Reduce, Reuse, Recycle: Top 10 Choosing Wisely Canada’s Recommendations for Conserving Laboratory Resources

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Abstract
The COVID-19 pandemic has significantly impacted the production, distribution, and demand of essential laboratory supplies worldwide. In 2021, severe shortages in required laboratory supplies such as blood collection tubes, butterfly needles, and blood gas syringes became a critical issue across Canada. Many hospitals or institutions had to instruct physicians and patients to limit laboratory testing where possible and, in some cases, required emergency shipments of tubes from alternative vendors or nearby hospitals. Laboratory testing is ubiquitous in managing patients. It is used for screening, diagnosis, and monitoring purposes. With limited blood collection tubes, consideration for restricting non-urgent testing is needed to conserve supply and protect acute care departments that manage critically ill patients. In addition, laboratories across Canada have experienced significant staffing shortages, resulting in an even greater need for appropriate laboratory

#On behalf of the Canadian Society of Clinical Chemists (CSCC) and Canadian Association of Medical Biochemists (CAMB)
The COVID-19 pandemic has put extraordinary strain on Laboratory Medicine in Canada due to critical shortages not just in blood collection tubes but also in other collection devices (i.e., butterfly needles) and laboratory staffing. Supply chain disruptions of clinical laboratory resources are expected to continue throughout 2022, indicating that now, more than ever, a focus on appropriate laboratory utilization is essential.

Résumé
La pandémie de COVID-19 a eu un impact considérable sur la production, la distribution et la demande de fournitures de laboratoire essentielles dans le monde entier. À partir de 2021, de graves pénuries de fournitures de laboratoire essentielles, comme les tubes pour prélèvement sanguin, les aiguilles à ailettes et les seringues pour l’analyse de gaz sanguin, sont devenues un question cruciale au Canada. De nombreux hôpitaux et établissements ont dû demander aux médecins et aux patients de limiter dans la mesure du possible les analyses en laboratoire et, dans certains cas, ont eu besoin qu’on leur envoie d’urgence des tubes provenant d’autres fournisseurs ou d’hôpitaux voisins. Les analyses en laboratoire sont omniprésentes dans la prise en charge des patientset sont utilisées à des fins de dépistage, de diagnostic et de suivi. Étant donné le nombre limité de tubes pourprélèvement sanguin, il faut envisager de restreindre les analyses non urgentes pour conserver les réserves et protéger les services de soins de courte durée qui prennent en charge les patients gravement malades. De plus, partout au Canada, les laboratoires connaissent des pénuries importantes de personnel, ce qui rend encore plus nécessaire une utilisation appropriée des laboratoires. Par conséquent, la Société canadienne des clinico-chimistes (SCCC) et l’Association des médecins biochimistes du Canada (CAMB), en collaboration avec Choisir avec soin (CAS), ont préparé des recommandations d’utilisation pour les milieux hospitaliers et de soins de santé primaires. Ces recommandations ont été spécifiquement choisies à partir de celles déjà publiées par CAS, en y ajoutant des énoncés des répercussions et des justifications, et visent à conserver les ressources de laboratoire à risque. On s’attend à ce que les perturbations de la chaîne d’approvisionnement en ressources de laboratoire clinique se poursuivent tout au long de l’année 2022, ce qui indique que maintenant, plus que jamais, il est essentiel de se concentrer sur une utilisation appropriée des laboratoires.

Keywords: conserving laboratory resources; CWC; practice guidelines; NPH

Introduction and Development of Practice Guidelines

The COVID-19 pandemic has impacted laboratories worldwide, causing a global shortage of blood collection tubes needed for routine clinical laboratory testing.1-4 Global tube manufacturers like Becton Dickinson (BD) communicated the concern in the summer of 2021, which resulted in large organizations like the National Health Service (NHS) in the United Kingdom temporarily halting all non-urgent laboratory testing.2 Subsequently, Health Canada and the United States Food and Drug Administration (FDA) updated their device shortage lists to include blood collection tubes.3,4 Many professional laboratory societies and media outlets have highlighted the issue over the past year.

The COVID-19 pandemic has put extraordinary strain on Laboratory Medicine in Canada due to critical shortages not just in blood collection tubes but also in other collection devices (i.e., butterfly needles) and laboratory staffing. These shortages have forced healthcare institutions to take immediate action to conserve tubes and supplies. To protect staffing levels, contingency plans were implemented to limit non-urgent testing, if required. The extent of shortages varied between different healthcare institutions and across provinces in Canada, which is confusing for clinicians trying to understand the problem. In Toronto, Canada, some hospitals were severely short on gold top serum separator tubes (required for testing essential routine tests, for example, electrolytes, liver enzymes, troponin). In contrast, other hospitals were short on lavender top tubes (required,
All recommendations were downloaded into Microsoft Excel from the official CWC website.\(^5\) Of 439 CWC recommendations, 66 were found to be directly related to core laboratory testing (biochemistry/hematology). These 66 recommendations were reviewed and ranked by each working group member from most to least impactful on at-risk laboratory resources. The scores were tallied, and the top 5 recommendations for each hospital and primary care setting were selected based on the group’s consensus, including a second review before being finalized. A literature search was conducted, and a concise statement highlighting the impact on the laboratory was developed for each recommendation. The final draft underwent further consultation through CWC, their family medicine physician leads, and the CSCC and CAMB Councils. This manuscript expands on the rationale and impact related to each recommendation.

### Top Five CWC Recommendations for Conserving Lab Resources in Hospitals

#### Recommendation 1

In the inpatient setting, don’t order repeated CBC and chemistry testing in the face of clinical and lab stability—Canadian Society of Internal Medicine, 2013.

**Lab impact statement**

DID YOU KNOW that just one blood draw per day for ‘routine’ daily lab testing can add up to removing the equivalent of a ½ unit of blood per week? The result is 20–30 blood tubes wasted, and iatrogenic anemia has a negative effect on patient outcomes.

**Rationale**

A standard blood collection tube requires \(~5\) mL of blood to fill for analysis adequately. A standard ‘daily’ lab order of Complete Blood Count (CBC), electrolytes, creatinine, venous blood gases, and INR requires approximately 3–4 blood collection tubes. While modern blood testing uses small volumes (<100 microliters) of blood to complete each test, additional blood is required with each draw to fill the different tubes and cover the minimal instrument volume needed (known as ‘dead volume’). Blood draws for chemistry testing only utilize about half of the blood after centrifugal separation of the serum from cells, and sufficient volume is required for repeat testing, add-ons, or reflex testing. Several studies have identified the mean

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**Table 1.** A List of General Strategies recommended Helping Conserve Laboratory Resources while Maintaining Patient Safety.

<table>
<thead>
<tr>
<th>How to Conserve at-risk Laboratory Resources</th>
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<tr>
<td>Physicians and patients are key partners with the laboratory in preserving supplies for testing where needed most. Before ordering tests, we ask clinicians to consider the following:</td>
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<td>• If, and how immediately, this test result will change patient management.</td>
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<td>• Strategies to minimize collections, for example, avoid or limit standing orders.</td>
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<tr>
<td>• Avoid unnecessary repeat testing, for example, check previous results or orders.</td>
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<tr>
<td>• Consult with your local lab professionals about how you can help conserve tubes.</td>
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volume of blood drawn daily to be between 20 and 60 mL per patient, depending on local laboratory protocols.6–8 Over a week, this can add up to over 150 mL of blood, which is approximately half the volume of a standard unit of blood. Iatrogenic anemia can develop due to these excess blood draws and has tangible impacts on patient outcomes and length of stay. Iatrogenic anemia has been associated with increased 30-day mortality and readmission.9 Patients who are critically ill, at risk for nutritional deficiencies, and with extended hospital stays can be particularly at risk.10 In addition, up to 20–30 blood collection tubes may be drawn unnecessarily, representing a significant problem during a blood tube shortage where hospitals only need to conserve tubes for essential testing. This situation is attributed mainly to practices of convenience and inappropriate historical practices rather than being ‘value-adding’ to patient care.

Recommendation 2
Don’t order baseline laboratory studies (i.e., complete blood count, coagulation testing, or serum biochemistry) for asymptomatic patients undergoing low-risk non-cardiac surgery—Canadian Anesthesiologists’ Society, 2015.

Lab impact statement
DID YOU KNOW that 1 in 20 results for healthy individuals falls outside the reference interval? Testing without an indication provides no clinical value, involves numerous blood tubes, and unexpected abnormal results can unnecessarily delay surgery.

Rationale
Multiple studies have found that pre-operative laboratory testing in healthy, asymptomatic individuals does not identify any clinically relevant abnormalities or affect the safety or outcome of the surgical intervention.11–13 A common pre-operative order for CBC, electrolytes and coagulation markers will use 3 blood collection tubes, over 10 mL of blood, and often requires the patient to visit the laboratory. Given the high number of surgical procedures performed on out-patients and the expected rate of abnormal results in 5% of healthy individuals (95% reference intervals), routine screening of asymptomatic individuals will lead to a significant number of false abnormal results. These clinically irrelevant, incidental findings may lead to unnecessary follow-up bloodwork and further invasive procedures and may result in undue delay or cancellation of surgeries. At a time of resource shortages and surgical backlogs, forgoing pre-operative testing, unless there is a specific clinical concern or risk to evaluate, is a sensible approach and improves overall efficiency.

Recommendation 3
Don’t request a serum protein electrophoresis in asymptomatic patients without unexplained hypercalcemia, renal insufficiency, anemia, or lytic bone lesions—Canadian Association of Medical Biochemists, 2020.

Lab impact statement
DID YOU KNOW that serum protein electrophoresis and immunofixation are labor-intensive tests in the lab, and the results are affected by acute illness? Ordering these tests in the hospital often only leads to repeat testing after the reactive process resolves.

Rationale
Serum protein electrophoresis and immunofixation are labor-intensive tests in the lab. These tests are often ordered in the hospital as part of an ‘anemia screen’ or when renal insufficiency or hypercalcemia are identified in acute intercurrent illness.14 Various studies have shown that 25–50% of serum electrophoresis and immunofixation requests are inappropriate, defined as not meeting any guideline or evidence-based criteria for ordering.14,15 In intercurrent illness and hospital admission, the sensitivity and specificity of these tests are diminished.16 Many acute inflammatory processes, including bacterial and viral infections, can create focussed reactive changes in immunoglobulins which may be initially mistaken for a monoclonal protein, or prevent the confident determination of an absence of a plasma cell dyscrasia.16–18 Certain electrophoresis methods are also subject to interferences from imaging contrast dyes and antibiotics.19 Ordering these tests in the hospital frequently leads to follow-up testing after the reactive process resolves.
testing in the lab is labor-intensive? Most individuals with a positive ANA do not have an autoimmune disease and are unlikely to develop one.

**Rationale**
The presence of ANAs, a historical misnomer for anti-cellular antibodies, is a screening marker for systemic autoimmune rheumatic diseases. ANA screening detects autoantibody binding to as many as 150 antigens in the nucleus and the cytoplasm, such as double-stranded DNA (dsDNA), extractable nuclear antigens (ENAs), and other specific autoantibody targets. ANA is a highly sensitive test but not very specific and therefore has low utility in the broad screening of patients, particularly in the setting of intercurrent illness.20

Negative ANA screening should not be repeated unless there is strong clinical suspicion of systemic autoimmune rheumatic disease. There is no need to repeat a positive ANA screen as it does not serve as a prognostic marker and generally does not correlate with disease activity or response to treatment.21,22

ANA screening for back pain or other aches is not an effective use of clinical resources and can be challenging to interpret, as 25% of the general population has measurable ANAs.21 Despite being positive for autoantibody binding to self-antigens, most individuals do not have an autoimmune disease and are unlikely to develop one.20–22 In the lab, ANA testing and subsequent interpretation steps are labor-intensive (taking 2–3 hours to complete) and require dedicated analyzers and specialized expertise.23 False positive ANA results may precipitate further unnecessary testing, such as additional serologies, erroneous diagnosis, specialist consultation, or even inappropriate therapy.

**Recommendation 5**
Don't order an erythrocyte sedimentation rate (ESR) to screen asymptomatic patients or as a general test to look for inflammation in patients with undiagnosed conditions—Canadian Association of Medical Biochemists, 2020.

**Lab impact statement**
DID YOU KNOW that ESR is a manual test in many laboratories, often drawn on a blood tube by itself, and takes up to 90 minutes of lab staff time to complete? Currently, the special tube for this test is in short supply.

**Rationale**
In an asymptomatic patient or a patient with a medical condition of uncertain etiology, the erythrocyte sedimentation rate (ESR) is not helpful, as multiple factors, beyond inflammation may lead to an abnormal ESR.24,25 In contrast, C-reactive Protein (CRP) production is directly linked to IL-6 activity26 and, thus, is more specific as a marker of inflammation. It is also more cost-effective and widely available as an automated test, with a faster turnaround time. ESR testing may be useful in managing select rheumatologic conditions (e.g., Systemic Lupus Erythematosus)27 or when considering the possibility of low-grade bone and joint infections (e.g., osteomyelitis and early prosthetic joint infections),28,29 but is not a useful diagnostic tool.

Many hospital laboratories are minimally staffed, particularly at certain times of the day. When an ESR test is ordered, up to 90 minutes of the laboratory technologist's time is diverted from the performance of tests more critical to patient care. Coupled with the lack of diagnostic accuracy, CRP should be ordered instead of ESR in routine practice, and CRP and ESR should not be ordered together.30
often included in annual screening, CBC is not a useful test in asymptomatic individuals. The only “routine” bloodwork recommended to family physicians is non-fasting lipid tests every 5 years (in men and women ≥ 40 years without risk factors of atherosclerotic cardiovascular disease) and hemoglobin A1c (HbA1c) at a frequency dependent on risk.

Laboratory reference intervals are commonly established by determining the central 95% values for a healthy population; the lower and upper reference intervals represent the 2.5th and 97.5th percentile, respectively, of a healthy population distribution. Therefore, by definition, 5% of healthy individuals have results that fall outside the reference limits and will flag as abnormal. When diseases are uncommon (prevalence around 1%), only 16% of abnormal results are true positives, indicating a disease state. Routine screening without clinical presentation is not recommended, as false positive results cause harm to patients in the form of physical, psychological, and financial harm and often lead to further unnecessary testing or invasive procedures.

Recommendation 2
Don’t support repeat test ordering at a frequency not backed by evidence—Canadian Society for Medical Laboratory Science, 2019.

Lab impact statement
DID YOU KNOW that up to 20% of tests in Canada are repeated too soon after a previous result and provide little to no change in management or additional clinical information? This significantly affects lab resources and uses precious blood tubes.

Rationale
Many lab tests in Canada are repeated too soon after a previous result. This testing offers little to no clinical value and wastes precious healthcare resources regarding blood collection tubes, supplies, test reagents, and laboratory technologists’ time. Tests that are often repeated too frequently include cholesterol, HbA1c, TSH, vitamin B12, vitamin D, ferritin, and serum protein electrophoresis. The appropriate repeat intervals have been defined in many manuscripts, and a summarized list has been provided by The Royal College of Pathologists. The most significant benefit would be in laboratories implementing automated hardstop rules that limit inappropriate repeats at the time of the blood draw. This will help conserve blood collection tubes and resources during the global tube shortage. Ordering providers should review appropriate testing intervals and previous results for these common tests before ordering. A previous result may be available, enabling faster clinical decision-making and reducing repeat visits to follow up on laboratory results.

Recommendation 3
Don’t routinely measure Vitamin D in low-risk adults—College of Family Physicians of Canada, 2015.

Lab impact statement
DID YOU KNOW that Vitamin D testing in many labs in Canada often requires dedicated analytical instruments, collection tubes, and laboratory staff? Except in rare circumstances, testing is unnecessary, and Vitamin D supplements can be used without testing.

Rationale
Routine vitamin D testing is not recommended in low-risk adults. This recommendation can be found in numerous practice guidelines from multiple provinces and advisory committees across Canada and is unaffected by a possible role of vitamin D deficiency in SARS-CoV2 susceptibility or severity. Measurement of 25-hydroxy vitamin D concentrations in asymptomatic individuals has little diagnostic value, as supplementation is generally indicated regardless of the test result. Many Canadians, particularly in the winter months, are vitamin D deficient and should ensure adequate vitamin D intake through diet and vitamins. Daily doses of Vitamin D up to 2000 IU are safe and recommended and do not require laboratory monitoring. Vitamin D testing should be reserved for individuals at high risk for vitamin D deficiency, such as those with severe liver disease, malabsorption syndromes, renal disease, evidence of metabolic bone disorders, or patients treated with medications that affect vitamin D metabolism.

Significant volumes of vitamin D testing are observed across the country, and some more extensive health networks or community labs have entire instruments and staff dedicated to vitamin D testing. For example, large community labs in Ontario, Canada process more than 90,000 vitamin D samples per month combined, costing the health system $11.66 per sample and equating to over CAD 1 million per month. In laboratories across Canada, Vitamin D testing is often not consolidated into a single tube with other tests, meaning that a separate collection tube will be drawn for vitamin D testing alone. During a blood collection tube shortage, it is timely to remind the community of the impact of this low-value test on our healthcare system.
Recommendation 4

Don’t order thyroid function tests in asymptomatic patients—College of Family Physicians of Canada, 2015.

Lab impact statement

DID YOU KNOW that an estimated 25% of TSH tests do not conform with ordering guidelines and result in unnecessary blood draws?

Rationale

Thyroid function tests commonly include thyroid stimulating hormone (TSH), free T4, and free T3. TSH has the highest sensitivity and specificity of any single blood test used to evaluate suspected thyroid dysfunction.52,53 TSH should be used as an initial screening test for symptoms of thyroid axis dysfunction unless a patient is suspected or known to have pituitary or hypothalamic disease.54 There is no evidence to support population-based screening of asymptomatic adults for thyroid disorders, except in pregnancy.55 An estimated 25% of TSH tests do not conform to ordering guidelines and result in unnecessary blood draws.56 A study of 150,944 Ontario patients found that 35.1% of patients with no identified indication had at least 1 TSH test done within 2 years, and 96.2% of those results were within the reference interval.57 Free T4 and free T3 are often unnecessarily coupled with TSH orders. One study shows that 39% of free T4 and 47% of free T3 orders were unnecessary as the TSH results were within the reference interval.58 Choosing Wisely Canada has recommended the implementation of a thyroid reflex algorithm to help reduce unnecessary free T4 and free T3 ordering.59

Recommendation 5

Don’t request a serum protein electrophoresis in asymptomatic patients without unexplained hypercalcemia, renal insufficiency, anemia, or lytic bone lesions—Canadian Association of Medical Biochemists, 2020.

Lab impact statement

DID YOU KNOW that serum protein electrophoresis and immunofixation are labor-intensive tests in the lab, and current practice guidelines do not recommend routine screening in the general population?

Rationale

The primary utility of serum protein electrophoresis is in investigating plasma cell disorders, such as multiple myeloma or AL amyloidosis, in patients who show clinical signs and symptoms of these conditions. The development of otherwise unexplained hypercalcemia, renal insufficiency, anemia, or lytic bone lesions (commonly referred to as CRAB features) may indicate end-organ damage associated with a plasma cell disorder.60,61 Screening in the absence of clinical suspicion for a plasma cell disorder may identify a monoclonal protein, but these are most commonly cases of clinically silent monoclonal gammopathy of undetermined significance (MGUS), which has a low risk of conversion to a symptomatic disease that requires therapy (approx. 1% per year).60 Targeted screening in high-risk individuals may be beneficial, but further research is needed. Broad-population screening is not currently recommended due to the low risk of malignant progression, absence of specific treatment, and lack of effect on patient outcomes.60–62

In a time of limited resources, it is even more important to reserve testing for patients with a clinical suspicion of a plasma cell disorder. In the clinical laboratory, serum protein electrophoresis and immunofixation are manual processes requiring specialized medical laboratory technologists and dedicated instruments. Each test result and accompanying final report must be reviewed by qualified personnel, with complex cases and newly identified monoclonal proteins escalated for further review and interpretation by a clinical biochemist. For a single hospital site in Canada, eight hours per week of technologist time can be dedicated to just these two tests, whereas at large community laboratories, these two tests require multiple full-time technologists due to the high test volumes and complexity of testing.

Conclusion

This expert CSCC and CAMB consensus report reflects CWC recommendations that will be most impactful in mitigating the current laboratory resource shortage crisis. These supply shortages are expected to continue throughout 2022 and may be subject to variability across provinces and institutions. At the same time, the national laboratory technologist shortage shows no end in sight. While laboratory utilization activities have been increasingly in the spotlight due to their downstream impact on healthcare, they are exceedingly important now during global shortages of laboratory supplies and personnel. This offers a unique moment for all healthcare providers to reflect on, motivate and promote appropriate laboratory testing. This is essential to ensure the
sustainability of resources during the current crisis and the long-term reduction of harm to the patient, other healthcare services, and the environment. Therefore, we advocate for improved utilization strategies to drive immediate and sustainable practices over time and call upon decision-makers to prioritize these initiatives and help conserve our public healthcare system.

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