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FEATURE STORY

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blending hospital economics with quality of care: a case study

Regulatory and market forces are combining to drive U.S. health care toward integration of clinical quality and healthcare finance—and creating new challenges for healthcare CFOs.

AT A GLANCE

Many hospitals have attained substantial gains in cost control. Unfortunately, the impact of cost initiatives on quality of care and clinical outcomes is not clear. However, by looking at the patient management costs incurred relative to clinical outcomes as the patient progresses through diagnosis and treatment, healthcare organizations can evaluate a technology's economic value.

Looming on the healthcare horizon is pay-for-performance, an emerging payment model that bases reimbursement on clinical outcomes as well as resource utilization. CMS and employer coalitions such as The Leapfrog Group have initiated programs to reward hospitals and physicians for attaining targeted quality and cost goals. Also, in December 2002, CMS launched the National Hospital Quality Initiative ("Project Public Trust") to collect and publish clinical performance data related to three disease areas: acute myocardial infarction, heart failure, and pneumonia.

Unfortunately, the impact of cost and productivity initiatives on quality of care and clinical outcomes is not clear. Although the relationships between quality and cost are generally accepted as inherently logical, specifics are tougher to come by; there are few published findings on the impact of cost control programs on changes in quality of care and clinical outcomes.

To that end, this article presents a model to measure the clinical outcomes and economic impact of a technology as it is used within a hospital's patient management protocol. Two new tests for diagnosing heart failure are used as a case study. By looking at the patient management "cash burn rate" (i.e., costs incurred relative to reimbursement as the patient progresses through diagnosis and treatment), healthcare providers are able to evaluate a technology's economic value to the hospital integrated with quality of care metrics.

We applied the model to two recently launched tests—brain natriuretic peptide (BNP) and N-terminal prohormone BNP (NT-proBNP). We selected heart failure to tie in with the national quality initiative; also, DRG 127 (heart failure and shock) accounts for the highest portion (5 percent) of the Medicare national reimbursement budget.

For their medical economics to be deemed "acceptable," the tests would have to provide a return on investment—relative to the hospital's current standard of care and competing technologies—in concert with clinical outcomes targeted by the hospital. Economic value would be based on the technology's effect on patient management outcomes.

Our findings reveal technology economic value and cost-effectiveness per patient, which in turn can be extended to value in total to the hospital. Economic value and cost-effectiveness calculations include an activity-based accounting of a technology's effect on the mean cost of care at various stages of a patient's

course of management based on avoided steps or procedures, patient complications, mortality, readmissions, use of ancillary technology, and length of stay. Other indications of clinical quality may be added depending on the intervention being considered.

Assessing New Technology for Heart Failure Diagnosis: A Case Study

Approximately 5 million people in this country are living with heart failure. An additional 500,000 cases are diagnosed annually. According to the American Heart Association, case volumes are rising at about 2 percent per year. CMS spends approximately $6.5 billion per year on heart failure—about 5 percent of its total DRG budget. In 2004, total costs for heart failure patient management are expected to exceed $38 billion. The mean per case charge for heart failure in 2002 was $14,470 versus $9,270 in 1993 (a 56 percent aggregate growth in cost, or about 6 percent per year).

Two diagnostic tests, one measuring BNP concentration in the bloodstream and the other measuring NT-proBNP, were cleared by the FDA over the past few years. NT-proBNP and BNP, both of the natriuretic peptide family of hormones, are generated and released into blood circulation as a reaction to heart failure symptoms. The tests work effectively as part of a diagnostic triage in patients presenting with symptoms suggesting heart failure and for ruling out diagnostic tests for populations deemed to be at high risk. They also perform as precursor measurements to help physicians decide between further diagnosis and a course of therapy.

Both tests are reported to help lower both diagnosis costs and patient management costs because of their diagnostic accuracy and by ruling out the need for echocardiography. Although echocardiography has been considered the gold standard for determining systolic dysfunction, it is expensive, is not always readily available, and may not reflect acute conditions.

A review of 169 published clinical studies conducted throughout the European Union, the Americas, Australia, and Asia addressed the efficacy of each test's abilities within emergency department (ED) and primary care environments to differentiate heart failure from other causes of heart failure symptoms and its prospective capacity to serve as a guide for complex drug therapy. Of these studies, 23 reported comparative clinical results of the tests, while only four addressed cost-effectiveness. The four cost-effectiveness studies evaluated the tests as a means to precede and guide the use of echocardiography. Of the 23 studies comparing the efficacies of the tests for various patient populations, 16 reported NT-proBNP as being a superior diagnostic test, one reported BNP as superior, and six declared the tests clinically equivalent.

Our case study is based on an actual patient population (120 patients) covered in one of the published clinical studies (Fuat, A., Murphy, J.J., Curry, J., et al., "A Comparison of the Two Commercially Available Assays for B-Type Natriuretic Peptide When Selecting Patients with Suspected Heart Failure in Primary Care," *Heart*, 89(Suppl):A38, 2003). Average patient costs are compared for three scenarios:

- The hospital's current diagnostic process (echocardiography) is used; neither BNP nor NT-proBNP are employed.
- BNP intervenes in the diagnostic process and is used as an echocardiography rule-out test.
- NT-proBNP rather than BNP is used for rule-out.

Evaluating the cost-effectiveness ratio. Use of a new healthcare technology has far-reaching economic and clinical implications. The figure on the following page displays these implications in the form of a cost-effectiveness ratio, which presents the cost value derived from a new technology relative to its clinical benefits. The intervention of a technology, such as a new diagnostic test, device, or therapy, requires the consumption of both direct healthcare resources (such as medical supplies and a pathologist's or clinician's time) and nonhealthcare resources (such as transportation). The new technology also requires the use of caregiver time and time expended by the patient for treatment. The Δ symbol denotes that we are interested in determining the relative changes in resource consumption resulting from the intervention, compared with the resources consumed for existing or alternative processes.

The reimbursement received by the hospital is a reflection of the payer mix of net revenue secured in relation to costs of utilized resources. The numerator then portrays the change in net operating income. (For the purposes of this case study, derivation of the hospital's mean cost of care relative to its reimbursement mix pertains to reimbursement minus direct hospital costs only.)

The denominator—the patient's health status—represents the change in clinical outcome based on the technology's use relative to results from current or alternative clinical processes. There may be a blend of objectives, such as reductions in morbidity, mortality, length of stay, unnecessary referrals, admissions, and readmissions. The clinical outcome, in turn, affects subsequent healthcare costs. The arrows indicate this relationship.

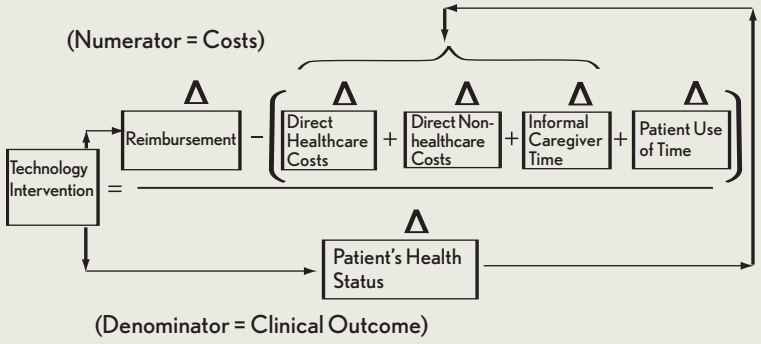
Clinical and economic benefits. The most prevalently reported clinical and economic benefits of the tests are summarized in the table below, right. The tests' significant economic values are that they facilitate improved quality of care as a result of their superior accuracy in diagnosis and enable clinicians to avoid using other costly tests. Before these two tests came onto the market, echocardiography was the preferred initial diagnostic test when the history, physical examination, and routine laboratory tests suggested or could not eliminate cardiac disease. However, because of its cost and frequently limited availability, echocardiography is no longer considered suitable as a primary diagnostic screening tool. A more cost-effective process would use echocardiography selectively.

Diagnosis algorithm. The exhibit on page 4 depicts the diagnosis algorithm for patients presenting with heart failure symptoms. A comparison is made between using echocardiography all the time versus using either test as a means to rule out the need for echocardiography. The algorithm serves as a template to follow both the clinical and economic effects of the tests and facilitates the activity-based costing of each key step in the patient management process. It follows published clinical studies wherein the results of either of the two diagnostic tests indicate referral to echocardiography only if necessary to help document, characterize, or rule out heart failure. The algorithm also serves as a foundation to analyze the mean cost of care relative to clinical value for patients presenting at the ED or primary care.

The process follows the patient from the point of meeting with the primary care physician or presenting at the hospital's ED with a symptom such as acute shortness of breath. The patient's clinical history is reviewed, and ECG and chest X-ray are administered. Then, rather than automatically referring the patient for echocardiography, the point-of-care diagnostic test is performed. Depending on results, the patient is discharged (if the findings are negative) with appropriate guidance or directed for an echocardiography. Given that no test is perfect, there are false-positives and false-negatives, which affect cost of care and clinical outcome.

Based on their reported diagnostic accuracies, the BNP test ruled out 55 patients (46 percent)—that is, those patients would *not* be referred for an echocardiography exam. The NT-proBNP test ruled out 51 patients (43 percent). The BNP test, however, missed six patients with heart failure (false-negatives); the NT-proBNP assay missed one patient. (Our findings do not perfectly match those of the published study due to our recalculation of positive and negative diagnostic results to comply with their reported specificity performances.) The relative cost impacts of each process are shown in

COST-EFFECTIVENESS RATIO



This expanded formula is founded upon an earlier one illustrated in Luce, B.R., Manning, W.G., Siegel, J.E., and Lipscomb, J., "Estimating Costs in Cost-Effectiveness Analysis," in Marthe R. Gold et al., *Cost-Effectiveness in Health and Medicine,* New York: Oxford University Press, 1996.

This cost-effectiveness ratio presents the cost value derived from a new technology relative to its clinical benefits. The Δ symbol indicates that we are interested in how these elements change as a result of the technology intervention.

DIAGNOSTIC ASSAY (NT-proBNP AND BNP) CLINICAL AND ECONOMIC BENEFITS

Clinical Benefits
- Diagnostic accuracy
- Superior results in predicting early stages of heart failure
- Improved prediction of patient outcome
- Better discrimination of NYHA stage I and II patients
- Excellent screening test
- Reduced false-positives and false-negatives relative to other tests
- Speed and ease of use
- Simple, highly effective; a favorable impact on patient management
- Lowered morbidity and mortality

Economic Benefits
- Decrease in utilization of other diagnostic tests
- Reduction in lengths of stay
- Elimination of unnecessary tests and therapy due to diagnostic uncertainty and inaccurate findings
- Reduction in admissions and readmissions
- Decrease in complications due to patient entry into an inappropriate clinical pathway
- Lowered mean cost of care

the table on page 5. The costs shown (used for illustration purposes only) indicate that when either test is inserted into the diagnostic process, cost savings occur. The use of either test enables the hospital to save costs by avoiding unnecessary referrals for echocardiography.

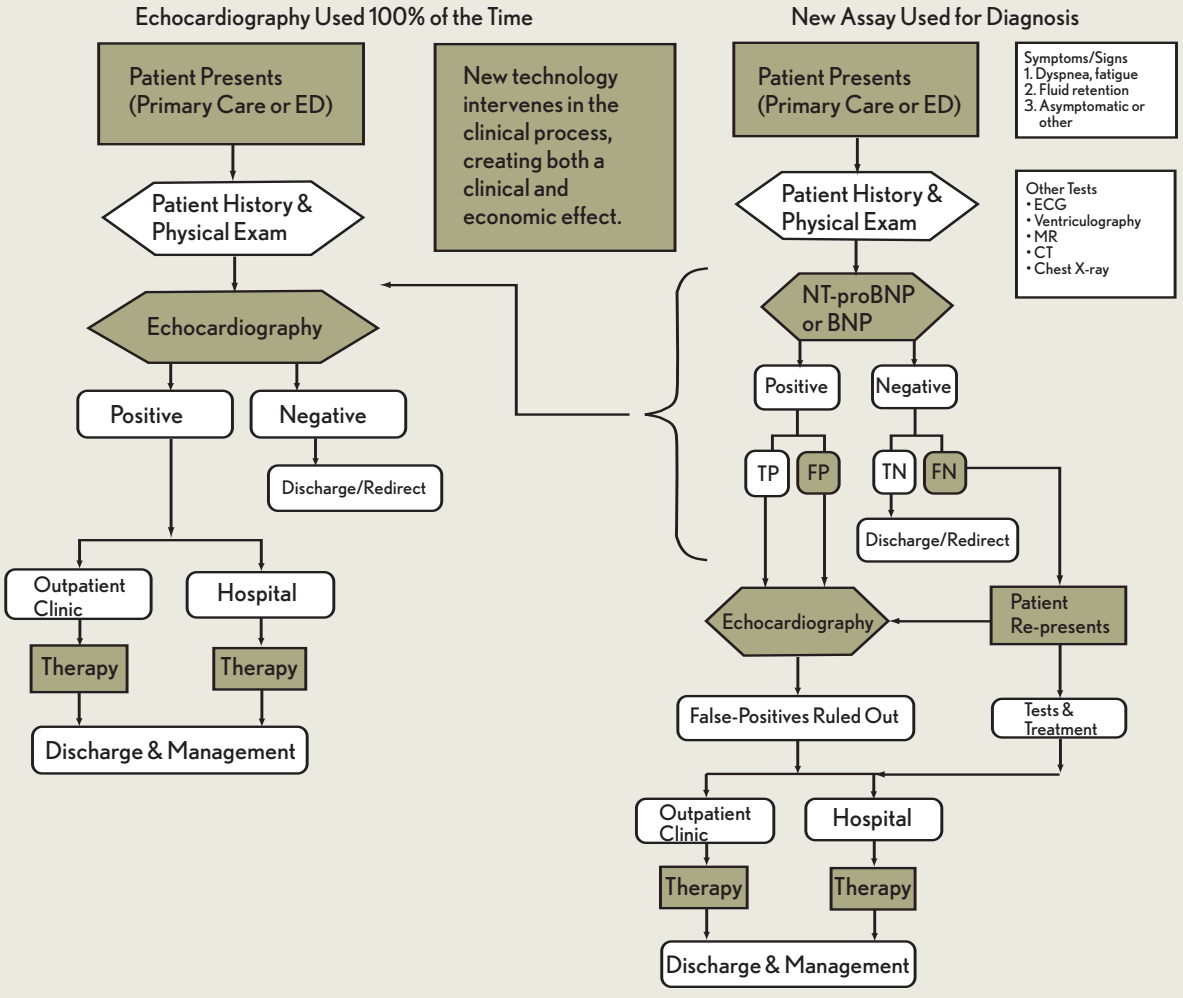
The findings, however, do not carry our analysis far enough—that is, they do not reflect the clinical impact of the diagnoses or the resulting patient management costs, all of which need to be measured.

Findings when both clinical and cost effects are measured. In the first scenario shown in the table on the bottom of page 5, neither diagnostic test was used as a precursor decision tool; all 120 patients were referred for echocardiography. Forty-four patients were determined to have heart failure and received appropriate therapy. Average comparable diagnostic cost plus drug therapy (for illustrative purposes, a $65 cost is used) for the total patient population was $229. No patient visits to the hospital's ED following diagnosis and treatment were assumed for this baseline.

When BNP was used for diagnosis, fewer patients (65) were referred for echocardiography, but echo referrals did include false-positives. Taking into account the prospective consequences of false-negatives, six patients presented to the ED and were given an echocardiography test. The mean cost per patient was $233 due to the added expenses of false-negative complications and false-positive referrals. This cost included patient visits to the ED due to complications from false-negative findings.

The scenario was repeated using NT-proBNP as the decision tool. In this scenario, more patients (69) were referred for echocardiography; one false-negative resulted. The impact of fewer ED visits due to complications from false-negative results made this test more effective from both a cost and clinical outcome perspective. The mean cost per patient was $179.

DIAGNOSIS ALGORITHM FOR PATIENTS PRESENTING WITH HEART FAILURE SYMPTOMS



The diagnosis algorithm shows the steps to be taken when either BNP or NT-proBNP is used in diagnosing heart failure. Depending on results, the patient may be discharged if echocardiography is not indicated—enabling the hospital to save costs.

As this analysis shows, use of either test can save costs by avoiding unnecessary referrals for echocardiography. However, the analysis does not consider the impact of the clinical diagnoses or resulting patient management costs.

DIAGNOSTIC TEST COST-EFFECTIVENESS*

All Patients Echoed: Without BNP or NT-proBNP	With BNP Measurement	With NT-proBNP Measurement
Echocardiography @ $205 n (120) X $205 = $24,600	BNP @ $25 n(120) X $25 = $3,000 55 Patients Ruled Out Echo ($205) X 65 = $13,325	NT-proBNP @ $25 n(120) X $25 = $3,000 51 Patients Ruled Out Echo ($205) X 69 = $14,145
Total Cost = $24,600 Cost per Patient = $205	Total Cost = $16,325 Cost per Patient = $136.04	Total Cost = $17,145 Cost per Patient = $142.88

*Cost analysis applied to patient population (n = 120).

COST IMPACT OF THREE TOOLS FOR DIAGNOSING HEART FAILURE

Test/Treatment	N	$/N	Cost
		Assay	
Assay	0	0	$0
Echo	120	205	$24,600
Therapy	44	65	$2,860
ED Visit	0	1,250	$0
Cost/Patients	120	229	$27,460
		BNP	
BNP	120	25	$3,000
Echo	71	205	$14,555
Therapy	44	65	$2,860
ED Visit	6	1,250	$7,500
Cost/Patients	120	233	$27,915
		NT-proBNP	
NT-proBNP	120	25	$3,000
Echo	70	205	$14,350
Therapy	44	65	$2,860
ED Visit	1	1,250	$1,250
Cost/Patients	120	179	$21,460

*CMI = Case-mix index.

In analyzing the mean cost of care relative to clinical value, the *true* cost impact of each diagnostic tool is evident when the clinical effect of that tool and the resulting patient management costs are taken into account.

Conclusion

These findings reflect the economics of a single published study covering a specified patient population. Analysis of other populations would reflect results compatible with intrinsic demographics, disease characteristics, and stages of acuity. The objective of the case study was to provide a simple start to assessing the blended clinical and economic effects of new technology in preparation for quality-of-care programs that will report provider data from both clinical and financial perspectives.

Hospital executives are considering various process, protocol, and technology changes to achieve the targeted quality outcomes proposed in CMS, The Leapfrog Group, and other initiatives, while continuing to improve their operating efficiencies and profitability. It is possible that they will bring life science, pharmaceutical, and medical device companies into the fold of accountability for these outcomes. Thus, companies might begin to consider solution services as their distinguishing market position. These could include not only process improvement consultation, but also the commitment to and management of expectations relative to the actual impact of their technology on the hospital's integrated clinical and economic outcomes. ●

About the author

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