ABSTRACT

The PT/INR (prothrombin time/international normalized ratio) and aPTT (activated partial thromboplastin time) were tests developed in the early 20th century for specific and unique indications. Despite this, they are often ordered together routinely. The objective of this study was to determine if a multimodal intervention could reduce PT/INR and aPTT testing in the emergency department (ED). This was a prospective multi-pronged quality improvement study at St. Michael’s Hospital. The initiative involved stakeholder engagement, uncoupling of PT/INR and aPTT testing, teaching, and most importantly a revision to the ED order panels. After changes to order panels, weekly rates of PT/INR and aPTT testing per 100 ED patients decreased (17.2 vs 38.4, rate ratio=0.45 (95% CI 0.43-0.47), p<0.001; 16.6 vs 37.8, rate ratio=0.44 (95% CI 0.42-0.46), p<0.001, respectively). Rate of creatinine testing per 100 ED patients, our internal control, increased during the same period (54.0 vs 49.7, rate ratio=1.09 (95% CI 1.06-1.12); p<0.0001) while the weekly rate per 100 ED patients receiving blood transfusions slightly decreased (0.5 vs 0.7, rate ratio=0.66 (95% CI 0.49-0.87), p=0.0034). We found that a simple process change to order panels was associated with meaningful reductions in coagulation testing without obvious adverse effects.

BACKGROUND

There has been a greater emphasis on the appropriateness of laboratory testing since the initiation of Choosing Wisely.2 3 Choosing Wisely was launched in 2012 by the American Board of Internal Medicine Foundation with a goal of avoiding wasteful or unnecessary medical tests, treatments and procedures.2 3 Hospitals have applied various strategies to reduce unnecessary testing, primarily through educational initiatives and promoting awareness about Choosing Wisely.6 7 ‘Coagulation testing’ represents an ideal area of focus since these tests are poorly understood by clinicians and often ordered indiscriminately.1 7

Our project was conducted in the ED at St Michael's Hospital in Toronto, Canada’s most populous city. St Michael’s Hospital is a regional trauma, stroke, and cardiac intervention center. Each day approximately 200 patients are seen in the ED. The ED is open 24 hours per day and is staffed each day by multiple ED physicians and over 20 ED nurses.

BASELINE MEASUREMENT

We collected the following data, when available, for all patients arriving to the ED: laboratory data (i.e., PT/INR, aPTT and creatinine), patient volume data (e.g., number of patients arriving to the ED), and blood transfusion data (e.g., number of units transfused per patient). These data are automatically captured and available through our hospital’s electronic health record system. Patient volume data were required to calculate the rate of PT/INR, aPTT, and creatinine testing. Blood transfusion data were recorded as a balancing measure to determine whether or not decreasing coagulation testing was associated with an increased rate of blood transfusions in the ED due to unrecognized coagulopathy.
The primary outcomes were change in the weekly rate of PT/INR and aPTT testing per 100 ED patients. Weekly rate of creatinine testing was recorded as a control. The rate of patients arriving to the ED via ambulance and the rate of admission into hospital were used as surrogates of patient acuity. The rate of patients receiving red blood cell transfusions (bleeding surrogate) was also estimated. Poisson regression models estimated weekly rates per 100 patients in the ED before and after the intervention, ratio of PT/INR and aPTT were unknowingly ordered because most PT/INR and aPTT were included in 11 panels (e.g., routine panel, abdominal pain panel) and after review by our research team in conjunction with the ED physicians we removed these tests from five panels (Table 1).

Table 1 Order panels in the ED at SMH.

<table>
<thead>
<tr>
<th>Order Panel</th>
<th>Before revisions</th>
<th>After revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Abdominal</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Abdominal (female 12-55 years)</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Cardiac</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Sepsis</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Massive transfusion protocol</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>First trimester bleed</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Stroke</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Trauma</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Trauma (female 12-55 years)</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Legend - X: indicates PT/INR and aPTT would automatically be ordered if this panel was selected and ‘-’ indicates neither would be ordered. Note aPTT would be ordered if the patient presented with a cardiac complaint requiring intravenous heparin.

Within days of changes to the order panels, weekly rates of PT/INR testing and aPTT per 100 ED patients...
decreased (17.2 vs 38.4, rate ratio=0.45 (95% CI 0.43-0.47), p<0.001; 16.6 vs 37.8, rate ratio=0.44 (95% CI 0.42-0.46), p<0.001, respectively) (Figure 1). This decrease in coagulation testing was associated with about $4,680 (USD) in direct cost savings per month (i.e., laboratory reagent and consumable costs) and a projected 1-year cost-saving of about $56,000 (USD). The weekly rate per 100 ED patients receiving blood transfusions slightly decreased (0.5 vs 0.7, rate ratio=0.66 (95% CI 0.49-0.87), p=0.0034), suggesting that changes to the order panels did not result in increased rates of bleeding. Weekly rates of creatinine testing per 100 ED patients increased during the same period (54.0 vs 49.7, rate ratio=1.09 (95% CI 1.06-1.12); p<0.0001) suggesting PT/INR and aPTT testing may have also increased during this time period if no intervention was implemented. The weekly rate per 100 patients arriving to the hospital via ambulance was unchanged (21.8 vs 22.1, rate ratio=0.99 (95% CI 0.95-1.03), p=0.6414) but the weekly rate per 100 of patients admitted into hospital increased (14.1 vs 13.2, rate ratio=1.07 (95% CI 1.01 1.13), p=0.0170). Both suggest that changes in patient acuity did not explain the decreased rates of PT/INR and aPTT testing we observed.

LESSONS AND LIMITATIONS

Although our study was prospective, the results are limited by the fact it was not randomized and it lacked individual patient-level characteristics. We also did not specifically monitor for when appropriate INR/PT or aPTT were not ordered because of our intervention. This is currently being assessed in a separate project that involves performing a full chart-review in a random subset of patient charts during our project. Furthermore, while we reduced PT/INR and aPTT testing in the ED, it is unknown whether these patients later had these tests ordered if admitted to hospital. This is, however, unlikely to affect the magnitude of our findings since only 15% of patients that arrive to the ED are admitted. Since our study was based at a single academic teaching hospital, the results may not be widely generalizable. In hindsight it would have been ideal to perform this study at multiple centers to strengthen our external generalizability.

An important consideration for any QI study is the sustainability of the observed results. We believe our results are sustainable since the biggest impact occurred after implementing a process change to the way laboratory tests are ordered in the ED. This process change made it easy for physicians to not order these unnecessary tests which we believe is crucial for sustainability. Additionally, the lower rate of coagulation test ordering rate has been maintained to the present date.

We also received positive feedback from the laboratory staff who noticed a decrease in test volumes after the order panel changes. This was apparent to the laboratory staff because the necessary supplies to perform these tests (i.e., chemical reagents) were now in abundance since less tests were being ordered. Decreased reagent use was the main source of money saved from the impact of our project.
We did not receive any negative feedback from the ED physicians after we revised the order panels. This might be because the changes to the order panels did not increase their workload.

CONCLUSION
While physician education and the development of practice guidelines may reduce unnecessary testing, these initiatives are minimally effective and seldom sustainable.8 This is particularly true at teaching hospitals where trainees rotate through different services. Our intervention, similar to past studies, decreased reflexive ordering of coagulation studies.6–9 This was primarily achieved by changing the process in which these tests were ordered so that it became easier for clinicians to not order these tests when they were not required. The benefit of a process change is that it can have a marked and sustained impact without requiring additional time or effort exerted by the individual.8–9,10

While this intervention focused on one area in our institution, its success highlights how a simple process change, when implemented with educational supports, can reduce unnecessary testing. The next steps for this project are to include other areas of the hospital. We have received support from St Michael’s Hospital to now implement changes to the ordering practices of coagulation tests on the inpatient wards, preoperative clinic and family practice unit.

Acknowledgements This study did not receive funding support. The opinions, results and conclusions reported in this paper are those of the authors. We thank Natalya O’Neill and Patrick O’Brien for their assistance with data input and acquisition. We thank the laboratory staff, emergency room staff, and senior leadership at SMH for all of their support with this project. Also, we thank the Institute for Healthcare Improvement students for their help in creating the teaching tools and for reviewing the ED order panels. Finally, we thank Dr. Allan Detsky and Dr. Peter Dodek for their editorial suggestions.

Declaration of interests Nothing to declare

Ethical approval This study was approved by quality improvement institutional authorities and did not require Research Ethics Board approval or written informed consent.

Open Access This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license. See:
- http://creativecommons.org/licenses/by-nc/2.0/
- http://creativecommons.org/licenses/by-nc/2.0/legalcode

REFERENCES