

Rationale and design of an evidence-based tool to guide preoperative evaluation and management

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Abstract

Background: In the United States, over-testing and over-treatment are recognised causes of excess cost and patient harm. Healthcare value, defined as health outcomes achieved relative to the costs of care, has become a focus to improve the quality and affordability of healthcare.

Aim: To describe the rationale for, and development of a standardised clinical preoperative decision-support tool.

Program description: An evidence-based, preoperative clinical decision tool was developed to guide preoperative testing and management of high-risk medications.

Program evaluation: Patient data before and after implementation of the tool will be analysed to determine its effectiveness in reducing preoperative testing.

Discussion: Preoperative testing is an area that presents an opportunity to increase healthcare value and decrease healthcare spending. Guidelines are available to standardise preoperative assessment but their adoption and acceptance into practice has been slow. To systematise preoperative assessment within our healthcare system, we reviewed current published literature and guidelines and synthesised them into an electronic, evidence-based, decision-support tool. After distribution of the tool to clinicians in our healthcare system, we will assess its impact on healthcare value, costs and outcomes. We believe that an evidence-based preoperative tool, seamlessly and efficiently integrated into clinician workflow, can improve preoperative patient care.

Keywords

Preoperative / Evaluation / Standardisation / Value / Safety / Clinical decision making

Provenance and Peer review: Unsolicited contribution; Peer reviewed; Accepted for publication 3 May 2020.

Introduction

Preoperative evaluation and management of the surgical patient represents a clear opportunity to improve healthcare value (Berwick & Hackbarth 2012, Brown & Brown 2011). An excess of 18 billion dollars are spent on preoperative testing in the United States; the majority of said testing is of low value and does not improve patient outcomes (Brown & Brown 2011). In Washington State alone, \$33 million were spent on unnecessary cardiac stress tests in 2017, and in 2018, another \$10.9 million were spent on unnecessary electrocardiograms, chest radiographs and pulmonary function testing (Washington Health Alliance). Leung et al (2015) found that 69.2% of preoperative blood tests performed in a general hospital ENT department in

the United Kingdom were unnecessary and that none of the test results affected patient management.

Furthermore, mismanagement of high-risk preoperative medications, particularly antiplatelet and anticoagulation agents, exposes patients to the risks of complications due to bleeding and thrombosis. Unfortunately, recommendations regarding antiplatelet and anticoagulant management are often vague and

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frequently not followed (Banerjee et al 2017, Childers et al 2017, Munyon et al 2017, Rechenmacher & Fang 2015).

Preoperative testing should be selective, based on medical morbidities and surgical risk (Bock et al 2016, Böhmer et al 2014, Hepner 2009). Despite medical society guidelines recommending elimination of routine testing, there has been little change in this practice over the past two decades (Sigmund et al 2015, Smetana 2015).

While guidelines and best practice recommendations have largely failed to reduce preoperative testing, there is preliminary evidence that unnecessary testing is reduced by utilising trained preoperative teams and by designated clinics using standardised testing protocols (American Society of Anesthesiologists 2017, Matulis et al 2017). This divergence between effective preoperative management and real-world practice provides an opportunity to standardise preoperative management with the goal of reducing costs and improving patient outcomes. In 2008, the New England Healthcare Institute (2008) identified insufficient point-of-care access to practice guidelines and insufficient Information Technology support as barriers to adoption of and adherence to guidelines. Therefore, we developed an electronic, cloud-based decision tool to guide clinician preoperative testing, to standardise high-risk medication management, to sustain perioperative practice change and to facilitate clinician communication across a large health system. The aim of the tool is to increase practitioner awareness of the guidelines and to facilitate its use by integrating it into the point-of-use, ie: the patient electronic medical record. As a result, users have ready access to necessary patient information with minimal disruption of workflow and in the end, are presented with timely, evidence-based management recommendations.

This project was reviewed by the Allina Health Institutional Review Board and was determined to be not human subjects' research.

Program description

Decision tool development

Following an extensive review of the primary literature and all major society preoperative guidelines, we developed an algorithm to guide preoperative testing and medication management. Studies have demonstrated suboptimal uptake of computerised decision support (CDS) tools by clinicians (Goswami 2018, Liberati et al 2017) due to the overly complex design of and cumbersome access to many such tools. We therefore developed an electronic CDS tool with a simple, user-friendly, front-end interface for

data entry coupled with a sophisticated back-end design that seamlessly generates recommendations with little or no interruption in clinician workflow. Three attributes, procedure risk, patient specific characteristics and procedural bleeding risk, are the basis for the tool's recommendations. The number of possible combinations and permutations addressed by the tool are vast. When the evidence is clear (for example, testing prior to cataract surgery) (Keay et al 2019), the recommendation is more prescriptive. When the evidence is less clear (for example, bridging for atrial fibrillation with a high CHADS₂ (congestive heart failure, hypertension, age, diabetes, stroke (doubled))), the recommendation is contextual. In these situations, we recommend a shared decision involving the clinician and the patient.

User interface

Procedural risk (Figure 1): Consensus does not exist on the optimal determination of the risk inherent to a specific procedure. Procedural risk categories are based on the modified Johns Hopkins surgical criteria, American College of Cardiology/American Heart Association (ACC/AHA) joint surgical classifications and expert opinion (Donati et al 2004, Fleisher et al 2014).

Patient characteristics (Figure 2): Age, gender, renal function (as estimated by the Cockcroft-Gault equation for creatinine clearance), morbidities, medications and functional capacity are considered as patient characteristics.

Bleeding risk (Figure 3): Bleeding risk is determined by the specific procedure and the anaesthetic modality most commonly utilised for that procedure.

Tool output

As shown in Figure 4, the summary and recommendations output screen assists the clinician in the preoperative evaluation. A focused summary of recommendations is provided to the ordering clinician, anaesthesiologist and surgeon. Clear instructions directing medication management are printed as a handout for the patient.

Program evaluation

Study goals

In January 2018, the tool was made available to approximately 600 clinicians performing preoperative evaluations at 63 clinics across Allina Health Systems (Minneapolis, Minnesota, USA). Tool utilisation, cost of testing, rates of bleeding and thrombotic complications, length of stay and readmission rates will be compared before and after tool implementation. Furthermore, given the large number of patients undergoing surgeries

Procedure Risk

* Please select one:

<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center; margin-bottom: 5px;">Minimal Risk</div> <p>Cataract</p> <p>Skin Procedures *</p> <p>Dental Procedures *</p> <p><small>* Most skin and dental procedures carry minimal cardiovascular and bleeding risk, and do not require preoperative testing or holding of medications</small></p>	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center; margin-bottom: 5px;">Low Risk</div> <p>Most Ambulatory Surgery Lap Cholecystectomy Inguinal Hernia Repair</p> <p>Most Breast Procedures ENT Procedures</p> <p>Arthroscopy Rotator Cuff Repair</p> <p>Colonoscopy / EGD</p>	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center; margin-bottom: 5px;">Intermediate Risk</div> <p>Joint Replacement</p> <p>Colectomy Ventral Hernia Repair Hysterectomy Gastric Bypass</p> <p>Breast Reconstruction</p> <p>Laminectomy Spine Fusion, 1-2 Levels TURP Radical Prostatectomy</p>	<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center; margin-bottom: 5px;">High Risk</div> <p>Total Joint Revision Spine Fusion, ≥ 3 levels A/P Spine Procedures Whipple</p> <p>Hepatic Resection</p> <p>Nephrectomy Splenectomy</p>
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Figure 1 Procedural risk categories that trigger procedure-specific, indicated preoperative testing.

Patient Characteristics

- Age > 65 years
- TIA or Stroke
- Diabetes Mellitus
- Bleeding History
- Hematologic Disorder
- Liver Disease (e.g. Ascites or Jaundice)
- Symptoms of Cystitis
- Corticosteroid use > 3 weeks in the past year
- Current symptoms warranting a CXR
- Chronic Kidney Disease

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Figure 2 Patient-specific characteristics that trigger clinically indicated preoperative testing.

across the system, we hope to fill particular evidence gaps such as the impact of bridging decisions in high-risk atrial fibrillation patients.

Discussion

Evidence review

The evidence for preoperative testing is based largely on expert opinion. Current guidelines recommend that preoperative testing should be guided by the history and physical examination, medical record review, and consideration of procedure complexity and potential for

blood loss (Bock et al 2016, Kumor & Srivastava 2011, Martin & Cifu, 2017).

Laboratory testing

Haemoglobin and coagulation studies. A history of anaemia is an indication for obtaining an haemoglobin prior to low-risk procedures. In intermediate and high-risk procedures, with potential for significant blood loss, obtaining a baseline haemoglobin is recommended (Bock et al 2016, Kaplan et al 1985). Routine coagulation studies or platelet counts are not predictive of perioperative bleeding. A history of increased bleeding or clinical conditions that predispose to bleeding

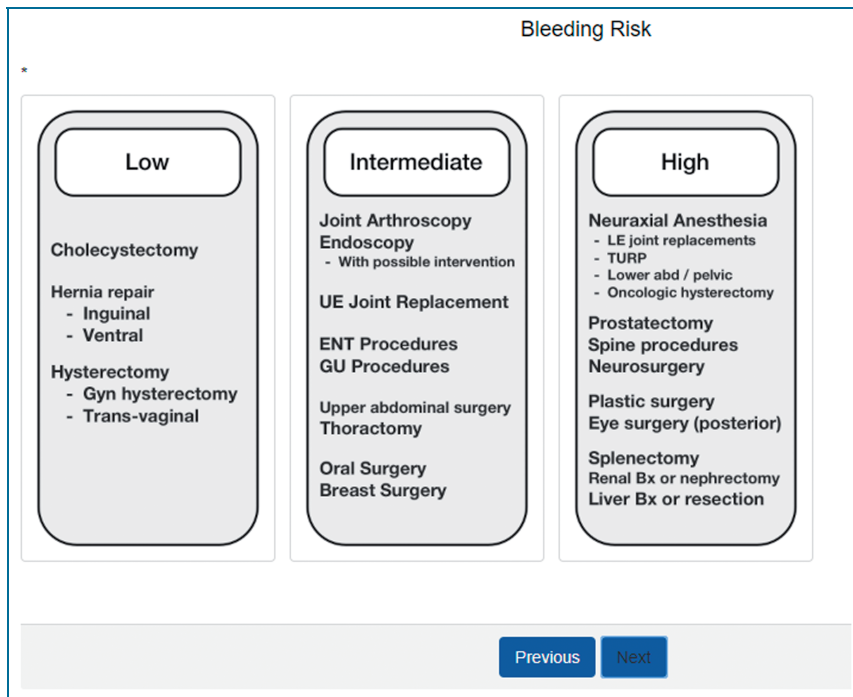


Figure 3 Surgery-specific bleeding risks that guide preoperative management of antiplatelet and anticoagulant medications.

The Pre-Op Tool

Recommendations

CV Snapshot

Intermediate Risk Procedure

Risk of CV Complication (RCRI)

- 3.5%

Current Cardiac Status

- Good exertional capacity (> 4 mets)
- EF 35% (most recent echo 2019)

Cardiac History

- No history of heart failure
- History of CABG
- History of coronary stent / PCI

Pre-Procedure Testing

Labs

- HGB within last 30 days
- Potassium within last 30 days
- Creatinine within last 30 days

EKG

- Baseline EKG within the last 12 months

CXR

- Not indicated

Stress Testing

- Not indicated

* Testing recommendations are intended to assist, but not direct, clinical decisions.

Anesthesia DOS

- Type & Screen should be obtained by Anesthesia only if the risk of transfusion is > 5% for the procedure

Medication Management Recommendations

- Hold Lisinopril (Prinivil, Zestril) the evening before and/or morning of the procedure.
- Continue taking Carvedilol (Coreg); be sure to take the evening before and/or morning of the procedure.
- Continue Aspirin 81mg perioperatively

Figure 4 Final electronic output with testing recommendations, medication management guidance, and patient risk communication and documentation.

(for example, liver disease) are indications for coagulation studies (Bock et al 2016, Feely et al 2013).

Electrolytes. The incidence of unexpected electrolyte derangement on routine preoperative testing is very low. Preoperative measurement of electrolytes should be based on specific clinical indications such as diuretic use. History of kidney disease is an indication for renal function testing (Bock et al 2016, Feely et al 2013).

Urinalysis. High-quality evidence does not support preoperative screening for asymptomatic bacteriuria in asymptomatic patients (Bock et al 2016, Drekonja et al 2013).

Timing. In those with an indication for laboratory testing, it is reasonable to use results obtained within the past 30 days (Ruetzler et al 2018).

Cardiovascular evaluation

In general, preoperative cardiovascular testing (for example, stress testing, electrocardiography, echocardiography) should be driven by standard clinical indications. A planned surgical procedure is not an indication for preoperative testing (Fleisher et al 2014).

Abnormalities on preoperative electrocardiograms (ECGs) are common but of limited value in predicting perioperative complications. The ACC/AHA recommend against obtaining routine ECGs in patients undergoing low-risk surgeries. Furthermore, obtaining ECGs in asymptomatic patients undergoing low-risk surgeries may lead to further unnecessary testing. In patients undergoing intermediate and high-risk surgeries, a baseline ECG may be useful in the event of postoperative status changes (Fleisher et al 2014).

Patients with good functional capacities of four or more metabolic equivalents of tasks (brisk walk, climbing one flight of stairs without stopping) have low perioperative risk and often require no preoperative stress testing irrespective of surgical risk. Regarding stress testing in patients with poor functional capacity, current guidelines are vague and unhelpful (Fleisher et al 2014, Munyon et al 2017). Importantly, in the only randomised trial evaluating high-risk patients undergoing high-risk, major vascular surgery, prophylactic revascularisation was not beneficial (McFalls et al 2004). Moreover, while the pathophysiology of perioperative myocardial infarction is unclear, most perioperative myocardial infarctions are not caused by haemodynamically significant epicardial artery stenosis (Gualandro et al 2012). Consequently, stress testing with subsequent prophylactic revascularisation is unlikely to be effective in prevention of perioperative myocardial infarction (Chopra et al 2010, Vaishnava & Eagle 2014).

High-risk medication management

Antiplatelet therapy in patients with coronary artery disease, including prior percutaneous coronary intervention: Approximately 10% of all patients who undergo coronary stenting require non-cardiac surgery within one year. These patients are at increased risk for perioperative major cardiac events. This risk decreases with time. Current American guidelines recommend delaying elective surgery for at least four weeks post-bare metal stent placement and at least six months post-drug-eluting stent (Banerjee et al 2017, Childers et al 2017, Levine et al 2016).

The decision to interrupt P2Y12 therapy (while often continuing low-dose aspirin therapy) depends on the timing of, indication for, and type of stent implanted in context of risk of surgical bleeding (Childers et al 2017, Holcomb et al 2017). Dual antiplatelet therapy, for example, aspirin and a P2Y12 inhibitor, significantly increases the risk of major surgical bleeding. The 2014 Perioperative Ischemic Evaluation 2 (POISE-2) trial demonstrated no benefit of low-dose, perioperative aspirin therapy, even in patients with established vascular disease. However, a subsequent sub-study suggested lower major adverse event rates in patients with prior coronary stenting taking aspirin. Therefore, P2Y12 inhibitors should be held and low-dose aspirin continued for patients with prior stent implantation (Devereaux et al 2014, Graham et al 2018, Vaishnava & Eagle 2014).

Anticoagulation bridging for atrial fibrillation

Although bridging anticoagulation for atrial fibrillation is frequently used, there is insufficient direct evidence to support this practice (Munyon et al 2017, Rechenmacher & Fang 2015). Thirty per cent of clinicians bridge patients at low risk for thromboembolism. The observational trial, Outcomes Registry for Better Informed Treatment of Atrial Fibrillation (ORBITA-AF) showed no difference in risk scores between patients bridged and not bridged, which suggests an indiscriminate bridging practice. In the 2015 Effectiveness of Bridging Anticoagulation for Surgery (BRIDGE) study, patients who received bridging anticoagulation experienced no reduction in thromboembolic events but suffered a tripled risk of major bleeding. However, only 3% of the studied population had a CHADS₂ score of 5 or 6, so the benefit of bridging in high-risk patients remains unknown (Douketis et al 2015). In aggregate, these data suggest a net harm of bridging to many patients in contemporary practice (Rechenmacher & Fang 2015).

CHA₂DS₂-VASC (cardiac failure or dysfunction, hypertension, age 75 years or greater (doubled), diabetes, stroke (doubled)-vascular disease, age 65–74 years and sex category (female) and the CHADS₂ scores

are validated risk models for estimating annual stroke rates for stable, outpatient atrial fibrillation patients. However, these risk models were never intended to stratify perioperative risk of thromboembolism nor has either been validated in the perioperative setting. In attempting to estimate preprocedural thrombotic risk, we use the CHADS₂ score, as this was the model used in the lone randomised trial of bridging to date (Douketis et al 2015).

Conclusion

We developed an evidence-based preoperative clinical decision tool to guide appropriate testing and to standardise management of high-risk medications. Despite the complexity of the underlying algorithms, every effort was made to ensure simplicity of the user interface. The tool was distributed to over 600 clinicians throughout the Allina Health Systems and data are being tracked to assess financial and quality outcomes.

Declarations

Competing Interests

Campbell, Cummings, Ingham and Mueller have financial interest in a company that will further develop and, in the future, market the preoperative decision tool.

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