Information Systems in the Perioperative Environment

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For many years, the development and use of commercial information systems (IS) in medical environments have focused upon meeting the financial and administrative needs of medical care. Clinical information systems developed along a relatively separate path, primarily in academic and medical center environments.

Today, trends resident throughout the United States are forcing the clinical, financial, and administrative sides of medicine to come together. These coalescing forces are driving the development of a new generation of information systems, with direct use and application for clinical practitioners.

As in other areas of medical care, the joint imperatives of controlling/reducing costs and preserving the quality of care are driving changes in the management, evaluation, and delivery of care. Developing clinically rich information systems which emphasize the benefits of interconnectivity, data collection, sharing, and analysis supports efforts to meet these demands.

To do so effectively, the new-age IS must consider the multitude of information exchanges and transactions necessary within the course of perioperative treatment–including the full scope of departments and areas affected by information collected, analyzed, or needed by perioperative practitioners. This review will focus upon the current capabilities and future directions of information systems in the perioperative environment.

INDUSTRIAL PRESSURES

The continued development of perioperative IS is being driven by numerous cost and quality tensions affecting the entire United States healthcare market. The evolving model of U.S. healthcare (Table 1) reflects the influence of three broad market shifts, changing medical as well as surgical care provision:

1. The growth of managed care
2. Changing patient mix
3. Growing pressures on the cost/quality balance

The Growth of Managed Care

Over the 10-year period from 1982 to 1992, the number of patients enrolled in a health maintenance organization (HMO) grew by over 400%, to nearly 50 million Americans.[1] The cost and utilization-control emphasis of these HMOs, centering upon the efficacy of care managed within a premium dollar, have widely impacted the collection and use of data (both clinical and administrative). As managed care payors capture more of the existing patient market, providers must address the cost and quality issues raised in order to remain competitive.

As cost and utilization data become more and more critical, healthcare IS–at all levels, at all points of care–must support the collection and analysis of accurate, flexibly presented data. Clinical, administrative, and financial data are all relevant in this cost/outcome process. The most directly affected areas include the following:

- *Cost.* Given the managed care emphasis upon controlled reimbursement and shared provider risk, surgical providers must know their own costs when contracting for managed care covered lives. A surgical facility's failure to know and understand what is driving its costs can lead to accepting responsibility for a pool of undercontracted lives.
- *Utilization Review.* Typically, managed care organizations have their own utilization review protocols. Surgical providers or groups must be able not only to articulate their choices and decisions against this standard, they must also be able to document any deviation.

- *Quality and outcomes.* The number and variety of groups collecting information on healthcare quality and outcomes across the United States is impressive. Just as imposing are their motivations. In addition to attempts to measure and improve the clinical quality of patient care, such studies also act at various times as marketing tools, reimbursement justifications, cost-control initiatives and risk-reduction strategies. There is tremendous concern among clinicians that such projects actually reflect a clinically acceptable measurement of quality.[2]

Changing Patient Mix

Throughout the United States, there is a clear movement away from inpatient care provision.[3] This trend holds true in the surgical environment as well. Between 1982 and 1992, the total number of surgeries performed in community hospitals in the United States rose 16.7%, from 19.59 million to 22.86 million. Over the same time period, inpatient surgeries dropped 32.1% to 10.55 million, *less than 1/2 the total surgeries performed*. Outpatient surgeries increased 203.1%, to over 12 million performed each year (Table 2).[4]

The move to an ambulatory patient population requires that healthcare information systems capture and disseminate perioperative data to more varied, dissimilar points of service. To meet this challenge effectively, systems must be able to communicate with each other across physical, departmental, and even organizational lines.

In considering outpatient surgery through the continuum of care, information systems must provide access to information typically collected by the primary care provider, including such information as the following:

- Functional health status
- Patient lifestyle
- Extent and depth of home support available

As emphasis continues to be on returning patients as rapidly as possible to home or extended care, this type of information can be valuable to surgical staff in care planning and follow-up.

	Traditional Model	**Evolving Model**
Focus of care	• Patients • Episodes of illness • Surgical intervention based on acute illness/need	• Enrollee/covered lives • Member "wellness" (preventive medicine) • Surgical intervention based on efficacy of surgical treatment
Reimbursement, revenue, risk	• Fee for service • Provider revenue/individual contracts • Risk primarily with the insurance company/payor • Major patient care departments are revenue centers	• Cost per unit and per member per month revenue • Capitation • Risk moves to the providers • Major patient care departments
Delivery models	• Independent, solo practitioners • Hospitals, physicians and other practitioners acting in loose affiliations • Hospital department operations emphasis • Local area geographic focus	• Large group practices with business ties to healthcare organizations (foundations, MSOs, PHOs) • Regional market • Integrated delivery networks spanning the continuum of care mutual economic risk
Characteristics of, access to care	• Inpatient-oriented • Treatment-based • Practice/treatment modalities vary widely • Patient has complete freedom in selecting care provider	• Care provided along the continuum of needs including wellness activities, ambulatory services, inpatient care, home health, skilled nursing facilities • Primary care physician 'gatekeeper' determines appropriate level of specialty care • Focus on clinical pathways and outcomes • Practice guidelines, progress-based care planning
Surgical environment	• Inpatient-oriented • Extensive post-surgical support cycle (post-anesthesia, surgical nursing)	• Outpatient, ambulatory, surgery center-based • Decreased intensity, shortened return to lifestyle • Minimized post surgical support cycle

Table 1. Changes in the delivery of healthcare.

Growing Pressures on the Cost/Quality Balance

By 1993, U.S. healthcare expenditures totaled almost 14% of the gross domestic product, over $884 billion ($3,299 per capita).[5] The sheer volume of money involved guarantees that cost will remain a prevailing issue of the day. As HMOs, large employers, the U.S. government, and other third-party payors look to control their business costs, healthcare expenditures are inevitably closely scrutinized. Providers are facing tremendous pressure both to justify costs and to maintain or improve the quality and outcomes of care they provide.

As ongoing quality and outcomes projects continue to incorporate data on surgical outcomes of care, healthcare information system suppliers integrate data capture and storage capabilities for this information. Indicators currently in use include the following:[6]

- The number of perioperative wound infections

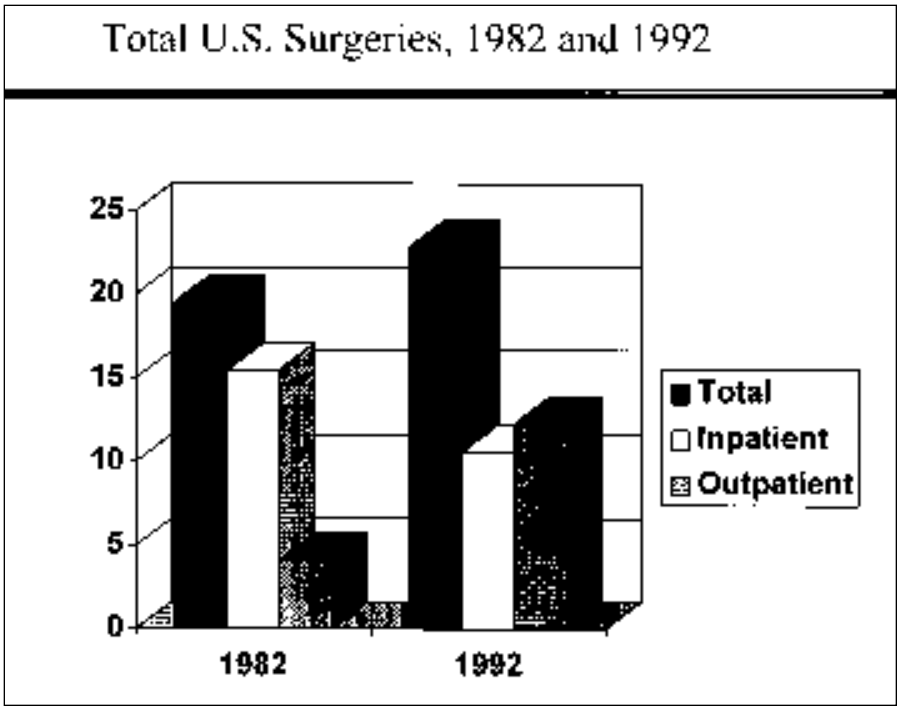

Table 2.

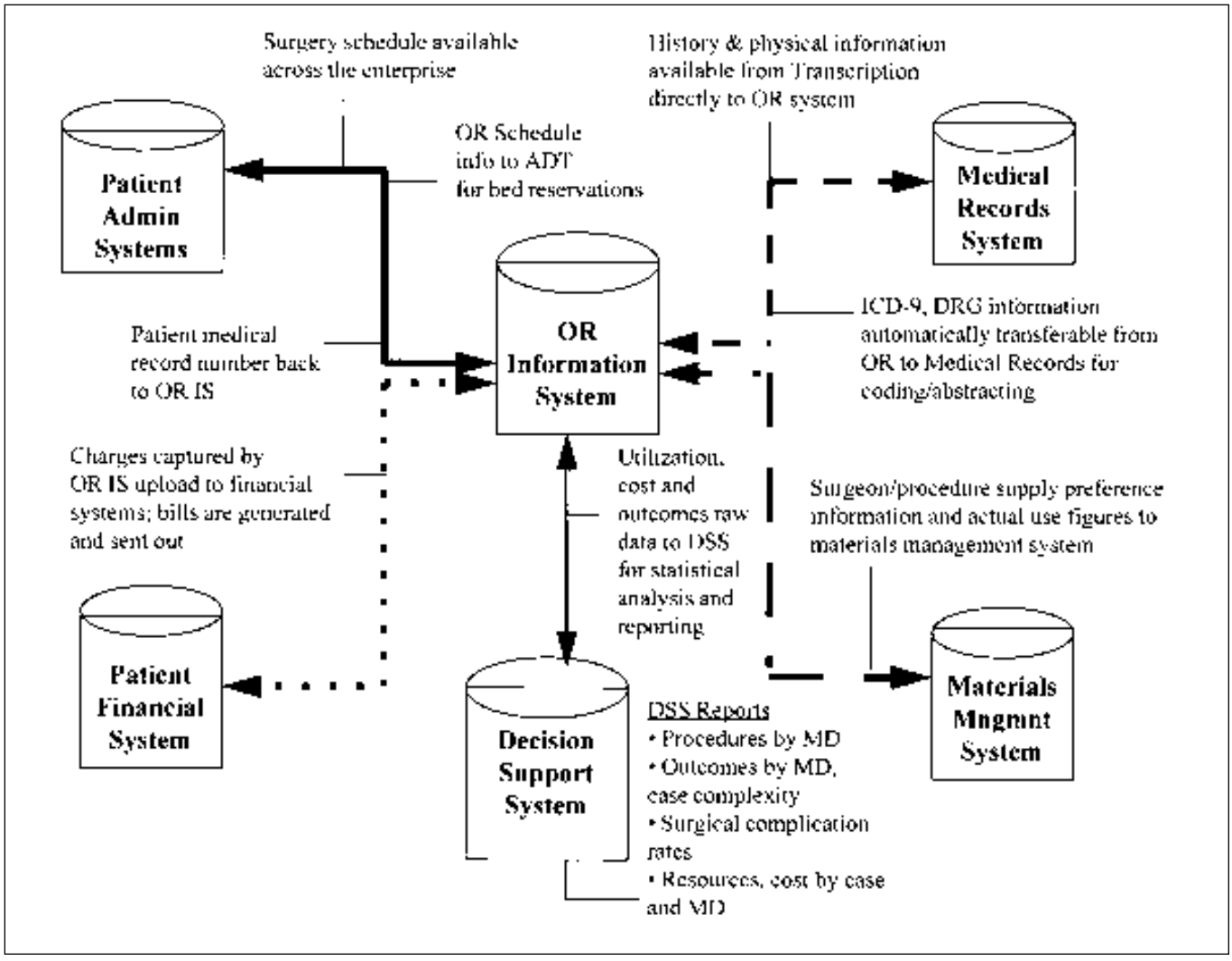

Figure 1. Surgical information transactions.

- Perioperative mortality rates
- The number of unscheduled returns to the operating room
- Patients within two postprocedure days of a procedure involving anesthesia administration developing CNS complications, developing a peripheral neurological deficit, developing an acute myocardial infarction, experiencing cardiac arrest

PERIOPERATIVE AUTOMATION

The nature of perioperative care indicates that an automated information system would interact on a number of levels with information collected at other points of the continuum of care. The ideal surgical information system performs a mixture of data collection, procedure scheduling, materials management, reporting, and alert activities in conjunction with core information systems throughout the medical facility. Figure 1 illustrates some of the most common information transactions that occur.

As illustrated by the diagram, while the OR system can collect and hold valuable data as a stand-alone system, it works most efficiently when considered an integral part of a centralized patient care system. Many data exchanges and information transactions occurring in perioperative settings have been automated. Characterized by the types of data involved, current OR systems can support a number of perioperative activities, including the following:

- *Patient administration*. Receipt of surgical referral; preauthorization; utilization review protocols from managed care organization; claims submission; scheduling of OR staff and resources; scheduling of pre- and postoperative care activities to ensure timely delivery of care services.
- *Patient care*. Longitudinal care planning; coordinating medications and treatment with surgical, postanesthesia, wound care protocols; alerts for incomplete pre- and postoperative care.
- *Decision support and managed care*. Best practices across cases; ability to track and reduce statistical variation; formulation and evaluation of surgical protocols; statistical reporting for cost and utilization by room, provider, procedure, and diagnosis.
- *Direct procedure support*. Optical imaging, camera support.
- *Teaching and research*. Surgical modeling; on-line case studies; instrumentation allowing practice for touch and sensitivity; data capture for outcomes/quality research.

In each of these areas, automation has the potential to control and decrease surgical costs. While patient, administrative, and basic clinical functionalities are fairly routinely automated, major advances are being made in advanced clinical automation, direct procedure support, and teaching and research.

EXTENDING CLINICAL AUTOMATION

Commercial information system vendors are working to extend the automation of clinical activities, focusing development resources on such functionalities as clinical documentation and "critical path" management. In developing these functionalities, vendors are requiring their systems to consider or incorporate information not only from outside the traditional perioperative environment, but also from outside the traditional hospital facility–gathering, storing, and analyzing data from clinics and primary care physician groups, home health, skilled nursing and other care providers not traditionally included in the inpatient view of surgical care.

As electronic medical record and clinical data repository technologies draw more active interest from providers across all types of care, the surgical information system–as a specialized component of the electronic medical records system–has the potential truly to integrate the various aspects of perioperative care.

In other areas of surgical IS, advances in computer imaging and 3-D and graphical presentation techniques have broken previous barriers in the electronic mapping and automation of the surgical process. Interactive and multimedia technologies, including virtual reality, are emerging as one of the most hotly developed areas of surgical technology.

Surgical Training and Education

TELEOS™ by High Techsplanations is one such tool.[7] The system uses three-dimensional technology to simulate human tissue and organs, allowing surgeons to experience surgical procedures in an automated environment, feeling the interaction between tissue and instruments, as well as seeing realistic blood flow. Designed for minimally invasive procedures, the system has potential application in endoscopic and laparoscopic treatment modalities; however, the degree of its usefulness in these modalities has yet to be demonstrated.

Surgical Procedure Support

The Neurosurgical Operating Arm System (NOAS), developed at Stanford University Medical Center,[8] uses imaging technology and a passive digitizing arm to help surgeons optimize their incisions. Using MR or CT scan images tied to the digitizing arm, NOAS allows surgeons to identify precisely the optimal incision point for each patient. Currently in use at Stanford, system developers plan to port the technology to other surgical procedures, including laparoscopy.

THE RETURN FROM IS

The use of information systems technology in the perioperative environment for clinical as well as administrative purposes is an essential component of modern medicine. healthcare reform and managed care will increase the need, focusing use of perioperative IS as a critical factor for business success.

Providers today should carefully evaluate information needs and requirements, and focus management time and fiscal resources on perioperative IS evolution. The authors believe that such an approach is warranted and offers substantial return for IS investment. STI

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