

Audit-and-Feedback Utilizing Resident Consensus Standards Reduced Daily Labs

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ABSTRACT

Background The Choosing Wisely campaign recommends that clinicians avoid repetitive laboratory testing in hospitalized patients who have clinical and laboratory stability; however, it is unclear how physicians define laboratory stability, or how they adhere to their own definition.

Objective To quantify and compare what internal medicine residents and hospitalists consider a stable complete blood count (CBC) and chemistry panel, and to assess an audit-and-feedback intervention on residents, utilizing resident definitions of lab stability.

Methods We used a 2-round consensus survey in 2023 to survey residents and hospitalists to determine consensus definitions of a stable CBC and chemistry panel. We then performed a 21-week audit-and-feedback intervention, providing residents weekly feedback of adherence to their cohort's lab stability definitions. Percent of stable lab panels repeated was compared at baseline, during, and after the intervention.

Results In our survey, residents (response rates 55 of 191, 29%; then 32 of 191, 17%) considered smaller day-to-day changes in complete blood count parameters as actionable compared to hospitalists (response rates 47 of 237, 20%; then 59 of 237, 25%). At baseline, residents repeated stable CBCs more often than hospitalists (1060 of 1566, 68% [95% CI, 65-70] vs 52 of 96, 54% [95% CI, 44-64], $P=.005$). During the intervention, residents repeated fewer stable CBCs (393 of 729, 54% [95% CI, 50-57], $P<.001$) a reduction sustained at 6-months (635 of 1083, 59% [95% CI, 56-62], $P<.001$).

Conclusions Residents more frequently repeated CBCs that their cohort termed "stable" than did hospitalists. When residents were given feedback on adherence to their cohort's lab stability criteria, there was a sustained reduction in the number of CBCs they ordered.

Introduction

Daily lab testing in hospitalized patients can lead to iatrogenic anemia, patient discomfort, sleep disruption, and strain on laboratory staff.¹⁻⁴ Reasons for ordering unnecessary laboratory tests are magnified in residency, such as inexperience, discomfort with diagnostic uncertainty, and fear that attending physicians may be critical if the test were not ordered.⁵ However, residency training is an important period for developing habits in high-value care.⁶ Our residency program has no formal curriculum for lab ordering.

The Choosing Wisely campaign recommends to "not perform repetitive complete blood count (CBC) and chemistry testing in the face of clinical and lab stability."⁷ Clinical stability generally refers to resolution of vital sign abnormalities and absence of new or changing symptoms.^{8,9} Recognizing clinical (in)stability is a core aspect of internal medicine residency training, but precisely what constitutes lab stability may vary depending on training level and experience.

Studies have quantified day-to-day variability in hospital lab values, but none have assessed how clinicians of different training levels interpret this when ordering additional daily tests.^{10,11} Audit-and-feedback is a proven strategy to reduce daily lab testing; however, no intervention has used standards developed by residents to give feedback on how often they adhere to their own criteria for lab stability.^{11,12} This study sought to (1) compare internal medicine residents' and hospitalists' thresholds for rechecking commonly trended inpatient labs to assess differences related to clinical experience, and (2) determine if resident lab ordering behavior changed when given regular feedback on their adherence to their own definition of stable labs.

Methods

Setting and Participants

This study involved a university-based internal medicine residency program (191 residents) affiliated with 4 hospitals. Residents and hospitalists manage patients with similar acuity and length of stay (LOS) across sites. Due to data availability, the audit-and-feedback intervention occurred only at the Durham Veterans

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Editor's Note: The online supplementary data contains the surveys used in the study and further data from the study.

Affairs (VA) hospital, a 151-bed tertiary referral center with 8 resident teams and one hospitalist team caring for non-ICU medical patients.

Defining Stability: We surveyed 2 groups in January 2023 using a 2-round consensus approach: internal medicine residents (n=191) and hospitalists (n=237) from the residency-affiliated hospitals. The survey asked, “What change (between daily labs) of the below lab tests do you feel would itself justify a recheck sometime in the next 28 hours?” The survey asked about 5 common lab tests that are often ordered on consecutive days for general medicine inpatients: hemoglobin (Hgb), white blood cell count (WBC), platelet count (Plt), serum sodium (Na), and estimated glomerular filtration rate (eGFR). The survey stated that in these hypothetical scenarios, the baseline (or most recent) value for WBC, Plt, and Na were all within normal limits (eg, “How much would a previously normal Plt count have to change between daily checks in a clinically stable patient for you to want to recheck a Plt count the next day?”) To allow for stable anemia, which is common among hospitalized adults, respondents were instructed to answer as if the most recent Hgb was at least 9 g/dL (online supplementary data). The survey used eGFR instead of creatinine due to creatinine’s non-linear relationship with renal function.

The survey was distributed via email. The initial round requested free-text responses, and the second round narrowed the choices to the top 3 initial survey responses for each question in each group (online supplementary data). The response with the most votes in the second round of the survey was identified as the stability threshold for each laboratory test, thus defining 2 sets of stability thresholds: one for residents and one for hospitalists.

Audit-and-Feedback Intervention: Before the intervention, residents were informed via email and brief presentation of (1) the resident survey-defined lab stability criteria; (2) the frequency of daily lab ordering

KEY POINTS

What Is Known

While attention to reducing waste in health care has increased the number of guidelines seeking to reduce unnecessary laboratory testing, validity data is needed around use of these tools.

What Is New

This study of implementation of Choosing Wisely guidelines to avoid repetitive lab testing in stable patients reports on one internal medicine program’s definitions of “stable” complete blood count, and how they adhered to their own definition.

Bottom Line

The implementation and results of this practical quality improvement project gives programs looking to decrease unnecessary testing a way forward.

from the past 6 months; (3) the harms of unnecessary lab testing; and (4) the upcoming audit-and-feedback intervention. Infographics were also hung up in resident workrooms to reinforce their lab stability criteria (online supplementary data FIGURE 1). Internal medicine resident lab ordering on non-ICU inpatient general medicine services at the Durham VA hospital was then audited, and weekly aggregated feedback was sent to each team (intern and resident) for 21 weeks, from February to July 2023, on the frequency of daily lab testing being done despite preceding stable labs. Stable labs were defined as 2 lab panels collected within 32 hours with insignificant interval changes, as defined in the survey (TABLE 1, online supplementary data TABLE). Feedback was delivered by a chief resident via instant messaging as a scorecard displaying each general medicine team’s count of additional daily CBCs and chemistry panels after lab stability (FIGURE 1). To ensure psychological safety, the identity of the other teams was blinded. Residents were encouraged to check labs every 2 or 3 days in clinically and lab-stable patients. Starting in May 2023, to increase engagement in the intervention, the team with the fewest repeated stable labs from the prior month was recognized as the “High Value Team of the Month” via email to the residency program and

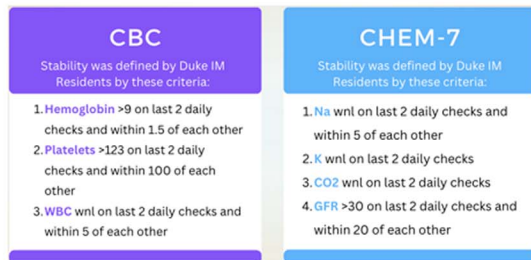
TABLE 1

Consensus Survey Results Showing Resident and Hospitalist Thresholds to Repeat a Daily Lab Based on Day-to-Day Changes in Lab Values, in the Absence of Clinical Changes

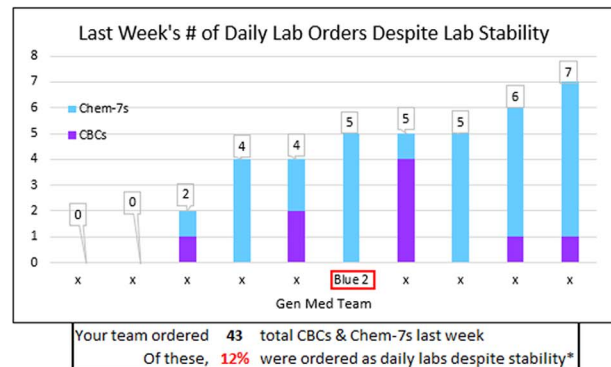
	Residents	Hospitalists
Hgb (when most recent value is >9 g/dL)	Decrease by 1.5 g/dl	Decrease by 2 g/dl
Plt (when most recent value is wnl)	Decrease by 100 K/mm ³	Would not repeat
WBC (when most recent value is wnl)	Change of ± 5 K/mm ³	Would not repeat
Na (when most recent value is wnl)	Change of ± 5 mmol/L	Change of ± 5 mmol/L
eGFR	Decrease of 20 mL/min/1.73 m ²	Decrease of 20 mL/min/1.73 m ²

Abbreviations: Hgb, hemoglobin; Plt, platelet count; WBC, white blood cell count; Na, sodium; eGFR, estimated glomerular filtration rate; wnl, within normal limits.

This feedback is not used for evaluation purposes and is only being sent to the intern and JAR for awareness of daily lab ordering practices compared to peers.



*There will be times when it is appropriate to check these labs daily despite these criteria. For example, if a patient has a change in clinical status, or is started on a medication that requires close lab monitoring (Vancomycin, Heparin gtt, etc), it may be appropriate to check these labs 3+ days in a row.



SHM: "Don't perform repetitive CBC and chemistry testing in the face of clinical and lab stability"

FIGURE 1

Example of a Lab Scorecard Distributed to Each General Medicine Team Weekly via Electronic Chat Message

Abbreviations: JAR, junior assistant resident; CBC, complete blood count; WBC, white blood cell count; Na, sodium; wnl, within normal limits; K, potassium; GFR, glomerular filtration rate; SHM, Society of Hospital Medicine.

brief congratulations at start of a resident conference. Hospitalists did not receive any feedback and were sent survey results in November 2023.

Measures: The outcome measure was the percent of stable CBC and chemistry panels that were repeated within 32 hours. Baseline lab ordering data was retrospectively collected from July 2022 to February 2023, and prospectively collected from February 2023 through December 2023. All laboratory ordering data were extracted from the electronic medical record, and statistical process control (SPC) p-charts were developed using QI Macros (KnowWare International Inc). As a process measure, lab scorecard message views were initially tracked.¹³ However, tracking was abandoned at week 3 after 100% of scorecard messages were "viewed," indicating only that the messages were opened, potentially just to clear alerts. Balancing measures included LOS, number of rapid response team alerts, and code blue alerts per month. To detect a possible impact on phlebotomist workflow, the monthly number of patient-declined phlebotomy visits was tracked.

Analyses: Resident and hospitalist lab ordering in the 32-week baseline period was compared using 2-proportion Z-tests. Baseline resident ordering was compared during and after the intervention using both 2-proportion Z-tests and SPC p-charts with Montgomery rules for special cause variation, with split limit analysis using a pragmatic approach performed at the time of intervention.¹⁴ Hospitalist lab ordering was evaluated for special cause variation with SPC p-charts. Balancing measures were evaluated with unpaired *t* tests comparing pre- and post-intervention periods.

This study was exempted from review by the Durham VA Institutional Review Board.

Results

Lab Stability Definitions

The survey response rate for residents was 55 of 191 (29%) for the first round and 32 of 191 (17%) for the second round. The hospitalist response rate was 47 of 237 (20%) for the first round and 59 of 237 (25%) for the second. Resident and hospitalist definitions of individual lab test stability are shown in TABLE 1.

Audit-and-Feedback Intervention

At baseline residents repeated stable CBCs more often than hospitalists (1060 of 1566, 68% [95% CI, 65-70] vs 52 of 96, 54% [95% CI, 44-64], $P=.005$), but stable chemistry panels were repeated similarly (1215 of 1631, 74% [95% CI, 72-77] vs 82 of 124, 66% [95% CI, 57-74], $P=.056$). During the intervention, the mean percent of stable CBCs repeated by residents decreased from 68% to 54% (393 of 729 [95% CI, 50-57], $P<.001$) and then remained decreased in the 6 months after the intervention compared to baseline (635 of 1083, 59% [95% CI, 56-62], $P<.001$; FIGURE 2). The mean percent of resident chemistry panels repeated decreased from 74% at baseline to 69% during the intervention (697 of 1009 [95% CI, 66-72], $P=.005$), but returned to baseline after the intervention (1072 of 1461, 73% [95% CI, 71-76], $P=.529$; FIGURE 3). The SPC charts for resident labs did not detect special cause variation in the baseline, intervention, or post-intervention periods (FIGURES 2 and 3). No special cause signal was identified in hospitalists' ordering

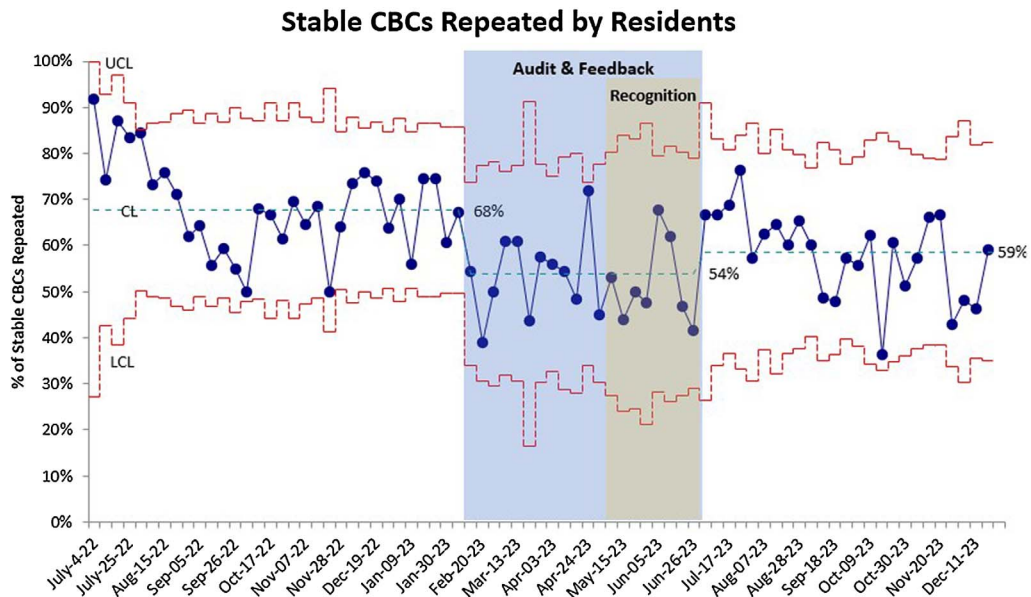


FIGURE 2
 Statistical Process Control Chart (p-chart) Showing the Percentage of Stable CBCs That Residents Repeated Within 32 hours

Abbreviations: CBC, complete blood count; UCL, upper control limit; CL, center line; LCL, lower control limit.
 Note: CBC stability was defined by the resident consensus survey. Split limit analysis was performed using a pragmatic approach. Baseline: mean 68%, range 42%. During-intervention: mean 54%, range 33%. Post-intervention: mean 59%, range 40%.

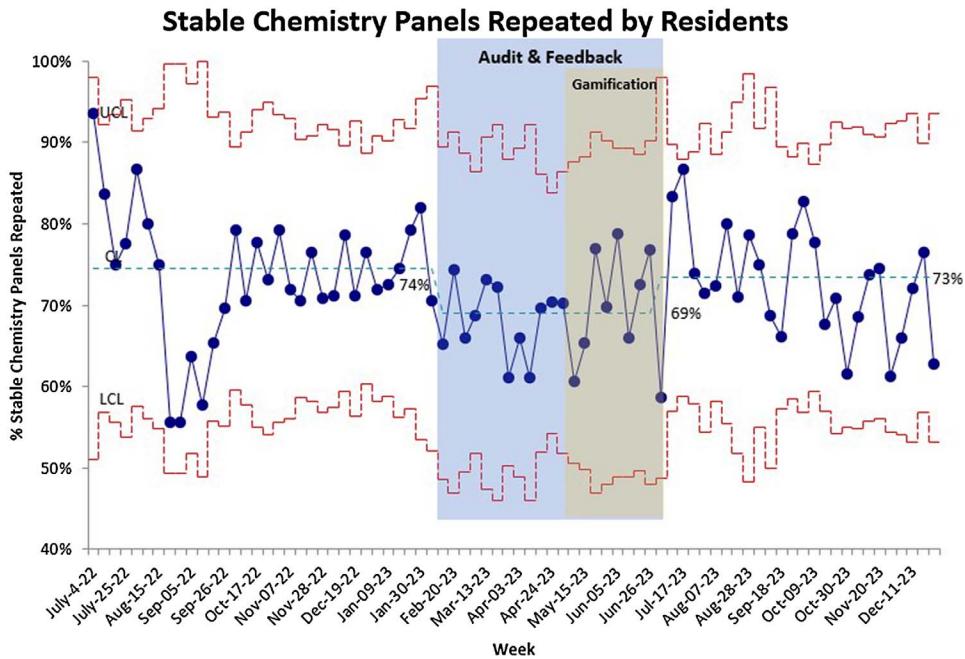


FIGURE 3
 Statistical Process Control Chart (p-chart) Showing the Percentage of Stable Chemistry Panels That Residents Repeated Within 32 hours

Abbreviations: UCL, upper control limit; CL, center line; LCL, lower control limit.
 Note: Chemistry panel stability was defined by the resident consensus survey. Split limit analysis was performed using a pragmatic approach. Baseline: mean 74%, range 38%. During-intervention: mean 69%, range 18%. Post-intervention: mean 73%, range 28%.

of CBCs during the study period (online supplementary data FIGURE 2). A special cause signal of astronomical data point was identified in the hospitalists' chemistry panel order in October 2023 (online supplementary data FIGURE 3).

The mean number of patient-declined laboratory draws per month was lower in the 8 months after starting the intervention (87 vs 37, $P=.001$). Balancing measures were similar before and after the intervention: LOS (6.2 vs 6.3 days, $P=.881$), rapid response team alerts per month (10.4 vs 14.4, $P=.138$), and code blue alerts per month (3.4 vs 2.6, $P=.478$).

Discussion

This study illustrates that internal medicine residents at our institution have lower thresholds than hospitalists for repeating CBCs in response to day-to-day changes in values. We also demonstrated that an audit-and-feedback intervention using the lab stability criteria established by residents led to a sustained reduction in CBC ordering, but only a transient reduction in chemistry panels. Hospitalists, who did not receive the intervention, had no change in their lab ordering practices over the same period.

This study's emphasis on lab stability is distinct from clinical appropriateness criteria, which has primarily been used to retrospectively identify inappropriate lab orders.¹⁵ Clinical appropriateness criteria for lab ordering typically do not account for laboratory trends or abnormal but stable lab values such as hemoglobin. Therefore, it is useful to understand how clinicians of different training levels may interpret day-to-day changes in commonly measured lab values and how these changes are acted upon in the clinical environment. Our finding that residents have a lower threshold for ordering repeating daily CBCs than hospitalists is consistent with previous findings that residents tend to order more CBCs than hospitalists.¹⁶ Our results suggest that this may be in part due to residents' lower threshold for repeating daily CBCs in response to day-to-day changes.

To our knowledge, this is the first published audit-and-feedback intervention that used lab stability criteria developed by residents themselves to impact lab ordering. The reduction seen in resident CBC ordering approximates 9 CBCs avoided per week on an average daily census of 64 inpatients. Our laboratory staff estimate each CBC can take up to 15 minutes to collect, process, and report. Thus, avoiding 9 CBCs per week could free up to 2.25 hours per week for laboratory staff to focus on patients requiring more prompt results.

Chemistry panel ordering is likely more challenging to impact than CBCs because many hospitalized patients require monitoring of electrolytes and renal

function for reasons unrelated to lab instability, such as during diuresis or when receiving intravenous antibiotics. The reduction in lab ordering by residents was likely due to the intervention because lab ordering by hospitalists, who did not receive the intervention, did not change. Hospitalist chemistry panel ordering showed a low astronomical point after the resident intervention, the significance of which is unclear but may be related to awareness of the recent resident intervention (online supplementary data FIGURE 3).

This intervention was conducted only at our VA hospital due to data availability. To strengthen our understanding of this intervention, the intervention could be sequentially introduced at each residency-affiliated hospital. The intervention concluded at the end of the academic year due to the first author's role change. This confounded interpretation of lab ordering post-intervention, as new interns are more likely to order unnecessary labs for reasons discussed above.⁷ To feasibly sustain the intervention long-term, administrative support for weekly data extraction would be required.

Our approach describes a framework that other groups could employ to impact the behavior of medical trainees. Engaging residents in developing their own standards, and publicly recognizing those who ordered fewer repeat labs, led to high acceptability among residents and may have contributed to the intervention's sustained effect. To expand on this work, we plan to survey residents to establish other standards for clinical practice and apply a similar audit-and-feedback intervention to those areas of clinical medicine.

Conclusions

Residents at our institution more frequently ordered additional daily CBCs than hospitalists after recent lab results had met their respective group's definition of stability. A sustained reduction in resident CBC ordering was seen following an audit-and-feedback intervention that used the residents' consensus criteria for repeating daily labs based on lab stability.

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