deployed a single integrated health or clinical information system to meet all information needs. In addition, most healthcare organizations have not fully depreciated their investments in information technology and, as a result, they cannot simply engage in wholesale replacement of existing siloed legacy systems with integrated information systems. Therefore, these organizations frequently require an approach that ties disparate information together from a wide variety of sources to create a much more robust picture of care across a diverse, often geographically disconnected, healthcare delivery organization.

Notwithstanding an increase in the use of information, healthcare is still far behind other industries in creating integrated, longitudinal, client-focused databases that can serve as repositories for data mining and analytics. At the same time, the quality-service-cost triad has driven many other industries to adopt new methods for driving “business intelligence” from massive stores of available data. Healthcare is only now beginning to apply these proven intelligence gathering technologies, which will create the PKM systems of the future. In the changing electronic world of healthcare, the abundance of massive data sets is creating the imperative among providers who increasingly recognize the value of data mining as a tool for driving better outcomes.

**Payer, Pharmaceutical, and Medical Device Communities.** The trend toward business intelligence is also affecting the Payer, Pharmaceutical, and Medical Device (PPMD) segments of the industry. For the insurance industry, it is increasingly recognized that disease management models provide significant value-add contribution to enhanced service and reduction in costs. Such models require, *a priori*, extensive data on the results or outcomes of care delivered by healthcare organizations and providers over time, which includes the availability of longitudinal, patient-centric information. Again, analytics on the care process has proven to be an invaluable resource for enhancing quality, increasing patient safety, promoting consistency, and reducing overall costs.

In addition, the market discrimination required by the PPMD segments of healthcare involves effective analysis of medical, health, and demographic trends over larger populations, both for purposes of understanding the impact of their products, as well as for driving unit sales. Intense marketing competition, shrinking margins, escalating research costs, increasing sales costs, and rising marketing costs are all contributors to the need for better business intelligence by the PPMD healthcare segments.

Companies are, therefore, seeking competitive advantage through data that gives their product an “edge,” or helps their sales and marketing effort fine-tune their respective strategy and message. Traditional data sources cannot deliver the types of information required for discovering new, care-related competitive leverage points. As an example, the pharmaceutical industry has historically used clinical data from sources such as medical chart abstractions, claims, and other publicly available data sources (e.g., Medicare database)—all secondary data sources. These secondary data sources represent extrapolations from actual clinical data. Extrapolated data excludes the causal detail that has immense analytical value. In addition, these data sources have not traditionally provided a longitudinal view on the patient. As a result, data analysis frequently fuses “extrapolated” databases to create additional “extrapolations” derived from nonintegrated sources (e.g., tying independent lab data to independent pharmacy data to independent radiology data, and so on). The best currently available sources of patient-focused data share common deficiencies:

- The data is generally old (i.e., > 6 months) when researchers finally gain access to the information.
- The most widely used data sources are based on insurance claims from pharmacies and payers; and, represent singular “encounters” with the healthcare system, rather than an integrated picture of a patient’s total medical experience.



- Diagnosis codes and other common identifiers are frequently unreliable.
- Clinical details are missing.
- Data is frequently of a poor quality because it is manually derived.
- Data on use patterns within a hospital is inadequate (for pharmaceuticals) or completely unavailable (devices).

Integrated data sources, on the other hand, provide the opportunity for these companies to conduct research related to pharmaco-vigilance, pharmaco-economics, sales and marketing, drug research and development, and post-marketing activities, among other research initiatives. Patient-level data that can be longitudinally analyzed—from the point where the patient presents with a chief complaint to the final outcome of a particular healthcare problem—represents the “Holy Grail” of competitive intelligence for the PPMD segments.

**Where Does the Road Lead?** PKM in the healthcare marketplace is continually evolving and is not a solution that will happen overnight. There remains a fair amount of time, hard work, and investment related to infrastructure investment and data integration to make PKM a true reality in healthcare. However, some significant milestones are making healthcare foresight possible.

First, purveyors of secondary data sources recognize the need to shift toward more patient-centric data. As a result, many purveyors of solution data sets are in the formative stages of developing more clinically focused database structures. In addition, clinical information system vendors are also attempting to develop data warehousing products.

Second, the federal government, through a variety of initiatives, is stimulating interest in creating patient-centric data models. The Agency for Healthcare Research and Quality (AHRQ), Centers for Medicare and Medicaid Services (CMS), the Department of Defense (DoD), the Veterans Administration (VA), the National Cancer Institutes (NCI), the National Institutes of Health (NIH), and a variety of state efforts (e.g., Pennsylvania) are fostering more interest in developing patient-centric systems.

Third, various collaborative initiatives are evolving. Healthcare professionals, healthcare systems, and other groups are recognizing the *power and value* of such information in conducting analytic work on their care delivery patterns. As an example, several specialty hospital associations are examining the potential of a common data warehouse for purposes of research for members (e.g., pediatrics, oncology, and cardiovascular). In a similar trend, evident among other industries that have already deployed business intelligence initiatives, healthcare

organizations increasingly recognize that the more one knows about oneself, the better able they are at directing or *predicting* their future.

Fourth, regulatory agencies (e.g., The Joint Commission, URAC, specialty accreditation organizations) are seeking models that provide them with quality data on care delivery patterns. The move toward outcomes and results is fostering the need for more patient data, which is integrated over time.

Fifth, the evolution of the Regional Health Information Organization (RHIO) movement will precipitate a need for PKM initiatives. As these organizations begin to move patient-centric data on a regional basis, the natural progression is to begin asking the question, “So, what is happening from a care delivery standpoint in our community?” This question is the next extension of the RHIO movement. While the movement continues to be in its early growth stages, it will clearly raise issues for local and regional communities on the type of care being delivered for people.

Finally, until very recently, the question, “Who would be willing to pay for quality?”, represented a rhetorical question, at best. However, the reimbursement landscape is changing very quickly. Today, it is clear—pay-for-performance incentives, external measurement, and recognition based on comparative performance, risk management, and medical error revelations are clearly forces that provide measurable ROI for quality. This shift to paying for quality also shows the change in the overall mentality from “the system is king” to “the data is king.”

## Perot Systems' Perspective on PKM

In order to understand how Perot Systems' perspective on PKM is unique, we must first understand what elements are necessary for true PKM capabilities, which the first part of this section addresses. PKM requires effective data warehousing, mining, and analytic support. In designing a data warehouse, there are clear advantages in building an approach that can be deployed across multiple organizations so that different questions can be answered utilizing the same resource.

Data mining requires the use of software tools to support the type of analysis required by various components of the healthcare industry. While, historically, this required customized solutions, there are now available options that provide "off-the-shelf" data analytic tools, which can be used by healthcare organizations.

Finally, data warehousing and mining are insufficient without effective data analytics, which requires the skills of highly talented experts (e.g., biostatisticians, clinical informaticists, bioeconomists, and others). Warehousing is a commodity service. Mining is an off the shelf capability that can be purchased or leased. Analytics is the essential tool that provides the value-add service for healthcare organizations seeking to develop their PKM capability.

**Data Warehousing.** Perot Systems believes a leveraged model provides a unique approach/method for collecting data from provider point-of-care clinical and administrative information systems and aggregating it into longitudinal, comparable, patient-centric records. With a primary data source established, healthcare providers would be able to extract valuable information related to clinical quality, safety, and cost-effectiveness. At the same time, the data can—at the option of the client—be de-identified and re-purposed for use by multiple other agencies (e.g., payers, pharmaceutical companies, device manufacturers, public health entities, government agencies, and other healthcare participants). Such an approach would allow the system to extract valuable information at a reasonable cost from many diverse sources.

Through PKM initiatives, the Perot Systems model assists clients in collecting information from provider operational and clinical systems, such as the administrative, pharmacy, radiology, laboratory, materials management, and financial systems. The information would then be aggregated at the patient level so that all aspects of a patient's longitudinal experience are chronologically linked together. After the data is cleansed and consolidated, a common vocabulary and cross-institutional patient index would be applied to enhance the value of this traditionally unorganized, noncomparable raw data.

Data transformed in this manner is of critical importance for healthcare providers focused on improving the effectiveness of their services. This same data—de-identified and combined with similar data from other organizations—can form the foundation of a new and highly valuable source of applied health research services across multiple sectors of the healthcare market.

As an example, for the pharmaceutical industry, data warehousing and data analysis techniques can be applied to solve critical business issues, such as:

- Detecting safety signals
- Measuring outcomes
- Sizing a market
- Defending a product
- Monitoring off-label product usage
- Reacting on a real-time basis to the effectiveness of a product launch or patient recruitment

The Perot Systems PKM model is designed to be a foundational platform that in the right environment would enable numerous business and scientific applications. Characteristics of clinical data used include the following:

- **Clinically Rich**—Clinical data collected from multiple clinical systems, including admissions, patient management, laboratory, radiology, and pharmacy
- **Longitudinal**—Data chronologically linked within and across multiple inpatient and outpatient encounters
- **Real-Time**—Data continuously collected from healthcare systems with an availability lag measured in hours
- **Fidelity**— Data captured at the point of care
- **Transferable Meaning**—Universal comparability, regardless of system, facility, provider, format, coding scheme, or vocabulary
- **Representative**—Multiple, U.S.-wide clinical sources with broad demographics for representative sampling
- **De-identified**—Patient identifiers excluded, consistent with HIPAA guidelines, patient privacy, and protection of data suppliers
- **Secure**—Encryption and security measures in place to restrict access to authorized users

The Perot Systems PKM approach could also be provided as a leveraged model across the more than 620 hospitals and 130 health plans (2006) that use its services. The intent is to grow a large data warehouse operated, managed, and marketed by a trusted entity, but *where the data is owned and controlled by the providers of data* [NOTE: This represents a

critical difference from other PKM models. The philosophy of Perot Systems is that the providers of data own the data]. Hospitals, hospital systems, and other healthcare provider organizations benefit in two ways when they provide data to the PKM model. First, they are able to proactively respond to the increasing pressure from public and private organizations to validate improvements in quality of care and the need to be more disciplined in the way they capture and analyze operational data. Second, healthcare providers can be compensated for the data they provide to other segments of the healthcare industry as a new source of income, if desired.

**Data Mining.** The process of data mining employs the “law of large numbers.” This data can then be used to address issues that surround decision-making where uncertainty exists. Data mining requires the autonomous extraction of information from large amounts of data with the end result being the identification of patterns and/or relationships in the data that may be beneficial to a particular segment of the industry. In the case of healthcare, these identified patterns and relationships could conceivably change the way in which healthcare is delivered. Data mining is also referred to as a process for knowledge discovery.

**Data Analytics.** Data analytics represents the true *value-add* and leveragable service in a PKM initiative. Analytics capabilities require highly skilled workers with unusual and highly sought-after skill sets. In general, these individuals are highly specialized *and* their knowledge can be leveraged across multiple clients. In addition, the analytics knowledge, once developed, can be used across organizations for driving deeper analysis of issues and/or problems. It is anticipated that the application of virtual approaches to staffing analytic services will also evolve over time.

## Perot Systems' PKM Operational Model

Medicine has had a long history of collaborative, evidence-based decision-making that supports improvements in patient care, and results in improved quality of life. To date, the vast majority of healthcare organizations have not had access to deep resources of evidence-based information. Most healthcare systems have not drawn sufficient value from their data warehousing initiatives due to small sample sizes, as well as a combination of insufficient granularity and the inadequacies of the databases for drawing statistical inferences.

The driving force behind a partnership approach with key sponsoring organizations is to build a solution by addressing two primary issues. First, such an initiative provides the capability for shared analytics and benchmarking among our healthcare clients improving quality, encouraging best practice and innovation, and driving down the cost of care. Second, eradicating the extensive technical and analytical expense that prevents health systems of all sizes from implementing a PKM solution is a major attraction for the healthcare industry. These solutions are required for raising the bar, and we believe with the right business model that this type of service could be more affordable, and more easily accessible to a broader range of and size of hospital systems, thereby enabling the industry to make greater strides forward in reducing healthcare costs while improving the overall care quality.

The leveraged approach of a Perot Systems PKM model uses a business approach similar to the cable television model. It recognizes the fact that it is far too expensive for a single organization to embark on the journey alone. With this in mind, the Perot Systems model provides standard “data channels” for basic reporting, “premier channels” for common, but specialty-driven services (e.g., special quality reports for heart hospitals), and “on-demand channels” for highly specialized reports needed for purposes of customized analysis on specific organizational-centric problems or concerns, such as an analysis of data in advance of The Joint Commission site visit to review a series of adverse events. These three levels—basic, premier, and on-demand services—represent the model for the Perot Systems PKM approach.

By spreading the time, effort, and cost of these PKM capabilities across multiple organizations, the overall cost can be reduced significantly, implementation can be accomplished more quickly, and translation of quality improvements can be accelerated for the financial, clinical, and patient safety benefits of all participating healthcare organizations.

While benchmark data is readily available in many key areas of analysis for providers, even if an organization has the analytics capability, there is a problem in knowing if the data received is good or bad. The

Perot Systems PKM model brings the approach and tools to drive the granularity of data down to a specific patient condition or internal hospital activity and blends an extensive set of internal and external hospital data to dramatically improve the care provided to a patient by orchestrating a pattern of immediate interactions. Plus, this leveraged approach makes PKM affordable for everyone.

Simply stated, the driving algorithm for Perot Systems' PKM is:

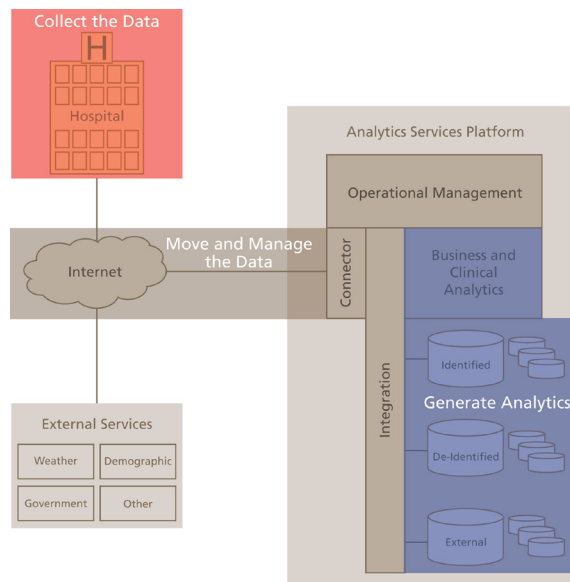
Real-Time Events  
Historical Information  
Analytics  
Real-Time Business Rules

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**Predictive Knowledge Management**

The Perot Systems PKM operational platform could provide a virtual on demand environment—one in which the user drives the process by dictating the deliverables they wish to receive. It also provides for an easily consumable solution, higher quality data, consideration of timing variations (i.e., real-time, near real-time, batch time), use of the organization's own data, transparency of data usage, and the predictiveness and reuse of data, as well as brokering quality methods on an elective basis.

The design principles of PKM enable data to be reused in response to different needs and output requirements. The data used is highly configurable, scalable, reliable, auditable, flexible, extensible, encryptable, and traceable.



The above diagram depicts how a hospital’s local technology applications (i.e., with some automation—human to system or with full automation—system to system) connect with the operational platform responsible for moving and managing data. Data is then taken “as is” and moved to the analytics platform where integration of operational management data, business and clinical analytics, and identified, de-identified, and external data is added to the equation—ending with the generation of evidence-based solutions.

**Generate Analytics.** As noted previously, business intelligence analytics includes the “drill down” and “drill through” techniques of information management. Basic, premier, and on-demand reporting consists of pre-defined reports that capture traditional departmental, financial, clinical, contractual, and environmental information, which is then combined with components of internal and external quality, patient and employee satisfaction, patient experience, predictiveness, internal measures, and performance information. This technology allows the same data to have multiple disciplinary outputs and equates to new business intelligence reporting capabilities. In other words, several factors combine and produce relatively complex ideas.

However, these same data sources—when combined with other data bases—can be enhanced in terms of value for the healthcare organization. Three simple examples exemplify the opportunity.

First, assume you represent a group of healthcare providers in Southern California. In the summer, when the temperature rises, the Los Angeles basin can experience an inversion due to the extreme high temperatures, which overlay the region. In an inversion, the ozone levels rise. High ozone levels precipitate asthmatic crises for patients who are vulnerable



to this problem. The end result is that when inversions occur, many asthmatic patients end up in emergency rooms, requiring care for a problem that could have been predicted. By tying together the clinical-operational database for a healthcare system with the publicly available database of the National Weather Service and, through the use of appropriate predictive tools, the number, type, frequency, location, and even individual patients could be identified who are vulnerable to asthmatic attacks. It is clear that the use of generative analytics could be applied to enhance the outcomes and process of care delivery for asthmatic patients during such an event.

A second example assumes that the Northeast Corridor will be hit with a terrible blizzard. The ferocity of the storm is such that the hospital realizes that staffing patterns for the next few days are likely to be inadequate, and medication levels are insufficient to treat the expected influx of patients. In such a situation, PKM could be used to transform and translate the data to execute an analysis for determining the impact of potential staffing and medication shortages on the organization. Again, the analysis could be performed on a proactive basis to produce recommended alterations in the usual approaches to people, resource, and supply chain management. PKM analytics would then generate a report and automatically trigger an event correlation that could be delivered to management. With PKM in place, the hospital would have adequate notice of the impending storm and the resultant staffing and medication problems that are likely to occur. A preemptive change in the management of the situation would allow the hospital to more appropriately staff the situation without necessarily incurring excessive overtime costs and allow it time to stock up on the medications and other necessities needed for this flood of patients. The solution to this simple example shows how the hospital is relieved of substantial headaches from a financial, operational, and clinical perspective. And, the beauty of this solution is that the entire process of information delivery can occur in seconds and hours, rather than days or weeks.

Third, the use of such data sets clearly alters the approach to decision-support programs for clinical information systems. In today's world, decision-support systems are almost exclusively represented by benchmark or best practices approaches. As such, the "real-time" data is analyzed against the practice deemed most appropriate and, if it falls outside of stipulated parameters, an alert is generated for the clinician. Through the use of generative analytics, the actual data of patients within and across healthcare organizations could be used to create "real-time analysis" of clinical information based on the patient's actual data. Clearly, such an approach will be far superior to retrospective, static systems deployed across most healthcare systems today.

## Summary

The problem of untimely, nonintegrated and nondetailed patient centric data plagues all of the major healthcare industry sectors—providers, insurers, pharmaceutical, medical device, and government segments of the industry. Access to such data creates an opportunity for fostering more predictive care delivery by dramatically altering care patterns, delivery approaches, insurance modeling, use of resources, and use of modalities.

PKM is not a new idea. It has been presented as a *fait accompli* for the last several decades by many healthcare futurists. Yet, it has not become a reality. Despite these limitations in healthcare, it has been adopted by much of the retail, financial, automotive, and other comparable industries. While it is relatively new to the healthcare industry, especially in the nonpharmaceutical and medical device areas, there are some visionary healthcare organizations, such as Kaiser Permanente, the Blue Cross Blue Shield Association, Humana, Harvard Pilgrim Health Care, Intermountain Healthcare, Partners Healthcare, Vanderbilt Medical Center, and others, who have made significant strides toward implementing the technology and putting the formative elements of an effective PKM program in place to move the notion from concept to reality.

PKM may look like a far-off dream to some, but for visionary companies that make the decision to strategically change the way they look at information now, the cost and quality benefits of their data assets will be reaped for years to come.

Perot Systems is one of the first systems integrators to offer its healthcare clients a PKM model as part of a portfolio of services—due primarily to its substantial market presence throughout the healthcare industry. Perot Systems also has a strong depth of capability related to the inherent technologies required to support the connectivity complexity and interoperability issues surrounding PKM.

Organizational trust is another key element. The data sources to be managed under the proposed Perot Systems PKM model require that the healthcare organizational participants' *trust* that their data will be held in confidence, be secure, and appropriately managed.

Organizational stability is a final characteristic of any third party that will be involved in managing healthcare data sets. These latter two points are especially important since the problem of data aggregation for purposes of deriving information and knowledge will likely only occur through the efforts of an independent third-party organization that can:

- Work across the many market segments
- Create financial incentives to facilitate organizational participation
- Share data beyond traditional boundaries under the direction of participants in a trustworthy manner

The Perot Systems' PKM model is designed to be a virtual information data interface that can provide basic, premier, or on-demand business intelligence operating across multiple time dimensions and delivering the required data in near real-time or real-time.

The revolutionary aspect of PKM is that it transforms data from granular segments to information sets and allows for the creation of organizational knowledge or business intelligence over time. The impact on patient lives and those caring for patients are as yet unrealized, but when actualized, the evolving PKM will thrust all healthcare providers into the 21st century as we continue to drive for the provision of the most proficient, least costly, and best care possible.

In an increasing consumer-driven healthcare environment, organizations that do not act quickly to begin the journey toward PKM may find themselves further behind the technology curve than they realize, which, in future terms, may mean struggling for market share or going out of business.

Comments and suggestions on this white paper are appreciated. Please feel free to contact Dr. Kevin Fickenscher with any thoughts through his e-mail at [kevin.fickenscher@ps.net](mailto:kevin.fickenscher@ps.net).

The table below provides an overview of the specific application areas Perot Systems supports for PKM initiatives across all segments of the healthcare industry.

Market	Value Proposition	Application Areas
Providers	Access to patient information across multiple, fragmented components of the healthcare system to improve information sharing and clinical decision-making	<ul style="list-style-type: none"> <li>• Accreditation</li> <li>• Benchmarking</li> <li>• Patient Care Outcomes</li> <li>• Cost of Care Analysis</li> <li>• Patient Flow Monitoring</li> </ul>
Life Sciences Companies	Ability to do better research, reduce costs for data collection, and conduct more real-time monitoring of product usage, safety, and efficacy	<ul style="list-style-type: none"> <li>• Market Analysis</li> <li>• Product Usage Analysis</li> <li>• Safety Surveillance</li> <li>• Outcomes and Economics Research</li> <li>• Patient Recruitment</li> </ul>
Government Agencies	Ability to measure health outcomes, increase patient safety and help achieve optimal use of scarce resources. More rapid, accurate, cost effective access to data to support surveillance, detection, management, and response to public health threats	<ul style="list-style-type: none"> <li>• Safety Surveillance</li> <li>• Outcomes Research</li> <li>• Disease Surveillance</li> <li>• Bioterrorism Surveillance</li> <li>• Fraud and Abuse Detection</li> </ul>
Payers	More efficient, more effective method of assessing and facilitating the improvement in quality of care across populations	<ul style="list-style-type: none"> <li>• Fraud and Abuse Detection</li> <li>• Outcomes and Economics Research</li> <li>• Case Management</li> </ul>

To find out how you can cost-effectively achieve visionary healthcare services, call us today at +1 888 888 3872 or send an e-mail to [perotsystemshealthcare@ps.net](mailto:perotsystemshealthcare@ps.net).

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