RESEARCH LETTER

LESS IS MORE

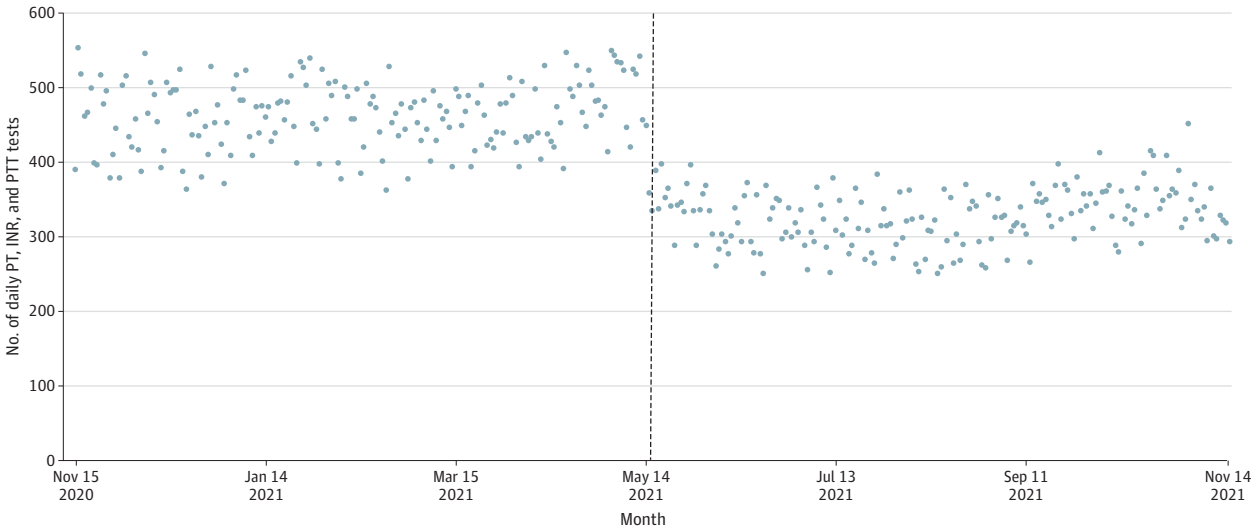
Evaluation of a Best Practice Advisory on Ordering Prothrombin Time, International Normalized Ratio, and Partial Thromboplastin Time Tests

Demand for citrate products increased in early 2021 because of rising COVID-19 infection rates and their use in COVID-19 vaccine development and therapeutics.[1] Thus, a shortage ensued of 3.2% sodium citrate laboratory tubes used primarily for prothrombin time (PT), international normalized ratio (INR), and partial thromboplastin time (PTT) testing. In June 2021, the US Food and Drug Administration added sodium citrate tubes to the device shortage list; currently, all blood specimen tubes are on the list.[2] Choosing Wisely Canada, a health education campaign, also issued recommendations in February 2022 to reduce coagulation testing, considering that several studies reported as few as 10% of PT and PTT tests were clinically indicated.[2-4] The aim of the present study was to evaluate whether a best practice advisory (BPA) changed the number of PT, INR, and PTT tests ordered.

Methods | In this quality improvement study, a BPA was instituted on May 15, 2021, at 1 academic hospital for adult patients (aged ≥18 years) who were hospitalized or presented to the emergency department. When clinicians ordered a PT, INR, or PTT test without other coagulation tests, the electronic medical record (EMR) displayed the message, "There is a national shortage on blue top tubes, and we request thoughtful restraint in reflexive ordering of PT/INR/PTT. Does this patient require PT/INR/PTT measurement?" and provided guidance on appropriate clinical scenarios. The message required acknowledgment but did not prohibit ordering. An email was also sent to all physicians detailing the conservation strategies. No other contaminating interventions in the weeks surrounding the BPA were identified because the US Food and Drug Administration added sodium citrate tubes to the device shortage list nearly a month later. An interrupted time series design was used to analyze changes in rates of PT, INR, and PTT testing between 6 months before (November 15, 2020-May 14, 2021) and 6 months after (May 15-November 14, 2021) the BPA. Data were analyzed using Stata, version 17 (StataCorp LLC). The University of Michigan Medical School Institutional Review Board deemed this study exempt from review because it was classified as a quality improvement study. The study followed the SQUIRE reporting guideline.

Results | Daily PT, INR, and PTT tests decreased from a mean 463.8 tests per day before to 329.0 per day after the BPA (-29.1%; $P < .001$). The reduction after the BPA was -31.4%, assuming that temporal trends (slopes) before and after the BPA were the same, and -26.0% when trends before and after the BPA were fitted separately ($P < .001$ for each). The trend for testing (ie, the slope) was slightly higher after the BPA (15 more tests per 100 days vs 10 more tests per 100 days before BPA; difference, 5 [95% CI, 0-10] tests per 100 days; $P = .07$). However, this trend was associated with less than a 10% reduc-

Figure. Number of Prothrombin Time (PT), International Normalized Ratio (INR), and Partial Thromboplastin Time (PTT) Laboratory Tests Collected During the Study Period



Circles represent the tests ordered. The dotted line shows when the best practices advisory was instituted on May 15, 2021.

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tion in the estimated effect size during the 6-month follow-up period (**Figure**).

Discussion | The COVID-19 pandemic necessitated innovations to ensure the provision of evidence-based care during a worldwide shortage of laboratory tubes commonly used for PT, INR, and PTT testing. Our findings suggest the BPA was associated with an immediate decrease in ordering of these tests, and the reduction persisted for 6 months. The BPA informed clinicians of a nationwide problem they may not have known about. The inclusion of guidance on appropriate clinical scenarios within the EMR may have contributed to the success of this intervention as well.[5,6]

Limitations of the study include the lack of data regarding clinical indication of the tests deferred and single-institution data. Given that the BPA was implemented when resources were scarce, the findings may not be representative of what a similar intervention would achieve when supplies are abundant.

A pandemic-created natural experiment highlighted the effectiveness of a BPA added to clinician communication to reduce potentially unnecessary care. As attention to low-value care grows, the addition of EMR-embedded decision-making tools may need to be considered and further evaluated.

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Author Contributions: Drs Bernstein and Hayward had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
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Acquisition, analysis, or interpretation of data: All authors.
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1. Sodium citrate blood specimen collection tube conservation strategies—letter to health care and laboratory personnel. US Food & Drug Administration. June 10, 2021. Updated January 19, 2022. Accessed January 20, 2022. https://www.fda.gov/medical-devices/letters-health-care-providers/sodium-citrate-blood-specimen-collection-tube-conservation-strategies-letter-health-care-and

2. Blood specimen collection tube shortage: frequently asked questions. US Food & Drug Administration. Updated January 19, 2022. Accessed January 20, 2022. https://www.fda.gov/medical-devices/coronavirus-covid-19-and-medical-devices/blood-specimen-collection-tube-shortage-frequently-asked-questions.

3. American Society for Clinical Laboratory Science: ten things physicians and patients should question. Choosing Wisely. Updated September 13, 2021. Accessed September 13, 2021. https://www.choosingwisely.org/societies/american-society-for-clinical-laboratory-science/.

4. Using labs wisely during global blood tube and other resource shortages. Choosing Wisely Canada. February 14, 2022. Accessed February 14, 2022. https://choosingwiselycanada.org/perspective/global-shortages/

5. Shojania KG, Jennings A, Mayhew A, Ramsay CR, Eccles MP, Grimshaw J. The effects of on-screen, point of care computer reminders on processes and outcomes of care. *Cochrane Database Syst Rev*. 2009;2009(3):CD001096.

6. Bejjanki H, Mramba LK, Beal SG, et al. The role of a best practice alert in the electronic medical record in reducing repetitive lab tests. *Clinicoecon Outcomes Res*. 2018;10:611-618. doi:10.2147/CEOR.S167499

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