Evaluating the Impact of Hospitalists

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The hospital-based generalist physician is a recent organizational innovation in health care in the United States. Does the hospitalist model provide improved health care? The answer to this question lies in a rigorous evaluation of the hospitalist system in the clinical setting. This paper describes key outcomes that need to be assessed and methodologic issues that need to be addressed when conducting and interpreting the results of evaluations of the hospitalist model. To provide evidence about the value of the hospitalist model, quality of care should be evaluated through the measurement of both processes and outcomes. The clinical processes assessed may include diagnostic tests and treatments that are causally linked with outcomes. A variety of outcomes can be measured, such as death, clinical or physiologic status, physical function, and psychological well-being. The analysis of resource use data can aid in an assessment of the relative costs and effectiveness of clinical services. An evaluation of the hospitalist model requires an adequate research design, which should include a precise definition of the model being studied, the selection of an appropriate comparison group, the collection of clinical and demographic information on patients, the specification of both process and outcome measures, and the use of statistical techniques that are appropriate to the questions being asked and the data being collected. The design must distinguish between outcomes attributable to the introduction of hospitalists and those attributable to other changes in medical treatments and the organization of care.

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The hospital-based generalist physician is a recent organizational innovation in U.S. health care (1). Although hospital-based subspecialists have existed for many years in the United States, the transfer of inpatient care from the primary care physician to the hospitalist is a significant and somewhat controversial departure from the traditional method of health care delivery. This change is occurring in an increasingly competitive health care industry in which the value of services is being heavily scrutinized because of growing concern about whether attempts to reduce costs are threatening clinical outcomes and patient satisfaction (2, 3).

The goal of the hospitalist model is to improve clinical outcomes and decrease the types and amount of resources used in patient care, but whether the model can achieve this goal has yet to be fully tested. The satisfaction of patients, providers, and trainees; the continuity of care; and the medical education system may all be affected by the introduction of the hospitalist model.

Does the hospitalist model provide improved health care? This question can be answered only through rigorous evaluation of the hospitalist system, and such evaluation is as likely to be done by clinician–managers as by experienced health services researchers. This paper is a primer for those who may need to interpret the results of studies of the impact of hospitalists or who wish to develop such studies. It describes 1) processes and outcomes that might be assessed in an evaluation of a hospitalist model and 2) important methodologic issues that are particularly relevant in such an evaluation.

What Should Be Evaluated?

Quality of health care has been defined as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (4). Donabedian (5) has defined three types of quality measures: measures of structure, measures of process, and measures of outcome. Most current methods for assessing health care quality focus on processes and outcomes.

Process measures assess what happens during a health care encounter. Two major types of processes are involved in patient–provider interactions: 1) clinical processes, which include the types of services delivered and the quality, appropriateness, and timeliness of those services, and 2) interpersonal processes, which include patient–provider communications, patient education, and the cultural sensitivity of care (6). Outcomes are the result of the health care encounter. Although many types of health care outcomes have been defined (7), we focus here on only three: health status, satisfaction, and resource use. We describe measures of processes and outcomes that might be assessed in an evaluation of a hospitalist model. **Table 1** summarizes the framework described below, and **Table 2** gives examples of measures of processes and outcomes for the hospitalization of a patient with asthma, a common general medical inpatient diagnosis.

Measures of Processes

The fundamental assumption about measures of process is that a definable causal link exists between a process and an outcome (that is, evidence shows that the process of providing a specific treatment leads to a measurable difference in outcome). A well-known example of a clinical process measure is the time "from door-to-drug" in a patient with an acute myocardial infarction. The causal link is known as a result of empirical evidence showing that earlier delivery of thrombolytic agents results in less myocardial damage and improved survival. Other process measures, such as adherence to practice guidelines, may be less well established but are assessed because expert opinion holds that they improve clinical outcomes, decrease costs, or have other beneficial effects. Interpersonal processes that might be linked with outcomes are the time that a physician spends with a patient or the compliance of patient and nursing staff with the use of a bedside teaching record.

The advantages of a hospitalist model might be assessed by measuring one or more processes that are thought to represent high-quality care to determine whether care provided by hospitalists differs from care provided by other physicians. Each of these processes should be linked to outcomes (health status, cost, or satisfaction). In the case of a patient admitted to a hospital with community-acquired pneumonia, one might assess the number and the appropriateness of diagnostic tests ordered on admission. Were blood cultures done? Were antibiotics given at the appropriate time? For a patient with gastrointestinal bleeding, time to endoscopy might be measured; for a patient with deep venous thrombosis, time to anticoagulation might be assessed. Examples of processes for patients with asthma are given in **Table 2**.

Table 1. Framework for Choosing Measures with Which To Evaluate the Effects of Hospitalists

Measures of processes
Clinical
Use of appropriate diagnostic measures
Use of appropriate treatments at appropriate times
Appropriate and timely use of consults and transfers
Appropriate referrals and discharge disposition (for example, referral to hospice or discharge to a skilled nursing facility)
Interpersonal
Communication with patients (for example, explanations of conditions and treatments)
Communication with primary care physicians (for example, notification of patient condition or treatments)
Measures of outcomes
Health status
Death
Adverse events and complications
Clinical status
Functional status
Psychological status
Satisfaction
Patients (for example, satisfaction with care in the hospital, physician communication, and health status)
Hospitalists (for example, satisfaction with the process of caring for patients, teaching, and administration)
Primary physicians (for example, satisfaction with communication with hospitalist)
Inpatient specialists (for example, satisfaction with number and type of consults)
Nursing and ancillary staff (for example, satisfaction with availability of physicians)
Trainees (for example, satisfaction with teaching and autonomy in decision making)
Resource use
Length of hospital stay
Overall costs of or charges for care
Use of specific types of resources (for example, tests, days in the intensive care unit)

Measures of Outcomes

Health Status

Health status outcomes may include death, clinical or physiologic condition, physical function, psychological well-being, or self-perceived health status (6). They may be traditional physician-reported measures, such as pulmonary function, or they may be patient-reported measures, such as functional status.

Death rates for a particular diagnosis are not a very sensitive measure because, for most diagnoses, death rates are low. Thus, significant differences in death rates would probably not be found for patients treated by hospitalists and nonhospitalists in a single hospital, or even in several hospitals. If death rates are assessed, it is important to consider both in-hospital deaths and those that occur within a specified period after discharge (such as 30 days), not only to detect the longer-term effect of hospital care after discharge but to capture deaths in patients who may have been discharged prematurely. In addition, not all deaths indicate poor quality of care: Terminally ill patients hospitalized for comfort care or patients who have declined to receive intensive care services may be appropriately excluded from death rate analyses.

Complications of care may be assessed as a health status outcome. When a complication occurs often or suggests poor-quality care, it might be assessed individually, but rare complications might be grouped to create sufficient "complication rates" for analysis. In the case of a patient with pneumonia, in-hospital myocardial infarction, unexpected transfer to the intensive care unit, need for intubation, or use of vasopressors might be considered separately or combined as a single "complications" outcome. Similarly, for a patient with asthma, unexpected transfer to the intensive care unit, intubation, pneumothorax, arrhythmia, or drug toxicity might be assessed. Complications in a patient with deep venous thrombosis might include minor and major bleeding

Table 2. Examples of Measures of Processes and Outcomes in Asthma*

Measures of processes
Clinical
Adherence to clinical guidelines for treatment of asthma
PEFR or FEV_1 monitoring throughout hospital stay
Corticosteroids administered in appropriate doses and by appropriate routes
Adjunct measures (such as anticholinergics or methylxanthines) used appropriately
Interpersonal
Teaching appropriate use of metered-dose inhalers, "rescue" medications, "action plan"
Primary care physician notified of patient's admission and treatment
Measures of outcomes
Health status
Mortality: death in the hospital or within 30 days of discharge
Adverse events and complications: transfer to intensive care unit, intubation, pneumothorax, drug toxicity, arrhythmias, relapse after discharge requiring emergency department visit or increase in systemic steroid therapy
Clinical status: PEFR, oxygen saturation at discharge, frequency of use of "rescue" medications after discharge, ability to use metered-dose inhaler
Functional status: return to work or regular activities
Psychological status: perceived disability, sense of control of disease
Satisfaction
Patients: frequency of hospitalist's visits, explanations of treatments, patient's ability to return to normal activities, transition to outpatient physician
Hospitalists: interactions with patients, constraints on resource use
Primary physicians: input into treatment decisions, timely receipt of discharge summary
Inpatient specialists: timelines and appropriateness of consults
Nursing and ancillary staff: communication about patient's condition and treatment
Trainees: quality of teaching, autonomy of decision making
Resource use
Hospitalization: length of index hospitalization, readmission within 30 days after discharge
Admission to emergency department within 30 days after discharge
Overall hospital costs
Costs for specific tests (for example, chest radiography), medications and equipment (for example, nebulizer or metered-dose inhaler, intravenous or oral medication), procedures (such as intubation)

* PEFR = peak expiratory flow rate.

complications, incidence of pulmonary embolus, or transfer to the intensive care unit. Relapse rates and rehospitalization within, for example, 30 days of discharge may be considered complications and may be identified through review of medical records or telephone follow-up.

Functional outcomes are most thoroughly assessed by comparing the patient's prehospitalization status with his or her functional status at the end of the hospitalization and at a defined time after discharge. Functional status at discharge can be partly assessed by the destination of the patient at discharge (for example, the patient's home, a rehabilitation facility, a skilled nursing facility, or hospice), but use of this method of assessment requires caution. For example, discharge to a skilled nursing facility might indicate greater disability than discharge to the patient's home, or it may simply reflect the patient's social circumstances. Other measures of functional status at discharge include scales (such as the SF-36 Health Survey and the Index of Activities of Daily Living [8, 9]) and simple indicators, such as the ability of patients to walk, feed themselves, or understand their medication regimens. For a patient with asthma, the peak expiratory flow rate and the ability to use a metered-dose inhaler at discharge could be measured. Thirty days later, the same patient might be assessed for compliance with peak flow monitoring, retention of metered-dose inhaler skills, and frequency of use of "rescue" medications; these outcomes would reflect the quality of both inpatient treatment and patient education. Return to work or regular activities is an important measure of functional status for most diagnoses.

Satisfaction

Although patient satisfaction is paramount, the satisfaction of other persons involved in the delivery of care, including families, health care providers, and trainees, should also be measured. Patients may be most concerned with interpersonal processes, health status outcomes, and, to a lesser extent, clinical processes (such as time to antibiotic delivery), as long as the clinical outcome is desirable. Primary care or referring physicians are usually most interested in interpersonal processes that involve communication between themselves and hospitalists, such as the frequency of updates on patients, the primary care physician's input into treatment decisions, and the timeliness of the discharge summary. Trainees may be most interested in how the hospitalist model affects their education. Does the model constrain their learning experience because attending physicians are more involved (and therefore the trainees have less autonomy) or because the number of inpatient attending physicians is reduced? The satisfaction of all of these parties is probably best assessed with surveys that address the most likely areas of concern.

Resource Use

The hospitalist model may be associated with shorter lengths of stay and lower resource use (10). Evaluating length of stay or costs of care without examining the consequences of savings in these areas risks ignoring negative clinical outcomes or substantial costs incurred after hospitalization. During a shorter hospitalization, or one in which fewer tests and procedures are done, does a patient receive an adequate diagnostic work-up and appropriate treatment? Is adequate time reserved for discharge planning and patient education? Do patients who are discharged sooner spend time in an extended-care facility rather than going home? Do patients who are discharged earlier have more frequent relapses or unintended rehospitalizations? Resource use must be evaluated in light of both health status and satisfaction outcomes. To some extent, judgments about appropriate resource use depend on

the value that individual persons and society place on the quality of medical care and patient satisfaction.

Resource use outcomes may include overall costs, measures of utilization, or more complex analyses of cost-effectiveness or cost–benefit. In an assessment of the "costs" of a hospitalist model, the most common question is likely to be related to the cost of the services provided to the patient in the hospital. Other possible questions include the costs of hiring hospitalists, the impact of these physicians on the hospital's budget, the cost of patient care to health insurers, and monetary and other costs to the patient's family.

When comparing a hospitalist model with a nonhospitalist model, one might use hospital charges as a proxy for the true costs of care, although the assumption that charges equal costs has substantial problems (11). Even the use of a hospital's estimated "costs" for specific services is problematic because cost and accounting structures differ among hospital departments. Because the underlying question is the relative difference in resource use with the hospitalist model and the nonhospitalist model, the conversion of measures of utilization to a common denominator that can be used for comparisons is a somewhat more complex, but probably more accurate, technique than assessing "costs" or charges alone. For example, in some studies, a single price list has been applied to services from various time periods and sites to adjust for both price changes over time and price differences among geographic areas and clinical settings (12).

In some models, hospitalists are paid by hospitals; in others, the medical group continues to pay hospitalists. Cost models must be able to allocate these costs to the proper inpatient or outpatient settings to determine whether the use of hospitalists is essentially a transfer of costs from the outpatient care budget to the inpatient care budget. A corollary issue is that, in a system that employs hospitalists, outpatient physicians spend less time in the hospital. Is this "extra" time assigned to more outpatient sessions, to paperwork, or to increased vacation or educational time?

Designing Studies of the Impact of Hospitalists

In an assessment of whether processes and outcomes of care are different with a hospitalist model of care, the primary analytic goal is to attribute measured differences in quality, satisfaction, or resource use to the hospitalist model and to rule out the possibility that something other than the hospitalist model has caused the differences (13). Key questions that should be addressed in an evaluation of studies of the hospitalist model are summarized in **Table 3**.

Table 3. Evaluating Studies of the Impact of Hospitalists: Key Questions

How is "hospitalist" defined?
What process measures are assessed? Does empirical evidence or theory suggest a causal link between processes and outcomes?
What outcome measures are assessed? Does empirical evidence or theory suggest that the outcomes are caused by the processes of care (that is, by the hospitalist model)?
With what is the hospitalist model compared? Are control groups defined and described adequately?
What is the unit of analysis? Is it appropriate to the research question being asked?
Is the statistical analysis appropriate for the types and distributions of the data? Do the analyses adjust for differences between hospitalist and nonhospitalist groups—for example, in patient characteristics or across time periods?
Are the study interpretations and conclusions consistent with the results?

Evaluation Design

Definition of "Hospitalist"

An important first step is to define the hospitalist model that is being studied and to determine how different this model is from the model currently in use. As Wachter describes (3), a variety of hospitalist models are now being used; these models differ primarily with respect to how isolated the hospitalist is from the outpatient setting. For example, a hospitalist system that uses a pool of primary care physicians who each attend on the inpatient service for 2 or 3 months per year but still maintain active outpatient practices may show fewer differences compared with the traditional system than does a hospitalist system in which three or four physicians with limited outpatient responsibilities attend on the inpatient service for 6 or more months each year.

Intervention and Control Groups

An inference of causation depends largely on whether the outcomes of a group of patients that undergoes a change (the intervention group) differs from the outcomes of a group that does not experience the change (the control group). The investigator must define a hypothesized causal link between the intervention (the implementation of the hospitalist model) and one or more outcomes. The control group may be patients treated at the same hospital or at another hospital, and it may be historical (such as the same inpatient service before the institution of a hospitalist program) or concurrent (such as another inpatient service in the same hospital that has not instituted a hospitalist system).

Caution is warranted, however. Even with carefully selected historical or concurrent control groups, uncontrolled factors (known or unknown) may bias results. The random assignment of patients, physicians, and hospitals to intervention and control groups is the best way to avoid such bias, but ran-

domization may be difficult or impossible to implement. Studies using historical or concurrent control groups should use the appropriate statistical techniques, described briefly below, to adjust for known or hypothesized differences between groups.

Historical Comparisons

When a historical control group is used, the care and outcomes of patients hospitalized in period one are compared with the care and outcomes of patients hospitalized in period two (in this case, after implementation of a hospitalist model). The primary threat to the validity of this design is that other changes in the hospital or the health care system may have produced the measured outcomes. For example, changes may have occurred in availability of care (a special care unit may have been opened or expanded), patient characteristics (there may have been a shift toward more acute illness), or processes of care (new diagnostic or treatment technologies may be in use or new treatment guidelines may have been implemented). Even though such changes may be completely independent of the implementation of the hospitalist model, the model might be credited or blamed for the differences in outcomes in the two study periods.

Major changes in the environment need to be addressed in both the study design and analysis. For example, use of low-molecular-weight heparin may decrease bleeding complications, the need for blood tests, and length of stay in patients with deep venous thrombosis, regardless of whether hospitalists are involved in care. If low-molecular-weight heparin gained widespread use between period one and period two, one might remove patients with deep venous thrombosis from the analysis or compare only those patients who were treated with intravenous heparin. If a set of guidelines for asthma treatment was adopted between the two study periods, one might exclude patients with asthma from the analysis. Statistical methods can also be used to adjust for various factors, such as severity of illness, that may have differed between periods.

Concurrent Comparisons

Confounding caused by temporal changes in health care can be avoided by using a concurrent comparison group. One or more hospitals (or even wards within hospitals) that have implemented a hospitalist model can be compared with hospitals that have not changed their inpatient care model for the same time period. Specific attention must be paid to differences among the study settings that might affect the processes and outcomes of inpatient care at each site. The possible differences among hospitals are numerous and include size, occupancy rate, complexity of patients and care, payer mix, and teaching status. It is important to minimize differences by selecting hospitals, or hospital wards, that are as similar as possible to the intervention site and by controlling, through design or analysis, for differences in clinical practices (unrelated to the hospitalist intervention) at the study sites.

Time Frame

An evaluation of the hospitalist model generally should extend beyond the period of hospitalization itself because in-hospital care is likely to affect health status and resource use after hospitalization. Length of stay and resource use may be lower for a patient with pneumonia on a hospitalist service, but will this patient later require more intensive outpatient care, such as home nursing, medical equipment rental, or more visits to the primary care physician or the emergency department? A period of 30 days from discharge is often used but, for some conditions, longer periods may be more appropriate. In an evaluation of care for patients with asthma, for instance, the clinical issue may be not only whether the patient has a relapse within a few weeks of discharge but whether adjustment of the patient's medication regimen and education in the hospital results in fewer visits to the emergency department in the next year.

Analytic and Statistical Issues

Unit of Analysis

The appropriate unit of analysis depends on both the specific research question being asked and certain statistical considerations. In a simplified example, if the primary question is about the effect on outcomes of a change in service delivery, it may be best to aggregate patient data to the hospital physician of record (who orders most services), defining the attending physician as the unit of analysis. Depending on the circumstances, other units of analysis, including the patient or the hospital, may be appropriate.

Data Distributions

Most multivariate analysis techniques depend on the assumption of a statistically "normal" distribution of the independent and dependent variables. Clinical and resource use variables, however, often violate this assumption. Patients hospitalized with pneumonia tend to be very old or very young; patients hospitalized with asthma will have peak expiratory flow rates that are generally lower than 70% of predicted (14), with a "tail" at the lowest end of the spectrum. In such cases, the results of statistical tests that rely on normal distribution (parametric tests) may be misleading.

Because many outcomes (such as death and some

in-hospital complications) are infrequent, it may not be appropriate to use analytic techniques that assume a high frequency of events and normal distributions. Both parametric and nonparametric statistical techniques may be used to determine whether the occurrence of low-probability events differs between groups (15, 16). With small samples or rare events that have important clinical consequences, it may be best to define the occurrence of an event as an epidemiologic "sentinel indicator" that should be assessed as a possible marker of poor care rather than attempting to analyze it with statistical tests. When a sentinel event is identified, a review of the patient's care may help in developing hypotheses about a possible effect of the hospitalist model.

Another common non-normal distribution, especially for resource use variables, is the occurrence of a small number of outcomes with high "outlier" values, that is, values that are extreme and produce a skewed distribution with a long "tail." Several techniques are available to reduce the probability of drawing the wrong inference from an analysis of a distribution with outlier values, including the reclassification of all outlier outcomes to, for example, three SDs above the mean; the use of a statistical transformation (such as a logarithm) of the variable; or the exclusion of outliers in one set of analyses to assess the sensitivity of the results to their presence (15, 17).

Risk Adjustment

Differences between the hospitalist (intervention) and nonhospitalist (control) groups that may have an effect on outcomes that is unrelated to the change in the inpatient care model include 1) the characteristics of patients, physicians, wards, or hospitals and 2) temporal changes, if historical controls are being used. Patient characteristics include age, diagnosis, comorbid illnesses, and illness severity on admission. Changes in practice, implementation of guidelines, and changes in the availability of ancillary services (such as laboratory resources, radiology services, and respiratory or physical therapy) should also be accounted for. Statistical adjustment techniques to minimize known variation between the experimental and control groups are most often used to control for these differences (18). From the point of view of the clinician, the key is to determine whether the myriad factors that might contribute to the differences in outcomes with the inpatient care models have been addressed.

Conclusions

Measuring the quality and outcomes of health care is a complex process. The hospitalist model of inpatient care has generated controversy. Some research suggests that this model is associated with lower costs and with similar or better patient outcomes. However, concern has been expressed that patients will be dissatisfied because of the lack of continuity of care; that referring physicians will be dissatisfied because of the loss of control of their patients; that costs may be higher for the hospital; and, perhaps most important, that health status outcomes may be adversely affected by the transfer of responsibility for a patient from a primary care physician to an inpatient generalist physician. To address these concerns and assess the full impact of a hospitalist model, rigorous evaluations must be conducted to provide convincing evidence about health status outcomes; satisfaction of patients, providers, and trainees; and costs of care.

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