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Optimizing Order Entry Automaticity Reduces Inpatient Laboratory Utilization☆

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INTRODUCTION

Health care expenditures in the United States are the world's highest: $9990 per person totaling $3.2 trillion in 2015, making up 17.8% of the national gross domestic product.[1] Overuse of laboratory tests is a major contributor to wasted health care spending, with $7 billion spent on laboratory tests in 2015 by Medicare alone.[2] Furthermore, 16% to 40% of these tests may be clinically unnecessary, adding limited value to patient care.[3,4] Prior efforts to impact provider ordering practices regarding laboratory overuse, including educational initiatives, clinical decision support (CDS) tools, and price displays, have been variably effective.[5-11]

Electronic medical records (EMRs) were originally intended to improve health care quality, efficiency, and cost effectiveness and have been implemented widely over the past decade. However, EMR use may actually increase the ordering of both laboratory and radiology studies[12,13] as well as corresponding costs.[14] Although EMRs offer promising tools to specifically reduce laboratory overuse, the most effective and sustainable best practices in achieving this goal are governed only by recent guidelines.[15] According to prior reports, targeting automaticity within computerized patient order entry (CPOE) systems is an appealing high-yield target.[7-9] We hypothesized that eliminating the ability to order perpetually repeating routine daily labs within the EMR would significantly reduce the number of labs ordered per inpatient bed day (IPBD).

METHODS

Design and Setting

This interventional study took place on internal medicine teaching services at a large federally funded medical center. The affected population consisted of adult inpatients (Table 1), and no admission diagnoses were excluded. All inpatient nurses and clinicians with ordering privileges were notified in advance. Following implementation of the intervention in the EMR, a 1-month familiarization period was allowed before a 2-month period of data collection.

Intervention

Detailed descriptions of 2 prior modifications to the EMR (Essentris; CliniComp, Intl., San Diego, CA) were previously published and demonstrated that removing recurring daily lab tests from admission order sets significantly reduced routine lab order rates, whereas price displays did not.[11] The current intervention was specifically designed to further reduce automaticity by targeting repeating discrete orders as a promising means of decreasing inpatient laboratory use. Even after prior removal of perpetually repeating daily lab tests from internal medicine admission order sets, clinicians could still select "QAM" or "QDAILY" frequencies from dropdown menus when placing discrete orders, which often resulted in repeating daily lab tests without reassessment of their necessity. The current intervention eliminated these options, replacing them with "QAMLAB × 3" and restricting all laboratory orders on inpatient services to a maximum 3-day recurrence, after

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Table 1 Basic Patient Characteristics During Each 2-Month Data Collection Period over the 4-Year Study

Characteristic	2014 Baseline	2015 Order Set	2016 Price Display	2017 3-Day Limits
Admissions, n	681	734	744	795
Age, average	68.3	66.4	65.1	66.8
Age, SD	19	20.2	18.9	19.7
Age, range	23-101	22-101	20-104	19-101
Male	364 (53.5%)	391 (53.3%)	393 (52.8%)	424 (53.3%)
LOS, average	4.4	4.5	5.3	4.4
LOS, SD	6.8	7.3	8.5	6.4
LOS, range	1-70	1-71	1-106	1-97
Internal medicine	421 (61.8%)	474 (64.6%)	501 (67.3%)	554 (69.7%)
Cardiology	195 (28.6%)	184 (25%)	206 (27.7%)	181 (22.7%)
Hematology and oncology	65 (9.5%)	76 (10.4%)	36 (4.8%)	59 (7.4%)

LOS = length of stay; SD, standard deviation.

which tests would require active reordering on the basis of continued clinical indication.

Outcome Measures

The primary outcome measure was the total number of routine labs per IPBD on internal medicine wards, defined as basic metabolic panel, liver-associated enzymes, magnesium, phosphorus, complete blood count, and coagulation panel, each of which was counted as 1 test. The secondary outcome measure was estimated cost avoidance. Balancing measures included reported adverse events and delays in patient care.

Data and Statistical Analysis

Data on the number of routine lab tests performed, in addition to the number of IPBD (sum of daily ward census totals), were collected during a 2-month representative study period following the CPOE modification. Similar data from comparable periods in preintervention years were used as a comparison baseline. Incidence rates (lab tests ordered during 2-month periods corrected for the number of IPBD) were created for the total number of routine daily lab tests ordered and individually for each specified test. The samples were large enough to compare preintervention and postintervention rates using the normal theory test. Confidence intervals (CIs) were constructed for incidence rate ratios (IRRs) for each test. Alpha was set at 0.05 for all analyses, which were performed using the statistical software R. Cost avoidance ranges (Table 2) were calculated using publicly available 2017 Centers for Medicare and Medicaid Services Clinical Laboratory Fee Schedule list prices and fair price cost estimates from the Healthcare Bluebook.[16,17] Daily cost avoidance was calculated by multiplying the reduction in lab tests per IPBD by the estimated cost per lab test. Annual cost avoidance was calculated by multiplying the daily cost avoidance per IPBD by the number of IPBD in the 2-month data collection period by 6 to estimate 12 months.

RESULTS

During the 2-month postintervention data collection period, 11,050 total routine laboratory tests were performed,

Table 2 Estimated Cost Reductions Resulting from CPOE Interventions

Current Intervention (2016-2017)

Lab Test	2017 CMS Cost	Healthcare Bluebook Cost	Reduction per IPBD	CMS Daily Cost Avoidance	Bluebook Daily Cost Avoidance	CMS Yearly Cost Avoidance	Bluebook Yearly Cost Avoidance
Phos	$6.50	$13	−0.13	−$0.85	−$1.69	−$17,182	-$34,364
Mag	$9.19	$18	−0.11	−$1.01	−$1.98	−$20,556	-$40,261
Coag	$10.66	$23	−0.12	−$1.28	−$2.76	−$26,011	-$56,122
CBC	$10.66	$21	−0.49	−$5.22	−$10.29	−$106,213	-$209,237
LAE	$14.49	$22	−0.04	−$0.58	−$0.88	−$11,786	-$17,894
BMP	$11.60	$23	−0.07	−$0.81	−$1.61	−$16,511	-$32,738
Total labs	—	—	—	−$9.75	−$19.21	−$198,259	-$390,616

All calculations were made using publicly available fair price cost estimates from the Healthcare Bluebook.[16,17] Daily cost avoidance was calculated by multiplying the reduction in lab tests per IPBD by the estimated cost per lab test. Annual cost avoidance was calculated by multiplying the daily cost avoidance per IPBD by the number of IPBD in the 2-month data collection period (3389) by 6 to estimate 12 months.

BMP = basic metabolic panel; CBC = complete blood count with differential; CMS = Centers for Medicare and Medicaid Services; Coag = coagulation panel; CPOE = computerized patient order entry; IPBD = inpatient bed day; LAE = liver-associated enzymes (hepatic function panel); Mag = magnesium; Phos = phosphorus.