

Supplemental Appendix S1

Five Things Physicians and Patients Should Question

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Cardiology

Five Things Physicians and Patients Should Question

by
Canadian Cardiovascular Society
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1 Don't perform stress cardiac imaging or advanced non-invasive imaging in the initial evaluation of patients without cardiac symptoms unless high-risk markers are present.

Asymptomatic, low-risk patients account for up to 45 percent of unnecessary "screening". Testing should be performed only when the following findings are present: diabetes in patients older than 40-years-old; peripheral arterial disease; or greater than 2 percent yearly risk for coronary heart disease events.

2 Don't perform annual stress cardiac imaging or advanced non-invasive imaging as part of routine follow-up in asymptomatic patients.

Performing stress cardiac imaging or advanced non-invasive imaging in patients without symptoms on a serial or scheduled pattern (e.g., every one to two years or at a heart procedure anniversary) rarely results in any meaningful change in patient management. This practice may, in fact, lead to unnecessary invasive procedures and excess radiation exposure without any proven impact on patients' outcomes. An exception to this rule would be for patients more than five years after a bypass operation.

3 Don't perform stress cardiac imaging or advanced non-invasive imaging as a pre-operative assessment in patients scheduled to undergo low-risk non-cardiac surgery.

Non-invasive testing is not useful for patients undergoing low-risk non-cardiac surgery (e.g., cataract removal). These types of tests do not change the patient's clinical management or outcomes.

4 Don't perform echocardiography as routine follow-up for mild, asymptomatic native valve disease in adult patients with no change in signs or symptoms.

Patients with native valve disease usually have years without symptoms before the onset of deterioration. An echocardiogram is not recommended yearly unless there is a change in clinical status.

5 Don't order annual electrocardiograms (ECGs) for low-risk patients without symptoms.

Don't obtain screening electrocardiogram testing in individuals who are asymptomatic and at low risk for coronary heart disease. In asymptomatic individuals at low risk for coronary heart disease (10-year risk <10%), screening for coronary heart disease with electrocardiography does not improve patient outcomes.

How the list was created

The Canadian Cardiovascular Society (CCS) established its Choosing Wisely Canada top 5 recommendations by working closely with the American College of Cardiology (ACC). The ACC provided the CCS with the literature review, complete to 2009, that had informed their top 5 recommendations. This provided a strong foundation for the CCS to begin its investigation into relevant top 5 recommendations for cardiac care in the Canadian context. The CCS then conducted an extensive literature review to include all relevant publications since January 1, 2009. Moreover the CCS also included all relevant existing Canadian Guidelines, any Canadian appropriate use criteria and Canadian national or provincial policies that pertained to the five statements. The CCS then performed an extensive dissemination and consultation with its membership via email, Facebook, Twitter, the annual national meeting and webinars to ensure awareness and approval of the top 5 recommendations. The first four items were adapted with permission from the Five Things Physicians and Patients Should Question, ©2012 American College of Cardiology. Item 5 was adapted with permission from the Five Things Physicians and Patients Should Question, ©2012 American College of Family Medicine.

Sources

- 1 American College of Cardiology Foundation Appropriate Use Criteria Task Force, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. J Am Coll Cardiol. 2011 Mar 1;57(9):1126-66. PMID: 21349406.
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- 2 American College of Cardiology Foundation Appropriate Use Criteria Task Force, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. J Am Coll Cardiol. 2011 Mar 1;57(9):1126-66. PMID: 21349406.
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- 4 American College of Cardiology Foundation Appropriate Use Criteria Task Force, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. J Am Coll Cardiol. 2011 Mar 1;57(9):1126-66. PMID: 21349406.
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About the Canadian Cardiovascular Society

The CCS mission is to promote cardiovascular health and care through knowledge translation, including dissemination of research and encouragement of best practices and professional development, as well as leadership in health policy. Its 2,000+ members include academic and community cardiologists, cardiac surgeons, pediatric cardiologists, trainees in those fields, researchers and other health care professionals working in cardiac sciences in all corners of the country.



Canadian Cardiovascular Society
Leadership. Knowledge. Community.

About Choosing Wisely Canada

Choosing Wisely Canada is a campaign to help physicians and patients engage in conversations about unnecessary tests, treatments and procedures, and to help physicians and patients make smart and effective choices to ensure high-quality care.

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Supplemental Table S1. Glossary of medico-legal terms

Term	Definition
Closed case	A final medico-legal outcome was determined by the court, regulatory authority, or hospital, or there was mutual agreement between the parties to resolve the action.
Criticisms	Documented criticisms based primarily on peer expert, regulatory authority, or hospital opinions in a medico-legal matter.
Interventions	Procedures, treatments, investigations, or medical acts that were causative factors leading to a medico-legal issue, complaint, or investigation and included the initial intervention that launched the cascade of events.
Medical analyst summaries	Concise narratives or synopses of each patient's course of medical events, written by a medical analyst at the time of coding.
Peer experts	Physicians retained by parties in a legal action who interpreted and provided their opinions on clinical, scientific, or technical issues surrounding the healthcare provided and the alleged injuries sustained; they typically had similar training and experience as the physicians whose care they were reviewing.

Supplemental Table S2. The CMPA's in-house definitions relating to healthcare-related harm,* adapted from the American Society for Healthcare Risk

Management's *Healthcare Associated Preventable Harm Classification Tool*²¹

Term	Description
Harmful incident	Based on peer expert opinion, the harm resulting from the care or services provided to the patient due to failures in the processes of care or in the performance of procedures, including provider error.
Inherent risk	Based on peer expert opinion, a harmful incident that is a known risk associated with a particular investigation, medication, or treatment. It is the risk from undergoing a procedure in ideal conditions, performed by qualified staff using current research, equipment, and techniques.
Asymptomatic	Patient safety event or patient safety incident** that reached the patient but the patient reports no symptoms and no treatment is required.
Mild harm	Patient harm is symptomatic, symptoms are mild, loss of function or harm is minimal (permanent or temporary), and minimal or no intervention is required (e.g. extra observation, investigation, review, or minor treatment).
Moderate harm	Patient harm is symptomatic, requiring intervention (e.g. additional moderate or minor operative procedure, additional therapeutic treatment), or an increased length of stay, or causing permanent or temporary harm, or loss of function.
Severe harm	Patient harm is symptomatic, requiring life-saving intervention or major medical/surgical intervention, or resulting in a shortening life expectancy, or causing major permanent or temporary harm or loss of function.
Death	Healthcare-related death

* Healthcare-related harm: Harm arising from, or associated with, plans or actions taken during the provision of healthcare, rather than an underlying disease or injury.

** Patient safety incident: An event or circumstance which could have resulted, or did result, in unnecessary harm to the patient.³²

Supplemental Methods S1. List of health interventions encountered during eligibility screening of medico-legal cases, and corresponding *Canadian Classification of Health Interventions (CCI)* codes²⁰

Included cardiac tests

A nurse-researcher (E.W.) included cases when the featured intervention was clearly a cardiac diagnostic test, corresponding with:

CCI Section 2: Diagnostic Interventions

- 2HZ08EJ Test, heart with physical exercise (e.g. bicycle, treadmill) alone
- 2HZ08EK Test, heart with pharmacological stress
- 2HZ24JAKF Electrophysiological measurement, heart, using apex cardiogram
- 2HZ24JAKH Electrophysiological measurement, heart, using Holter monitor [ambulatory ECG]
- 2HZ24JAXJ Electrophysiological measurement, heart, using recording electrodes [or ECG NOS]

CCI Section 3: Diagnostic Imaging Interventions

- 3ID20WC Computerized tomography [CT], aorta
- 3ID30HA Ultrasound, aorta
- 3GT10VA X-ray, lung
- 3GY10VA X-ray, thoracic cavity
- 3IP10^^ X-ray, heart with coronary arteries, cardiac catheterization for coronary angiography
- 3IP20WA Computerized tomography [CT], heart with coronary arteries

- 3IP30^^ Ultrasound, heart with coronary arteries
- 3IP30HA Ultrasound, heart with coronary arteries, endoscopic [EUS]
transesophageal
- 3IP70 Diagnostic nuclear (imaging) study, heart with coronary arteries
- 3IP70KG Diagnostic nuclear (imaging) study, heart with coronary arteries,
using scintigraphy perfusion imaging
- 3ZZ20VA Computerized tomography [CT], total body

Excluded health interventions

A nurse-researcher (E.W.) excluded cases when the featured intervention was not a cardiac diagnostic test, corresponding with:

- The following CCI Section 2 codes:
 - 2ZZ02ZZ Assessment or examination, total body
 - 2LZ28JAPL Pressure measurement, circulatory system, using
externally applied pressure measuring device [e.g. cuff
sphygmomanometer]
- The following CCI Section 3 code:
 - 3AN20 Computerized tomography [CT], brain
- Laboratory tests:
 - 4KL1699 Antibody test for hepatitis C virus, any specimen type
 - 4MC0201 Bacterial culture, whole blood

Other excluded health interventions

Unless otherwise eligible, a nurse-researcher (E.W.) excluded cases with the following intervention codes:

- CCI Section 1: Physical/Physiological Therapeutic Interventions
- CCI Section 5: Obstetrical and Fetal Interventions
- CCI Section 6: Cognitive, Psychosocial and Sensory Diagnostic and Therapeutic Interventions
- CCI Section 7: Other Healthcare Interventions
- CCI Section 8: Therapeutic Interventions Strengthening the Immune System and/or Genetic Composition

Supplemental Methods S2. Methodology used to extract eligible cases from the CMPA data repository for subgroup analysis

To identify criticism of test underuse, we extracted eligible cases with criticism of a diagnostic issue (i.e., contributing factor code DIAGNOSIS defined below in Table SM2). From those, we extracted the subgroup of cases with delays/failures in performing a diagnostic test (PERF) or interventions not done/delayed (IDN) if the intervention related to screening or diagnostic testing. If these cases did not clearly involve a cardiac test (**Supplemental Methods S1**) then a nurse-researcher (E.W.) manually excluded them. Similarly, we excluded cases when criticisms related only to the care provided after testing, such as monitoring or follow-up. Additionally, we excluded cases in which a non-cardiologist made the testing decision unless a cardiologist was ultimately responsible for that decision, then we included the case.

Table SM2. Contributing factor codes used for case extraction in the current study, from the CMPA contributing factors framework¹⁹

Contributing factor code	Definition
CONTRA	Criticism of a contraindicated procedure or pharmacotherapy
DAMAGE	Criticism of injury arising from, or associated with, plans or actions taken during the provision of healthcare, rather than an underlying disease or injury
DIAGNOSIS	Criticism of a diagnostic issue
EVAL	Deficient histories or general evaluation
IDN	Intervention not done or delayed
PERF	Delay or failure in the performance of a diagnostic test or therapeutic intervention

To identify criticism of test overuse, we extracted eligible cases with criticism of a contraindicated procedure (CONTRA) or healthcare-related injury (DAMAGE), defined in Table SM2. We also conducted a word search in Microsoft Word of medical analyst summaries (a short synopsis of the case, defined in **Supplemental Table S2**) for evidence of test overuse using search terms such as “necessary”, “excessive”, and “needed”. A nurse-researcher (E.W.) manually reviewed these cases to confirm eligibility, as for test underuse.

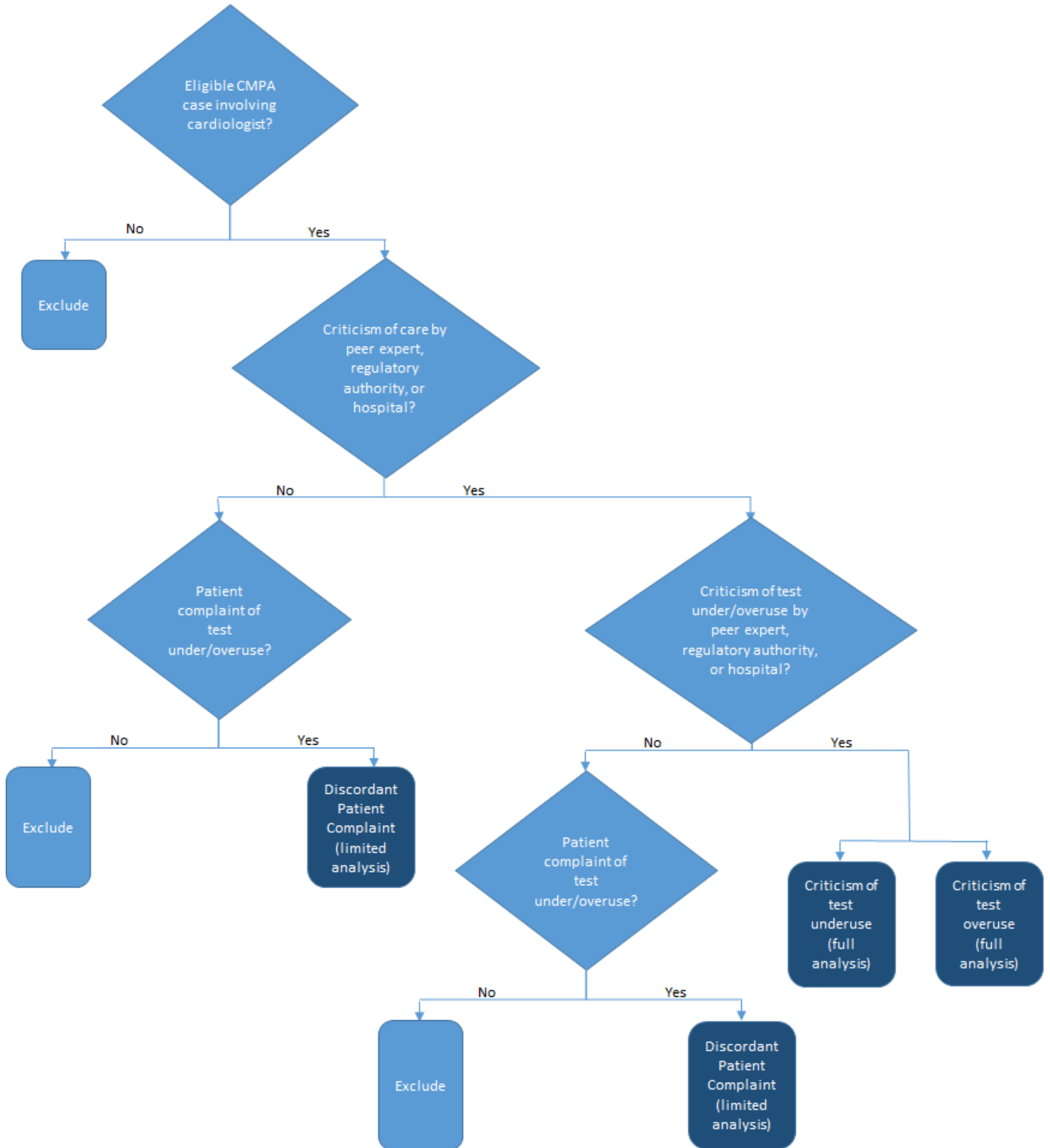
To identify discordant patient complaints, we extracted eligible cases with a patient complaint of underuse or overuse (reason for complaint DIAGNOSIS, PERF, CONTRA, DAMAGE, or EVAL in Table SM2) but no criticism of this by peer experts, Colleges, or hospitals.

Supplemental Methods S3. Methodology used to derive variables for analysis in the current study

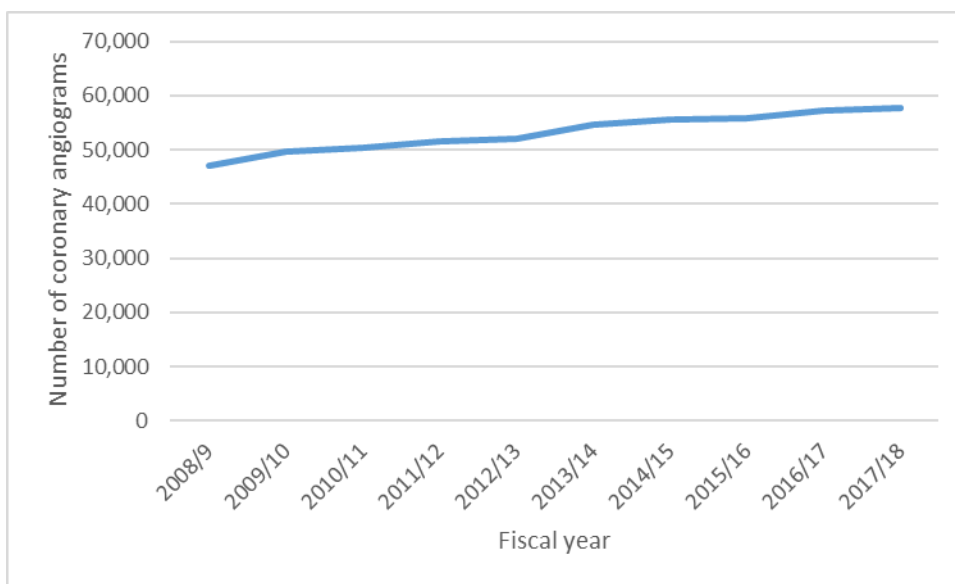
A nurse-researcher (E.W.) derived several variables for analysis as follows:

- “Years since graduation” indicated the time since graduating from a medical degree (MD), and was calculated as [(year of test underuse or overuse) - (physician year of MD graduation)].
- “Geographic location” was the city in which underuse/overuse took place, mapped to Canadian 2016 census data and population sizes defined by Statistics Canada (small, medium, large).³¹
- The reasons for cardiac testing were categorized as “focused” (to investigate a patient’s new or worsening symptoms) or “routine” (lacking new symptoms).

Supplemental Figure S1: Decision tree for case selection and subgroup classification



Supplemental Figure S2. Frequency of coronary angiograms performed annually in Ontario from April 1st, 2008 to March 31st, 2018. Results are based on a CMPA analysis of data from ICES (<https://www.ices.on.ca/>, Toronto, Canada) made possible through a data sharing agreement with the CMPA.



Date	Coronary angiogram frequency
April 1st, 2008 to March 31st, 2009	46,970
April 1st, 2009 to March 31st, 2010	49,705
April 1st, 2010 to March 31st, 2011	50,502
April 1st, 2011 to March 31st, 2012	51,557
April 1st, 2012 to March 31st, 2013	52,063
April 1st, 2013 to March 31st, 2014	54,578
April 1st, 2014 to March 31st, 2015	55,509
April 1st, 2015 to March 31st, 2016	55,824
April 1st, 2016 to March 31st, 2017	57,138
April 1st, 2017 to March 31st, 2018	57,784
Total	531,630