Understanding Decision Support Systems

By Steven A. Ponedal and Michael Tucker

Customer expectations are creating specific demands upon managed care pharmacists for the 21st century. The AMCP Project, Pharmacy’s Framework for Drug Therapy Management in the 21st Century, holds our profession accountable for meeting the needs of our diverse customer base.1 Readers of this article are encouraged to familiarize themselves with this important Academy project. The project should be of interest to employers, academicians, government officials, health plan administrators, pharmaceutical manufacturers, patients, nurses, and physicians.

The Framework cites seven expectations commonly held amongst the professions’ customers. New information tools will be needed to meet or exceed these customer expectations. These new tools are going to be business intelligence and decision support systems.

Decision Support Tools

The approach to information infrastructure is subtle in the Framework report. The Institute of Medicine report, Crossing The Quality Chasm, takes a more robust view specifically identifying the need for an improved information infrastructure and the form it should take to improve the quality of America’s health care.2 Information and decision support systems, however, will be the girders supporting the Framework infrastructure. Health care data warehouses now contain vast amounts of information which must become retrievable in a standardized format across all payer platforms.

This information, in an easily retrievable format, will provide the basis for meeting the fundamental requirements set forth in the Framework’s seven domains. Pertinent patient information sent via e-mail or other media, with messages crafted in writing styles easily understood by all customers, will be the stimulus for interactive collaborations between the patient and the physicians designing care plans. The patients will have their opportunity to be self-determining in regard to the quality of life they want for themselves.

What Is a Decision Support System?

Within the context of this article, a decision support system (DSS) is specifically designed to allow end-users to perform their own computer-generated data analyses.3 One of the most basic DSS tools for “data manipulation” is the spreadsheet. A user enters data or imports it through an interface to populate the spreadsheet. Then the user can conduct limited analyses on the data, such as calculating the average age of a population or the total dollars spent on drugs during a given time period. Today’s more sophisticated DSS technologies provide the ability to access data in an online processing environment, hitting the data in real time through a system optimized for analytical output.

A similar term is clinical decision support system (CDSS). It is defined by one source as “software designed to directly aid in clinical decision-making in which characteristics of individual patients are matched to a computerized knowledge base for the purpose of generating patient-specific assessments or recommendations that are presented to clinicians for consideration.”4 Hospital pharmacists might use a CDSS for theophylline or aminoglycoside dosing assistance. The end-user (i.e., a pharmacist) enters discrete variables such as height, weight, or serum creatinine into a program; a recommended dose is calculated and displayed. There are also clinical decision support systems that send physicians reminders about the need to perform a mammogram on a particular patient or reminders that a patient is due for an influenza vaccination.

A DSS and a CDSS differ in several important ways. A CDSS lacks the comprehensiveness of a DSS. A CDSS usually focuses on one very specific aspect of information or care, so the program that calculates an aminoglycoside dose or total cost probably cannot remind clinicians that a mammogram is due. In contrast, a DSS is a comprehensive health care tool that allows a wide range of end-user queries.

An effective DSS transforms integrated medical and pharmacy data along with data gathered by clinicians and patients and then interprets and distributes this information with a specific goal: to affect change. Systematic data evaluation is the key: A DSS provides the ability to drill into very granular detail to improve or maintain an individual member’s health status. When patterns or trends are revealed, specific opportunities become apparent; interventions emerge for specific members, prescribers, pharmacies, drugs, diseases, or diagnoses; and outliers are identified.

Author

STEVEN A. PONEDAL, Pharm.D., MBA, is Director of Clinical Solutions and MICHAEL TUCKER, M.S., is Vice President of Technology Solutions, MedInitiatives, Inc., Rancho Cordova, California

AUTHOR CORRESPONDENCE: Steven A. Ponedal, Pharm.D., MBA, MedInitiatives, 10901 Gold Center Drive, Suite 250, Rancho Cordova, CA 95670-6047, Tel: (916) 861-7774, Fax: (916) 861-4334 E-mail: sponedal@medinitiatives.com

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Management by exception (focus of efforts on high-risk or high-cost issues) reduces administrative costs expended on patient management.

Analysis can measure favorable changes in prescribing behaviors and practices, and then conduct member outreach and education across populations to assure that drug therapy management contributes to population health. End-users can impact prescribing to improve care for each individual patient by using patient-specific, two-way communications to physicians with evidence-based recommendations for improved treatment. Beside the content, a critical factor in affecting change is the timeliness of the data displayed to the prescriber. Interventions with data more than 90 days old may lose their impact.

### Components of a Decision Support System

Organizations can build or buy decision support systems. Three components are needed for best results: liveware, hardware, and software.

#### Liveware

Liveware is the term used to describe the people who develop, maintain, and use the system.

The data administrator plans, develops, and maintains standards, policies, and procedures, as well as the conceptual/logical database design. Working with departmental representatives such as the pharmacy director, the data administrator incorporates the organization's business rules. This ensures that the pharmacy, medical staff, underwriting staff, and salespeople all recognize a member or an enrollment date in the same way.

The database administrator is responsible for physical database design, security, and performance. Working closely with the data administrator, the database administrator implements the logical design and business rules. The database administrator's responsibilities are more technical than the data administrator's, but both must have domain intelligence.

Domain intelligence is the knowledge of how a particular business works and its data and database requirements. This is important for the company with an implementation using outside consultants who must be educated on all business rules, requirements, and unique data elements and layouts.

For example, in the field of health care, domain intelligence requires the knowledge that an NDC code is 11 numbers with no decimal point, or that an ICD-9-CM code is a five-character alphanumeric entry that contains a decimal point with two numbers on its right. Time spent training system designers will affect the organization's timelines, project costs, and potential for return on investment (ROI).

Another example of domain intelligence is found in the manner in which managed care employers screen prospective employees. It's common to see professional recruitment ads for clinical pharmacists in which the applicant is required to have several years of post-graduate work experience. What these employers are conveying is that work experience contributes a significant amount to an applicant's knowledge base and is part of the domain intelligence requirement for the position.

End-users are important components of liveware and are the system's customers. They vary widely in responsibility and skill. Domain intelligence is important for them, too. End-users who understand their company's business model and possess the correct domain intelligence will be able to assess information provided when a query is made and determine if the results are relevant and reliable.

#### Hardware

Sophisticated analysis relies on the ability to process large amounts of data. Powerful, multi-component computer hardware is needed for specific functions. In general, a DSS needs the basic components described in Table 1 (next page) and in more detail below.

A relational database management system (RDBMS) provides the horsepower necessary to sift through large volumes of data and forwards results to the requestor. The RDBMS is a significant resource investment, particularly in fixed disk storage. It usually provides several gigabytes (GB) of storage capacity and a GB or more of random access memory (RAM) to support several functions. These include database caching and structured query language (SQL) parsing and compiling. Most database servers use multiple, high-powered central processing units (CPUs) to perform complex functions.

Another key component is the application system. Generally, online analytical processing (OLAP) software operates on this system. OLAP is relatively new, having been around for the last 8 years. It is not online transaction processing (OLTP). The difference between the two is centered on the specific use of the data stored in each respective system.

An example of a large OLTP system would be an airline reservation system. The reservation system must be able to accommodate many different users retrieving and updating a variety of different types of data simultaneously. The OLTP system is generally very complex, with a large number of highly specialized tables to store unique groups of information separately from other groups of information. The term to describe this separation process is data "normalization."

In contrast, an OLAP system is primarily designed for information retrieval and analysis. An OLAP system is optimized to query and return information organized for sophisticated reporting. The OLAP system is generally more simply structured, with data grouped together in "reportable" sets. The term used to describe this grouping is data "de-normalization."

The OLAP server is the brain of the system, receiving and interpreting the initial request into query language for the RDBMS and forwarding results from the RDBMS to the end-user. Hardware at this tier usually includes multiple high-powered CPUs and significant (possibly 2 GB or more) RAM. This power is needed to cache data requests for presentation to the user. Cached requests are generally main-
Understanding Decision Support Systems

To move data from a data source to a data warehouse, extraction/transformation/ loading (ETL) software is needed. The source might be a claims processing system, another database, or a simple text file or spreadsheet. ETL software transforms the data, corrects misspellings, and screens to ensure entries are consistent with field requirements. It ensures data integrity. Additionally, the ETL process decodes cryptic information into meaningful terms, and then loads the data into tables.

**Data modeling software** aggregates and summarizes data, improving system performance and speed. For example, a given organization’s data warehouse may contain pharmacy claims from ten years, but only 5% of the organization’s users retrieve data older than 18 months. The database administrator can use the data modeling software to aggregate claims accordingly so that query times are faster.

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**Table 1: Hardware Considerations for Decision Support Systems**

<table>
<thead>
<tr>
<th>Component</th>
<th>Processor Type/Speed</th>
<th>Main Memory</th>
<th>Disk Storage</th>
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<tbody>
<tr>
<td>Relational Database Management Systems</td>
<td>1 or more Central Processing Units (CPUs), the faster the better. Pentium III or more is necessary.</td>
<td>512 MB to 2 GB or more depending on the database software and number of concurrent users.</td>
<td>A 200,000-life health plan could use approximately 5 GB of storage for every year of data maintained.</td>
</tr>
<tr>
<td>Application Server or OLAP Server</td>
<td>1 or more CPUs. The more the better, especially if many users are using the system concurrently.</td>
<td>1 GB or more of main memory. Needs large amounts of memory to minimize disk storage access, which takes more time.</td>
<td>Minimal. Generally a couple of large redundant disks to store source data is adequate.</td>
</tr>
<tr>
<td>Presentation System</td>
<td>1 powerful CPU. More if the solution is Web-based with many concurrent users.</td>
<td>512 MB should be more than adequate in most circumstances.</td>
<td>Minimal. A sufficient amount of disk to provide system storage and operation.</td>
</tr>
<tr>
<td>End-user Workstation</td>
<td>Single powerful CPU. Pentium III or better is preferred.</td>
<td>128 to 256 MB is the current desktop standard.</td>
<td>Whatever disk is necessary to support desktop computing needs.</td>
</tr>
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</table>
Data modeling software helps the database administrator develop metadata, or data about data. This eliminates the need for end-users to digest complex tables or fields in raw programming language. So, the fieldname “DIR_F” is easily recognized as “direct unit price.”

Data modeling software also enables professionals to create relationships between various tables in the database. Thus, member identification in one table links correctly to all other tables.

To see the results of an information request, there must be a direct user interface to the DSS environment called application software. Application software provides a conduit for user requests to be sent to the system’s components. It is generally installed directly on the user’s workstation, or can be accessed via an Internet Web browser. Presentation software returns data in a recognizable format, reading metadata and capitalizing on established table relationships.

Presentation tools, especially the newest of them, allow users to save query definitions, share them with others, and use them again. With one click of a button, they can be updated to produce results for more current time periods, as specified by the user through date settings. With the right technology, queries can be so simple that analysts, technicians, nurses, physicians and pharmacists can develop queries quickly and without information technology staff assistance.

A comprehensive presentation tool has a number of output options. Some prefer graphic or tabular displays of information while others like spreadsheet formats. It should export information into other applications, such as e-mail, hypertext markup language (html) or text formats and have the option of printing for standard U.S. mail distribution.

Developing a Decision Support System

According to Ron Lyon, vice president of pharmacy for Trigon Blue Cross Blue Shield, “It takes a lot of resources to put together your own DSS. Even in a large organization, it takes a close working relationship between programmers and clinical end-users during the development phase. Keeping this relationship intact throughout the process is difficult as department priorities and resources shift in response to the business environment.”

The first consideration in creating a DSS includes deciding whether to build computer systems internally or buy an integrated computer system from an outside vendor. Both options require purchases from outside vendors, including hardware, software, etc. Table 2 summarizes the process of developing a DSS in an organization. For an in-house solution, a company has the option to buy individual components from various vendors or purchase a turnkey solution that includes all components.

As an alternative, a company can subscribe to an application through an application service provider (ASP). The ASP deployment option should offer computer system development, hosting, service, and management of the application on the vendor’s internal servers in its facilities. Customers access the applications through secure connections from any computer. All computer system upgrades and maintenance are fully managed by the hosting organization rather than each individual user or client company. This low-risk deployment option provides rapid implementation and easy maintenance at the lowest possible cost, maximizing the ROI.

Managed care pharmacists knowledgeable in DSS systems can troubleshoot problems with less stress, manipulate data more efficiently, and apply the information to the Framework requirements in ways that improve care and reduce costs through proactive medical management.

Implications for Managed Care Pharmacists

Most systems used today—necessitated by managed care—fail to integrate data easily and accurately across all payer types and platforms. This may lead to difficulty in meeting customer expectations laid before us in the Framework. Managed care pharmacists knowledgeable in DSS systems can troubleshoot problems with less stress, manipulate data more efficiently, and apply the information to the Framework requirements in ways that improve care and reduce costs through proactive medical management.

Guidelines can be integrated with claims data to identify at-risk patients and communicate concerns to physicians. Thus, coming closer to meeting the domain requirement of providing health information and drug therapy that are accurate and convenient.

Here’s an example: Three million people contract chlamydia infections annually, resulting in health care costs of billions. Many remain untreated, leading to infertility, pain, and complicated pregnancies. Less than 25% of people at risk are screened, although screening is low-cost and simple. Early intervention with low-cost antibiotics minimizes costly, long-term consequences. For this reason, NCQA HEDIS guidelines consider the chlamydia-screening rate an indicator of quality and effectiveness of care.

A good DSS can incorporate treatment guidelines into routine practice. Figure 1 (next page) is a sample of an electronic notification that can be generated using a DSS. It not only identifies patients at risk but also offers easy access to task force recommendations so prescribers can screen routinely and intervene early.

The fifth domain addresses the need to detect and prevent adverse drug events. Adverse drug event prevention is a perfect use of a DSS. For example, one study found that up to 12% of patients for whom an anticholinesterase inhibitor was prescribed were also receiving contraindicated anticholinergic drugs. While anticholinesterase inhibitors can delay cognitive
function decline and potentially forestall nursing home admission, use of anti-cholinergics can exacerbate cognitive impairment. A tailored DSS can alert physicians to the problem (see Figure 2). Ultimately, nursing home admission may be delayed. With annual costs for nursing homes up to and in excess of $20,000, avoiding institutionalization for even one month can result in significant savings.7

An effective DSS can boost health promotion and disease prevention programs. “Prior to the decision support system, we didn’t have the ability to analyze data and monitor formulary compliance as well as identify patients for disease management programs,” says Amy Hagood, Pharm.D., Clinical Director at Catalyst Rx, a Las Vegas, Nevada-headquartered pharmacy benefits manager. “This system provides us with the necessary tools to not only identify these patients, but monitor success or failure of the disease management programs we offer.”

Assessing Return on Investment

Assessing the return on investment of these systems is important so that more investment will be made in them. In projecting ROI for decision support technology, you can reduce administrative costs or medical costs or perhaps a hybrid of both. To assess opportunities to reduce administrative costs, evaluate the number of people conducting a particular task, the tasks they perform, the time to perform the tasks, and the number of tasks per person, hour, day, etc.

For instance, production and distribution of physician profiles can be streamlined. Some organizations produce prescriber profiles in a batch process through the IT department. Original programming probably took several weeks, and modification requires additional programming time. Using a tool to easily program, update, and produce prescriber profiles allows more tasks to be accomplished in less time. It also reduces the production cost per profile from the time units consumed or the expense of the labor used for production.

With a DSS, production and distribution of reports can be handled by administrative staff, successfully reducing programming time for query development and subsequent updates in less time with a less costly resource for production. If the need arises for modification, this can easily be made in a very short timeframe without involving the information technology staff.

Reducing the cost per unit or the units

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<th>TABLE 2</th>
<th>Data Warehouse Implementation Schedule</th>
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<td>There are several steps to internally developing an internal DSS, from initial goal development to implementation, training, use, and maintenance, including:</td>
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**Planning**

| Step 1 | Perform needs assessment; establish goals; gather input from a variety of users |
| Step 2 | Establish internal team to ensure cross-functional needs are addressed, incorporated, and routinely met |
| Step 3 | Identify technology vendors and assess implementation assistance requirements |
| Step 4 | Perform cost and ROI analysis/justification for system expense; establish a budget |
| Step 5 | Select vendors for software, including database management system, data extraction tools, business intelligence tools, presentation tools; hardware and disaster recovery, adequate security; consultants to assist with integration of software and business requirements |

**Project Management**

| Step 6 | Manage project team, ensuring functional requirements are addressed and that team is working toward the common goal |
| Step 7 | Define project scope, business rules and develop process documentation |
| Step 8 | Build, test, and evaluate system in a test phase. Repeat steps until functional requirements are met |

**Implementation**

| Step 9 | Deploy system into a production environment |
| Step 10 | Train users to maximize potential of the ROI |

**Ongoing**

| Step 11 | Evaluate functionality and performance against original project scope to measure project success/failure |
| Step 12 | Management/maintenance. Continuously cleanse and load data; conduct system upgrades for hardware and software; monitor usage and query performance. Monitor and implement emerging technology |
consumed results in cost savings, which can be quantified and measured in discrete financial terms for evaluation across an organization. Organizations can experience robust administrative cost reduction with efficient use of a DSS.

■ Conclusion

The Framework project lays out a challenging but doable agenda for our profession. What may not have been known to readers prior to this article is that the decision support systems needed for the 21st century are already here. These systems will allow the pharmacy profession to meet its customer’s expectations.

In a white paper on knowledge information systems, Dr. Yogesh Malhotra suggests that we “view the organization as a human community capable of providing diverse meaning to information outputs generated by technical systems, instead of the traditional emphasis on command and control.” For many, the DSS will be the stimulus for the creativity we all possess that will create the solutions required by the Framework.

REFERENCES