Rapid Synthesis

Ensuring Appropriate Use of Laboratory Tests

3 March 2023

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Rapid Synthesis:
Ensuring Appropriate Use of Laboratory Tests
10-day response

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McMaster Health Forum

The McMaster Health Forum's goal is to generate action on the pressing health and social issues of our time. We do this based on the best-available research evidence, as well as experiences and insights from citizens, professionals, organizational leaders, and government policymakers. We undertake some of our work under the Forum banner, and other work in our role as secretariat for Rapid-Improvement Support and Exchange, COVID-19 Evidence Network to support Decision-making (COVID-END), and Global Commission on Evidence to Address Societal Challenges.

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Timeline

Rapid syntheses can be requested in a three-, 10-, 30-, 60- or 90-business-day timeframe. This synthesis was prepared over a 10-business-day timeframe. An overview of what can be provided and what cannot be provided in each of the different timelines is provided on McMaster Health Forum's Rapid Response program webpage.

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Conflict of interest

The authors declare that they have no professional or commercial interests relevant to the rapid synthesis. The funder played no role in the identification, selection, assessment, synthesis or presentation of the research evidence profiled in the rapid synthesis.

Merit review

The rapid synthesis was reviewed by a small number of policymakers, stakeholders and researchers in order to ensure its scientific rigour and system relevance.

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KEY MESSAGES

Question

- What is known from the evidence and from other jurisdictions about successful approaches to monitor, report and manage laboratory utilization?

Why the issue is important

- Concerns about the efficient use of health resources following the COVID-19 pandemic are fueling an increased interest in appropriate laboratory test use.
- A number of challenges contribute to the misuse of laboratory testing, including fragmentation between sectors and clinicians, rapid advances in technology, an increasing menu of testing options, and limited or unclear guidance about what tests to run and when.
- One solution to this has been the development of laboratory test utilization or stewardship committees who are responsible for monitoring, reporting and evaluating the use of laboratory tests, and implementing initiatives that help to manage appropriate usage.
- This rapid response aims to examine approaches that have been used by these committees to ensure the appropriate use of laboratory testing described in the literature and in select countries and Canadian provinces.

What we found

- We identified three evidence syntheses and 13 primary studies that addressed the question.
- The included literature focused on eight different interventions that have been used to support the appropriate use of laboratory testing, including clinical guidelines, redesign of patient transfer forms, cost displays, educational interventions, computerized order entry system, clinical decision support tools and multi-component interventions.
- Significant heterogeneity in the interventions was reported in the included literature, limiting the ability to draw clear conclusions about the comparative effects of the approaches.
- However, one systematic review concluded that when the interventions are tailored to address local barriers to change, then multi-component interventions may be more effective than individual interventions.
- We also undertook a jurisdictional scan to examine the experiences of monitoring, reporting and managing laboratory utilization in two countries (Australia and the U.K.) and in three Canadian provinces (Alberta, Ontario and Nova Scotia).
- Relatively little was identified with respect to laboratory management at the national level in Australia, though the Public Health Laboratory Network provides leadership and guideline development for medical laboratories to help fulfil their responsibilities.
- Approaches to support laboratory management in the U.K. are rooted in the Good Laboratory Practice Regulation, 1999 and the establishment of the Good Laboratory Practice Monitoring Authority which ensures adherence to standards of good laboratory practice.
- In Alberta, the 2017 Provincial Plan for Integrated Laboratory services provides recommendations for improving laboratory information system, improving standardization, optimizing logistics and ensuring access to skilled laboratory professionals.
- In Ontario, laboratory management was the focus of a recent Auditors General's report which noted price lists and unnecessary testing were major issues for the province and suggested 25 recommendations to be implemented.
- Nova Scotia has established a Laboratory Utilization Committee with the primary aim of monitoring, reviewing and evaluating utilization initiatives within the Nova Scotia Health Authority as well as having implemented a hospital information system which has helped to standardize ordering processes for tests.

QUESTION

What is known from the evidence and from other jurisdictions about successful approaches to monitor, report and manage laboratory utilization?

WHY THE ISSUE IS IMPORTANT

Concerns about the efficient use of health resources following the COVID-19 pandemic are fueling an increased interest in appropriate laboratory test use. This involves ensuring that patients in need of laboratory testing can access it in a timely manner, but also that inappropriate tests, including duplicates of the same test, are not being issued.

A number of challenges contribute to the misuse of laboratory testing including, but not limited to:

- fragmentation between sectors and clinicians
- advances in technology that make 'just running another test' the default
- an increasing menu of testing options
- limited or unclear guidance about what tests to run and when.

One solution to this has been the development of laboratory test utilization or stewardship committees. These committees are made up of multidisciplinary clinicians, who are responsible for monitoring, reporting and evaluating the use of laboratory tests, as well as implementing initiatives to help manage the appropriate use of tests moving forward.

This rapid response aims to examine approaches that have been used by these committees to ensure the appropriate use of laboratory testing described in the literature, and in select countries and Canadian provinces.

Box 1: Background to the rapid synthesis

This rapid synthesis mobilizes both global and local research evidence about a question submitted to the McMaster Health Forum's Rapid Response program. Whenever possible, the rapid synthesis summarizes research evidence drawn from systematic reviews of the research literature and occasionally from single research studies. A systematic review is a summary of studies addressing a clearly formulated question that uses systematic and explicit methods to identify, select and appraise research studies, and to synthesize data from the included studies. The rapid synthesis does not contain recommendations, which would have required the authors to make judgments based on their personal values and preferences.

Rapid syntheses can be requested in a three-, 10-, 30-, 60- or 90-business-day timeframe. An overview of what can be provided and what cannot be provided in each of these timelines is provided on the McMaster Health Forum's Rapid Response program webpage.

This rapid synthesis was prepared over a 10-business-day timeframe and involved three stages:

1) submission of a question from a policymaker or stakeholder (in this case, the British Columbia Ministry of Health)
2) identifying, selecting, appraising and synthesizing relevant research evidence about the question
3) drafting the rapid synthesis in such a way as to present concisely and in accessible language the research evidence.

WHAT WE FOUND

From the searches descried in Box 2, we identified three evidence syntheses and 13 primary studies that addressed the question. All studies related to interventions to address both over- and under-utilization of laboratory tests. We did not identify any reviews or studies that provided details about implementing a laboratory utilization committee, though some studies referred to one being in existence.

The included literature focused on eight different interventions that have been used to support the appropriate use of laboratory testing (from least to most intensive):

- clinical guidelines
- redesign of patient transfer forms
- cost displays
- educational interventions
- computerized order entry system
- clinical decision support tools
- multi-component interventions.

There was significant heterogeneity reported between the interventions, particularly when multiple component interventions were examined. This limited the ability for the authors of the systematic reviews to undertake meta-analyses or other synthesis methods to draw clear conclusions about the comparative effectiveness of each of the interventions.

Box 2: Identification, selection and synthesis of research evidence

We identified research evidence (systematic reviews and primary studies) by searching (in February 2023) Health Systems Evidence (www.healthsystemsevidence.org) and in PubMed. In Health Systems evidence, we used the search term "laboratory." In PubMed "laboratory test" AND utiliz* AND (manag* OR report* OR monitor*) were used.

We identified jurisdictional experiences from two countries (Australia and the U.K.) and from three Canadian provinces (Alberta, Ontario and Nova Scotia).

The results from the searches were assessed by one reviewer for inclusion. A document was included if it fit within the scope of the questions posed for the rapid synthesis.

For each systematic review we included in the synthesis, we documented the focus of the review, key findings, last year the literature was searched (as an indicator of how recently it was conducted), methodological quality using the AMSTAR quality appraisal tool (see the Appendix for more detail), and the proportion of the included studies that were conducted in Canada. For primary research (if included), we documented the focus of the study, methods used, a description of the sample, the jurisdiction(s) studied, key features of the intervention, and key findings. We then used this extracted information to develop a synthesis of the key findings from the included reviews and primary studies.

Further, one systematic review noted that very few studies indicate the rationale for the choice of combinations of interventions to include in multi-component approaches, challenging the ability to make clear generalizations from the literature.(1) The authors of this review conclude that if interventions are tailored to address local barriers to change then multi-component interventions may be more effective than individual interventions.(1) It was noted that these interventions would be most successful when rooted in known attitudes and behaviours responsible for existing laboratory testing patterns.(1) This is also emphasized in one primary study which notes the importance of using data from electronic health records and electronic ordering forms to inform a problem definition and choice of the best approaches to shift behaviour.(2)

In addition to the list above, one commentary, which was included because of its pertinence to the question, identified a toolbox for laboratory test utilization management and provided grading from strong to weak (although the methods used to determine this categorization were not included). Approaches deemed to be strong, include:

- banning of select tests
- creating a laboratory test formulary
- using combined or multi-component interventions
- implementing required pre-approval or consultation for select tests
- changing computerized order entry forms

- offering reflexive testing (e.g., the automatic issuing of a subsequent, often complementary test, when an initial one meets pre-determined criteria).(3)

Table 1 below synthesizes the effects of each of the identified interventions by type, and identifies (wherever possible) mentions of comparative effectiveness.

Finally, we identified a document produced through a collaboration between Choosing Wisely and the Canadian Society of Medical Laboratory Science, which includes seven evidence-based lessons for laboratory utilization:

- "don't collect more blood than what is needed – use short draw tubes and consider add-on testing to reduce or combine duplicate orders"
- "don't proceed with testing or reporting when sample quality or identification is suspect"
- "don't collect extra blood tubes in anticipation of test order"
- "don't support repeat test ordering (re-testing) at a frequency that is not backed by evidence"
- "don't routinely repeat critical results for most common analytes before reporting"
- "don't support ordering system mechanisms that contribute to over-testing, and instead encourage the development of evidence-based utilization management programs that include interventions such as unbundling order sets, reflex testing algorithms, and decision-support technology"
- "don't allow standing orders for repeat testing without a stop or review date."(4)

In addition to the literature search, we undertook a jurisdictional scan to examine the experiences of monitoring, reporting and managing laboratory utilization in two countries (Australia and the U.K.) and in three Canadian provinces (Alberta, Ontario and Nova Scotia). We also identified an older environmental scan conducted by CADTH, which provides a complementary pan-Canadian perspective on approaches to laboratory utilization management.(5) Our detailed findings are reported in Table 2 and summarized below.

We found relatively little with respect to laboratory management and utilization at the national level in Australia. The Public Health Laboratory Network (PHLN) provides leadership and consultation for public-health microbiology and disease control which includes the development of guidelines and advice to medical laboratories to help fulfil their responsibilities. In addition, we identified that at the national level, the National Pathology Accreditation Advisory Council (NPAAC) develops and maintains standards, whereas the Quality Use of Pathology Program (QUPP) funds projects to improve the management, delivery and use of Medicare pathology services.

In the U.K., the Good Laboratory Practice Regulations 1999 established the Good Laboratory Practice Monitoring Authority (GLPMA), which consists of the Secretary of State for Health, the National Assembly for Wales, the Scottish Ministers and the Department of Health and Social Services for Northern Ireland, and ensures that operators uphold the standards of good laboratory practice. In 2022, the UK Health Security Agency (UKHSA) published Laboratory reporting to UKHSA: A guide for diagnostic laboratories, which outlines Health Protection (Notification) Regulations 2010 and U.K. standards for microbiology investigations and reporting requirements, including to inform appropriate and timely action on detecting new threats and contending with emerging problems. As part of the National Pathology Programme, NHS England published Digital First: Clinical Transformation through Pathology Innovation, which aims to better integrate digital technology into pathology services, including approaches to ensure appropriate use.

At the provincial level, Alberta's 2017 Provincial Plan for Integrated Laboratory Services, which was informed by stakeholder engagement and a best practice environmental scan, provides recommendations for improving Alberta's laboratory information system and investing in innovation and technology, reorganizing laboratory service delivery, improving standardization, optimizing logistics and facility infrastructure, ensuring access to skilled laboratory professionals, and accreditation. A significantly older document, the 2011 Alberta College of Pharmacy's Guidelines for Pharmacists Ordering Laboratory Tests and Using Laboratory Data provides guidance for pharmacists using lab test data and specific protocols and restrictions for ordering lab

tests, avoiding duplication, following up with test results, and documenting decisions and rationales for decisions when relevant.

In Ontario, the Ontario Association of Medical Laboratories produces guidelines for clinical laboratory practice that are intended to encourage better use of laboratory services and interpretation of results. A 2017 report by the Auditor General of Ontario provided a comprehensive overview of laboratory services in Ontario, with a major area noted for improvement being costs to the ministry and patients that arise from price list issues and unnecessary testing. A 2019 follow-up report found that only seven (28%) of the 25 recommended actions had been fully implemented and a further 13 (52%) were in the process of being implemented. Several Ontario hospitals are participating in Choosing Wisely Canada's 'Using Labs Wisely' program, which is focused on changing practices and policies, sharing data, and learning from participants to reduce low-value and unnecessary lab testing. Finally, The Laboratory Medicine and Pathobiology Quality Council (based at the University of Toronto) brings together representatives of hospital labs in the Toronto area to develop guidance and programs aimed at improving patient outcomes and quality of lab services. This consortium is currently focusing on harmonization of critical values and quality indicators for labs as well as reducing wasteful test utilization.

Finally, in Nova Scotia, in November 2010, a Laboratory Utilization Committee was established with the primary aim of monitoring, reviewing, and evaluating utilization initiatives within the Nova Scotia Health Authority (previously branded as Capital District Health Authority at the time). This committee is responsible for:

- reviewing physician ordering practices (e.g., requiring approval to implement additional or alternate testing within the laboratory)
- evaluation requirements for cancellation rules and reviewing utilization guidelines
- auditing the ordering patterns of physicians and comparing this with a 'peer group'.

In addition, the implementation of the Nova Scotia Hospital Information System has helped to standardize the ordering process for tests by ensuring consistency among all laboratories, and has also further improved the utilization of laboratory resources.

Table 1: Summary of interventions to support monitoring, reporting and managing laboratory utilization

Intervention	Reported outcomes from systematic reviews and primary studies
Clinical guidelines	• Two studies included in an older medium-quality evidence synthesis both reported positive results from the use of guidelines to change test ordering habits among primary-care physicians • One of the studies in the same review found that integrating clinical guidelines into patient electronic records was more effective than decision-support tools based on limited testing offered in modified request forms (1)
Redesign of patient transfer forms	• One recent primary study found that redesigning the patient transfer letter to include a section on lab tests performed resulted in a reduction in inappropriate testing (6)
Cost display	• One older medium-quality evidence synthesis found that real-time display of cost information resulted in insignificant changes for five out of six high-cost tests, however the review reports conflicting evidence among studies that have included physicians in hospital settings (1) • One recent primary study found that within hospital settings, displaying the cost of the test either at the moment of ordering or at the presentation of results had no effect on test volume • However, the study found that the implementation of cost displays alongside issuing-cost charges resulted in a significant reduction in laboratory test ordering in privately operated primary healthcare centres in Sweden (7)
Educational interventions	• One older medium-quality evidence synthesis found educational strategies had a positive effect on primary-care physician laboratory testing patterns and, in particular, it was found that diagnosis- or symptom-based education strategies involving a multidisciplinary approach proved effective o However, the review notes some concern about the long-term effectiveness of educational interventions, but two included studies found that it can be maintained with regular re-enforcement (1) • One older medium-quality evidence synthesis found that educational interventions were most effective for targeted reductions in over-utilization for a single test, however significant heterogeneity in the educational components that comprised the interventions was noted as limiting the strength of this conclusion (8) • One primary study introduced five separate interventions to reduce duplicate testing (three of which focused on educational interventions including a poster intervention and a presentation intervention directed to clinicians as well as a patient-education intervention), and the study found none of these to have been successful in reducing inappropriate testing o For the clinician-focused interventions, study authors noted that this may have been a result of clinicians not engaging with either the posters or the presentation o For the patient-focused pamphlet, the study reported an increase in tests, likely as a result of raising greater awareness among patients and driving demand (6) • One primary study found that team-based learning among first- and second-year medical students was successful in supporting appropriate use of laboratory coagulation tests and analyses (9)
Computerized order entry system (which	• One recent primary study noted that computerized order entry systems allow for the collection and analysis of data that can inform problem-solving

may include the use of reflex testing)	○ In particular, the study highlighted that the data reports stemming from computerized order entry systems supported volume monitoring, laboratory menu optimization, and analysis of miscellaneous laboratory requests (and greater ability to determine where it is being used inappropriately)(10) • One recent primary study implemented a series of automatic supports within the computerized order entry system, which included automatic ordering of specific tests when indicator values were within range, as well as automatically negating requests for duplicate or unnecessary tests ○ The study found that these approaches supported greater optimization of tests and a reduction in inappropriate requests (11) • One recent primary study found the implementation of a minimum recommended interval for repeat testing within a computerized order system was successful in reducing the inappropriate use of full blood counts and biochemistry profiles, as well as for coagulation screenings on older adults (6) • One older primary study found the automatic blocking of unnecessary duplicate tests when using computerized physician order entry was successful in reducing 11,790 unnecessary tests and resulted in a cost savings of US$183,586 during a two-year period ○ The study initially trialed a 'soft stop version' which could be circumvented, but it was found to be ineffective in stopping duplicate test orders for routine assays (12)
Clinical decision support tools (embedded in EHRs and in computerized order entry systems)	• One recent primary study found the implementation of a clinical decision support tool which included automated blocking of select stool microbiology tests based on pre-determined criteria within an EHR resulted in a reduction of unnecessary test orders and saved the hospital laboratory over US$8,000 in reagent and labour costs for the single-test type over the 11 months studied (13) • One recent primary study found that clinician compliance rates with alerts are inversely related to the number of alerts issued by clinical decision-support tools ○ The study found that key factors associated with accepting an alert include: orders for patients with a prior abnormal result for a test, orders for patients entered upon outpatient encounters in which the patient did not have a visit, and orders submitted by trainees or nurse practitioners/physician assistant ○ The study found higher compliance with alert issues from provider-specific models, which tailored the alerts to go off when there was either a duplicate test or when the model predicts substantial likelihood that the clinician would accept the alert (based on previous data from computerized laboratory order entry)(14) • One older primary study found that reformatting computerized order entry forms to avoid bundling tests together under single diagnostic classifications reduced orders by 31% to 41% relative to pre-intervention levels (15)
Multi-component interventions	• One older high-quality and one older medium-quality evidence synthesis found that most multi-component interventions that included an audit and feedback component had a positive effect on changing provider ordering habits, however this depended on the other components included (1; 16) ○ The reviews found that audit and feedback interventions were rarely used on their own and as a result could not report on their effectiveness independently ○ The reviews found that feedback was most frequently provided in written format to individual clinicians, but was also sometimes presented as aggregate data, which may be most effective when coupled with outreach visits and other educational reminders

	• One older medium-quality evidence synthesis reported that among education, audit and feedback, and incentive/penalty interventions, the largest relative reduction that targeted the misuse of four or more tests came from a multi-component systems intervention that included a computerized ordering entry system, the display of previous laboratory results to physicians ordering tests, the prevention of recurring orders in select circumstances, and the unbundling of tests so that each component had to be ordered individually (8) • One recent primary study reported on the implementation of a multi-component intervention in general medicine at a community teaching hospital that resulted in an absolute reduction of unnecessary tests of between 7% and 16% for each complete blood count and basic metabolic panel o The intervention included educational material on inappropriate clinical indications, general information about costing and the burden of over testing, and encouraged a friendly competition between two medical teams of medical residents (17) • One older primary study reported on the implementation of a multi-faceted educational campaign and found a 50% reduction in the number of tests for five targeted analytes, resulting in an estimated annual savings of $52,298 o The intervention included presentations to primary-care physicians, feedback letters including an educational component on the highest requesting primary-care physicians, information on appropriate testing, and information on changing laboratory testing rules (18)

Table 2: Experiences of monitoring, reporting and managing laboratory utilization

Country	Summary of experiences
Australia	• The Public Health Laboratory Network (PHLN) provides leadership and consultation for public-health microbiology and disease control o The committee established their terms of reference, list of members, monthly teleconference calls, and yearly face-to-face meetings o Members include those from the states and territories, Australian government, expert members, and observers • Most pathology services qualify for the Medicare Benefits Schedule (MBS) which is a referred service determined by the treating healthcare provider • The government has specific criteria to be an approved pathology authority, practitioner, laboratory, or collection centre • The National Pathology Accreditation Advisory Council (NPAAC) develops and maintains standards, whereas the Quality Use of Pathology Program (QUPP) funds projects to improve the management, delivery and use of Medicare pathology services
United Kingdom	• The Good Laboratory Practice Regulations 1999 established the Good Laboratory Practice Monitoring Authority (GLPMA), which consists of the Secretary of State for Health, the National Assembly for Wales, the Scottish Ministers and the Department of Health and Social Services for Northern Ireland o Operators of test facilities can gain membership of the United Kingdom good laboratory practice compliance program (U.K. GLP compliance program), which ensures that operators uphold the standards of GLP

	• The U.K,'s Medicines and Healthcare products Regulatory Agency publishes guidance on Good laboratory practice (GLP) for safety tests on chemicals, which includes the following contents:
	  ○ GLP monitoring inspections and grading of inspection findings
	  ○ actions after an inspection and regulatory or enforcement of action
	  ○ further guidance and text of regulations
	  ○ stakeholder engagement meetings.
	• In 2022, the UK Health Security Agency (UKHSA) published Laboratory reporting to UKHSA: A guide for diagnostic laboratories, which outlines Health Protection (Notification) Regulations 2010 and U.K. standards for microbiology investigations and reporting requirements
	  ○ The purpose of these surveillance measures is to: 1) ensure early detection of changes in temporal, geographic and age distribution of new and known diseases; 2) analyze source of exposure, prevalence, burden, morbidity, mortality, carriage and long-term trends, and monitor the use and coverage of interventions, including adverse events and the overall impact of disease-control measures; and 3) inform appropriate and timely action to protect public health at local and regional levels as well as new policies for detecting new threats and emerging problems
	• As part of the National Pathology Programme, NHS England published Digital First: Clinical Transformation through Pathology Innovation, which aims to better integrate digital technology into pathology services
	  ○ Digital enhancements to pathology services include digital dictation, voice recognition, automatic ID and data capture, digital clinical correspondence, mobile working, voice over internet protocol, secure SMS, and online meeting services
	  ○ Such efforts are noted as helping people feel in control of their health and improve access to test results, improve multidisciplinary teams' access to timely information and specialist advice, enable better workflows between wards and labs to improve turnaround time, and improve identification and management of samples to enhance patient safety, convenience and reduce costs associated with re-testing
	  ○ Pathology innovation will help improve the effectiveness and efficiency of services necessary to help diagnose illness, screen for congenital disease, cancer and other conditions, and monitor the progress of disease and manage therapies

Canada – Alberta	• The Alberta college of Pharmacy has published Standards of Practice for Pharmacists and Pharmacy Technicians (effective January 2022) and Standards for the Operation of Licensed Pharmacies (updated June 2022) to provide standards of practice that align with relevant Acts and Regulations within the province as well as regulatory framework for prescribing
	• Alberta's 2017 Provincial Plan for Integrated Laboratory Services, which was informed by stakeholder engagement and a best practice environmental scan, provides recommendations for improving Alberta's laboratory information system and investing in innovation and technology, reorganizing laboratory service delivery, improving standardization, optimizing logistics and facility infrastructure, ensuring access to skilled laboratory professionals, and accreditation
	  ○ Some of the proposed actions highlighted include:
	  ▪ moving to a program of individual certificates of accreditation by site versus one certificate for all laboratories in each delivery organization
	  ▪ continuing to support working towards a western accreditation program across Manitoba, Saskatchewan, Alberta and British Columbia

	▪ establishing a province-wide program responsible for logistics supporting the provincial integrated laboratory system ▪ creating organizational policies on standardization and formalizing criteria informing decisions to standardize, as well as the process to manage requests for exceptions by clarifying the criteria and decision-making process ▪ developing a menu of appropriate funding mechanisms and related policies to support regular capital investment in equipment and technology. • The 2011 Alberta College of Pharmacy's Guidelines for Pharmacists Ordering Laboratory Tests and Using Laboratory Data provide guidance for pharmacists using lab test data o Lab data may be indicated for situations including: 1) reviewing drug orders and doses to ensure they are appropriate for the individual patient while reviewing patient blood levels; 2) monitoring patients' response to therapy to ensure optimal outcomes; 3) monitoring for adverse effects; and 4) screening patients for untreated health conditions o The guidelines also specify protocols and restrictions for ordering lab tests, avoiding duplications, following up with test results, documenting decisions and rationales for decisions when relevant, and patient confidentiality and delivering test results
Canada – Ontario	• A 2012 report states that laboratory services in Ontario are divided between public hospital laboratories and private outpatient laboratories o The funding mechanism for private labs (which includes industry-wide and corporation-specific funding caps) prevents providers from competing on market share and volume and forces them to compete on efficiency and cost-optimization o The Ministry of Health negotiates private laboratory service agreements with the Ontario Association of Medical Laboratories every three years • The Ontario Association of Medical Laboratories produces guidelines for clinical laboratory practice that are intended to encourage better use of laboratory services and interpretation of results o The guidelines are produced by the Quality Assurance of Clinical Laboratory Practice Committee and targeted at client physicians or other healthcare practitioners who order tests o Twenty-eight guidelines were published between 1996 and 2019 • A 2017 report by the Auditor General of Ontario provides a comprehensive overview of laboratory services in Ontario and notes several areas for improvement o One major noted area for improvement relates to costs to the ministry and patients that arise from price list issues and unnecessary testing o The lack of oversight of laboratories and their performance was noted as another major area of concern o The report provides 12 recommendations consisting of 25 actions for the Ministry of Health o A 2019 follow-up report found that seven (28%) of the 25 recommended actions had been fully implemented and a further 13 (52%) were in the process of being implemented • Several Ontario hospitals are participating in Choosing Wisely Canada's 'Using Labs Wisely' program o This program is focused on changing practices and policies, sharing data, and learning from participants to reduce low-value and unnecessary lab testing

	• The Laboratory Medicine and Pathobiology Quality Council (based at the University of Toronto) brings together representatives of hospital labs in the Toronto area to develop guidance and programs aimed at improving patient outcomes and quality of lab services o This consortium is currently focusing on harmonization critical values and quality indicators for labs as well as reducing wasteful test utilization • Health Quality Ontario produces health technology assessment reviews and recommendations that concern the utilization of laboratory services (as well as other health topics); most of their recommendations have been accepted by the health ministry • The Ontario Laboratories Information System provides healthcare providers with standardized access to patient lab test results from hospital, community, and public-health laboratories
Canada – Nova Scotia	• In November 2010, a Laboratory Utilization Committee was established with the primary aim of monitoring, reviewing and evaluating utilization initiatives within the Nova Scotia Health Authority (previously branded as Capital District Health Authority at the time), and this committee is responsible for: o reviewing physician ordering practices (e.g., requiring approval to implement additional or alternate testing within the laboratory) o evaluating requirements for cancellation rules and reviewing utilization guidelines o auditing the ordering patterns of physicians and comparing this with a 'peer group'. • An environmental scan conducted by the Canadian Agency for Drugs and Technologies in Health in 2014 revealed that the Cape Breton District Health Authority released memos to the top 50% of physicians ordering laboratory tests to notify them of their usage/ordering volume as compared to their counterparts o An estimated $330,000 were reported in savings upon a reduction in ordering volume of the tests under analysis • The Department of Pathology and Laboratory Medicine provides monthly performance indicators on their 'turn-around-time' for laboratory test results, which can be viewed online and includes the order volumes for various microbiology, immunology, hematology, clinical chemistry, and blood transfusion tests • The implementation of the Nova Scotia Hospital Information System has helped to standardize the ordering process for tests by ensuring consistency among all laboratories, and has also further improved the utilization of laboratory resources • Health professionals and institutions can access laboratory results through the Laboratory Reporting and Inquiry Services o This service issues an estimated two million reports and responds to an average of 450 phone calls on a daily basis

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APPENDICES

The following tables provide detailed information about the systematic reviews and primary studies identified in the rapid synthesis. The ensuing information was extracted from the following sources:

- systematic reviews - the focus of the review, key findings, last year the literature was searched, and the proportion of studies conducted in Canada
- primary studies (in this case, economic evaluations and costing studies) - the focus of the study, methods used, study sample, jurisdiction studied, key features of the intervention and the study findings (based on the outcomes reported in the study).

For the appendix table providing details about the systematic reviews, the fourth column presents a rating of the overall quality of each review. The quality of each review has been assessed using AMSTAR (A MeaSurement Tool to Assess Reviews), which rates overall quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality. It is important to note that the AMSTAR tool was developed to assess reviews focused on clinical interventions, so not all criteria apply to systematic reviews pertaining to delivery, financial or governance arrangements within health systems. Where the denominator is not 11, an aspect of the tool was considered not relevant by the raters. In comparing ratings, it is therefore important to keep both parts of the score (i.e., the numerator and denominator) in mind. For example, a review that scores 8/8 is generally of comparable quality to a review scoring 11/11; both ratings are considered "high scores." A high score signals that readers of the review can have a high level of confidence in its findings. A low score, on the other hand, does not mean that the review should be discarded, merely that less confidence can be placed in its findings and that the review needs to be examined closely to identify its limitations. (Lewin S, Oxman AD, Lavis JN, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP): 8. Deciding how much confidence to place in a systematic review. *Health Research Policy and Systems* 2009; 7 (Suppl1):S8).

All of the information provided in the appendix tables was taken into account by the authors in describing the findings in the rapid synthesis.

Appendix 1: Summary of findings from evidence syntheses about ensuring appropriate use of laboratory tests

Type of evidence synthesis	Focus of systematic review	Key findings	Year of last search/ publication date	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada
Systematic review	Effectiveness of interventions to improve laboratory requesting patterns among primary care physicians (1)	The review included 11 studies that focused on seven strategies: education programs, laboratory profiles, clinical guidelines, guidelines and feedback combined, cost displays, the redesign of order forms, and the use of feedback and education strategies. Education-based interventions appear to have promising effects. Similarly, educational strategies have also been effective in changing other primary-care behaviours associated with laboratory tests. Diagnoses or symptom-based education strategies is often questioned in the literature. With respect to the feedback-based interventions, their effects were dependent on the particular combinations that were used. In particular, enhanced feedback combined with brief educational reminder messages had a positive effect on requesting patterns. Feedback interventions were found to be ineffective when provided following guidelines. Similarly, decision-supports were less effective when used individually then when coupled with electronic patient records. Finally, real-time cost displays showed a significant but small change in laboratory testing patterns. The review also noted that conflicting results exist between whether the intervention works for physicians in primary care as opposed to those working in hospitals.	2014	7/10 (AMSTAR ratings from the McMaster Health Forum)	0/11
Systematic review	Examining the influence of education, audit and feedback, system based and incentive and penalty interventions to reduce laboratory test utilization (8)	The review included 109 studies and categorized the interventions as one or more of: education, audit and feedback, system based, or incentive or penalty. The highest relative reduction came from education interventions, however there was significant heterogeneity in the components that made up each intervention, how the interventions were implemented, the study setting, and the tests that were targeted for reduction, making meaningful generalizations difficult. The largest relative reduction for interventions that targeted four or more tests came from a multi-component systems intervention which included a computerized ordering entry system, the display of previous laboratory results to physicians ordering tests, the prevention of recurring orders in select circumstances, and the unbundling of tests so that each component had to be ordered individually.	2013	7/10 (AMSTAR rating provided by McMaster Health Forum)	7/109
Systematic review	Examining the use of audit and feedback to change ordering behaviours (16)	The review examines the use of audit and feedback as an intervention for modifying providers' behaviours when ordering tests within critical care units. The review included 16 studies. Of those, most described multi-component interventions which included an audit and feedback element, rather than its use on its own. Feedback was most frequently provided in written format, however at times it was presented as aggregate data. Most studies reported a positive effect, however this varied based on the other components included and not all studies used statistical analyses to determine whether the results were significant.	2016	9/11 (AMSTAR rating provided by McMaster Health Forum)	2/16

Appendix 2: Summary of findings from primary studies about ensuring appropriate use of laboratory tests

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
Examining the state of laboratory test utilization practices (2)	*Publication date: 2022* *Jurisdiction studied: U.S.* *Methods used: Survey*	Survey was sent to members of the American Association for Clinical Chemistry Artery online discussion form as well as distributed by email to the Patient-centred Laboratory Utilization Guidance Services network Respondents included pathology department member, lab supervisor/administrator, other medical professionals, executive team member and others	Not applicable	The study found a wide distribution of laboratory utilization initiatives including educational lectures, computerized-provider-order-entry, providing cost information, ordering restrictions, prospective order review, and retrospective order feedback. When asked about the most recent methods implemented, the most common was pre-testing approval or consultation, data analysis to guide process changes, or education. The study found that many initiatives targeted chemistry testing, infectious-disease testing, genetics testing, immunology testing, and hematology/coagulation testing. For respondents who provided cost savings, the majority indicated savings were less than US $100,000. There was not a significant correlation between the number of initiatives and the estimated average annual cost savings. About 50% of respondents indicated that their programs were somewhat successful. When asked about what was most effective or what they had learned about implementation, respondents often emphasized access to data and IT support.
Toolbox on managing laboratory test utilization (3)	*Publication date: 2014* *Jurisdiction studied: Not reported* *Methods used: Not reported*	Not reported	Not reported	The study outlines a toolbox for laboratory test utilization management and provides a grading from strong to weak. Identified tools include: ban the test (strong); laboratory test formulary (strong); combined intervention (strong); stop paying for unnecessary testing (strong); ban repetitive orders (strong); privilege ordering providers (strong); require high-level approval (strong); change computerized order entry options (strong); offer reflexive testing (strong); utilization report cards (moderate); computerized reminders/decision support (moderate); post guidelines on paper order forms (weak); education alone/call for enhanced vigilance (weak).
Implementing a clinical decision support tool for stool cultures in hospitalized patients (13)	*Publication date: 2017* *Jurisdiction studied: U.S.* *Methods used: Cross-sectional study*	Microbiology lab within hospital	The implementation of a clinical decision support tool that provides an automated blockage of select stool microbiology tests when ordered through the hospital information system	The study implemented clinical decision support tools within their hospital specifically to curtail stool microbiology testing. The study found it significantly decreased unnecessary test orders and saved their laboratory over US $8,000 in reagent and labor costs during an 11-month post-intervention period.
Introducing cost display to reduce laboratory test utilization (7)	*Publication date: 2018* *Jurisdiction studied: Sweden* *Methods used: Cross-sectional*	Inpatient hospitals, emergency departments, and public and private primary healthcare centres in Kronenburg	Implementation of cost display for inpatient hospitals, emergency departments and outpatient specialist providers	The study found that despite having the cost of a laboratory test display both at the moment of test ordering and at the presentation of the results, the intervention had no effect on laboratory test volume in either private or public clinics. However, the study found that the introduction of a cost charge, requiring primary healthcare centres to pay full laboratory costs, significantly decreased laboratory test ordering in the privately operated primary healthcare centres.

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
Using machine-learning to optimize clinical-decision support tools (14)	*Publication date: 2021* *Jurisdiction studied: Massachusetts* *Methods used: Before-after study*	Electronic Health Records at Partners HealthCare for eight months; Partners HealthCare has eight affiliated hospitals including two academic medical centres and six regional/community-based hospitals	Interruptive alerts that prompted providers to discontinue orders for testing considered to be duplicative. Alerts were set to go off when the selection of a test order came from either the result of a search or from selection from a predefined menu or order set item. An additional model was tested that accounted for individual provider tendencies to either accept or ignore the alert	Compliance with the alert set as is was approximately 70%, with the overall compliance for the duplicate order alerts being significantly lower, noting that the frequency of firing and compliance rates were significantly reduced when too many alerts went off. Factors associated with accepting the alert included having a prior abnormal result for the test, orders entered on outpatient encounters in which the patient did not have a visit, and orders from trainees or NPs/PAs. Compliance by hospital type and by specialty/primary-care physician varied. The provider-specific model outperformed the provider-independent model suggesting that knowledge of the specific clinician is useful in understanding alert acceptance, even after adjusting for other factors. This strategy only fired the alert when there was a test duplicate or the model predicts substantial likelihood that the clinician will accept the alert.
Creating an electronic health record reporting database (10)	*Publication date: 2018* *Jurisdiction studied: Massachusetts* *Methods used: Qualitative case study*	Massachusetts General Hospital, which is a 999-bed tertiary care teaching hospital	Development of an EHR laboratory orders database which would feed into an EHR laboratory order report	The EHR laboratory orders database has been a central part of the laboratory utilization program including to support volume monitoring, menu/search optimization, and miscellaneous test monitoring. On the first issue, the laboratory data allows for the hospital to compare recent weekly and monthly test volumes of all tests to historical test volumes. Further, it allows for an understanding of how the orders originated in the EHR which supports hospital management in developing targeted interventions to curb usage. On the second, greater detailed data about order patterns allowed management to examine the menu of laboratory test options and determine whether there were any that could be removed. Finally, having an electronic order permits the utilization of the database to analyze miscellaneous laboratory requests and determine where it is appropriate and where it is being used inappropriately. The aggregation and importing of daily EHR reports into a query table EHR orders database offers numerous advantages including the ability to run these queries across any time period of interest to observe trends and trajectories of testing in the hospital. Having this data accessible decreases the demands on resource-constrained EHR reporting teams and reduces the time required for analysis. Similarly, awareness of the details of test ordering allows the clinical laboratory to identify trends in test usage, consider additions and removals to the test menu, consider modifications to existing order sets, and identify targets for more advanced decision support.
Managing inappropriate	*Publication date: 2016*	Clinical laboratory at the Public University Hospital of San Jan,	Designed and established four strategies in consensus with	The strategies collectively supported greater optimization of tests and demonstrate how these approaches can detect inappropriate requests of

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
requests of laboratory tests (11)	*Jurisdiction studied: Spain* *Methods used: Before and after*	which serves a population of 234 551 people. Hospitalized patients' samples are collected in every ward by nurses and then transported to the laboratory.	GPs and the test-requesting hospital physician, including: laboratory information system for discard free thyroxine tests when TSH value is in reference range; laboratory information system automatically adds s-Ca to the GP request made for patients 45 years or older who have not had a test in the previous three years; measuring tBil only when the icteric index is above 2 mg/dl; and automatically negate requests for tests of total cholesterol, HDLc or A1c if previously requested and completed in the past seven days.	laboratory tests as well as monitor success, using process and outcome indicators that have been customized according to the type and stage of the strategy. The study notes that the first step is to determine whether there is over- or under-requesting of laboratory tests, while the second is to correct such inappropriateness through strategies approved by requesting clinicians, and the third is to monitor the corrective interventions after their establishment.
Multi-component interventions to reduce inappropriate duplicate lab tests (6)	*Publication date: 2018* *Jurisdiction studied: Ireland* *Methods used: Before and after*	Use of three tests among geriatric patients for full blood counts, biochemistry profiles and coagulation screens	Five interventions were put in place to reduce duplicate tests: poster/education intervention; presentation/educational intervention; lab information technology system review which included a minimum recommended interval for repeat testing; patient empowerment through a leaflet explaining common blood tests was made available to patients; and modification of the transfer letter to include a section on lab tests performed during the inpatient stay and on the day of the transfer.	The intervention was to reduce unnecessary and duplicate testing that was occurring as a result of patients being transferred. Approximately 720 patients transferred to University Hospital of Limerick resulted in 1,035 unnecessary tests, while 1,929 patients transferred from UHL resulted in 1,400 unnecessary tests. The study found the implementation of these approaches to be successful with levels of inappropriate tests decreasing from a high of 80% down to 14% for full blood counts and biochemistry profiles, and 65% to 0% for coagulation screens. It was notable that following each of the interventions there was a decrease in inappropriate testing with the exception of Intervention 2 (i.e., presentation and educational intervention), after which patients transferred from UHL underwent increased tests. Similarly, after the patient empowerment intervention there was an increase in bio profiles. Total savings were approximately 13,500 euros for the study period.
Implementing a hard stop for duplicate laboratory testing using a clinical decision support tool (12)	*Publication date: 2014* *Jurisdiction studied: U.S.* *Methods used: Cross sectional*	Implementation within the Cleveland Clinic Hospital network	Implementation of a clinical decision support tool to block unnecessary duplicate tests during computerized physician order entry	Over a two-year period the clinical decision support tool blocked 11,790 unnecessary duplicate test orders resulting in a cost savings of US$183,586. Initially, a soft stop version was implemented, but was ineffective for stopping duplicate test orders for routine assays.

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
Using team-based learning to support the appropriate use of laboratory tests (9)	*Publication date: 2018* *Jurisdiction studied: U.S.* *Methods used: Before and after*	Hematology and Oncology course for first- and second-year medical students at the University of Central Florida	Team-based learning module which included an individual and group readiness assurance test, team application activity, clinical case and white board, interpretation of laboratory results, final diagnosis and treatment suggestions.	Team-based learning was found to provide a powerful way of teaching students clinical reasoning approach to coagulation, which supports them in making appropriate use of laboratory tests and analyses.
Quality improvement program to reduce over-utilization of blood tests (17)	*Publication date: 2019* *Jurisdiction studied: U.S.* *Methods used: Interrupted time-series analysis*	Adult patients hospitalized on the general medicine service at a community-based teaching hospital	Education of medical residents through the distribution of flyers that outlined the inappropriate clinical indications for the use of specific laboratory tests and some general information regarding the costs and financial burden of over-testing on patients and the healthcare system. In addition, friendly competition was encouraged between the two medical teams by measuring their specific test indices for a two-week period. The medical residents received pocket cards with the trends of each of the teams indices for both tests, and a program-wide email was sent around announcing who won.	A decrease was observed in the use of both tests under study with an absolute reduction of between 7% and 16% for each complete blood count and basic metabolic panel tests.
Using multi-faceted educational approaches to curb inappropriate use of laboratory tests (18)	*Publication date: 2016* *Jurisdiction studied: Canada [Nova Scotia]* *Methods used: Cross-sectional*	Pathology department within the Nova Scotia Health Authority (central zone)	Multi-faceted educational campaign including: presentation to primary-care physicians on appropriate test use; feedback letter including an educational component sent to highest requesting primary-care physicians; memorandum sent with educational and directional elements to all physicians; information on appropriate testing published in Lab	The intervention resulted in a 50% reduction in the number of tests for five of the targeted analytes from 2013 to 2014. The result was an estimated annual saving of $52,298.

Focus of study	Study characteristics	Sample description	Key features of the intervention(s)	Key findings
			Corner, a monthly newsletter; implementation/change of laboratory rules of testing	
Revising a computerized order entry form to support laboratory management (15)	*Publication date: 2009* *Jurisdiction studied: U.S.* *Methods used: Before and after study*	An Israeli managed-care organization called Leumit Health Fund	Reformatting the computerized order form so that tests were not bundled together under a single diagnostic classification but rather appeared among a general list.	The study found a decrease in orders observed following implementation by 31% to 41% relative to the pre-intervention time.

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