CADTH

ENVIRONMENTAL SCAN

Detection and Diagnosis of Sepsis in Rural and Remote Areas of Canada: An Environmental Scan

Service Line: Environmental Scan
Issue: 83
Publication Date: January 2019
Report Length: 41 Pages

CADTH

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Cite As: *Detection and diagnosis of sepsis in rural and remote areas of Canada.* Ottawa: CADTH; 2019. (Environmental scan; no. 83).

Funding: CADTH receives funding from Canada's federal, provincial, and territorial governments, with the exception of Quebec.

Context

Sepsis is a complex and potentially deadly cascade of physiological responses to infection, defined as "… life-threatening organ dysfunction caused by a dysregulated host response to infection…," or "… in lay terms, sepsis is a life-threatening condition that arises when the body's response to an infection injures its own tissues and organs."[1]

In Canada and throughout the world, sepsis is a major cause of death and is associated with significant health care costs — mainly due to longer hospital stays and intensive care needs.[2-4] Based on 2008–2009 data, Canadian patients with sepsis spent a median of 12 days in hospital — nine days longer than the median length of stay for other conditions.[2] Survivors of sepsis often experience long-term health problems, including physical, psychological, and cognitive impairments.[3,5-8] In 2011, an estimated one in 18 deaths in Canada involved sepsis (either as the underlying cause or as a contributing cause).[9] However, the incidence of sepsis is likely underestimated for several reasons, including the different definitions used, clinical difficulties in diagnosing sepsis, and hospital coding practices that may attribute the cause of death to the source infection or sequelae of sepsis, rather than to sepsis itself.[4,5,7,8,10,11]

The infection that results in sepsis can originate from virtually any type of pathogen (bacterial, viral, fungal, or protozoal), and the source of infection can vary.[1,3,9,12-15] The most common sites are the lungs (i.e., respiratory infections), gastrointestinal tract, bloodstream, kidneys and genitourinary tract, and skin.[3,16] Infants and the elderly are among those at highest risk for sepsis.[2,17] Also at greater risk are those who have recently undergone surgery, are immunocompromised, those with chronic illnesses (such as diabetes), and women who are pregnant or have recently been pregnant.[2,6,13,17]

Early recognition and treatment of sepsis can reduce adverse events and the risk of death.[3,13,18] Early treatment also reduces the health care costs associated with sepsis; in particular, the costs of intensive hospital care and subsequent costs for post-sepsis rehabilitation and care.[5] Detecting sepsis is challenging, as the signs can be difficult to distinguish from those caused by other illnesses, and currently no diagnostic test specifically for sepsis is available.[19-21] Newborns and children have different risk factors for and symptoms of sepsis than adults.[21,22]

There is no gold standard test for sepsis, and diagnosis relies on clinical assessment, diagnostic imaging, and laboratory tests to identify the pathogen causing the infection and the most appropriate antimicrobial treatment.[6,23] In many cases, laboratory tests cannot identify the pathogen.[7,16] Moreover, laboratory tests and blood cultures take time and require equipment that may not be available in pre-hospital care or remote health facilities.[24,25]

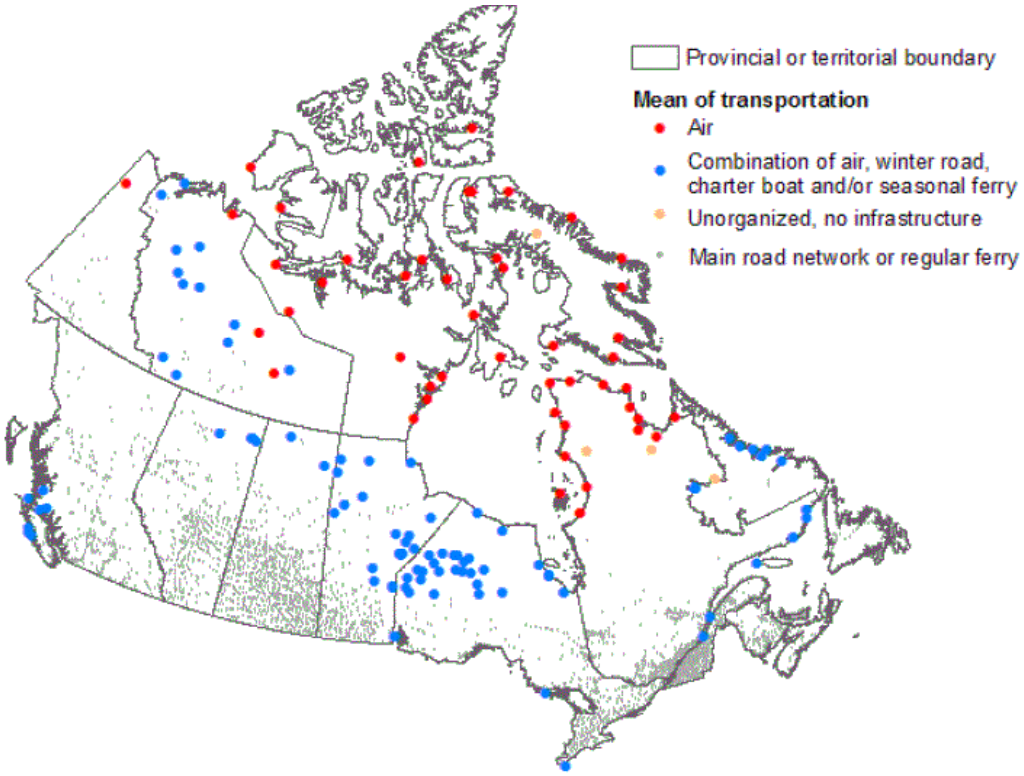
Rural and Remote Populations in Canada

There is no Canadian consensus on the definitions of rural and remote communities, but the following definitions have been used generally for the purposes of this report.

Rural communities are considered those beyond commuting distance of large urban centres (centres with populations of 10,000 or more).[26] More than six million Canadians (approximately 20% of the population) live in rural areas.[27]

Remote communities include remote isolated (no scheduled flights or road access and with minimal telephone or radio service) through to non-isolated remote (road access and less than 90 km away from physician services).[28] Approximately 200,000 Canadians live in remote communities (including larger remote communities, such as Whitehorse and Yellowknife).[29] About half of the Indigenous Peoples in Canada live in rural or remote communities.[30]

Figure 1: Remote Communities in Canada[a]



Note: Each dot is a CSD representative point.
Source: authors' computations.

[a] This map displays communities and type of transportation infrastructure (connected versus not connected to the main road network), and the different types of transportation infrastructure by community for CSDs (census subdivisions) across Canada. Each CSD is shown by the location of its "representative point." *The map shows* the boundaries of Canada's provinces and territories. Four types of CSDs are displayed: CSDs connected to the main road network or regular ferry (gray dots). These are the vast majority of CSDs; CSDs connected with a combination of air, winter road, charter boat and/or seasonal ferry (blue dots), mostly located in the northern part of Canada; CSDs connected only by air (red dots), mostly in the far north of Canada; and Unorganized CSDs with no transportation infrastructures (light orange dots).

Image and description source: Statistics Canada. Measuring remoteness and accessibility: a set of indices for Canadian communities. 2017. *Reproduced and distributed on an "as is" basis with the permission of Statistics Canada.*[31]

Determinants of Health in Rural and Remote Settings

People in rural and remote communities may face barriers to care beyond those of geography and the more limited health care resources available locally.[32] Many remote Indigenous communities are at increased risk for sepsis because of socioeconomic factors that affect their health. These factors include inadequate housing, poor nutrition, unsafe drinking water, and comorbidities (such as diabetes), with consequently higher rates of injuries, respiratory infections, and skin and soft tissue infections.[32-42] The 2015 *Yukon Health Status Report*, for example, cites a sepsis rate of 9.28 per 100,000 population compared to 4.35 per 100,000 elsewhere in Canada.[43]

Tobacco use in rural and remote communities is higher than elsewhere in Canada, increasing the risk of respiratory infections.[28,39] Rates of respiratory infections in Nunavut, for example, are four times higher than the national average.[44] Higher rates of tuberculosis, also a risk factor for sepsis, are reported in

some parts of Canada, including Newfoundland and Labrador, Alberta, Saskatchewan, Manitoba, Northwest Territories, and in particular, in Nunavut.[45,46]

Compared to urban populations in Canada, in general, residents of rural areas are older and more likely to suffer from chronic health conditions.[28,47-49] Both age and chronic health conditions increase the risk for sepsis.[50,51] Rural and remote populations also have higher rates of medical emergencies, including infectious diseases and injuries, than the national average.[28,37,52]

Access to Health Care

Health Canada reports that there are more than 600 First Nations communities across Canada that are served by 79 nursing stations and more than 195 health centres.[53] More than 95,000 Indigenous Peoples live in 85 remote communities where health services are mainly provided through nursing stations.[40] Responsibility for the provision of health services for Indigenous Peoples in rural and remote communities varies across Canada in a complex system of federal, provincial, territorial, and community-run health services.[30,40,54]

Many remote communities are only accessible by air and, in medical emergencies, patients are transported by air ambulance or private air services to larger regional hospitals several hours away.[37,44,52,55] Remote communities may not have the necessary infrastructure, navigational equipment, or landing strip lighting and maintenance — meaning that pilots "fly by sight" and cannot land or take off in poor weather conditions, delaying emergency transport.[55]

Remote communities often do not have local ambulance or 911 emergency response services and rely on family or community members to transport patients to the nursing station.[55] In many communities, basic first aid training may be provided to some community members, but the frequency and type of training varies and may not meet the needs of the community.[37,55] Limited access to health services can be a barrier to the timely diagnosis and treatment of sepsis.[56-58]

There is broad interest across Canada in developing protocols and identifying the optimal technologies for recognizing and diagnosing sepsis — including in rural and remote areas. This could be informed by a better understanding of current resources and practices for sepsis detection in these settings. In this context, CADTH conducted an Environmental Scan on the detection of sepsis in rural and remote areas, which adds to previous CADTH work on health care in rural and remote areas,[59] and recognition and diagnosis of sepsis in adults.[60-62]

Objectives

The objectives of this Environmental Scan are to:

- describe the current guidance (i.e., policies, protocols, guidelines, algorithms) for detecting and diagnosing sepsis in rural and remote health care settings in Canada
- describe current practice for detecting and managing sepsis in rural and remote health care settings in Canada and how this compares with recommended practice
- identify the diagnostic technologies and other resources available for sepsis detection, diagnosis, and management in rural and remote health care settings in Canada.

Methods

Approach

The findings of this Environmental Scan are based on responses to a survey questionnaire (Appendix 1) distributed to contacts in jurisdictions across Canada. Responses were received from June 8 until September 7, 2018. Additional information was integrated from publications identified through a literature search.

Table 1: Components and Information-Gathering Approach

Components	Inclusion
Population	Patients (of any age) with suspected (or possibly at risk for) sepsis
Intervention	Protocols, guidelines, algorithms, procedures, current practices, diagnostic tests or other tools for detecting or diagnosing sepsis
Settings	• Any remote or rural Canadian health care setting, including pre-hospital care, and care delivered remotely via telehealth or at a community health facility
Outcomes	• Canadian guidance for identifying or diagnosing sepsis in patients outside of urban areas and hospitals (guidance may be local, regional, provincial, or at the national level) • Barriers to and facilitators of use • Strategies for improving and available resources for detection, diagnosis, and management of sepsis in rural and remote areas

Literature Search

Research Questions

- The literature review attempted to address the following questions through the literature search: What practices and resources are currently used to detect or diagnose patients with sepsis in rural or remote areas of Canada?
- What are the barriers to or facilitators of the timely diagnosis and treatment of sepsis in rural and remote areas?

Search Methods

A limited literature search was conducted on key resources including Ovid MEDLINE, PubMed, the Cochrane Library, and the University of York Centre for Reviews and Dissemination databases. Grey literature was identified by searching relevant sections of the *Grey Matters* checklist (https://www.cadth.ca/grey-matters) and by conducting a focused Internet search. No methodological filters were applied to limit retrieval by study type. The search was limited to English- and French-language documents published between January 1, 2008 and April 13, 2018. Monthly alerts updated the search and continued until October 19, 2018. Conference abstracts were excluded from the search results.

Screening and Study Selection

One author screened the literature search results to select articles for full-text review using the criteria shown in Table 1. The reference lists of relevant papers were also scanned to identify further studies.

Survey

The survey included 12 questions (Appendix 1) covering the respondents' demographics and clinical setting of work, diagnostic strategies, challenges, barriers, and recent local strategies for improving the detection or diagnosis of sepsis. Survey questions included dichotomous (i.e., yes/no), multiple choice, and open-ended questions. External stakeholders and CADTH research staff reviewed the draft survey questions.

We distributed the survey electronically using Hosted in Canada Surveys.[63] The distribution included more than 140 contacts identified by the CADTH Implementation Support and Knowledge Mobilization team, and Program Development staff and clinical experts identified through the published literature and through referrals. The survey was sent to contacts in:

- government (in particular, decision-makers in federal, provincial, and territorial health ministries)
- regional health authorities
- hospitals
- academic research groups
- practitioners and associations involved in emergency medical care, and provision of health care services in rural and remote areas (such as paramedics, nurse practitioners, rural and emergency care physicians).

Contacts were also asked to forward the survey link to their colleagues or to suggest further respondents. Due to this secondary distribution, we could not determine the total number of respondents invited to participate. Initial survey contacts who did not respond within the first deadline were sent one email reminder with a two-week extension.

Additional stakeholder feedback was obtained by posting the draft version of this report on the CADTH website, via email notices to CADTH mailing lists, and by contacting the survey respondents who indicated they were willing to provide more information. The feedback received was considered during the revision of the draft report.

Synthesis Approach

Survey responses were abstracted by question, and organized by type of respondent and jurisdiction. Themes were identified for discussion and information from the published literature was summarized under these topics, along with information from the survey responses.

Findings

Literature Search

The main database search identified 292 citations and the monthly search alerts identified another 62 citations. Of these, 37 papers were retrieved for full-text review. Additional references were identified through the grey literature search, previous CADTH reports on this topic,[59-62] the reference lists of relevant papers, further targeted searches, and publications suggested by survey respondents, for a total of 62 papers that were relevant to the objectives of this project.

Summary of Survey Results

Ninety survey responses were received, including four duplicate responses, for a total of 86 unique responses. Of the survey responses, 38 (44%) were mostly incomplete, while 13 other respondents (12%) noted that they were not involved in the early detection of patients with possible sepsis in rural or remote areas (at which point they were able to opt out of the remainder of the survey). Ultimately, 28 responses (32%) were included in the report.

Survey Respondent Characteristics

Attempts were made to obtain responses from all provinces and territories, and from the federal government. Responses came from a variety of organizations, with at least one response received for most provinces and territories, with the exception of Ontario, Quebec, and New Brunswick. Information on the jurisdictions and organizations represented by survey respondents is summarized in Appendix 2, Table 6. Information on the professions and occupational settings of survey respondents are summarized in Appendix 2, Table 7.

Respondents' involvement included:

- physicians providing health care in rural and remote areas (in rural or tertiary hospital emergency departments, through locums in the communities, or via telehealth consults)
- patient transfer
- clinical oversight, standards, and quality
- policy and guideline development
- nurses and nurse practitioners
- staff training and education
- implementing laboratory initiatives to improve testing for and appropriate antimicrobial treatment of infectious diseases.

Resources for Sepsis Management in Rural and Remote Areas

Guidelines, Algorithms, and Protocols

Of the 28 survey responses, 19 (68%) respondents noted that their organization had guidance for detecting or diagnosing sepsis, and 15 (54%) provided references to these documents (clinical decision rules, protocols, guidelines, algorithms, or other clinical practice tools). Another eight (29%) respondents stated that their organization had no such guidance. The guidance documents referenced by respondents are listed in Appendix 3.

The literature search identified other Canadian sepsis tools intended for in-hospital or emergency department care, including the *BC ED Sepsis Guidelines Algorithm (2017)*,[64] and the Canadian Patient Safety Institute sepsis kit.[65] Recent algorithms for detecting sepsis in children have been developed at Manitoba's TREKK–Translating Emergency Knowledge for Kids) network.[66-68]

International guidelines and tools for sepsis detection and management include the Surviving Sepsis Campaign guidelines,[18,69] and the UK Sepsis Trust *Prehospital Sepsis Screening and Action Tool* checklist.[70] Guidance from the UK NICE–National Institute for Health and Care Excellence includes algorithms and risk stratification tools for recognizing sepsis in both primary and acute care settings.[22] The US CDC–Centers for Disease Control and Prevention also offers clinical and patient education materials on sepsis.[16] In addition, the World Health Organization recommendations on sepsis management in resource-limited settings may be applicable to remote care settings.[71] With the

exception of the Health Canada guidelines for primary care nurses (currently being revised),[72] the Canadian guidance and tools identified are intended for in-hospital use rather than for use in pre-hospital or remote settings.

One respondent commented on the need for national guidelines with expected care standards for the detection, diagnosis, and treatment of sepsis — particularly for remote fly-in communities served by federal nursing stations. They also suggested that these national standards could be adopted by provincial health systems and monitored. This would track all patients who receive emergency transport or who die of sepsis, allowing review of cases and reporting to provincial standards committees to identify opportunities for system improvement. Another respondent noted that they hoped an outcome of this work would be the development of protocols and standards for organizations overseeing care in remote communities. A fourth respondent remarked that, although their organization did not have a local sepsis protocol, this had been developed at another level in the organization and should be adopted locally.

In critical care, the systemic inflammatory response system (SIRS) and Sequential Organ Failure Assessment (SOFA) scores are used to assess the severity of sepsis and the risk of death in adults but results of laboratory tests are needed for scoring.[1,73] A modified measure, quickSOFA (qSOFA), relies on clinical examination, can be performed quickly, and does not involve laboratory tests.[1] However, these tools were intended to be used to predict patient risk rather than used as diagnostic tools.[23,73] Other early warning scoring systems for sepsis are available or in development, but their usefulness in pre-hospital settings is still unclear.[20,25,74-76] Different risk factors and clinical signs are used for detecting sepsis in pediatric patients, depending on their age.[66,67,77,78]

Smartphone Applications

Several smartphone applications (apps) have scoring systems to help health care providers identify patients who may have sepsis. A UK National Early Warning Scoring (NEWS) and a sepsis screening tool, which combines the NEWS calculator (respiration rate, oxygen saturation, supplemental oxygen, temperature, heart rate, systolic blood pressure, level of consciousness), a qSOFA calculator, and a sepsis care bundle are freely available as smartphone apps.[79,80] The Surviving Sepsis App, from the Surviving Sepsis Campaign, is included as part of the Society of Critical Care Medicine guidelines app.[81] Other sepsis apps, such as the ESCAVO Sepsis Timer, are also available.[82]

Available Diagnostic Technologies

Table 2 summarizes the responses to the survey question on the diagnostic tools available. Respondents could make multiple selections. Additional comments provided by respondents are included beneath the table.

Table 2: Additional Diagnostic Tools Available On-Site

Tool[a]	Number of Responses/28 (%)
Protocols for referral of patients to other care settings	12 (42%)
Access to laboratory services for blood, wound, or respiratory culture, or measurement of sepsis-related markers (e.g., procalcitonin)	18 (64%)
Access to point-of-care tests for sepsis-related markers	7 (25%)
Urinalysis	23 (82%)
Imaging	18 (64%)
Specialist consultation via telemedicine	12 (42%)
Other[b]	6 (21%)

[a] In response to the survey question: What additional diagnostic tools does your facility have available on-site for detecting, diagnosing, or initially treating patients with suspected sepsis?

[b] The six respondents who answered yes to "Other" specified the following:

- All of the above (specialist consult service)
- X-rays only
- Hospitals have a lab on site; remote nursing stations have urinalysis, glucometer, and point-of-care hemoglobin only
- Specialist consultation via telephone
- Tertiary care-level diagnostic services and specialist support
- On-site specialists (urban centre supporting rural/remote facilities).

One respondent noted that rural areas in Manitoba have small hospitals and emergency departments, which have some resources and trained professionals to diagnose, treat, and transfer patients with sepsis. However, they also noted that this is not the case in nursing stations. The nurses in these facilities may have access to a physician by phone but seldom in person, and they may be several hours away (by boat or air) from a facility that has the resources needed.

Similarly, a respondent in the Northwest Territories commented that they have reasonably good tools for the diagnosis and treatment of sepsis in the larger centres. However, remote area resources such as laboratory tests, diagnostics, and treatments are "scant," and diagnosis may be based on clinical descriptions of the patient provided over the phone by a nurse in a remote community to an emergency physician in Yellowknife or Inuvik.

Blood Culture

One respondent, who provided comments during the stakeholder feedback period, stressed the importance of taking blood samples for subsequent culture before antibiotic treatment begins.[18,69] Even if laboratory facilities for blood culture are not available in remote areas, blood samples taken at the initial point of care and transported with the patient may help identify the type of infection and allow more targeted antibiotic therapy once the patient reaches the hospital.[18]

Point-of-Care Testing

Lactate

Lactate is a marker of tissue perfusion; higher levels of lactate in the blood are associated with severity of sepsis.[83] Rapid, inexpensive, point-of-care lactate test units are commercially available in Canada.[75,83,84] These devices provide blood lactate values from a finger prick blood sample in about a minute.[74,85,86] Lactate measurement in the pre-hospital setting is intended to reduce the time to obtain a lactate value and provide an earlier baseline value for continued assessment once the patient reaches the emergency department.[85,87]

The survey questionnaire did not specifically ask about the availability of point-of-care lactate testing, and no respondents mentioned that this testing was available in remote health care settings. Nevertheless, one respondent from Manitoba described a pilot study of point-of-care testing, underway in three communities, that includes lactate and white blood cell count. This will be rolled out to all

Manitoba communities in conjunction with provincial laboratory services. Another survey respondent successfully advocated for getting point-of-care lactate in some smaller hospitals in Nova Scotia. This respondent also provides health services in Nunavut, and commented that having point-of-care lactate testing available there would be very helpful. Another Nunavut respondent also noted that having the capacity for point-of-care blood work would be helpful.

Intravenous Fluids, Oxygen, and Antimicrobials

Administration of intravenous (IV) fluids is a key element of sepsis treatment, but IV resuscitation is not available in some remote health care settings. One survey respondent noted that, in their experience, some nursing stations had only one IV pump, while others had none.

A recent study of injuries treated at nursing stations in northern Ontario found that, although most (74%) administered IV fluids, only a few (less than 10%) provided oxygen or antibiotics, and none administered vasopressors to stabilize blood pressure.[88] Vasopressors are administered under the direction of a physician, but support from physicians via telemedicine could have provided this direction before the patient was transported.[88]

Storage and Access to Antimicrobials

One survey question asked whether there were challenges with the storage of or access to critical first-line antimicrobial agents for the early treatment of suspected sepsis. Of the 28 responses to this question, eight (28%) answered "yes" (there were challenges), and 20 (71%) answered "no" (there were no challenges in accessing antimicrobials).

Comments from the eight respondents who noted challenges in accessing antimicrobials are summarized in the table that follows.

Table 3: Challenges With Storage and Access to Antimicrobials for the Early Treatment of Sepsis

Themes Summarized From Survey Responses[a]
• There is a limited choice of antibiotics available (and those that are, offer only a narrow spectrum of coverage). • Some antibiotics (such as piperacillin, tazobactam, meropenem, and gentamicin) are used frequently and supplies often run out. • Broad-spectrum antibiotics may not be readily available. • Vancomycin (an antibiotic for the treatment of serious bacterial infections) cannot be used in many remote areas because the laboratory blood testing required for monitoring the safe use of this drug is not available locally. • There is limited storage in medicines room and no local pharmacies. • Restocking of medications can be slow (e.g., this may take weeks after an urgent request is made, or be delayed due to bad weather and flight delays). • One respondent also mentioned a growing problem with extended spectrum, beta-lactamase-producing *Escherichia coli* (*E. coli*) bacterial infections.

[a] In response to the survey question: In your jurisdiction or facility, are there challenges with the storage and ready access to critical first-line antimicrobial agents for prompt and early treatment of suspected sepsis?

Barriers to the Timely Detection of Sepsis

In answer to the survey question about barriers to the timely detection of sepsis in their organization or jurisdiction, 20 (71%) respondents answered "yes" to this question (i.e., there were barriers). The answers to the types of barriers (multiple selections could be made) are shown in Table 4.

Table 4: Barriers to the Timely Detection of Sepsis

Barrier[a]	Number of Responses/20 (%)
Patients and family or home caregivers are unaware of signs and risks of sepsis	13 (65%)
Lack of local medical expertise or training in the initial detection and diagnosis of sepsis	10 (50%)
Lack of guidelines for identifying and managing patients with potential sepsis	8 (40%)
Appropriate rapid diagnostic tests are not available on-site	11 (55%)
Appropriate treatments are not available on-site (for example, broad-spectrum antibiotics)	3 (15%)
Difficulty incorporating diagnostic or treatment options into care pathway	10 (50%)
Lack of coordination of care by multiple providers	11 (55%)
Geographic barriers to accessing services	14 (70%)
Delays in transporting patients for specialist care (see the following paragraph for the respondents' reasons for these delays)	11 (55%)
Other[b]	3 (15%)

[a] In response to the survey question: Which of the following barriers to the timely detection of sepsis are experienced in your organization or jurisdiction?
[b] Other reasons provided were:
- lack of good documentation or a tool that would effectively identify patients whose condition is deteriorating
- busy emergency rooms, resulting in delays in patients receiving blood work
- emergency room consults in the receiving facility may also involve delays.

Patient Transportation

Survey respondents provided further explanations of the reasons for delays in transporting patients for specialist care:

- remote communities are often accessible only by air, winter, or gravel roads, while medical evacuation transportation (medevac) comes in from larger centres, which can delay transport considerably
- availability of air ambulance or medevac transport is limited, and flights in and out take several hours
- bad weather grounds flights in and out
- out-of-province transport and acceptance at the referral hospital is required for severe endovascular infections.

Staff Training, Experience, and Resources

Survey respondents also noted that lack of training and experience of primary care staff is a barrier to the early recognition of sepsis in remote health facilities. One respondent commented that First Nations communities in remote areas are staffed mainly by nurses who may lack the training and experience needed to recognize sepsis. In addition, the limited health care staff available may make it difficult for patients to access care, with delays meaning they present at a more advanced stage of illness.

In response to the call for public stakeholder feedback, one company noted that phlebotomy training for nurses would help to address this barrier. The importance of and need for training has been reported by others.[40,89,90] Devices that simplify blood and urine sample collection and reduce sample contamination may also play a role.[91,92]

Another survey respondent noted the lack of morbidity and mortality — or M&M — rounds was a barrier to improvement. These rounds are intended to be educational opportunities for staff physicians and medical trainees, and as opportunities to identify quality and patient safety issues.[93] The respondent also noted that benchmarking for key sepsis indicators was lacking, and mentioned the need to recognize that some treatment interventions require two nurses.

Recent Improvements or Changes

We asked survey respondents whether there had been any recent improvements or changes made to help quickly detect and treat patients with suspected sepsis at their facilities. Twelve respondents (43%) answered "yes" (there had been changes). Thirteen respondents (46%) answered "no" to this question, and three (11%) did not respond to this question. Of those who answered yes, nine respondents provided the following examples of improvements or changes:

Table 5: Recent Improvements or Changes to Detection and Treatment of Patients with Suspected Sepsis

Themes Summarized From Survey Responses[a]
Education • Improved education of clinical staff and regular instruction for residents; for example, education regarding the importance of collecting cultures and then administrating antimicrobials within the first hour of the sepsis diagnosis. • Patient safety events and recommendations are de-identified and shared.
Guidance • Greater use of systemic inflammatory response syndrome/quick Sequential Organ Failure Assessment criteria (criteria for assessing patients), development of protocols, and the use of treatment guidelines. • Wide dissemination of guidelines and sharing of other jurisdictions' patient safety information. • New guidelines and policies for primary care nurses in remote nursing stations are being drafted (by Health Canada and Indigenous Services Canada). These will include guidance on identifying and treating sepsis. • Province-wide policy implementation.
Emergency Care • Prompt resuscitation in the emergency department • Easy access to antibiotics in the emergency department/night cupboard • In Manitoba, a pilot project of point-of-care testing, including lactate and white blood cell count, being rolled out in three communities, with a plan to roll it out to all communities in conjunction with provincial lab services • Tracking the time it takes from ordering antimicrobials to administering them, using the clinical informatics system • Implementation of a Rapid Response Team to aid in the identification of sepsis and early fluid resuscitation with the aid of medical directives

[a] In response to the survey question: Have recent improvements or changes been made to help quickly detect and treat patients with suspected sepsis in your facility?

Limitations

A limited literature search supplemented this Environmental Scan. Relevant published information was scarce. This was not unexpected, as earlier CADTH work on remote health care facilities and identification of sepsis also found limited published information.[59-62]

Although invaluable information was provided by the survey respondents, not all relevant agencies and health care providers were represented. In addition, the response rate for many of the questions varied, resulting in a proportion of incomplete responses. Particular gaps include a lack of responses from paramedic and other pre-hospital emergency care providers, Indigenous communities, and nursing staff in rural and remote areas. Given these shortcomings and the few responses from some provinces and territories, the representation and generalizability of the results might be limited.

Finally, we did not assess the quality of any of the information identified, including the quality of the guidance documents. Consequently, this report is not intended to provide recommendations on the appropriateness of any of the interventions cited.

Discussion

Beyond the barriers of geography and weather, the survey respondents noted many additional barriers to the timely detection of sepsis, particularly in remote communities. Several survey respondents noted the lack of or limited supplies of basic equipment. Supplies of appropriate medications for the early treatment of infections was also noted as inadequate, and restocking of medications could be slow. One company response to the draft report noted this barrier might be addressed by automated systems for dispensing and supply chain management of medication inventories.

Recent telepharmacy guidelines from the Canadian Society of Hospital Pharmacists recommend that those considering introducing an information technology system for telepharmacy start with a "gap analysis" of the current situation and the changes needed.[94]

A 2018 CADTH Environmental Scan on remote health care facilities did not find any recent lists of essential equipment for remote facilities in Canada.[59]

Diagnostic Equipment

Patients in remote Canadian communities may face some of the same delays in diagnosis and treatment seen in resource-limited health care settings in developing countries.[12,95] Nursing stations in remote areas of Canada have limited diagnostic equipment and treatment options on hand.[59,88] In particular, diagnostic imaging to detect infections, such as chest X-rays or point-of-care ultrasound, and equipment for initial management of patients with sepsis, such as intravenous (IV) fluids and oxygen, may not be available.[52,59,95]

No survey respondents mentioned the use of other point-of-care technologies, such as portable ultrasound. Low-cost, point-of-care ultrasound administered by trained health care providers in remote settings and supported by remote specialists may be used to identify some sources of infection and early signs of sepsis.[96]

Point-of-Care Testing

Two survey respondents noted the need for point-of-care lactate test units. A 2017 UK systematic review of point-of-care lactate testing for sepsis found limited evidence on these devices but concluded this may be a useful diagnostic test in pre-hospital settings.[97] Point-of-care lactate testing is widely used in the UK.[98] The study of pre-hospital sepsis care in northern Australia also found that pre-hospital, serial lactate measurements may be useful.[99] The Surviving Sepsis Campaign also recommends measuring lactate levels and notes that rapid assessment of lactate should be considered standard of care.[100,101] In Canada, Health Canada has approved at least one point-of-care lactate test unit and the device is commercially available.[84]

Studies of point-of-care lactate test use in remote health care settings are lacking, but the introduction of rapid, point-of-care tests for detecting common sepsis-related pathogens may improve early detection of sepsis.[102-105] Point-of-care biomarker tests have been studied for their role in distinguishing bacterial from viral infections and in determining the severity of infection.[105-108] With the exception of lactate, the role of point-of-care tests in detecting sepsis is still under investigation.[87] Biomarker tests, such as procalcitonin, C-reactive protein, and presepsin, may also support clinical assessment in determining the appropriate use of antibiotics in the treatment of sepsis and antimicrobial stewardship.[109-112]

Smartphone-based, point-of-care technologies may soon be available for rapid detection of common infections that can lead to sepsis; for example, devices to detect urinary tract infections that do not require laboratory testing or culture.[113-115]

Pre-Hospital Care

As with enhanced emergency care for patients experiencing a heart attack or stroke, emergency medical care providers can play a role in the early detection and treatment of patients who may have sepsis.[85,98] Studies in the US, UK, and the Netherlands have assessed whether training and equipment to improve early recognition and treatment of sepsis by paramedics can improve patient outcomes.[76,85,116] The US pilot study provided paramedics with an educational session on sepsis and kits containing temporal artery thermometers, and portable lactate test units and test strips.[85] Other studies have noted that regularly measuring vital signs — such as pulse, blood pressure, temperature, and respiratory rate — would be simple interventions that could help to identify patients whose conditions are deteriorating and who may be at risk of sepsis.[98,117] A recent Canadian commentary noted the need for sepsis trigger tools to detect and manage patients with sepsis — tools that are intended for use in the community setting and that require minimal training and effort to use.[118] The commentary noted that such tools should build on advances in artificial intelligence and use data from electronic health records to optimize algorithms for detecting sepsis.[118] Artificial intelligence and other digital technology may require Internet connectivity, as well as other infrastructure, training, funding, and other supports, which may result in barriers to implementation in some rural and remote health care settings.[119]

The UK review of sepsis recognition in the pre-hospital setting found there was poor recognition of sepsis by ambulance personnel, and that most screening tools had not been validated in the pre-hospital setting.[116] Subsequently, researchers in the UK recently published a protocol for a randomized study of pre-hospital recognition of sepsis and administration of antibiotics.[120] The Netherlands study found value in improving training for emergency medical services personnel to recognize early signs of sepsis, as this ultimately reduced the time to treatment in the emergency department.[76]

It is not clear whether the findings of these studies are applicable to remote health care settings in Canada, but results of a 2016 study in northern Australia may be relevant.[99] The Australian study looked at interventions provided by air transport medical teams in patients with severe sepsis in remote areas.[99] Almost all (99%) of the 67 patients in the study received antibiotics in the pre-hospital setting, and 80% of patients received pre-hospital intravenous fluid resuscitation.[99] This, in addition to other interventions,

such as supplemental oxygen provided before or during transport to the hospital may have contributed to the relatively low, 30-day mortality (13%).[99]

Improving Public Awareness of Sepsis

As noted in the survey responses in Table 4, lack of patient, family, and caregiver awareness of sepsis is one of the barriers to timely care. Despite media coverage of deaths due to sepsis, several publications have noted the need for greater public recognition of sepsis as a medical emergency.[1,16,21,121,122]

A 2018 review found that improved clinician and public awareness of sepsis due to educational campaigns, such as the Surviving Sepsis Campaign, has improved patient outcomes.[3,7] Public awareness campaigns in the US, the UK, and Germany have also increased knowledge of the signs and symptoms of sepsis.[8,123] The US CDC recommends that clinicians educate patients and their families about the signs and symptoms of sepsis, particularly in individuals at higher risk for infections. The CDC also encourages patients to manage their chronic health conditions, stay up to date with vaccinations, and practice good hand hygiene to reduce the risk of infections.[16]

The 2017 WHO Resolution on Sepsis also noted the importance of health care providers using the term "sepsis" to further promote awareness of the condition to other health care providers, patients, their families, and the community.[8,15] The WHO resolution included the recommendation for national programs to "increase public awareness of sepsis, particularly among high-risk groups, to ensure prompt recognition and presentation for treatment…"[8,15] The Global Sepsis Alliance also promotes patient and family awareness with infographics about maternal and neonatal sepsis.[124]

Training and Provision of Care

Survey respondents noted that lack of training or experience of primary caregivers is a barrier to the timely recognition of sepsis in remote health facilities. In most remote communities in Canada, primary and emergency care is provided by nurses at community health clinics.[40,44] Staffing is an ongoing problem. A recent report from Nunavut found that almost half of the health care postings there had not been filled, and temporary health care providers were often needed to fill staffing gaps.[44] There is also documentation of high rates of staff turnover and inadequate training for nurses in remote areas of Canada given the expanded scope of practice needed in those remote areas.[40,44]

Many remote communities in Canada do not have a paramedic or 911 emergency dispatch service.[37] Researchers in Ontario have suggested one option may be a Community-Based Emergency Care model, where community members are trained as lay health providers.[37,52]

National Standards and Reporting for Sepsis in Canada

Several survey respondents commented that the way in which sepsis is reported and patient outcomes are tracked across Canada needs to be improved. The Chair of the Canadian Sepsis Foundation recently called for a national system to standardize definitions and improve the reporting and tracking of sepsis.[5]

Preventive Measures

Preventive measures in at-risk populations, such as infants and the elderly and those with cancer or chronic illnesses, are reported as reducing the risk of infections that can lead to sepsis. Interventions reported in the literature include:

- breastfeeding to reduce infections in newborns[5]
- ensuring good hand hygiene practices[5,7,16,117]
- healthy diet, exercise, and other interventions to encourage mobility and reduce frailty[7]
- interventions to promote smoking cessation[36]
- best practices to prevent pressure ulcers[125]

- optimal wound care[7,125]
- management of chronic health conditions[14,16,32]
- vaccinations to prevent infections that may lead to sepsis (such as meningitis vaccination for adolescents and young adults, and influenza and pneumococcal pneumonia vaccinations).[5,7,16,117]

A study of sepsis in northern Indigenous Australian communities concluded that efforts to prevent sepsis should include improved housing, access to health services, management of comorbidities, and initiatives to reduce alcohol and tobacco use.[36]

Final Remarks

As one survey respondent noted, sepsis continues to be a challenging clinical presentation. This report sought to identify the guidance (i.e., policies, protocols, guidelines, algorithms, and other tools) used to detect patients with sepsis in rural and remote health care settings in Canada. Survey respondents and the literature search identified a variety of guidance and other tools that are being used, but, with the exception of the Health Canada *Clinical Practice Guidelines for Nurses in Primary Care*[72] (currently being updated), most are not specific to practice in remote health facilities.

Guidance developed collaboratively by pre-hospital and primary care providers and clinical experts who support remote health services could streamline and reduce the time to treatment and improve patient outcomes.[24,98] It is suggested that guidance should be easy to use and suitable for the local context (e.g., the available equipment, tests, and clinical expertise).[118] This may be less of an issue for rural health facilities for which provincial, regional health authority, or hospital-level guidance is available. As there is no accepted national guidance, it was not possible to address the question of how current practice compares with recommended practice. National standards and guidance may support improvements in care for people with sepsis.

In the survey questionnaire, we also sought to identify the diagnostic technologies and other resources available for sepsis detection, diagnosis, and patient management in rural and remote health care settings in Canada. Most of the information obtained focused on remote health care settings. In many of these facilities, basic equipment and essential medications needed to diagnose and treat sepsis are either not available or the supplies on hand are insufficient. A national standard on essential equipment and supplies for nursing stations and other small health facilities common to rural and remote settings would help to address these issues and support the appropriate procurement of equipment and medications. To help address some of the issues identified by survey respondents, it may be worthwhile for stakeholders to explore engaging industry partners in assessing appropriate technologies for sepsis detection and management in remote health care settings.

The Canadian Institutes of Health Research recently announced funding for a new Sepsis Research Network Initiative to improve "prevention, detection, and management of sepsis" through supporting interdisciplinary, collaborative research projects.[126] Given the gaps in guidance and services identified through this Environmental Scan, research to improve the care of patients with sepsis in remote health care settings could be used to help address these issues.

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Appendix 1: Environmental Scan Survey — Detection and Diagnosis of Sepsis in Remote and Rural Areas of Canada

A. Demographics and Clinical Setting

1. For which province/territory do you work?

- ☐ Alberta
- ☐ British Columbia
- ☐ Manitoba
- ☐ New Brunswick
- ☐ Newfoundland and Labrador
- ☐ Northwest Territories
- ☐ Nova Scotia
- ☐ Nunavut
- ☐ Ontario
- ☐ Prince Edward Island
- ☐ Quebec
- ☐ Saskatchewan
- ☐ Yukon
- ☐ Federal Health Program (such as, Indigenous Services Canada, Canadian Armed Forces, Correctional Service Canada)
- ☐ Other (please specify) (free text)

2. What is your profession? The options below correspond to both care provided on-site and remotely. (Multiple Choice and Other)

- ☐ Director or manager of remote care facility
- ☐ Government decision-maker overseeing remote care provision
- ☐ Health care administrator, manager, or director within health authority overseeing remote care provision
- ☐ Physician overseeing remote care provision
- ☐ Registered nurse overseeing remote care provision

☐ Nurse practitioner overseeing remote care provision

☐ Other, please specify (free text)

3. Are you currently involved in any capacity with the early detection of patients with possible sepsis in or from rural or remote settings?

☐ Yes; if yes, please describe the nature of your involvement (free text)

☐ No; if no, please end the survey here

4. Do you work in one or more of these geographical settings? (Please select all that apply.)

☐ Urban

☐ Rural

☐ Remote
(Please self-identify based on your local understanding of the criteria for remote. As an example, Health Canada defines various levels of remote, ranging from *remote isolated* = no scheduled flights or road access and minimal telephone or radio service, through to *non-isolated remote* = road access and less than 90 km away from physician services.)

☐ Other (please specify) (free text)

5. Do you work in one or more of these types of facilities or settings? (Please select all that apply.)

☐ Hospital

☐ Ambulatory (Outpatient) Care Clinic

☐ Community Care (e.g., public health clinic, family health centre, community outpost)

☐ Palliative (supportive) Care

☐ Home Care

☐ Public Health

☐ Physician's office

☐ Telehealth or Telepharmacy service

☐ Pre-hospital settings

☐ Health research or academic institute

☐ Government or Regional Health Authority

☐ Other (please specify) (free text)

B. Diagnostic Strategy

6. a. Does your organization have guidance for detecting or diagnosing sepsis (for example, clinical decision rules, protocols, guidelines, algorithms, or other clinical practice tools)?

   ☐ Yes

   ☐ No

   b. If yes, please specify the title, date, and name of the originating organization that publishes the document and if possible, please provide a link to the document or upload the document here please note if the document is confidential: free text and link to upload)

7. If your organization does not have specific internal guidance for detecting or diagnosing sepsis, are there other formal policies or guidelines that you use in your practice?

   ☐ Yes (please specify the title, date, and agency that publishes the document, and, if possible, a link to the document or upload the document here): free text and link to upload)

   ☐ No

8. What additional diagnostic tools does your facility have available on-site for detecting, diagnosing, or initially treating patients with suspected sepsis?

   ☐ Protocols for referral of patients to other care settings

   ☐ Access to laboratory services for blood, wound, or respiratory culture, or measurement of sepsis-related markers (e.g., procalcitonin)

   ☐ Access to point-of-care tests for sepsis-related markers

   ☐ Urinalysis

   ☐ Imaging

   ☐ Specialist consultation via telemedicine

   ☐ Other (please specify) (free text)

9. In your jurisdiction or facility, are there challenges with the storage and ready access to critical first-line antimicrobial agents for prompt and early treatment of suspected sepsis?

☐ Yes (if yes, please describe) (free text)

☐ No

10. a. Do you feel there are barriers to the timely detection of sepsis in your organization or jurisdiction?

☐ Yes (if yes, please proceed to question 10b and check whichever categories apply, and add any additional barriers under the Other category)

☐ No (if no, please skip to question 11)

10. b. Which of the following barriers to the timely detection of sepsis are experienced in your organization or jurisdiction? (Please select all that apply.)

☐ Patients and family or home caregivers are unaware of signs and risks of sepsis

☐ Lack of local medical expertise or training in the initial detection and diagnosis of sepsis

☐ Lack of guidelines for identifying and managing patients with potential sepsis

☐ Appropriate rapid diagnostic tests are not available on-site

☐ Appropriate treatments are not available on-site (for example, broad spectrum antibiotics)

☐ Difficulty incorporating diagnostic or treatment options into care pathway (please specify reasons why) (free text)

- ☐ Lack of coordination of care by multiple providers
- ☐ Geographical barriers to accessing services
- ☐ Delays in transporting patients for specialist care (please specify reasons for these delays)
- ☐ Other (please specify) (free text)

11. Have recent improvements or changes been made to help quickly detect and treat patients with suspected sepsis in your facility?

- ☐ Yes (if yes, please describe) (free text)

- ☐ No

12. Do you have any additional comments you would like to make regarding the detection or diagnosis of sepsis in rural and remote areas of Canada? (free text)

C. Permission to Contact Regarding CADTH Environmental Scan Use

13. Please provide your contact information in case we need to clarify any responses or request permission to cite information you have provided:

    Name:

    Title:

    Organization:

    City:

    Province:

    Email:

    Phone:

14. Would you be willing to be consulted further on this topic, either through an informal phone call or by email?

    ☐ Yes

    ☐ No

15. Can you suggest any other individuals or organizations we should contact for more information or to participate in this survey?

    ☐ Yes (please insert name, title, agency, and contact email)

End of Survey — Thank you for your time.

Appendix 2: Information on Survey Respondents

Table 6: Jurisdictions and Organizations of Survey Respondents

National/Federal/Province/ Territory	Organizations Represented by Survey Respondents[a]
National	• Canadian Critical Care Society and the Canadian Sepsis Foundation (n = 1) • Nurse Practitioner Association of Canada/Association des infirmières practiciens du Canada (n = 1)
Federal	Indigenous Services Canada (n = 1)
British Columbia	University of British Columbia (n = 1)
Alberta	Mount Royal University and CUPS–Calgary Urban Project Society (n = 1)
Saskatchewan	Saskatchewan Health Authority (n = 2)
Manitoba	• Winnipeg Regional Health Authority (n = 1) • Northern Health Region/Northern Regional Health Authority (n = 4) • Ongomiizwin Indigenous Institute of Health and Healing and Ongomwiizin Health Services, University of Manitoba (n = 3) • Interlake-Eastern Regional Health Authority (n = 1) • Flin Flon General Hospital and Northern Health Region (n = 1) • University of Manitoba (n = 1)
Ontario	No responses
Quebec	No responses
New Brunswick	No responses
Nova Scotia	Nova Scotia Health Authority (n = 3)
Prince Edward Island	Health PEI (n = 2)
Newfoundland and Labrador	• Western Health (n = 1) • Eastern Health (n = 1)
Nunavut	Government of Nunavut (n = 2)
Northwest Territories	Northwest Territories Health and Social Services (n =1)
Yukon	Community Nursing, Yukon Health and Social Services (n = 1)

[a] Note: Some respondents represented more than one organization or jurisdiction.

Table 7: Profession and Occupational Settings of Survey Respondents

Profession and Occupational Settings of Respondents	Number of Respondents (% of 28)[a]
Profession	
Director or manager of remote care facility	1 (4%)
Government decision-maker overseeing remote care provision	0 (0%)
Health care administrator, manager, or director within health authority overseeing remote care provision	4 (14%)
Physician overseeing remote care provision	14 (50%)
Registered nurse overseeing remote care provision	4 (14%)
Nurse practitioner overseeing remote care provision	0 (0%)
Other (included are physicians [in urban, rural, and remote areas, involved in primary care, emergency, and intensive care], nurses and nurse practitioners, and medical microbiology)	7 (25%)
Occupational Setting	
Hospital	20 (71%)
Ambulatory (outpatient) care clinic	6 (21%)
Community care (e.g., public health clinic, family health centre, community outpost)	6 (21%)
Palliative (supportive) care	1 (4%)
Home care	1 (4%)
Public health	0 (0%)
Physician's office	3 (11%)
Telehealth or telepharmacy service	8 (29%)
Pre-hospital settings	2 (7%)
Health research or academic institute	4 (14%)
Government or regional health authority	5 (18%)
Other (e.g., emergency department, nursing station, rural health centre with no physician)	3 (11%)
Geographical Setting	
Urban	15 (54%)
Rural	15 (54%)
Remote	12 (43%)
Other (e.g., support practice in remote locations, private clinic)	2 (7%)

[a] Note: Some respondents identified as working in more than one geographical setting.

Appendix 3: Tools, Policies, Guidelines, and Other References for Sepsis Detection Suggested by Survey Respondents

Please note that some of these documents are either not publicly available, or we were unable to identify a publicly available source based on the information provided. Two respondents noted they use the online medical resource UpToDate online for sepsis tools. It is available to individuals or organizations with a subscription. UpToDate is not a comprehensive list of tools for detecting or diagnosing sepsis — many other agencies and associations have also developed such guidance.

Pediatric

- *Clinical Practice Guidelines for Nurses in Primary Care* — pediatric and adolescent care [update in progress]. Health Canada. First Nations and Inuit Health; 2012.
- Intended for use by community health nurses providing primary care in remote First Nations communities. Health Canada is also working on guidance for diagnosing sepsis, including laboratory work and protocols for patient referral and physician support. This is in draft form and expected to be released soon.
- Patient Screening for Sepsis. Child Health BC; 2015.
- Could this Pediatric Patient be Septic? 0 days of age — 17 years of age less 1 day (adapted from TREKK[a] PedsPac).[66] Child Health BC; 2017.
- Pediatrics-initial management of pediatric septic shock in emergent/urgent care settings: 0 days of age — 28 days of age. Child Health BC; (n.d.).[b] (web link not available)
- Pediatrics-initial management of pediatric septic shock in emergent/urgent care settings: 29 days of age — 1 year of age less 1 day. Child Health BC; (n.d.).[b] (web link not available)
- Physician orders for pediatric severe sepsis, Interlake-Eastern Regional Health Authority; 2017. (web link not available)
- Pediatric sepsis assessment screening tool (age less than 17 years). Interlake-Eastern Regional Health Authority; 2017. (web link not available)
- Pediatric sepsis assessment/screening tool. Northern Health Region, Manitoba; 2013. (web link not available)
- American College of Critical Care Medicine Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock (Pediatric Advanced Life Support sepsis guidelines]).[127]

Adult

- *Adult care: Clinical Practice Guidelines for Nurses in Primary Care* (update in progress). Health Canada, First Nations and Inuit Health; 2015.
  Intended for use by community health nurses providing primary care in remote First Nations communities. Health Canada is also working on guidance for diagnosing sepsis, including laboratory work and protocols for patient referral and physician support. This is in draft form and expected to be released soon.
- Adult sepsis/severe sepsis medical directive — trigger tool. Saskatoon Health Region, [n.d.].[b] (web link not available)

[a] TREKK = Translating Emergency Knowledge for Kids, based at the Children's Hospital Research Institute of Manitoba. Their updated (September 26, 2018) Pediatric Severe Sepsis Algorithm (for children > 28 days of age) is available at: https://trekk.ca/events/Updated-sepsis-algorithm
[b] n.d. = no publication date available

- Physician's order sheet orders for adult severe sepsis and septic shock. Interlake-Eastern Regional Health Authority, Manitoba; 2014. (web link not available)
- Treatment of adult with suspected sepsis (age greater than 16 years). Interlake-Eastern Regional Health Authority, Manitoba; 2017. (web link not available)
- Adult diagnostics — bloodwork (age greater than 16 years). Interlake-Eastern Regional Health Authority, Manitoba; 2017. (web link not available)
- Sepsis protocol developed at the Queen Elizabeth Hospital (confidential documents), Charlottetown, PEI; [n.d.].[b] (web link not available)
- Criteria for sepsis/septic shock. Health PEI; [n.d.].[b] (web link not available)
- Provincial Antibiotic Advisory Team Empiric Antibiotic Treatment Guidelines for Sepsis Syndromes in Adults. Health PEI; 2014.
- Emergency room triage sheet (in progress, nearing completion — builds on the British Columbia guidelines but geared to community emergency practice). (web link not available)
- Surviving Sepsis Campaign guidelines and updates.[18,69]

[b] n.d. = no publication date available