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REDucing Unnecessary Coagulation Testing in the Emergency Department (REDUCED)

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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.^{3 4} 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.^{3 4} Hospitals have applied various strategies to reduce unnecessary testing, primarily through educational initiatives and promoting awareness about Choosing Wisely.^{5 6} '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 populace 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.

PROBLEM

The PT/INR (prothrombin time/international normalized ratio) blood test was developed in the 1930s and validated for warfarin monitoring.¹ The aPTT (activated partial thromboplastin time) was developed in the 1940s to screen for hemophilia in high-risk individuals and later validated for heparin monitoring.¹ Despite these specific indications, both tests are often ordered 'routinely' as 'coagulation' tests.^{1 2}

The SMART AIM of our study was to reduce PT/INR and aPTT blood testing in the emergency department (ED) over a 12-month period using an iterative quality improvement strategy.



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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, rate ratios and 95% confidence intervals. An offset was included to account for different number of weekly patients admitted in the ED during the study period. Data were analyzed with SAS 9.4 (SAS Inc. Cary, NC).

Baseline data were collected over a 13-week period and included data from about 8,000 patients. During this period, PT/INR testing was occurring in about 42 per 100 ED patients and that aPTT testing was occurring in about 41 per 100 ED patients. Creatinine testing was occurring in about 54 per 100 ED patients.

DESIGN

This was a prospective quality improvement study in the ED at St. Michael's Hospital.

We met with relevant stakeholders (i.e., ED physicians, ED nurses, laboratory staff, hospital administrators), uncoupled PT/INR and aPTT testing options, presented at ED rounds, distributed educational materials and revised ED order panels. Initial blood work for patients arriving in the ED is ordered using a form with checkboxes for laboratory tests. Each checkbox represents a panel of tests that are automatically performed when the checkbox is selected (i.e., an order panel). Initial bloodwork in the ED can be ordered by an ED physician.

STRATEGY

PDSA Cycle 1: The aim for this cycle was to determine reasons why PT/INR and aPTT tests were being frequently ordered in the ED. We hypothesized it might be due to an unfamiliarity with coagulation tests. To determine this we spoke with ED physicians, nurses, and laboratory staff to determine why these tests were being frequently ordered. We realized that most often PT/INR and aPTT were unknowingly ordered because most bloodwork in the ED is based on an order panel (Table 1). Furthermore, all of the order panels included both PT/INR and aPTT despite the fact that these tests are rarely required together. We also learned that PT/INR and aPTT were linked at the back-end via laboratory software that automatically ran both tests even if only one was ordered.

PDSA Cycle 2: The aim of this cycle was to better understand and change how coagulation tests were being performed in the laboratory. Our research team, comprised of a hematologist, laboratory technologist, and the medical director of the coagulation laboratory, discussed the feasibility of uncoupling these tests by

Table 1 Order panels in the ED at SMH.

Order Panel	Before revisions	After revisions
Routine	X	-
Abdominal	X	-
Abdominal (female 12-55 years)	X	-
Cardiac	X	-
Sepsis	X	-
Massive transfusion protocol	X	X
First trimester bleed	X	X
Stroke	X	X
Trauma	X	X
Trauma (female 12-55 years)	X	X

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

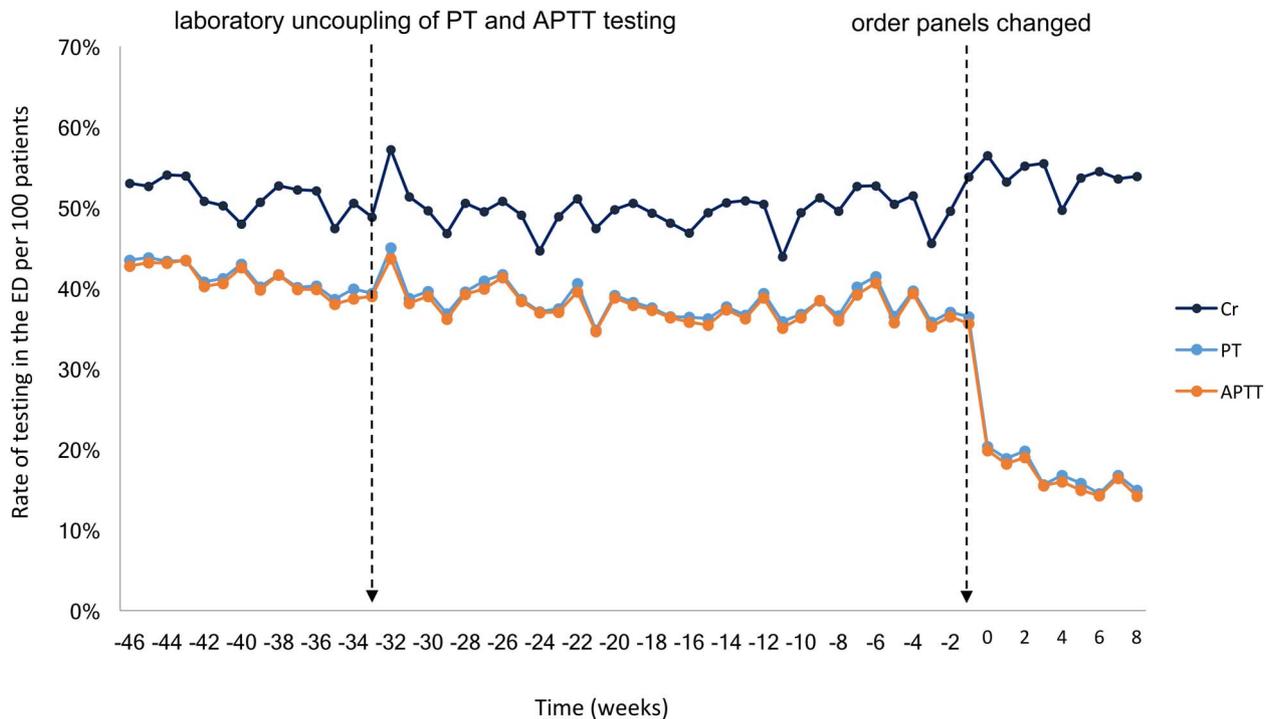
modifying laboratory software so that the two tests would not automatically be processed together. We hypothesized that uncoupling these tests would decrease the frequency that they are run together. It was deemed feasible to uncouple the tests and on May 20th, 2015 (Figure 1. See week -33) changes were implemented within the laboratory so that the two tests were not automatically run unless both were individually ordered. This step had a minimal impact on the rate of tests being ordered (PT/INR 41.7 per 100 ED patients, 95% CI 38.6-43.8, vs 38.3 per 100 ED patients, range 34.8-45.0 and aPTT 41.3 per 100 ED patients, 95% CI 38.0-43.5, vs 37.8 per 100 ED patients, 95% CI 34.6-43.7).

PDSA Cycle 3: We hypothesized that the uncoupling had a minimal impact because the ED panel checklist was not revised and thus both tests were still being automatically ordered at the front-end. Our aim was to revise the order panels and thus we met with ED physicians to propose changes to the order panels. Prior to our intervention, 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).^{1 2} Following our panel revision, if the ED clinician thought the PT/INR and/or aPTT was clinically warranted, they had to order it separately. The panel changes were implemented on January 13th, 2016 (Figure 1. See week 0).

Over the course of each PDSA cycle there was also educational material provided to the ED physicians in the form of paper and electronic pocket cards. These cards provided the top 5 reasons to order these tests as well as the top 5 reasons not to order these tests. We also provided a didactic teaching session to the ED physicians.

RESULTS

Within days of changes to the order panels, weekly rates of PT/INR testing and aPTT per 100 ED patients



Legend: Cr = creatinine, PT = prothrombin time, APTT = activated partial thromboplastin time

Figure 1 Laboratory testing in the ED at SMH.

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 hind-sight 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 10} 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.

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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.

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