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Health-Based Payment and Computerized Patient Record Systems

Health care information technology is changing rapidly and dramatically. A small but growing number of clinicians, especially those in staff and group model HMOs and hospital-affiliated practices, are automating their patient medical records in response to pressure to improve quality and reduce costs. Computerized patient record systems in HMOs track risks, diagnoses, patterns of care, and outcomes across large populations. These systems provide access to large amounts of clinical information; as a result, they are very useful for risk-adjusted or health-based payment. The next stage of evolution in health-based payment is to switch from fee-for-service (claims) to HMO technology in calculating risk coefficients. This will occur when HMOs accumulate data sets containing records on provider-defined disease episodes, with every service linked to its appropriate disease episode for millions of patients. Computerized patient record systems support clinically meaningful risk-assessment models and protect patients and medical groups from the effects of adverse selection. They also offer significant potential for improving quality of care.

Data systems in today's HMOs are substantially more advanced than those that existed less than a decade ago. Until recently, vast stores of clinical knowledge were locked in paper records or in automated systems that could not be linked to individual patients or providers. Growing data automation will change the way in which clinical, administrative, and performance data are collected and interpreted. In response to pressure to improve quality and lower costs, a small but growing number of clinicians, especially those in integrated staff and group model HMOs and hospital-affiliated practices, are automating their patient medical records. For the first time in most HMOs, these computerized patient record (CPR) systems will create systematic access to automated, on-line, provider-generated clinical information for large patient populations. By linking clinical information from all care settings, CPR systems will allow clinicians, epidemiologists, health services researchers, health economists, and clinic managers to identify and understand the causes of disease and to identify the most effective and efficient care processes.

Largely untapped applications of clinical data are risk-adjusted capitation payments to health plans and internal area-wide budgets to medical groups or medical offices. Per capita payments and outcomes should be adjusted for the underlying health status of the relevant enrolled populations. Risk-adjusted capitation offers the potential to greatly improve coverage of disadvantaged populations (e.g., elderly and disabled persons and persons with severe chronic diseases) through appropriate payment for higher expected risks. Risk-adjusted capitation reduces incentives for health plans to invest resources in selecting healthy enrollees rather than providing appropriate, efficient, high-quality care (1, 2). The Balanced Budget Act of 1997 mandated risk-adjusted capitation for payment of Medicare risk contractors beginning in the year 2000.

Current risk-adjustment tools are not designed to take advantage of CPR technology. Current HMO data come from fee-for-service–like claims or utilization systems (ambulatory encounters and hospital discharge abstracts). Automated claims data systems designed for fee-for-service procedure-based payment also contain diagnostic codes from the International Classification of Disease, ninth revision (ICD-9). Claims and utilization data streams form the basis of today's risk-assessment models, which include ambulatory care groups (ACGs), ambulatory diagnosis groups (ADGs) (3, 4), principal inpatient diagnostic cost groups (PIP-DCGs) (5-7), hierarchical coexisting conditions (HCCs) (8), the disability payment system (DPS) (9), and the global risk-assessment model (GRAM) (10).

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Research on risk-assessment models has used various measures of health status: demographic data (e.g., Medicare's adjusted average per capita cost [AAPCC]), principal inpatient diagnoses (e.g., PIP-DCGs), outpatient primary diagnoses (e.g., ACGs), functional health status (11), cost-weighted deaths (12), laboratory test values (13), and prescribed medications (14). Recent models combine diagnostic data from inpatient discharge abstracts or claims and ambulatory encounters or claims with demographic data to measure risk within or across payers (e.g., HCCs [8], ACGs and ADGs [3, 4], and GRAM [10]). These models have used varying data sources and diagnosis classification systems, but they all rely on ICD-9 diagnosis data (15) to improve their performance in predicting future expenses for defined populations. Developers of these models have repeatedly demonstrated that models using all diagnoses perform better than those that include only demographic data or inpatient diagnoses (8, 10).

We outline the contributions that CPR systems can make to risk-adjustment modeling and health-based payment. We contend that by supporting physicians in the delivery of high-quality care, CPR systems also support improved payment and resource allocation systems.

Identifying the Principal Diagnosis

Most new health-based payment models, including DCGs, ACGs, HCCs, GRAM, and DPS, require information on primary diagnoses in inpatient or ambulatory settings. The ICD-9 diagnostic codes entered on claims are clinically suspect. These codes are used to assign a number to any diagnostic term that a physician may enter in a patient chart. The ICD-9 contains many synonyms that have been assigned different diagnostic codes, with the result that coders must use considerable discretion in selecting a number to represent a diagnostic label. Physicians as a group and even individual physicians over time use abbreviations, partial diagnostic labels, and myriad synonyms when recording a diagnosis in the chart. From the perspective of medical record technicians and coders, this practice increases the apparent variation in diseases. Collection of ambulatory data generally involves preprinted encounter abstract forms; changes in the form also change the distribution of diagnosis data. Moreover, physicians may check a precoded field on the encounter form to save the extra effort of searching for the most accurate diagnotic code. Claims diagnoses are assigned with the purpose of obtaining payment and not for documenting physician decision making; hence, concern persists about the possible re-emergence of "code creep" or revenue-maximizing coding practices (16, 17).

In many claims systems, medical record technicians and billing clerks perform the diagnostic coding, and physicians do not validate the assigned ICD-9 codes. Handwritten diagnoses are sometimes illegible, introducing another source of error in the coding process. Even when done well, ICD-9 coding—the most common disease classification system—captures less than half of the clinical data (18). For example, a typical paper chart includes laboratory test results (e.g., hematocrits, creatinine levels, hemoglobin A_{1c} values, and T_4 cell counts) and radiology results (e.g., stage of tumor or presence of a fracture or aneurysm). This and other chart information are necessary to determine disease stage accurately; track chronic conditions; and identify clinical information predictive of short-, medium-, and long-term health care utilization, costs, and outcomes.

Computerized patient record systems involve physicians in the coding process and improve standardization of disease coding practices and data collection procedures. When physicians select the diagnostic code for a disease, the validity and accuracy of diagnostic data increase markedly. For example, many claims and utilization systems do not compensate for nonspecific (i.e., three-digit level) diagnostic labels. Recording a diagnosis of "pneumonia" does not indicate the cause (bacteria, virus, or mycoplasma) or location (right, left, upper, lower, or multiple lobes) of disease. In contrast, CPR software can prompt physicians to use greater refinement when generic disease labels are applied, especially if the code represents a final diagnosis. These programs can also feature a field to indicate whether a diagnosis is tentative or final. Standardization of coding is important to reduce the number of "home-grown" codes and idiosyncratic diagnostic labels and to establish guidelines for recording untreated diagnoses (e.g., obesity or history of cancer).

We contend that by supporting physicians in the delivery of high-quality care, CPR systems also support improved payment and resource allocation systems.

Identifying Secondary Diagnoses

The presence of comorbid conditions and their potential interactions challenge risk modelers to respecify their models. One approach to comorbid conditions is to count only the most expensive diagnosis (e.g., PIP-DCGs, ACGs). Another approach is to count multiple diseases separately and additively (e.g., ADGs, GRAM, HCCs).

These two approaches, however, do not address interaction effects among comorbid conditions where a second disease affects the natural course and treatment of the first. Capturing interaction effects requires the definition of new classes for specific clusters of diagnoses or direct modeling of the interaction effect. This, in turn, requires dealing with many disease combinations. With the current structure of diagnostic coding in claims and utilization data systems, it is not particularly useful to develop risk models for comorbid conditions because the codes contain so much "noise." In contrast, CPR systems can more accurately identify diagnostic codes, discriminate among various manifestations of a disease, highlight progression of a disease from one to several body systems, and identify multiple coexisting diseases.

> **The clinical validity of risk models will improve as risk-assessment modelers begin to include additional clinical information to increase the predictive power of their models.**

Assessing Severity of Illness

Computerized patient record systems can aid in measurement of illness severity in several ways. Disease staging software can be run automatically in the background on ICD-9 codes (19). Physicians can be prompted for subjective clinical judgment of severity for various subsets of patients. In systems with on-line physician entry, disease-specific severity algorithms can be programmed to appear whenever the diagnosis code is entered. The charting process should not be encumbered, however, by unnecessary steps in entering measurement data. To alleviate on-line entry burdens, CPR-based severity measures can be run automatically in the background—by means of diagnosis-specific algorithms applied to laboratory and radiology results. Typical claims systems, by comparison, indicate only the existence of a particular test. For example, diabetic patients with high hemoglobin A_{1c} values would receive higher risk scores, thereby demonstrating a strong correlation between this score and future health care expense for diabetic populations (20). Radiography offers similar potential by describing, for example, the stage of an anterior cruciate ligament tear or cartilage deterioration in an injured athlete. This could be associated with the level of physical or occupational therapy required. The ejection fraction for patients with heart valve failure or congestive heart failure may be used to assess severity. Other measurements (e.g., blood pressure and body mass index) and laboratory values (e.g., serum cholesterol level, T_4 cell count, and creatinine level) may offer potential for long-term risk modeling.

Applications of Diagnoses in Current Health-Based Payment Systems

Computerized patient record systems can improve risk-adjustment technology and health-based payment in two ways. First, CPR vendors can readily generate risk scores from available algorithms. This will allow clinicians and others within a health plan to rapidly and reliably identify subgroups of members at risk for generating high costs before such costs are incurred; as a result, appropriate interventions to prevent or ameliorate these conditions can be implemented. Second, the clinical validity of risk models will improve as risk-assessment modelers begin to include additional clinical information, such as data on comorbid conditions, laboratory results, imaging findings, and functional status, to increase the predictive power of their models. Disease identification done by using a CPR system could rely on more objective disease definitions and vital signs. Accurate clinical information (e.g., diagnostic coding, vital signs, symptoms, laboratory values, radiology results, and clinician notes) can allow risk models to move beyond registries of heterogeneous patients to identifying the disease stage and trajectory of a population of individual patients within a general disease class. Such models can identify patients with a similar expected treatment method and intensity, providing meaning to both managers and clinicians.

The Balanced Budget Act of 1997 mandates reform of Medicare's AAPCC payment formula for HMOs. Health plans with Medicare risk contracts are now required to submit inpatient data by using the UB-92 claims format. Soon, risk contractors will be required to submit ambulatory encounter data to the Health Care Financing Administration (HCFA) by using the HCFA-1500 claims format. Starting in the new millennium, the HCFA plans to modify the AAPCC risk-adjustment formula to include PIP-DCGs. Risk contractors with higher hospitalization rates for high-cost diagnoses will be paid more than they are under the current demographic model. At some point, when ambulatory diagnostic data are of sufficient quality, the HCFA may switch to a model similar to that used by the HCCs for risk-adjusting payments (8). This means that all diagnoses, primary and secondary and inpatient and outpatient, will eventually be counted when Medicare payments are set.

Several states and localities have already instituted health-based payment systems to cope with adverse selection in small group and public employee markets. In California's small-group health insurance reform initiative, the Medical Risk Management Information Board has developed a contemporaneous diagnostic risk-adjustment model that counts a greatly restricted set of high-cost diagnoses (21). Similarly, the New York State small-group initiative uses a few high-cost diagnoses to adjust payments from the risk pool to the participating plans. In Washington State, the Health Care Authority is modifying its demographic risk-adjustment model to include inpatient and outpatient diagnoses in computing payments to HMOs for public employees (22). The Medicaid programs in Colorado, Michigan, Missouri, New York, and Ohio have implemented the DPS to adjust capitation payments to HMOs for disabled Medicaid recipients (9). In a private initiative, the Minneapolis Buyers Health Care Action Group implemented a diagnostic risk-adjustment model (23). These are only a few examples of the increasing number of initiatives to reform capitation payment systems and reduce the problems of adverse and favorable selection. It is likely that diagnostic risk-adjustment models will cover all of an HMO's risk business in a few years. Pressure from payers to reduce payments for favorable selection and from HMOs to increase payments for adverse selection is accelerating this development.

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Other Applications of Risk-Adjustment Models

Because risk-adjusted payment models measure the underlying health status of a defined population, they have potentially important budgeting, performance assessment, and clinical applications. For example, Group Health Cooperative of Puget Sound in Seattle and HealthPartners in Minneapolis are using ACGs in medical office budgets for risk-adjustment of differences in the health status of their service area populations. Health plans are beginning to evaluate risk-adjustment models to adjust overall utilization patterns for risk and to identify high-cost populations that are likely to benefit from more intensive case man-

TABLE 1

Proposed Enhancements to Computerized Patient Record Systems

DOMAIN	DESCRIPTION
Disease and care episodes	Organize computerized patient record around health problems or disease episodes. Link all services to disease episodes. Distinguish between complications of a given disease and separate comorbid conditions. Identify phases of chronic disease episodes, stage of treatment, and recurrence of disease episodes. Include mapping to other disease and procedure coding systems, such as *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*; Standard Nomenclature of Medicine [SNOMED]; Abbreviated Injury Scale; Glasgow Coma Score; and *Current Procedural Terminology, Fourth Edition*.
Functional health status	Support functional status screening and assessment at generic and disease-specific levels. Provide brief, single-domain screening instruments for use in office visits and comprehensive multidomain assessments for developing complex care plans. Provide self-reported health status scores and performance-based functional assessments.
Behavioral risk factors	Support standardized health-risk appraisal instruments and protocols to measure behavioral and environmental health risks.
Social and caregiver assessment	Support instruments to assess social support and caregiver skills, capabilities, and strain.
Self-care	Support individually tailored instructions for patient self-care and World Wide Web access to health information.
Telemedicine	Support remote sensing of physiologic variables (e.g., body temperature, blood pressure, respiration, blood oxygen levels, echocardiogram, blood pressure, skin elasticity) and digital photography.
Secured Internet World Wide Web interface	Support links to chronic disease databases for comparisons of risks, treatments, and outcomes. Enable treating physicians and other providers to have on-line access to the patient's lifetime medical history.

agement (24). Risk-adjusted expense models can assess the adequacy of third-party payments and forecast payments and costs in the next enrollment period. Risk-adjustment models can also be used to evaluate relative risks across competing plans in payment systems that are not adjusted for risk. Finally, risk-adjustment models can be used in medical outcome and quality studies as a health status adjuster.

Strategic Developments

Medical record automation and risk-adjustment technology are in their infancy. At present, less than 5% of providers have automated their paper charts. Risk-adjusted capitation payment systems have been implemented in a few places; this is expected to expand rapidly for Medicare in response to the Balanced Budget Act risk-adjustment reform mandates and for Medicaid and employer groups in response to actual or perceived selection bias across HMOs. For the first time, CPR systems provide access to clinical information on a large scale, which makes it possible to use this information for risk adjustment. The next stage of evolution in health-based payment will occur when data sets with millions of HMO members are accumulated on provider-defined disease episodes with every service linked to its appropriate episode. This will provide sufficient cases of rare, serious diseases to allow estimation of stable risk coefficients and to help establish the predictive and clinical validity of these models.

Computerized patient record systems offer the opportunity to develop clinically meaningful risk-assessment models, to protect patients and medical groups from the effects of adverse selection, to improve payment and outcome risk-adjustment models, and to enhance quality of care. As interest in risk-adjustment modeling grows, more attention is being given to developing and refining CPR systems. Priorities for future enhancements to CPR systems are highlighted in Table 1 and are described below.

Measuring Disease

A natural, unexploited synergy exists between advances in health information automation and risk-adjustment technology. Future CPR systems should improve measurement of disease episodes, including onset, progression, severity, and outcomes (25). A CPR system should link each service to a disease episode and identify phases of chronic disease episodes (e.g., flare-ups or maintenance) and adverse reactions to treatments. Idiosyncratic variations in symptoms and other manifestations of a given disease should not be classified as new diseases, but complex cases should be distinguishable from uncomplicated cases. Treatment of disease episodes, classified by diagnosis, represents multiple-product outputs of HMOs. A CPR system should support standardized disease episode classification systems to facilitate comparison of HMO outputs. When a particular diagnosis is assigned several times over a series of visits during 1 year, the disease episode coding structure discriminates between disease recurrence and episode progression (26).

Functional Health Status

Classifying diagnoses is necessary but not sufficient for measuring HMO output, especially in the area of chronic disease. When diseases are incurable by definition, quality of care and medical outcomes are defined in terms of functional health status. For example, previous research has demonstrated the value of self-reported health status as a diagnostic tool (27) and as a risk adjuster (11, 28, 29). Physicians routinely assess functional health status through direct observation of patients in their examination rooms. Physicians recognize patients who have difficulty communicating, understanding, and responding to commands or requests or performing routine maneuvers (e.g., getting onto the examination table or getting undressed).

Functional health status assessments are not usually recorded in charts but enter the physician calculus of disease severity and patient ability to cope with and respond to therapy. Paper charts contain functional health status information only incidentally, when physicians feel that it is clinically significant. In populations with high proportions of disabled, aging, and frail patients, functional health status becomes relatively more important in measuring health status and predicting future expense. As baby-boomers reach retirement age and beyond, CPR systems should include standardized functional assessments applicable in clinical encounters, including prompts for the need to assess functional status and disabilities. A CPR system should have Internet interfaces to enable patients to complete self-administered functional and perceived health status instruments from home, work, medical office waiting rooms, and other locations and to send the data to their physicians.

Behavioral Health Risks

Persons who have poor health habits represent greater financial risks to HMOs. The epidemiologic evidence on the health effects of alcohol and tobacco use, for example, shows that drinkers and smokers place a heavy financial burden on health care delivery systems. A CPR system should prompt clinicians to collect and record behavioral health risks, such as use of tobacco or alcohol, eating habits, immunization status, and sexual practices. It should serve as a tracking system for disease screening programs and prompt clinicians to screen patients who are overdue for such examinations.

Social Support and Caregiver Assessment

Lack of adequate caregiving support can generate considerable use of medical care resources, particularly among frail elderly patients and disabled patients. A CPR system should provide standardized instruments to enable clinicians to evaluate and document the level of caregiving support available and provided to patients.

Self-Care and Health Education

Patients who do not have good self-care guidelines for their diseases generate more expenses than those who have such guidelines. A CPR system should support health education and self-care for patients. Clinicians should be able to generate tailored instructions for each patient for after-visit self-care and support and provide on-line information sources for patients with questions about their diseases and changes in symptoms.

Telemedicine

Patients with an unstable, unpredictable health status tend to generate more expenses than patients with stable, predictable disease courses. Future CPR systems should be designed to incorporate advances in telemedicine and real-time physiologic monitoring. Remote physiologic sensing and digital photography will enable physicians to evaluate and treat patients (especially those with established chronic or routine acute diseases) in their homes on a continuous or more frequent basis rather than in episodic office visits. Computerized telemetry systems are being introduced to care for frail elderly patients for whom early diagnosis and treatment of complications are preferable to waiting until an office visit with a physician can be scheduled.

Lifetime Medical Records

A CPR system should support the transfer of patient records when patients switch to another health plan, thereby enabling all treating physicians to have immediate access to their patients' lifetime medical histories in any setting.

Confluence of Information Technology Streams

Considerable clinical knowledge is locked in paper records because of the high cost of manual abstraction of clinical data. Accordingly, health care information technology is changing rapidly and dramatically. Given the imperatives to improve quality of care and reduce costs, more providers are using CPR systems to track health risks, patterns of care, and outcomes across large populations. Clinicians, especially those in staff and group model HMOs and hospital-affiliated practices, are increasingly automating their patient medical records (30). At the same time, public and private payers are implementing health-based payment systems, which impose significant demands on health plan data systems for accurate diagnostic data. Yet another data stream is the Health Plan Employer Data Information Set (HEDIS), which includes a set of disease-specific outcome measures and will probably move toward more sophisticated risk-adjustment models for these outcomes. Computerized patient record systems document and guide clinical work in support of efforts to improve patient health. Rather than developing separate data systems to support individual goals of quality assurance, technology assessment, performance assessment, consumer scorecards, and health-based payment, CPR systems can and should serve as the foundation for all of these applications.

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