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

Alex R Campbell, David P Ingham, Michele F Shepherd, Joshua J Mueller, Timothy D Henry, Scott W Sharkey and Michael K Cummings

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

Abbott Northwestern Hospital, Minneapolis, Minnesota, USA

Corresponding author:
Michele F Shepherd, Abbott Northwestern Hospital, 800 E. 28th Street, Minneapolis, MN 55407-3799, USA.
Email: shelley.shepherd@allina.com

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 $CHADS_2$ (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

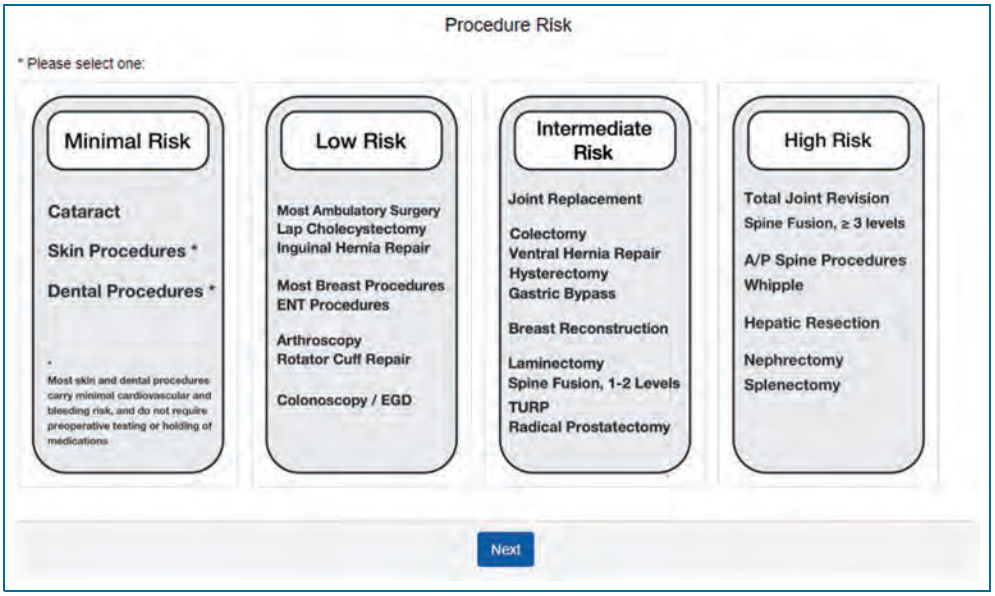

Figure 1 Procedural risk categories that trigger procedure-specific, indicated preoperative testing.

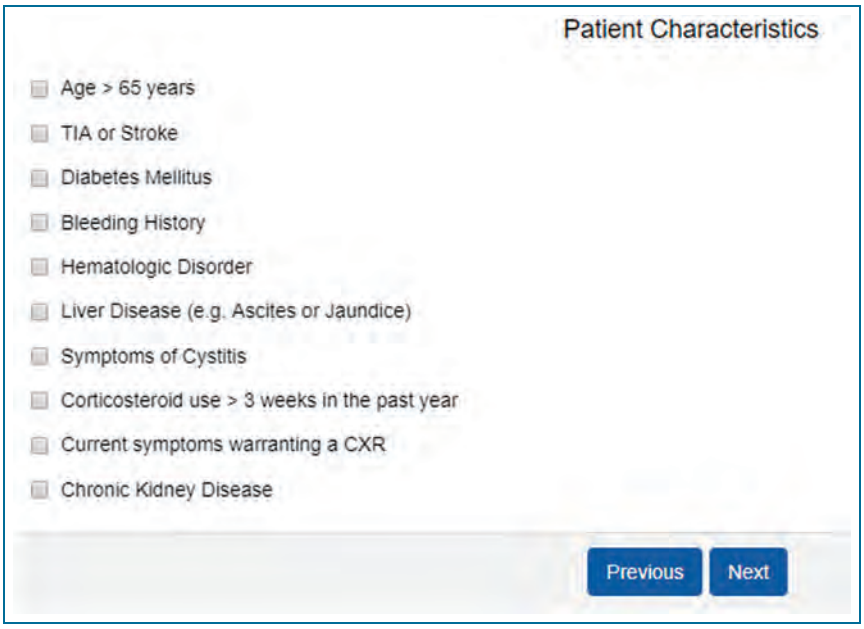

Figure 2 Patient-specific characteristics that trigger clinically indicated preoperative testing.

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

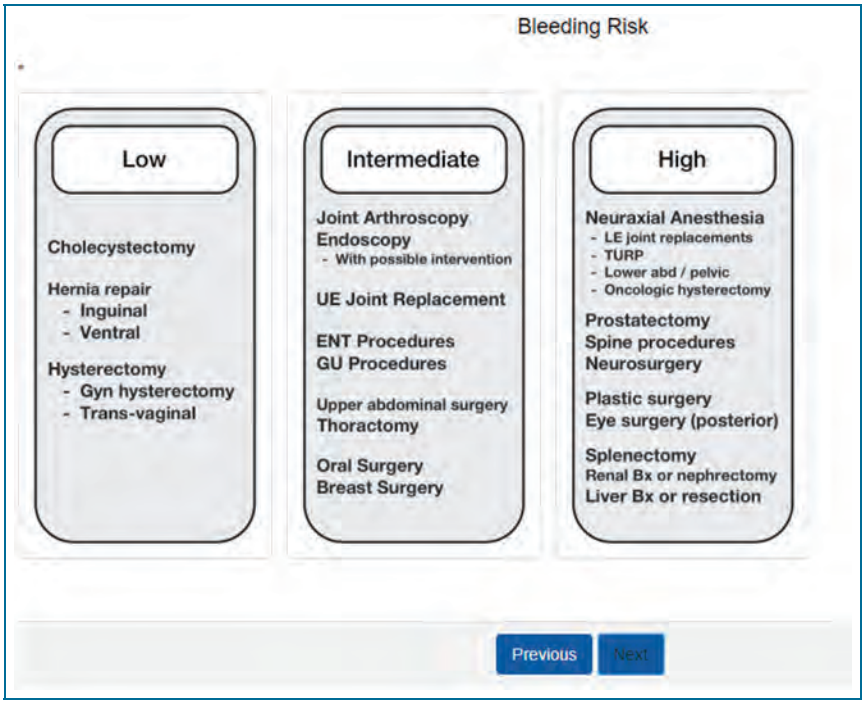

Figure 3 Surgery-specific bleeding risks that guide preoperative management of antiplatelet and anticoagulant medications.

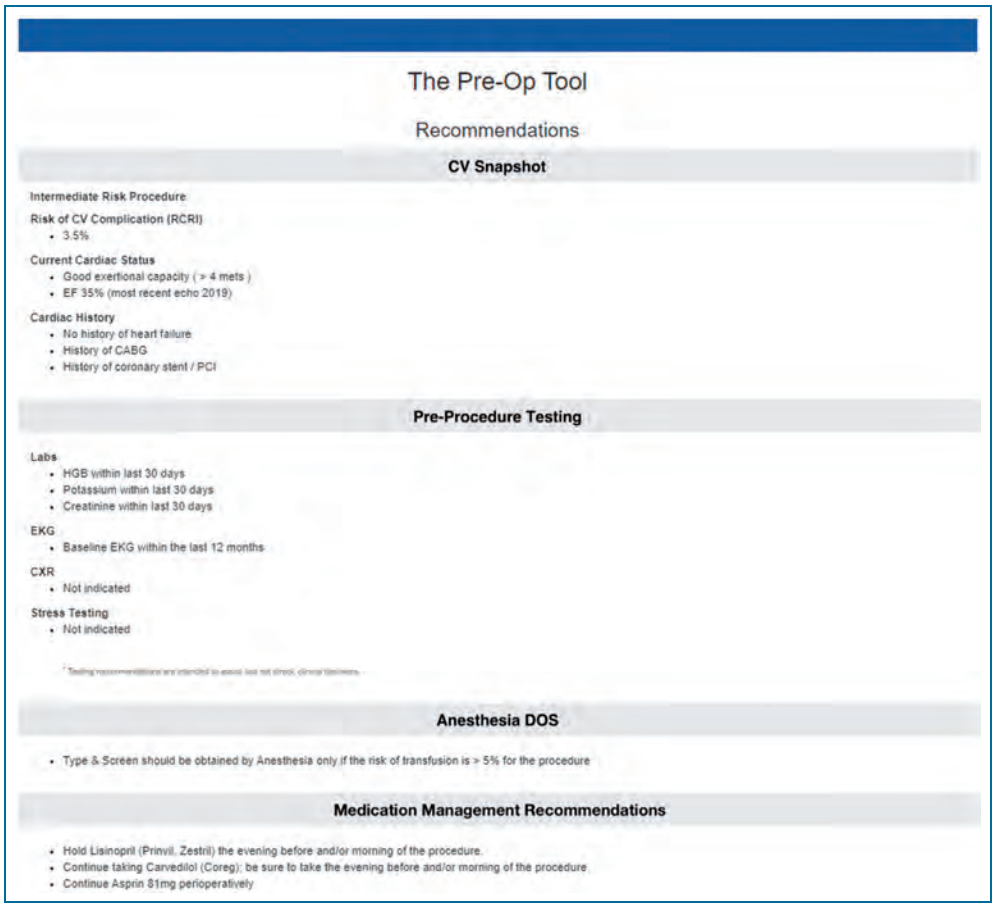

Figure 4 Final electronic output with testing recommendations, medication management guidance, and patient risk communication and documentation.

(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 $CHADS_2$ 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).

CHA_2DS_2-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 $CHADS_2$ 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 $CHADS_2$ 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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ORCID iD

Michele F Shepherd https://orcid.org/0000-0002-5756-9869

References

American Society of Anesthesiologists 2017 Preop testing unit cut costs by 47% by applying guidelines Available at www.medscape.com/viewarticle/887820 (accessed 1 April 2018)

Banerjee S, Angiolillo DJ, Boden WE, et al 2017 Use of antiplatelet therapy/DAPT for post-PCI patients undergoing noncardiac surgery ***Journal of the American College of Cardiology*** 69 (14) 1861–1870

Berwick DM, Hackbarth AD 2012 Eliminating waste in U.S. ***healthcare JAMA*** 307 (14) 1513–1516

Bock M, Fritsch G, Hepner DL 2016 Preoperative laboratory testing ***Anesthesiology Clinics*** 34 (1) 43–58

Böhmer AB, Wappler F, Zwissler B 2014 Preoperative risk assessment from routine tests to individualized investigation ***Deutsches Ärzteblatt International*** 111 436–437

Brown SR, Brown J 2011 Why do physicians order unnecessary preoperative tests? A qualitative study ***Family Medicine*** 43 (5) 338–343

Childers CP, Maggard-Gibbons M, Shekelle PG 2017 Antiplatelet therapy in patients with coronary stents undergoing elective noncardiac surgery Continue, stop, or something in between? ***JAMA*** 318 (2) 120–121

Chopra V, Flanders S, Froehlich J, et al 2010 Perioperative practice: Time to throttle back ***Annals of Internal Medicine*** 15 247–251

Devereaux PJ, Mrkobrada M, Sessler DI, et al 2014 Aspirin in patients undergoing noncardiac surgery ***New England Journal of Medicine*** 370 (16) 1494–1503

Donati A, Ruzzi E, Adrario P, et al 2004 A new and feasible model for predicting operative risk ***British Journal of Anaesthesia*** 93 (3) 393–399

Douketis JD, Spyropoulos AC, Kaatz S et al 2015 Perioperative bridging anticoagulation in patients with atrial fibrillation ***New England Journal of Medicine*** 373 (9) 823–833

Drekonja DM, Zarmbinski B, Johnson JR 2013 Preoperative urine cultures at a Veterans Affairs Medical Center ***JAMA Internal Medicine*** 173 (1) 71–72

Feely MA, Collins SC, Daniels PR, et al 2013 Preoperative testing before noncardiac surgery: guidelines and recommendations ***American Family Physician*** 87 (6) 414–418

Fleisher LA, Fleischman KE, Auerbach AD, et al 2014 2014 ACC/AHA guideline on perioperative cardiac evaluation and management of patients undergoing noncardiac surgery: Executive summary A report of the American College of Cardiology/American Heart Association task force on practice guidelines ***Journal of the American College Cardiology*** 64 (22) 2373–2405

Goswami S 2018 Overcoming adoption barriers of cloud support for clinical decision support Available at: www.insight-rx.com/post/overcoming-adoption-barriers-of-cloud-software-for-clinical-decision-support (accessed 1 March 2020)

Graham MM, Sessler DI, Parlow JL et al 2018 Aspirin in patients with previous percutaneous coronary intervention undergoing noncardiac surgery ***Annals of Internal Medicine*** 168 (4) 237–244

Gualandro DM, Campos CA, Calderaro D, et al 2012 Coronary plaque rupture in patients with myocardial infarction after noncardiac surgery: Frequent and dangerous ***Atherosclerosis*** 222 (1) 191–195

Hepner DL 2009 The role of testing in the preoperative evaluation ***Cleveland Clinic Journal of Medicine*** 76 (suppl 4) S22–S27

Holcomb CN, Graham AL, Richman JS et al 2017 The incremental risk of noncardiac surgery on adverse cardiac events following coronary stenting ***Journal of the American College of Cardiology*** 64 (25) 2730–2739

Kaplan EB, Scheiner LB, Boeckmann AJ 1985 The usefulness of preoperative laboratory screening ***Journal of the American Medical Association 253*** (24) 3576–3581

Keay L, Lindsley K, Tielsch J, et al 2019 Routine preoperative medical testing for cataract surgery (review) ***Cochrane Database of Systematic Reviews*** 1: CD007293

Kumor A, Srivastava U 2011 Role of routine laboratory investigations in the preoperative evaluation ***Journal of Anaesthesiology, Clinical Pharmacology*** 27 (2) 174–179

Leung BD, Nazeer S, Smith M, McRae D 2015 Reducing unnecessary preoperative testing in elective ENT surgery: Clinical and financial implications ***Journal of Perioperative Practice*** 25 (11) 225–229

Levine GN, Bates ER, Bittl JA, et al 2016 2016 ACC/AHA guideline focused update on duration of dual antiplatelet therapy in patients with coronary artery disease: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines: An

update of the 2011 ACCF/AHA/SCAI guideline for percutaneous coronary intervention, 2011 ACCF/AHA guideline for coronary artery bypass graft surgery, 2012 ACC/AHA/ACP/AATS/PCNA/SCAI/STS guideline for the diagnosis and management of patients with stable ischemic heart disease, 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction, 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes, and 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery ***Circulation*** 2016 134 (10) e123–e155

Liberati EG, Ruggiero F, Galuppo L 2017 What hinders the uptake of computerized decision support systems in hospitals? A qualitative study and framework for implementation ***Implementation Science*** 12 (1) 113–125

Martin SK, Cifu AS 2017 Routine preoperative laboratory tests for elective surgery ***JAMA*** 318 (6) 567–568

Matulis J, Liu S, Mecchella J, et al 2017 Choosing wisely: A quality improvement initiative to decrease unnecessary preoperative testing ***BMJ Quality Improvement Reports*** 6 (1) 1–5

McFalls EO, Ward HB, Moritz TE, et al 2004 Coronary-artery revascularization before elective major vascular surgery ***New England Journal of Medicine*** 351 (27) 2795–2804

Munyon R, Cohn SL, Slawski B, et al 2017 2017 update in perioperative medicine: 6 questions answered ***Cleveland Clinic Journal of Medicine*** 84 (11) 863–872

New England Healthcare Institute 2008 Improving physician adherence to clinical practice guidelines: Barriers and strategies for change Available at www.nehi.net/writable/publication_files/file/cpg_report_final.pdf (accessed 1 January 2020)

Rechenmacher SJ, Fang JC 2015 Bridging anticoagulation: Primum non nocere ***Journal of the American College of Cardiology*** 66 (12) 1392–1403

Ruetzler K, Lin P, You J, et al 2018 The association between timing of routine preoperative blood testing and a composite of 30-day postoperative morbidity and mortality ***Anesthesia & Analgesia*** 127 (4) 897–903

Sigmund AE, Stevens ER, Blitz JD, et al 2015 Use of preoperative testing and physicians' response to professional society guidance ***JAMA Internal Medicine*** 175 (8) 1352–1359

Smetana GW 2015 The conundrum of unnecessary preoperative testing ***JAMA Internal Medicine*** 175 (8) 1359–1361

Vaishnava P, Eagle KA 2014 The yin and yang of perioperative medicine ***New England Journal of Medicine*** 370 (16) 1554–1555

Washington Health Alliance 2018 First, do no harm: Calculating health care waste in Washington State Available at www.wacommunitycheckup.org/media/47156/2018-first-do-no-harm.pdf (accessed 1 March 2020)