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Teaching High-value, Cost-conscious Care: Improving Residents' Knowledge and Attitudes

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Rising health care costs have created an urgent need to improve physicians' education regarding cost and value in health care.[1] The Accreditation Council of Graduate Medical Education core competency of systems-based practice encompasses cost awareness and risk-benefit analysis,[2] but there recently has been a call to expand this competency to create a new, 7th core competency of high-value, cost-conscious care.[3] Although many would agree that educating learners in the concepts of high-value, cost-conscious care is important,[3,4] there does not appear to be any consensus on the best way to provide this education. The American College of Physicians and the Alliance for Academic Internal Medicine have deemed it to be such an important topic in graduate medical education that they have developed and provided a free curriculum on high-value, cost-conscious care.[5,6] Although this curriculum incorporates some important aspects of self-reflection and audit and feedback, there is a dearth of empiric research examining the utility of audit and feedback of health care cost information for enhancing residents' knowledge and attitudes toward high-value, cost-conscious care.

Previous studies have shown that physicians often have a poor understanding of the costs of tests and medications that they order[7] and that providing cost data for tests influences ordering behavior[8,9] and knowledge of the cost of tests.[10] A recent study by Sommers et al[11] utilized a 45-minute teaching session with audit and feedback of cost information to teach residents cost-conscious care. This study showed no significant difference in total costs of hospitalization but did show a cost reduction in subgroup analysis of patient admissions that occurred during the study. Resident attitudes about cost were largely unaffected in this study, and resident knowledge of the costs of tests was not measured.

We set out to design a tool to provide internal medicine residents with data on the cost and charges of health care tests and services provided to their patients and to determine if an audit and feedback exercise using these billing data would improve resident knowledge and attitudes about costs of care.

METHODS

We conducted a pre-post analysis of the effect of an audit and feedback curriculum using billing data on the knowledge and attitudes of 88 categorical internal medicine residents (44 postgraduate year [PGY]-1 and 44 PGY-3) at Mayo Clinic in Rochester, Minn. The curriculum was instituted in August 2009 and

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continued through June 2010. This study was deemed exempt by the Mayo Clinic Institutional Review Board.

We developed an electronic tool called "Checkbook," which provides data on costs and charges for patients cared for at Mayo Clinic. This Web-based tool automatically retrieves selected patients' cost and billing data, allowing residents to view all the costs and charges for a specific patient and time interval in real time. These data include all itemized costs and billing data (eg, for specific tests, procedures, medications), total cost, and total charge. The reported data include both inpatient and outpatient services, and encompass all aspects of care, including physician and nursing charges, facility fees, medications, tests, and procedures. Checkbook allows residents to review each ordered item and perform trade-off analyses regarding impact of performing tests on final costs of care. They can subtract any item from the total bill to see the reduction in cost that would have occurred if the test or procedure was not ordered.

PERSPECTIVES VIEWPOINTS

- Teaching high-value, cost-conscious care is an increasingly important part of graduate medical education.
- Audit and feedback has not been well studied as a way to educate residents about high-value, cost-conscious care.
- An exercise asking residents to review the care of 3 patients and reflecting upon costs and charges led to improved knowledge and attitudes.
- Programs seeking to educate residents in high-value, cost-conscious care should incorporate audit and feedback when possible.

We conducted a pre-post analysis of the effect of Checkbook on resident knowledge and attitudes of costs of care. The knowledge assessment consisted of 15 commonly ordered tests and services (**Table 1**). We contacted the Mayo Clinic administrative office to identify the most frequently ordered blood tests to include in this assessment. Residents were asked to estimate the charge for each test and service to the nearest dollar. The attitudes assessment consisted of 8 items designed to ascertain resident perceptions about costs, ordering behaviors, and the learning climate as it relates to high-value cost-conscious care (**Table 2**). Items were structured on 5-point scales (1 = strongly disagree, 3 = neutral, 5 = strongly agree). Agreement with the statement was defined as a rating of 4 or 5 on this scale.

Following the pretest of knowledge and attitudes, residents used Checkbook to examine actual billing data from 3 hospitalized patients for whom they personally provided care. Residents were allowed to select the patients for review. Selected patients must have been hospitalized for at least 48 hours to allow for sufficient billing data to be available for this exercise; however, we did not place any other limitations on the patient selection. The residents could select any patient from any area of the hospital for whom they personally provided care during their training. Residents used Checkbook to review the patient's cost of care; then residents reflected upon which, if any, tests or services may have been avoidable. If tests or services were felt to be avoidable, residents were asked to reflect upon why they were unnecessary and why they were ordered, then document this rationale on the exercise. Residents used Checkbook to calculate the difference in cost and charge had the unnecessary tests and procedures not been performed. This allowed residents to see easily the amount of money that could have been saved had different choices been made in the care of the patient. Following the Checkbook exercise, residents completed an identical post-test of knowledge and attitudes.

Pre- and poststudy results were compared using paired *t* tests. Percentage error was used to measure accuracy of charge estimates. Percentage error is defined as the degree and direction (positive or negative) of error in charge estimate as a percentage of the actual charge. This calculation is ([estimated charge − actual charge]/actual charge) × 100%. For example, if a test has a charge of $50 and a resident estimates the charge is $100, this difference is a +100% percentage error. If the resident estimates the charge is $75, it is a +50% percentage error; if they estimate that the charge is $25, it is a −50% percentage error.

RESULTS

Forty-three PGY-1 (97.7%) and 40 PGY-3 (90.9%) residents completed the Checkbook exercise, and 37 PGY-1 (84.1%) and 31 PGY-3 (70.5%) completed the pre/post-tests. Pretest data of resident knowledge of costs showed that residents were more likely to overestimate the cost of tests and services, as 11 of the 15 charge estimates by residents had a mean percentage error greater than the actual charge (**Table 1**). Preintervention charge estimates varied significantly, with average percentage error ranging from 2.7% to 324.6%. No significant difference was found in baseline knowledge of estimated charges between PGY-1 and PGY-3 residents before the intervention (all $P > .08$).

The preintervention survey of resident attitudes toward costs of care showed that neither PGY-1 nor PGY-3 residents felt that they knew the costs of tests that they ordered for their patients (2.3%, 7.5%, respectively), that they did not have adequate access to information on the costs of tests that they ordered (4.7%, 5%, respectively), and that they had not yet

Table 1 Estimated Charges (Percentage Error) Before and After Checkbook Intervention (n = 68 Residents)

Charge	Pretest Mean Percentage Error* (SD)	Post-test Mean Percentage Error (SD)	Change Mean Percentage Error (SD)	*P* Value
Complete blood count with differential	+31.7% (82.9)	+3.4% (71.0)	−28.3% (100.5)	.02
Serum glucose	−3.1% (58.7)	−15.4% (54.0)	−12.2% (64.4)	.12
Creatinine	+7.3% (67.9)	−13.2% (45.7)	−20.6% (74.5)	.03
Electrolyte panel	+83.1% (119.7)	+13.4% (64.3)	−69.7% (121.9)	<.0001†
Total calcium	+17.2% (84.8)	−12.0% (48.3)	−29.2% (83.9)	.006†
AST	+16.0% (67.6)	+0.2% (62.1)	−15.8% (70.9)	.07
Cholesterol	+171.0% (288.5)	+136.9% (225.9)	−34.1% (214.5)	.19
Prothrombin time	+37.8% (108.5)	+26.8% (113.3)	−11.0% (121.3)	.46
Magnesium	−2.7% (58.0)	−16.5% (55.8)	−13.7% (59.7)	.06
BUN	+6.7% (60.9)	−8.5% (51.7)	−15.2% (77.0)	.11
PA and lateral chest radiogram	+324.6% (545.7)	+128.9% (210.6)	−195.7% (516.7)	.003†
CT abdomen and pelvis	−63.1% (22.8)	−64.0% (21.6)	−0.9% (26.0)	.77
12-lead electrocardiogram	+38.5% (159.7)	−9.5% (93.9)	−48.0% (114.9)	.001†
MRI of the head with contrast	−51.3% (27.1)	−50.6% (19.4)	0.7% (29.8)	.84
1 night semi-private nonmonitored bed	+35.0% (114.9)	+3.6% (46.9)	−31.4% (100.5)	.01†

AST = aspartate aminotransferase; BUN = blood urea nitrogen; CT = computed tomography; MRI = magnetic resonance imaging; PA = posteroanterior.

*Percentage error = degree and direction (positive or negative) of error in charge estimate as a percentage of the baseline charge. [(estimated charge − actual charge)/actual charge] × 100%.

†$P \leq .01$.

received adequate education about cost (2.3%, 2.5%, respectively). Residents agreed that patients wanted to know how much they would be charged for tests (62.8%, 67.5%, respectively). More than two thirds of residents believed that all patients should receive the same level of care regardless of costs (67.4%, 62.5%, respectively). Before the intervention, PGY-1 residents were less likely than PGY-3 residents to agree that cost influenced their decisions when ordering (34.9% vs 70.0%, $P = .002$).

Following the Checkbook exercise, resident knowledge of costs improved as measured by decreased percentage error in their estimates of the charges for commonly ordered tests and services, including electrolyte panel (mean percentage error preintervention 83.1% vs postintervention 13.4%, $P < .0001$), serum calcium (17.2% vs 12.0%, $P = .006$), chest radiograph (324.6% vs 128.9%, $P = .003$), electrocardiogram (38.5% vs 9.5%, $P = .001$), and a 1-night hospital stay (35.0% vs 3.6%, $P = .01$) (**Table 1**). Less commonly

Table 2 Attitudes Toward Cost Considerations Before and After Intervention for PGY-1 (n = 37) and PGY-3 (n = 31) Residents

Question	Group	Pre Agree n (%)	Post Agree n (%)	*P* Value
1. I know the costs of tests that I order for my patients.	PGY1	1 (2.7%)	10 (27.0%)	.003*
	PGY3	3 (9.7%)	13 (41.9%)	.002*
2. Patients want to know how much they will be charged for tests.	PGY1	21 (56.8%)	26 (70.3%)	.10
	PGY3	23 (74.2%)	24 (77.4%)	.74
3. Cost influences my decision when ordering.	PGY1	14 (37.8%)	25 (67.6%)	.005*
	PGY3	23 (74.2%)	22 (71.0%)	.74
4. All patients should receive the same level of care, including tests and procedures, regardless of costs.	PGY1	26 (70.3%)	29 (78.4%)	.37
	PGY3	20 (64.5%)	20 (64.5%)	>.99
5. My supervising consultants consistently encourage me to consider costs when making medical decisions.	PGY1	9 (24.3%)	17 (46.0%)	.01*
	PGY3	8 (25.8%)	9 (29.0%)	.76
6. I have adequate access to information about the costs of care that I provide.	PGY1	2 (5.4%)	20 (54.1%)	<.0001
	PGY3	2 (6.5%)	8 (25.8%)	.06
7. Better knowledge of costs would change my ordering.	PGY1	34 (91.9%)	33 (89.2%)	.65
	PGY3	25 (80.7%)	29 (93.6%)	.10
8. I have received adequate education about cost of care before today.	PGY1	1 (2.7%)	19 (51.4%)	<.0001*
	PGY3	0 (0.0%)	10 (32.3%)	.002*

PGY = postgraduate year.

ordered tests such as abdominal computed tomography scan and head magnetic resonance imaging scan did not show an improvement in accuracy of charge estimate. Following the intervention, residents were less likely to overestimate the charges, with only 7 of the 15 items showing a positive percentage error.

Regarding changes in resident attitudes toward costs of care after using Checkbook, both PGY-1 and PGY-3 residents were more likely to agree that they knew the costs of common tests (PGY-1 pre-intervention 2.7% vs post-intervention 27%, $P = .003$; PGY-3 pre-intervention 9.7% vs post-intervention 41.9%, $P = .002$) and that they had received adequate education regarding cost of care (PGY-1 2.7% vs 51.4%, $P \leq .001$; PGY-3 0% vs 32.3%, $P = .002$) (**Table 2**). After using Checkbook, PGY-1 residents were more likely to agree that cost influenced their ordering decisions (37.8% vs 67.6%, $P = .005$), that their supervising physicians encouraged them to consider cost when ordering tests (24.3% vs 46%, $P = .01$), and that they had adequate access to the costs of care that they provide (5.4% vs 54.1%, $P < .001$).

DISCUSSION

This study shows that utilizing audit and feedback with the aid of a cost/charge calculator to reflect on care provided improves resident knowledge and attitudes about costs of care. Previous studies have shown improvement in knowledge of costs using various methods,[7,10] but to our knowledge, this study is the first to demonstrate increased precision in charge estimates after the use of audit and feedback with patient cost and charge data. This study also adds to the previous study done by Sommers et al[11] by showing that resident attitudes can be influenced through the use of audit and feedback of hospital billing data.

Residents believe that patients want to know the costs of tests, and they feel that better knowledge of costs would influence their ordering behaviors. Unfortunately, without a program like Checkbook, residents are unlikely to have sufficient access to institutional cost data. Furthermore, the majority of residents indicated that their supervising physicians did not consistently encourage them to consider costs when making decisions, indicating opportunities to improve role modeling and the learning environment to support the practice of cost-conscious care. For all these reasons, the development of both formal and informal curricula to teach high-value cost-conscious care is important. High-value, cost-conscious care is a critical outcome for studying how to deliver health care in a sustainable way for the future. Medical schools and teaching hospitals across the country are beginning to embrace the import of the science of health care delivery, both for research[12] and education for the providers of tomorrow. Audit and feedback utilizing patient billing data may be a valuable component of such curricula and should be incorporated as appropriate.

Our study has several limitations. First, the study was performed at a single institution, which limits the generalizability of the results; however, insofar as residents at other institutions are unaware of the costs of the care they deliver, the study is likely applicable. Second, we allowed residents to select the patients that they reviewed with the Checkbook exercise, which may be both a limitation and strength. We intentionally allowed residents to select their own patients so that the patients they reviewed in the exercise would be familiar and personally meaningful to them. We felt this was important for residents to obtain the greatest benefit from the reflective aspect of the Checkbook exercise. However, allowing residents to select their own patients, in addition to requiring them to review just 3 patients, probably did not expose them to the broadest possible range of costs and charges for tests and services. Third, we did not determine if knowledge gains were sustainable by retesting at a later date. Last, while we measured knowledge and attitudes, we did not assess ordering patterns to determine if the intervention changed behavior. These latter 2 limitations are considerations for future studies.

In summary, resident physicians desire education relating to high-value cost-conscious care and believe that greater knowledge of the costs of care are likely to influence their practice behaviors. Residency programs should continue to collaborate in the development and assessment of curricula to teach value and cost in health care; our results would support the inclusion of audit and feedback as part of a curriculum teaching high-value cost-conscious care.

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