ORIGINAL RESEARCH

The Assessment of Stat Laboratory Test Ordering Practice and Impact of Targeted Individual Feedback in an Urban Teaching Hospital

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BACKGROUND: Overuse of inpatient stat laboratory orders ("stat" is an abbreviation of the Latin word "statim," meaning immediately, without delay) is a major problem in the modern healthcare system.

OBJECTIVE: To understand patterns of stat laboratory ordering practices at our institution and to assess the effectiveness of individual feedback in reducing these orders.

INTERVENTION: Medicine and General Surgery residents were given a teaching session about appropriate stat ordering practice in January 2010. Individual feedback was given to providers who were the highest utilizers of stat laboratory orders by their direct supervisors from February through June of 2010.

MEASUREMENTS: The proportion of stat orders out of total laboratory orders per provider was the main outcome measure. All inpatient laboratory orders from September 2009 to June 2010 were analyzed.

RESULTS: The median proportion of stat orders out of total laboratory orders was 41.6% for nontrainee pro-

viders (N = 500), 38.7% for Medicine residents (N = 125), 80.2% for General Surgery residents (N = 32), and 24.2% for other trainee providers (N = 150). Among 27 providers who received feedback (7 nontrainees, 16 Medicine residents, and 4 General Surgery residents), the proportion of stat laboratory orders per provider decreased by 15.7% (95% confidence interval: 5.6%-25.9%, *P* = 0.004) after feedback, whereas the decrease among providers who were high utilizers but did not receive feedback (N = 39) was not significant (4.5%; 95% confidence interval: 2.1%-11.0%, *P* = 0.18). Monthly trends showed reduction in the proportion of stat orders among Medicine and General Surgery residents, but not among other trainee providers.

CONCLUSIONS: The frequency of stat ordering was highly variable among providers. Individual feedback to the highest utilizers of stat orders was effective in decreasing these orders. *Journal of Hospital Medicine* 2014;9:13–18. © 2013 Society of Hospital Medicine

Overuse of inpatient stat laboratory orders ("stat" is an abbreviation of the Latin word *statim*, meaning "immediately, without delay"; alternatively, some consider it an acronym for "short turnaround time") is a major problem in the modern healthcare system.[1–5] Ordering laboratory tests "stat" is a common way to expedite processing, with expectation of results being reported within 1 hour from the time ordered, according to the College of American Pathologists.[6] However, stat orders are also requested for convenience,[2] to expedite discharge,[7] or to meet expectation of turnaround times.[8–10] Overuse of stat orders

increases cost and may reduce the effectiveness of a system. Reduction of excessive stat order requests helps support safe and efficient patient care[11,12] and may reduce laboratory costs.[13,14]

Several studies have examined interventions to optimize stat laboratory utilization.[14,15] Potentially effective interventions include establishment of stat ordering guidelines, utilization of point-of-care testing, and prompt feedback via computerized physician order entry (CPOE) systems.[16–18] However, limited evidence is available regarding the effectiveness of audit and feedback in reducing stat ordering frequency.

Our institution shared the challenge of a high frequency of stat laboratory test orders. An interdisciplinary working group comprising leadership in the medicine, surgery, informatics, laboratory medicine, and quality and patient safety departments was formed to approach this problem and identify potential interventions. The objectives of this study are to describe the patterns of stat orders at our institution as well as to assess the effectiveness of the targeted individual feedback intervention in reducing utilization of stat laboratory test orders.

METHODS

Design

This study is a retrospective analysis of administrative data for a quality-improvement project. The study was deemed exempt from review by the Beth Israel Medical Center Institutional Review Board.

Setting

Beth Israel Medical Center is an 856-bed, urban, tertiary-care teaching hospital with a capacity of 504 medical and surgical beds. In October 2009, 47.8% of inpatient laboratory tests (excluding the emergency department) were ordered as stat, according to an electronic audit of our institution's CPOE system, GE Centricity Enterprise (GE Medical Systems Information Technologies, Milwaukee, WI). Another audit using the same data query for the period of December 2009 revealed that 50 of 488 providers (attending physicians, nurse practitioners, physician assistants, fellows, and residents) accounted for 51% of total stat laboratory orders, and that Medicine and General Surgery residents accounted for 43 of these 50 providers. These findings prompted us to develop interventions that targeted high utilizers of stat laboratory orders, especially Medicine and General Surgery residents.

Teaching Session

Medicine and General Surgery residents were given a 1-hour educational session at a teaching conference in January 2010. At this session, residents were instructed that ordering stat laboratory tests was appropriate when the results were needed urgently to make clinical decisions as quickly as possible. This session also explained the potential consequences associated with excessive stat laboratory orders and provided department-specific data on current stat laboratory utilization.

Individual Feedback

From January to May 2010, a list of stat laboratory orders by provider was generated each month by the laboratory department's database. The top 10 providers who most frequently placed stat orders were identified and given individual feedback by their direct supervisors based on data from the prior month (feedback provided from February to June 2010). Medicine and General Surgery residents were counseled by their residency program directors, and nontrainee providers by their immediate supervising physicians. Feedback and counseling were given via brief individual meetings, phone calls, or e-mail. Supervisors chose the method that ensured the most timely delivery of feedback. Feedback and counseling consisted of explaining the effort to reduce stat laboratory ordering and the rationale behind this, alerting providers that they were outliers, and encouraging them to change their behavior. No punitive consequences were discussed; the feedback sessions were purely informative in nature. When an individual was ranked again in the top 10 after receiving feedback, he or she received repeated feedback.

Data Collection and Measured Outcomes

We retrospectively collected data on monthly laboratory test orders by providers from September 2009 to June 2010. The data were extracted from the electronic medical record (EMR) system and included any inpatient laboratory orders at the institution. Laboratory orders placed in the emergency department were excluded. Providers were divided into nontrainees (attending physicians, nurse practitioners, and physician assistants) and trainee providers (residents and fellows). Trainee providers were further categorized by educational levels (postgraduate year [PGY]-1 vs PGY-2 or higher) and specialty (Medicine vs General Surgery vs "other"). Fellows in medical and surgical subspecialties were categorized as "other."

The primary outcome measure was the proportion of stat orders out of total laboratory orders for individuals. The proportion of stat orders out of total orders was selected to assess individuals' tendency to utilize stat laboratory orders.

Statistical Analysis

In the first analysis, stat and total laboratory orders were aggregated for each provider. Providers who ordered <10 laboratory tests during the study period were excluded. We calculated the proportion of stat out of total laboratory orders for each provider, and compared it by specialty, by educational level, and by feedback status. Median and interquartile range (IQR) were reported due to non-normal distribution, and the Wilcoxon rank-sum test was used for comparisons.

In the second analysis, we determined pre-feedback and post-feedback periods for providers who received feedback. The feedback month was defined as the month immediately after a provider was ranked in the top 10 for the first time during the intervention period. For each provider, stat orders and total laboratory orders during months before and after the feedback month, excluding the feedback month, were calculated. The change in the proportion of stat laboratory orders out of all orders from pre- to post-feedback was then calculated for each provider for whom both pre- and post-feedback data were available. Because providers may have utilized an unusually high proportion of stat orders during the months in which they were ranked in the top 10 (for example, due to being on rotations in which many orders are placed stat, such as the intensive care units), we conducted a sensitivity analysis excluding those months. Further, for comparison, we conducted the same analysis for providers who did not receive feedback and were ranked 11 to 30 in any month during the intervention period. In those providers, we considered the month immediately after a

TABLE 1. Proportion of Stat Laboratory Orders by Provider, Comparison by Feedback Status

	All Providers		Feedback Given		Feedback Not Given		
	N	Stat %	N	Stat %	N	Stat %	P Value*
Total	807	40 (15.8–69.0)	37	72.4 (55.0–89.5)	770	39.0 (14.9–65.7)	<0.001
Nontrainee providers†	500	41.6 (13.5–71.5)	8	91.7 (64.0–97.5)	492	40.2 (13.2–70.9)	<0.001
Trainee providers‡	307	37.8 (19.1–62.7)	29	69.3 (44.3–80.9)	278	35.1 (17.6–55.6)	<0.001
Medicine	125	38.7 (26.8–50.4)	21	58.8 (36.8–72.6)	104	36.1 (25.9–45.6)	<0.001
PGY-1	54	28.1 (23.9–35.2)	5	32.0 (25.5–36.8)	49	27.9 (23.5–34.6)	0.52
PGY-2 and higher	71	46.5 (39.1–60.4)	16	63.9 (54.5–75.7)	55	45.1 (36.5–54.9)	<0.001
General surgery	32	80.2 (69.6–90.1)	8	89.5 (79.3–92.7)	24	78.7 (67.9–87.4)	<0.05
PGY-1	16	86.4 (79.1–91.1)	8	89.5 (79.3–92.7)	8	84.0 (73.2–89.1)	0.25
PGY-2 and higher	16	74.4 (65.4–85.3)					
Other	150	24.2 (9.0–55.0)					
PGY-1	31	28.2 (18.4–78.3)					
PGY-2 or higher	119	20.9 (5.6–51.3)					

NOTE: Values for Stat % are given as median (IQR). **Abbreviations:** IQR, interquartile range; PGY, postgraduate year; Stat, immediately.

*P value is for comparison between providers who received feedback vs those who did not.

†Nontrainee providers are attending physicians, nurse practitioners, and physician assistants.

‡Trainee providers are residents and fellows.

provider was ranked in the 11 to 30 range for the first time as the hypothetical feedback month. The proportional change in the stat laboratory ordering was analyzed using the paired Student *t* test.

In the third analysis, we calculated the proportion of stat laboratory orders each month for each provider. Individual provider data were excluded if total laboratory orders for the month were <10. We then calculated the average proportion of stat orders for each specialty and educational level among trainee providers every month, and plotted and compared the trends.

All analyses were performed with JMP software version 9.0 (SAS Institute, Inc., Cary, NC). All statistical tests were 2-sided, and $P < 0.05$ was considered significant.

RESULTS

We identified 1045 providers who ordered ≥1 laboratory test from September 2009 to June 2010. Of those, 716 were nontrainee providers and 329 were trainee providers. Among the trainee providers, 126 were Medicine residents, 33 were General Surgery residents, and 103 were PGY-1. A total of 772,734 laboratory tests were ordered during the study period, and 349,658 (45.2%) tests were ordered as stat. Of all stat orders, 179,901 (51.5%) were ordered by Medicine residents and 52,225 (14.9%) were ordered by General Surgery residents.

Thirty-seven providers received individual feedback during the intervention period. This group consisted of 8 nontrainee providers (nurse practitioners and physician assistants), 21 Medicine residents (5 were PGY-1), and 8 General Surgery residents (all PGY-1). This group ordered a total of 84,435 stat laboratory tests from September 2009 to June 2010 and was responsible for 24.2% of all stat laboratory test orders at the institution.

Provider Analysis

After exclusion of providers who ordered <10 laboratory tests from September 2009 to June 2010, a total of 807 providers remained. The median proportion of stat orders out of total orders was 40% among all providers and 41.6% for nontrainee providers (N = 500), 38.7% for Medicine residents (N = 125), 80.2% for General Surgery residents (N = 32), and 24.2% for other trainee providers (N = 150). The proportion of stat orders differed significantly by specialty and educational level, but also even among providers in the same specialty at the same educational level. Among PGY-1 residents, the stat-ordering proportion ranged from 6.9% to 49.1% for Medicine (N = 54) and 69.0% to 97.1% for General Surgery (N = 16). The proportion of stat orders was significantly higher among providers who received feedback compared with those who did not (median, 72.4% [IQR, 55.0%–89.5%] vs 39.0% [IQR, 14.9%–65.7%], $P < 0.001$). When stratified by specialty and educational level, the statistical significance remained in nontrainee providers and trainee providers with higher educational level, but not in PGY-1 residents (Table 1).

Stat Ordering Pattern Change by Individual Feedback

Among 37 providers who received individual feedback, 8 providers were ranked in the top 10 more than once and received repeated feedback. Twenty-seven of 37 providers had both pre-feedback and post-feedback data and were included in the analysis. Of those, 7 were nontrainee providers, 16 were Medicine residents (5 were PGY-1), and 4 were General Surgery residents (all PGY-1). The proportion of stat laboratory orders per provider decreased by 15.7% (95% confidence interval [CI]: 5.6% to 25.9%, $P = 0.004$) after feedback (Table 2). The decrease remained significant after excluding the months in

TABLE 2. Stat Laboratory Ordering Practice Changes Among Providers Receiving Feedback and Those Not Receiving Feedback

| | Top 10 Providers (Received Feedback) | | | | | Providers Ranked in 11–30 (No Feedback) | | | | |
| | Mean Stat % | | | | | Mean Stat % | | | |
	N	Pre	Post	Mean Difference (95% CI)	P Value	N	Pre	Post	Mean Difference (95% CI)	P Value
Total	27	71.2	55.5	−15.7 (−25.9 to −5.6)	0.004	39	64.6	60.2	−4.5 (−11.0 to 2.1)	0.18
Nontrainee providers	7	94.6	73.2	−21.4 (−46.9 to 4.1)	0.09	12	84.4	80.6	−3.8 (−11.9 to 4.3)	0.32
Trainee providers	20	63.0	49.3	−13.7 (−25.6 to −1.9)	0.03	27	55.8	51.1	−4.7 (−13.9 to 4.4)	0.30
Medicine	16	55.8	45.0	−10.8 (−23.3 to 1.6)	0.08	21	46.2	41.3	−4.8 (−16.3 to 6.7)	0.39
General Surgery	4	91.9	66.4	−25.4 (−78.9 to 28.0)	0.23	6	89.6	85.2	−4.4 (−20.5 to 11.6)	0.51
PGY-1	9	58.9	47.7	−11.2 (−32.0 to 9.5)	0.25	15	55.2	49.2	−6.0 (−18.9 to 6.9)	0.33
PGY-2 or Higher	11	66.4	50.6	−15.8 (−32.7 to 1.1)	0.06	12	56.6	53.5	−3.1 (−18.3 to 12.1)	0.66

NOTE: **Abbreviations:** CI, confidence interval; PGY, postgraduate year; Stat, immediately.

which providers were ranked in the top 10 (11.4%; 95% CI: 0.7% to 22.1%, $P = 0.04$).

In comparison, a total of 57 providers who did not receive feedback were in the 11 to 30 range during the intervention period. Three Obstetrics and Gynecology residents and 3 Family Medicine residents were excluded from the analysis to match specialty with providers who received feedback. Thirty-nine of 51 providers had adequate data and were included in the analysis, comprising 12 nontrainee providers, 21 Medicine residents (10 were PGY-1), and 6 General Surgery residents (5 were PGY-1). Among them, the proportion of stat laboratory orders per provider did not change significantly, with a 4.5% decrease (95% CI: −2.1% to 11.0%, $P = 0.18$; Table 2).

Stat Ordering Trends Among Trainee Providers

After exclusion of data for the month with <10 total laboratory tests per provider, a total of 303 trainee providers remained, providing 2322 data points for analysis. Of the 303, 125 were Medicine residents (54 were PGY-1), 32 were General Surgery residents (16 were PGY-1), and 146 were others (31 were PGY-1). The monthly trends for the average proportion of stat orders among those providers are shown in Figure 1. The decrease in the proportion of stat orders was observed after January 2010 in Medicine and General Surgery residents both in PGY-1 and PGY-2 or higher, but no change was observed in other trainee providers.

DISCUSSION

We describe a series of interventions implemented at our institution to decrease the utilization of stat laboratory orders. Based on an audit of laboratory-ordering data, we decided to target high utilizers of stat laboratory tests, especially Medicine and General Surgery residents. After presenting an educational session to those residents, we gave individual feedback to the highest utilizers of stat laboratory orders. Providers who received feedback decreased their utilization of stat laboratory orders, but the stat ordering pattern did not change among those who did not receive feedback.

The individual feedback intervention involved key stakeholders for resident and nontrainee provider education (directors of the Medicine and General Surgery residency programs and other direct clinical supervisors). The targeted feedback was delivered via direct supervisors and was provided more than once as needed, which are key factors for effective feedback in modifying behavior in professional practice.[19] Allowing the supervisors to choose the most appropriate form of feedback for each individual (meetings, phone calls, or e-mail) enabled timely and individually tailored feedback and contributed to successful implementation. We feel intervention had high educational value for residents, as it promoted residents' engagement in proper systems-based practice, one of the 6 core competencies of the Accreditation Council for Graduate Medical Education (ACGME).

We utilized the EMR to obtain provider-specific data for feedback and analysis. As previously suggested, the use of the EMR for audit and feedback was effective in providing timely, actionable, and individualized feedback with peer benchmarking.[20,21] We used the raw number of stat laboratory orders for audit and the proportion of stat orders out of total orders to assess the individual behavioral patterns. Although the proportional use of stat orders is affected by patient acuity and workplace or rotation site, it also seems largely affected by provider's preference or practice patterns, as we saw the variance among providers of the same specialty and educational level. The changes in the stat ordering trends only seen among Medicine and General Surgery residents suggests that our interventions successfully decreased the overall utilization of stat laboratory orders among targeted providers, and it seems less likely that those decreases are due to changes in patient acuity, changes in rotation sites, or learning curve among trainee providers. When averaged over the 10-month study period, as shown in Table 1, the providers who received feedback ordered a higher
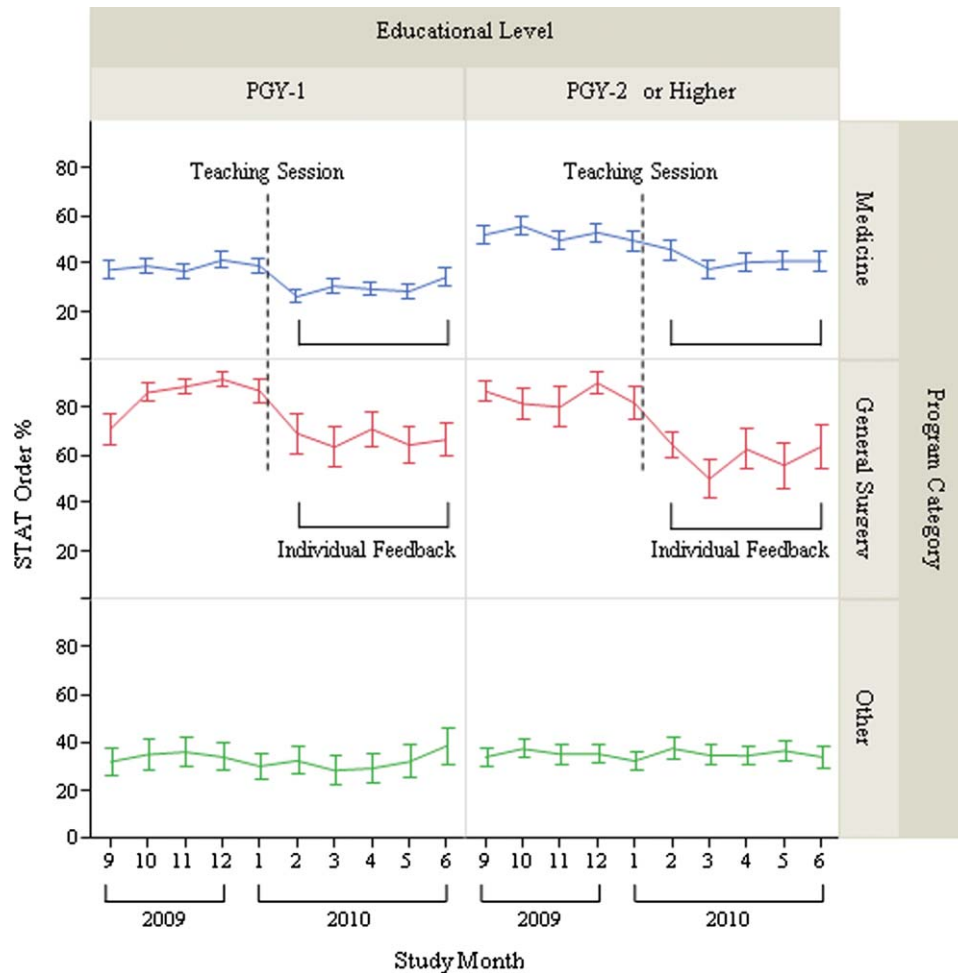
FIG. 1. Monthly trends for the average proportion of stat orders among those providers. Abbreviations: PGY, postgraduate year; stat, immediately.

proportion of stat tests than those who did not receive feedback, except for PGY-1 residents. This suggests that although auditing based on the number of stat laboratory orders identified providers who tended to order more stat tests than others, it may not be a reliable indicator for PGY-1 residents, whose number of laboratory orders highly fluctuates by rotation.

There are certain limitations to our study. First, we assumed that the top utilizers were inappropriately ordering stat laboratory tests. Because there is no clear consensus as to what constitutes appropriate stat testing,[7] it was difficult, if not impossible, to determine which specific orders were inappropriate. However, high variability of the stat ordering pattern in the analysis provides some evidence that high stat utilizers customarily order more stat testing as compared with others. A recent study also revealed that the median stat ordering percentage was 35.9% among 52 US institutions.[13] At our institution, 47.8% of laboratory tests were ordered stat prior to the intervention, higher than the benchmark, providing the rationale for our intervention.

Second, the intervention was conducted in a time-series fashion and no randomization was employed. The comparison of providers who received feedback with those who did not is subject to selection bias, and the difference in the change in stat ordering pattern between these 2 groups may be partially due to variability of work location, rotation type, or acuity of patients. However, we performed a sensitivity analysis excluding the months when the providers were ranked in the top 10, assuming that they may have ordered an unusually high proportion of stat tests due to high acuity of patients (eg, rotation in the intensive care units) during those months. Robust results in this analysis support our contention that individual feedback was effective. In addition, we cannot completely rule out the possibility that the changes in stat ordering practice may be solely due to natural maturation effects within an academic year among trainee providers, especially PGY-1 residents. However, relatively acute changes in the stat ordering trends only among targeted provider groups around January 2010, corresponding to the timing of interventions, suggest otherwise.

Third, we were not able to test if the intervention or decrease in stat orders adversely affected patient care. For example, if, after receiving feedback, providers did not order some tests stat that should have been ordered that way, this could have negatively affected patient care. Additionally, we did not evaluate whether reduction in stat laboratory orders improved timeliness of the reporting of stat laboratory results.

Lastly, the sustained effect and feasibility of this intervention were not tested. Past studies suggest educational interventions in laboratory ordering behavior would most likely need to be continued to maintain its effectiveness.[22,23] Although we acknowledge that sustainability of this type of intervention may be difficult, we feel we have demonstrated that there is still value associated with giving personalized feedback.

This study has implications for future interventions and research. Use of automated, EMR-based feedback on laboratory ordering performance may be effective in reducing excessive stat ordering and may obviate the need for time-consuming efforts by supervisors. Development of quality indicators that more accurately assess stat ordering patterns, potentially adjusted for working sites and patient acuity, may be necessary. Studies that measure the impact of decreasing stat laboratory orders on turnaround times and cost may be of value.

CONCLUSION

At our urban, tertiary-care teaching institution, stat ordering frequency was highly variable among providers. Targeted individual feedback to providers who ordered a large number of stat laboratory tests decreased their stat laboratory order utilization.

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