Optimizing laboratory test utilization in long-term acute care hospitals

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Laboratory tests can be considered inappropriate if overused or when repeated, unnecessary "routine" testing occurs. For chronically critically ill patients treated in long-term acute care hospitals (LTACHs), inappropriate testing may result in unnecessary blood draws that could potentially harm patients or increase infections. A quality improvement initiative was designed to increase physician awareness of their patterns of lab utilization in the LTACH environment. Within a large network of LTACHs, 9 hospitals were identified as having higher patterns of lab utilization than other LTACHs. Meetings were held with administrative staff and physicians, who designed and implemented hospital-specific strategies to address lab utilization. Lab utilization was measured in units of lab tests ordered per inpatient day (lab UPPD) for 8 months prior to the initial meeting and 7 months after the meeting. A repeated measures mixed model determined that postintervention lab utilization improved, on average and adjusted by case mix index, by 0.37 lab UPPD ($t = -3.61$, 95% CI 0.17 to 0.58) compared to the preintervention period. Overall, the case mix index 8 months prior to the intervention was no different than it was 7 months after the initial meeting ($t[8] = -0.96$, $P = 0.37$). Patient safety and outcome measures, including percentage of patients weaned from a ventilator, readmission rates, central catheter utilization rates, and the incidence of methicillin-resistant *Staphylococcus aureus* and other multidrug resistant organisms, showed no significant change. Hospital staff meetings focused on lab utilization and the development and deployment of tailored lab utilization strategies were associated with LTACHs achieving significantly lower lab utilization without negatively impacting quality outcomes.

Laboratory tests are crucial in clinical decision making; however, tests can be considered inappropriate if overused, i.e., when tests are ordered but are not directly indicated, when initial testing is inappropriate based on patient evaluation, or when repeated "routine" testing is not necessary (1). For chronically critically ill patients treated in long-term acute care hospitals (LTACHs), inappropriate testing can result in unnecessary blood draws that may result in potential harm to patients (2). Lab test overutilization can also lead to an increase in false-positive results (3). Strategies for optimizing lab test utilization include physician education, improved test requisition processes through an enhanced electronic medical record (4), standardized clinical assessment (5), improved communication between clinicians and lab professionals (6, 7), and elimination of standing orders (8, 9). A quality initiative, the Clinical Variability Project (CVP), was designed to reduce clinical variability in lab test utilization in LTACHs. The CVP had three directives: 1) examine the variability of laboratory test utilization in multiple LTACHs; 2) present lab test utilization data to hospital administration and physicians; and 3) support process changes and measure the impact of these changes on patterns of lab test utilization.

METHODS

A total of 9 LTACHs (4 freestanding and 5 hospital-within-hospital, with an average of 46 beds per hospital) were selected for the CVP based on the presence of a relatively high average number of lab units per patient day (UPPD) compared to over 100 LTACHs within the same health care organization. The LTACHs studied were located in Pennsylvania, Florida, New Jersey, South Carolina, and Ohio.

In the first phase of the CVP, the volume of lab UPPD was examined for each LTACH. Lab UPPD was defined as the total volume of lab tests for each LTACH divided by the total number of patient days. A lab UPPD correlates with any study or panel that is ordered (complete blood count, basic metabolic panel, albumin, magnesium, etc.); no data were available for the amount of blood (number of tubes) drawn. The most frequent lab tests included basic and comprehensive metabolic panels and complete blood count. Information on lab test frequency, the percentage of patients, and the number of patient days that had lab tests done was also collected but was not included in the analysis.

For the second phase of the CVP, overall patterns of lab utilization were presented to hospital administrators and physicians who treated patients in the LTACH. Monthly lab UPPD data from the previous 8 months, specific to each LTACH, were

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presented to the group, together with comparative data from 92 other LTACHs. In most of the participating LTACHs, the overall lab UPPD data had not been presented in aggregate prior to the meeting. During the presentation, care was taken to make sure the purpose of the meeting was positive and not punitive; physicians were never told that they were ordering too much or that they were doing something clinically incorrect.

In the third phase of the CVP, processes were developed by each hospital administrative and clinical staff, at each LTACH, to optimize lab utilization; no predesigned bundle was provided to the hospital administrators. Approximately 1 month after the initial meeting, conference calls were conducted with each participating LTACH during which evidence-based best practices for chronically critically ill patients were reviewed, including studies that examined the potential clinical implications from patterns of lab ordering (2, 3). It was left up to each LTACH administration and the clinical team to determine the best way to implement processes for lab test optimization.

Following the third phase, the impact of the CVP on subsequent lab utilization was determined for all LTACHs; lab UPPD was measured monthly 8 months prior to the initial meeting (beginning January 2015) and 7 months after the meeting (ending April 2016). Independent variables included an indicator for the intervention occurring at the end of the 8th month, time points (in months) at which the respective lab UPPD measurements were obtained, and the average monthly LTACH case mix index (CMI). CMI was used in the model because different levels of patient acuity could have contributed to different rates of lab utilization. Results were analyzed using a linear mixed-effect model with restricted maximum likelihood estimation to investigate the association between the intervention and the direction of lab UPPD trends over time and also to investigate the assumption that CMI is associated with the baseline and trend of lab UPPD. Rather than using the mean response for the pre- and postintervention periods, the variation in monthly lab UPPD was determined by modeling the variance-covariance matrix of the residuals for lab UPPD for each hospital. This method takes into account variability within and between hospitals.

RESULTS

The CVP intervention had a significant main effect [F(1, 34.33) = 13.04, $P = 0.001$]. The overall mean lab UPPD 8 months prior to intervention was 3.25 (SD = 1.14); the CMI was 1.24 (SD = 0.13). The linear mixed model that included CMI as a random covariate (AIC = 152.12) outperformed the model that omitted it (AIC = 156.02). On average, lab utilization decreased by 0.09 UPPD each month per hospital following the intervention. The average unadjusted decrease in lab utilization by the end of the postintervention period was 0.49 UPPD *(Figure 1)*.

Patient safety and outcome measures were examined in a series of paired *t* tests pre- and postintervention to determine whether reduction in lab UPPD had unintended consequences. As displayed in *Table 1*, there were statistically significant differences (at a .05 significance level) in pretest to posttest scores for lab UPPD, but not for any of the patient safety and outcome measures. Overall, CMI 8 months prior to the intervention was no different than CMI 7 months after the initial meeting (t[8] = –0.96, $P = 0.37$). Similarly, the percentage of patients weaned from the ventilator, readmission rates, and central catheter utilization rates were not significantly different after the intervention *(Table 1)*. In addition, the incidence of central line–associated bloodstream infection, methicillin-resistant *Staphylococcus aureus* infection, and other multidrug resistant organism infection remained unchanged after the intervention *(Table 1)*.

All the LTACHs studied had a decrease in lab UPPD over the 15-month period. The effect of the intervention had a magnitude (β) of 0.37 (t = –3.61, 95% CI 0.17 to 0.58) when

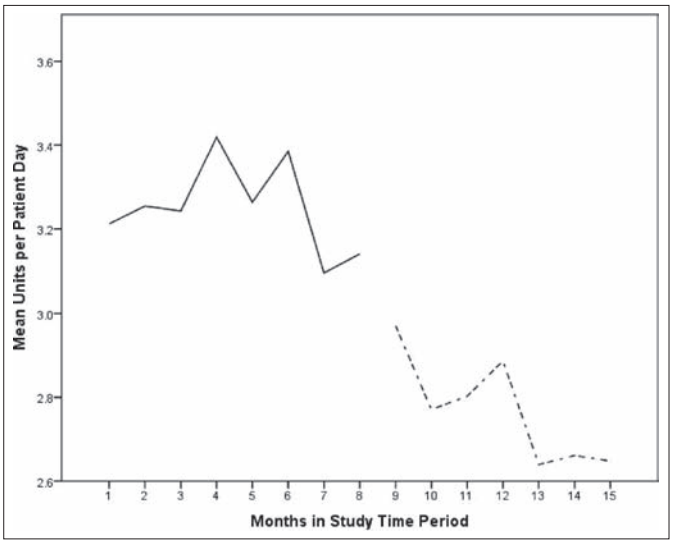

Figure 1. Mean laboratory units per patient day for the 9 long-term acute care hospitals in the study over 15 months of observation. The solid line represents the preintervention period and the dashed line, the postintervention period.

Table 1. Descriptive statistics and *t* test results for lab units per patient day, case mix index, safety measures, and outcome measures for the preintervention and postintervention periods

Outcomes	Pre – post		95% CI for mean difference	R	*t*	df
	Mean	SD				
UPPD	0.48	0.46	0.13, 0.83	0.93*	3.18*	8
CMI	–0.03	0.09	–0.09, 0.04	0.75*	–0.96	8
Vent wean	0.06	0.12	–0.04, 0.15	0.65	1.40	8
Readmissions	–0.01	0.03	–0.03, 0.02	0.86*	–0.48	8
Central lines	0.02	0.12	–0.07, 0.11	–0.13	0.51	8
CLABSI	0.40	0.60	–0.06, 0.86	–0.11	–1.99	8
MRSA	–0.14	0.27	–0.34, 0.07	0.55	–1.53	8
Other MDRO	–0.09	0.40	–0.40, 0.22	0.90*	–0.66	8

* $P < 0.05$.

UPPD indicates units per patient day; CMI, case mix index; CLABSI, central line–associated bloodstream infection; MRSA, methicillin-resistant *Staphylococcus aureus*; MDRO, multidrug-resistant organisms.

adjusted by CMI. Successive measurements of lab UPPD within a given hospital resulted in an estimated variance of 0.19 and an estimated correlation of 0.54, both of which were significant at the $P < 0.001$ level, verifying the appropriateness of the repeated measures design.

Each hospital administration and clinical staff developed a set of policies, processes, and procedures to improve patterns of lab utilization in their LTACH. Because these processes were not standardized, changes in levels of lab test utilization could not be associated with specific action plans that were implemented in the LTACHs included in the CVP. However, several processes were used at more than one LTACH; the 10 most frequent processes used to optimize lab test utilization are summarized in *Table 2.*

DISCUSSION

Successful laboratory utilization management typically involves several interventions that include ordering, monitoring, follow-up (10), and formulary restriction combined with restrictive reporting (11). The current study demonstrated that, in LTACHs with relatively high rates of lab test utilization, physician education and hospital staff awareness of patterns of laboratory utilization can effectively support lab test optimization. Despite lab UPPD significantly decreasing from pretest to posttest, CMI remained unchanged after the intervention, indicating that lab utilization was not correlated with patient acuity. Patient safety and outcome measures, including percentage of patients weaned from a ventilator, readmission rates, central catheter utilization, and the incidence of central line–associated bloodstream infection, methicillin-resistant *Staphylococcus aureus* infection, and other multidrug resistant organism infection, showed no significant change.

There are no generally accepted targets for over- or under-utilization of lab tests. Initiatives to reduce the number of lab tests often have short-term success based on the type of changes implemented in the hospital; effective processes for lab test utilization reduction typically involve changes to data collection, patient evaluation, and education (4). Results of the CVP initiative have determined the importance of education in LTACHs that have relatively high lab utilization rates. Reduction in lab test utilization can have substantial cost savings; for the majority of tests ordered in the 9 LTACHs, the average 2016 Medicare fee schedule payment is $15. Based on the average amount and an unadjusted reduction of 0.49 lab UPPD, the 9 LTACHs studied realized a potential savings of approximately $1,000,000 for the 7 months after the intervention.

Limitations of the CVP include a lack of standardization of the education component; the material presented at each initial meeting was amended following input and requirements from each LTACH. Also, no standard set of policies and procedures was used to optimize patterns of lab utilization in each LTACH. Each hospital administration and clinical staff developed their own set of processes and procedures that they thought would improve patterns of lab utilization in their facility. Specific action plans developed at each LTACH were not examined separately or analyzed for their ability to impact levels of lab test utilization; therefore, it is not possible to infer which processes were most effective in optimizing lab test utilization.

Implementation of the CVP has resulted in reduction of variability in lab test utilization through different combinations of policies and procedures, in multiple LTACHs. The process of establishing an initial hospital administrative and clinical staff meeting focused solely on lab test utilization, together with recent lab test utilization data and the development and deployment of tailored lab utilization strategies, can result in reduced lab utilization variability in LTACHs with relatively high utilization rates. Reduced lab test utilization variability can result in a significantly lower overall utilization rate without negatively impacting quality outcomes.

Table 2. List of processes implemented to improve patterns of laboratory test utilization

1	Determine the clinical reasoning behind the most frequently ordered lab tests.
2	Present comprehensive aggregate data to physicians: case mix index, lab test costs, budgeted goals, outcomes, quality metrics, trends, and individual physician ordering practices.
3	Provide information from peer-reviewed publications that include evidence-based lab utilization practices for the patient populations being treated.
4	Provide information on the potential clinical implications of lab ordering patterns.
5	Provide comparative data from other units or hospitals that have different patterns of lab test utilization but have similar types of patients or similar case mix index values.
6	Select a physician champion who will organize educational sessions and provide the information required for improving lab test utilization.
7	Develop goals and a method for measuring and communicating successful lab test utilization management through frequent meetings that will sustain practice changes.
8	Reduce or eliminate standing orders for lab tests.
9	Determine whether specific directives are necessary, e.g., having blood drawn on specific days unless there is a specific medical necessity.
10	Engage all executive administrative staff and provide effective and nonjudgmental communication to all physicians involved in patient care.

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