REVIEW OF ULTRASOUND IN BC

Report for the Laboratory, Diagnostic and Blood Services Branch,

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EXECUTIVE SUMMARY

BACKGROUND: Ultrasound (US) is a non-invasive imaging technology that detects and displays acoustic energy reflected from soft tissue interfaces within the body. Traditionally, images are captured by an US technologist, interpreted by a radiologist, and reported to a referring physician. US is provided in most hospitals in British Columbia (BC) to both inpatients and outpatients and is also provided in both publicly- and privately-owned outpatient facilities. About 800,000 US services were billed in BC in 2012/13 with total billings of about $70 million. US technologist human resources (training, clinical placement, recruitment and retention) is a challenging issue and can be a limiting factor for facilities approved to provide US services.

In order to bill the BC Medical Services Plan (MSP) for provision of outpatient US services, approval must be granted by the Medical Services Commission (MSC) itself or by the MSC's Advisory Committee on Diagnostic Facilities (ACDF). Pending completion of a significant policy and program review, on December 19, 2012, the MSC instituted a moratorium on applications for new Certificates of Approval for all diagnostic services modalities under the authority of the ACDF (including US), with two notable exceptions where applications would still be considered: (1) for applications to add new services to existing Certificates; and (2) for demonstrated urgent health or safety needs. The general moratorium on diagnostic service applications was lifted on June 1, 2014; however, the US moratorium was continued and is currently scheduled to be lifted on June 1, 2015.

PROJECT OBJECTIVES AND RESEARCH QUESTIONS: The project reviewed the medical appropriateness of the current MSC rules pertaining to the use of US in the delivery of patient care in BC. The project focused on publicly-funded outpatient US services, but also considered emergency department (ED) and inpatient US services. Research questions were posed under the following headings: (A) Current US Practice in BC, e.g., how US is used, in what settings, by which health care providers, and rural and remote issues; (B) The Evolving Landscape, e.g., clinical indications and urgency categories; and (C) MSC Requirements, e.g., the medical basis for the current requirements to receive a Certificate of Approval to bill MSP for outpatient US services, the medical basis for the different categories of US approval currently used, and the medical basis for the current restrictions on Doppler studies and echocardiography (i.e., currently these services may only be provided in public diagnostic facilities and hospitals.

METHODS

Literature review: A May 2014 literature search of publicly available medical databases and 'grey literature' sought English language references published within the past 5 years that discussed uses of US in medicine, use by different health care professions, and use in tertiary care and telehealth.

Jurisdictional survey: Medical consultants at the Ministries of Health (MoH) from the other nine Canadian provinces were contacted by e-mail regarding US policies and practices in their jurisdictions.

Interviews of experts and stakeholders: More than forty telephone interviews were conducted with stakeholders and experts such as radiologists, cardiologists, maternal-fetal-medicine specialists

(MFMs), technologists, diagnostic facility managers, equipment manufacturers, and staff/representatives from the British Columbia Institute of Technology (BCIT), BC MoH, Ontario MoH, and the College of Physicians and Surgeons of British Columbia's (CPSBC) Diagnostic Accreditation Program (DAP).

FINDINGS

A. Current US Practice in BC

A1. Literature review of US innovation: A dramatic innovation in US is the use of smaller, less expensive, mobile, point-of-care (POC) units by various types of physicians (and non-physicians), versus the traditional paradigm involving primarily fixed US devices operated by US technologists with images interpreted by radiologists. Generally POC US is used for triage, with quick examinations that are not formally documented. An estimated 450 POC units are in use in BC. BC physicians are not compensated for performing or interpreting POC US exams, although it is noted that ED physician fee items have been established in Ontario and Prince Edward Island.

A2. Jurisdictional survey comparing BC to other provinces: Information on US policy and procedures was obtained for six provinces: Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, and Newfoundland and Labrador. (Note that there are no private imaging facilities in Manitoba, New Brunswick, and Newfoundland and Labrador.) In Alberta and Saskatchewan, policy for privately-owned facilities is the same as for public facilities; in Ontario, the *Independent Health Facilities Act* provides specific guidance for privately-owned facilities. With respect to US urgency categories, only Saskatchewan has developed provincial guidelines, although Alberta expects to have categories developed by mid-2015. Regarding US telemetry, none of the responding provinces requires special permissions or prior authorizations, with images interpreted via telemetry treated the same as those interpreted by an on-site radiologist (although Ontario fees are lower for off-site interpretation).

A3. Professional regulatory environment: Physicians wishing to bill MSP for interpreting US must have special credentialing, currently granted by the College of Physicians and Surgeons of BC (CPSBC), although health authorities will shortly take over this responsibility. Radiologists are exempt from the requirement for additional CPSBC credentialing as their residency training includes six months of US. There is currently no formal requirement for training in POC US, aside from optional certification offered by the Canadian Emergency Ultrasound Society (CEUS), and this lack of formal, consistent training is a concern for some. With respect to US technologists, a regulatory body and licensing requirement do not currently exist in BC, although regulatory options are actively being considered. A national professional society, Sonography Canada, provides entry-to-practice credentialing exams and national credentials for US technologists.

A4. Issues for rural and remote communities: The main challenge for rural and remote communities is recruitment and retention of US technologists and radiologists along with other practical challenges such as lack of back-up help for vacations or illness, a need for technologists to have enough experience and confidence to work alone, limited opportunities for continuing education, and difficult schedules if on-call is required.

B. The Evolving Landscape

B1. Evolution in US indications: As US resolution has improved, indications have expanded, e.g., musculoskeletal conditions (e.g., shoulder, ankle and knee); first trimester nuchal translucency prenatal scanning for detection of Down syndrome and other congenital anomalies; visualization of very small structures like the carotid artery wall and foreign bodies in the eye; and increasing use for image-guided procedures such as biopsies, placement of lines, and needle-guided nerve blocks. There was no indication from interviews with technologists, clinicians and industry representatives that BC is not keeping up with clinical practice developments.

B2. US telemetry: US telemetry is the performance and capture of US images in a location without a radiologist on-site, with electronic transmission to another location for interpretation. In BC, ACDF guidelines generally require a radiologist to be on-site when an US is performed but an exception may be made and a Certificate of Approval for US telemetry (interpretation performed by a radiologist located off-site) awarded. MoH data from January 2014 show 34 (public) hospitals/diagnostic facilities with Certificates of Approval to transmit US images to 17 receiving hospitals, e.g., the Castlegar and District Hospital transmitting images to the Trail Regional Hospital. While ACDF US telemetry policy states "the majority of ultrasound scans rendered at the diagnostic facility will continue to be scheduled when the visiting radiologist is on-site for the purpose of ultrasound supervision" (See Policy 2.4.3 at p. 22 of the ACDF Policies and Guidelines), in practice the frequency of radiologist visits varies widely. Generally, radiologists providing telemetry (interpretation) services visit the transmitting location every week, particularly in the southern parts of the province where population centres are not so geographically dispersed. However, there is considerable variation in frequency elsewhere in the province, for instance, once a month in some cases in the Interior Health Authority (IHA) and once a year in some cases in the Northern Health Authority (NHA). With respect to the impact of telemetry on provision of US in BC, four radiologists providing US telemetry services were interviewed and described the use of telemetry as an excellent and necessary practice.

B3. US urgency categories: The BC benchmark for urgent, non-emergency US is 10 working days. Across Canada, only Saskatchewan currently has provincial benchmarks for US wait times although Alberta is developing them. The Saskatchewan benchmarks are: (1) < 24 hours to diagnose and/or treat life-threatening disease; (2) 2 to 7 days when indicated to resolve a clinical management imperative; (3) 8 to 30 days when indicated to investigate symptoms of potentially life-threatening importance; (4) and 31 to 90 days when indicated for long-range management or for prevention.

C. MSC Requirements

The following issues related to policy and clinical practices were specifically explored in this report.

C1. Medical basis for the requirements for a privately-owned facility to receive a Certificate of Approval to bill MSP for outpatient US services: (a) the facility must have ≥ one radiologist and (b) US Category IV approval

(a) The original rationale for the requirement for the facility to have one or more (credentialed) radiologists was that a radiologist's knowledge and experience were essential from a quality assurance standpoint. No significant evidence regarding the current medical appropriateness of this requirement

could be discerned and there was no consensus on this topic across physician specialties. An emerging consideration is the possibility that, if various other policies were to be changed, an imaging facility may not require an affiliated radiologist. With sufficient checks and balances in place (e.g., technologist and physician credentialing and DAP accreditation), quality of care could be monitored. However, conflict-of-interest with physicians potentially self-referring for US exams is a concern, as is the potential for a significant increase in utilization, with corresponding increased costs to the public plan.

(b) Interviewees were not familiar enough with the policy details to state opinions about this requirement.

C2. Medical basis for the eight different categories of US approval currently used

Most interviewees were unaware of the various categories of US approval; an exception was management staff members from privately-owned community imaging clinics. Interviewees often thought the current categories were awkward, but there was no consensus about how the system could be improved. The most common opinion favoured reducing the number of approval categories, or even consolidating to just one (general) approval category.

C3. Medical basis for the current restrictions on Doppler studies and echocardiography

Currently in BC, all Doppler and echocardiography studies must be performed in a public diagnostic facility/hospital. Interviewees were asked whether they could see a medical reason to continue this public diagnostic facility/hospital-only restriction, and the answer was generally 'no'. It was felt that this limitation means hospital-based US departments are dominated by Doppler and echocardiography exams, leaving little booking room for other types of US that, consequently, must often be done by privately-owned community imaging clinics. A Doppler application particularly useful outside hospital settings is suspicion of deep vein thrombosis where a delay in booking can affect patient outcomes. A potential advantage of changing the policy to allow echocardiography in non-hospital settings is improved access with the potential for shorter wait times and increased convenience for patients. However, there were also areas of potential concern, e.g., movement of technologists to the private sector, increased utilization, flow of routine echocardiography referrals to the private sector leaving the more complex examinations to the public diagnostic facilities, quality of care issues, and privacy and information security issues.

C4. Medical basis for requirements to receive a Certificate of Approval to bill MSP for outpatient US telemetry services [primarily the requirement that "the transmitting and receiving sites are specified in the application and are all public diagnostic facilities"]

Interviewees involved in US telemetry were positive about the technology and practice, with the point made that telemetry makes US possible in smaller communities, enhancing patient access. However, there is significant variation in the frequency of radiologist visits to transmitting sites ranging from several times per week to once a year. It was noted that there is really no medical reason to restrict receiving sites to public diagnostic facilities as long as such sites (e.g., privately-owned diagnostic facilities) satisfy suitable quality processes.

CONCLUSIONS

The project's purpose was to explore the provision of US services in BC as a first step in assessing whether the rules governing such practices accord with current clinical standards and best practices. Project research explored the current state of US in BC (e.g., uses, settings, providers); changes and innovations in US delivery locally and internationally; the use of US telemetry and urgency categories across Canada; and the medical appropriateness of several specific MSC policies that have been in place for many years. Through a literature review, stakeholder interviews and information from other provinces, it appears there is room for consideration of changes to some of the current US policies in BC. It is acknowledged that policy change can lead to unintended consequences related to utilization, costs, quality, human resources, and operational matters; as such, further review of policy and service delivery impacts (including financial and operational analyses), along with consultation and collaboration with stakeholders and partners, is recommended.

Acronyms and Abbreviations Used

AAA	Abdominal aortic aneurysm
ACDF	Advisory Committee on Diagnostic Facilities
BC	British Columbia
BCIT	British Columbia Institute of Technology
CADTH	Canadian Agency for Drugs and Technologies in Health
CAR	Canadian Association of Radiologists
CARDUP	Canadian Association of Registered Diagnostic Ultrasound Professionals
CEUS	Canadian Emergency Ultrasound Society
CPSBC	College of Physicians and Surgeons of BC
CSDMS	Canadian Society of Diagnostic Medical Sonographers
CT	Computed tomography
DAP	Diagnostic Accreditation Program
DI	Diagnostic imaging
ED	Emergency Department
FFS	Fee-for-service
HTA	Health Technology Assessment
ICU	Intensive care unit
IHA	Interior Health Authority
IP	Independent practitioner
MFM	Maternal-fetal-medicine
MSC	Medical Services Commission
MSP	Medical Services Plan
MoH	Ministry of Health
MRI	Magnetic resonance imaging
NHA	Northern Health Authority
NT	Nuchal translucency
OHIP	Ontario Health Insurance Plan
PACS	Picture Archiving and Communication System
POC	Point of care
SOGC	Society of Obstetricians and Gynecologists of Canada
TEE	Trans-esophageal echocardiography
US	Ultrasound

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Background

Ultrasound (US) is a non-invasive medical imaging technology that detects and displays acoustic energy reflected from soft tissue interfaces within the body. The reflections provide the information needed to form high-resolution gray scale images of the body, including blood flow. Images are generally captured by an US technologist (also known as a sonographer) using a specific type of US probe, with various probes available for specific functions. Traditionally, images are interpreted by a radiologist and a report is developed for a referring physician.

US is provided in most hospitals in British Columbia (BC) to both inpatients and outpatients and is also provided in both publicly- and privately-owned outpatient facilities as a benefit of the BC Medical Services Plan (MSP). According to MSP data, roughly 800,000 US services (including Doppler) were billed in 2012/13 with total billings of about $70 million. Most commonly billed services were obstetrical US and US examinations of the abdomen, non-pregnant pelvis, kidneys and extremities, as well as Doppler echocardiography of the heart. As of August 20, 2014, 96 BC facilities (publicly- and privately-owned, i.e., including hospitals and community imaging clinics) were approved for US services and 39 facilities (all public diagnostic facilities/hospitals) were approved for echocardiography services.

In order to provide US services to MSP beneficiaries as benefits and bill MSP, an approval must be granted by the Medical Services Commission's (MSC) Advisory Committee on Diagnostic Facilities (ACDF) or the MSC itself. Pending completion of a significant policy and program review underway at the time, on December 19, 2012, the MSC instituted a moratorium on applications for new Certificates for Approval for all diagnostic service modalities under the authority of the Advisory Committee on Diagnostic Facilities (ACDF) (including US), with two notable exceptions: (1) for applications to add new services to existing Certificates; and (2) for demonstrated urgent health or safety needs.[1] The general moratorium on diagnostic service applications was lifted effective June 1, 2014; however, the US moratorium was continued and is currently scheduled to be lifted June 1, 2015.

Background on US technologist training and supply issues in BC[2]

The British Columbia Institute of Technology (BCIT) offers the only US technologist training program in BC. The 27-month diploma program includes theory, labs and clinical training. Historically, there have been 24 entry seats. This number increased to 30 in 2010. The attrition rate from the program is very low, e.g., 30 of 30 will graduate in 2014 and it is anticipated that 29 of 30 will graduate in 2015. Clinical placement is a challenge. Students rotate through hospitals and clinics but a one-on-one training model means only one student goes to each site. The public system bears the training load as there is minimal involvement of privately-owned community imaging clinics.

BCIT graduates write Canadian and/or United States exams set by the Canadian Association of Registered Diagnostic Ultrasound Professionals (CARDUP) and the American Registry for Diagnostic Medical Sonography exams, respectively.

[1] http://www.health.gov.bc.ca/msp/infoprac/diag.html

[2] Most information was obtained in a May 2014 telephone interview with staff at BCIT including the Program Head, an Associate Dean and the Sonography Program Head.

To write the Canadian exams[3], students must have graduated from an accredited program but this is not true for the United States exams. Successful students are certified in general and/or cardiac sonography but licensing or regulation by the province is variable.[4] Anecdotally, migration of graduates to Alberta is a challenge for BC employers (Alberta salaries are higher and there can be attractive signing bonuses).

Within BC there are also challenges for public diagnostic facilities/hospitals compared to privately-owned community imaging clinics with respect to recruiting and retaining US technologists. For instance, community imaging clinics are reported to provide more favourable pay scales and hours. For those dedicated to hospital work, advantages include public sector benefits and longer vacations for senior staff plus a wider variety of clinical experiences.

There is no central data collection for numbers of US technologists in BC; however, late 2014 numbers reported for public facilities in the Lower Mainland are 193 technologists/132 full-time equivalents (FTEs).[5] Extrapolating from the provincial population and its distribution (approximately half in the Lower Mainland and half in the rest of the province), the numbers of US technologists in BC can be estimated at 400 technologists and 250 FTEs – in the *public sector only*. There would be similar numbers in the community based clinics,[6] leading to a 'ballpark' total of 800 US technologists and 500 FTEs in BC.

The job vacancy rate in this field is significant. For example, approximately 70 FTE US position vacancies in public diagnostic facilities/hospitals were reported across the province in a July 2013 survey including 54 regular full-time positions, 9 part-time (4.3 FTE), 10 temporary full-time and 6 temporary part-time (3.2 FTE). In addition, there were 20 casual positions available.[7] More recent data for the Lower Mainland public facilities and hospitals showed that, as of December 15, 2014, there were 37 active postings despite the hiring of 14 sonographers from the recent BCIT graduating class.

[3] Students writing the Canadian exam have complete mobility across Canada because they write the national certification exam of a national professional society. To make this certification work, Canada has a national accreditation program for education organizations, ensuring education outcomes align with a national set of competencies. The national body is now called Sonography Canada, representing a merger of the credentialing organization, CARDUP, and the professional association, the Canadian Society of Diagnostic Medical Sonographers (CSDMS). (Personal communication, BCIT Associate Dean of Diagnostic Technologies and Interim Vice President Academic/Vice President Education Research and International, December 17, 2014).

[4] Only Quebec and Nova Scotia currently have a licensing regime for sonographers, although potential provincial regulatory or licensing regimes are being explored in Ontario and actively considered in BC. As of December 18, 2014, a regulatory regime was pending in New Brunswick. (Personal communication, BCIT Associate Dean of Diagnostic Technologies, December 17, 2014).

[5] Personal communication: Medical Imaging Manager, Lower Mainland/Provincial Imaging Council, September 2, 2014.

[6] Personal communication: Medical Imaging Manager, Lower Mainland/Provincial Imaging Council, September 2, 2014.

[7] Based on survey information supplied by the Operations Director, Medical Imaging; St. Paul's, Mount Saint Joseph, Children's and Women's Hospitals.

Project Objectives

BC Ministry of Health (MoH) staff intend to review policies governing MSP-funded US including those related to telemetry (electronic transmission of US images from one location to another for interpretation by a radiologist). The objectives of the current project are to review the medical appropriateness of the rules pertaining to the use (and public funding) of US, including telemetry, in the delivery of patient care in BC. This need arises from:

- Advancements in US and digital imaging technology
- Evolving clinical indications, standards of care, and best practices in service delivery
- Information obtained as part of the ACDF Modernization Project[8]

The report constitutes a detailed review of current US practices, primarily through a lens of medical appropriateness,[9] as a first step in assessing whether the rules governing such practices reflect current clinical standards and best practices.[10] The scope of the project includes inpatient, outpatient and emergency department (ED) settings, and all types of publicly-funded US exams.

This report examines: (a) roles and responsibilities of health care providers, including individuals (e.g., physicians and technologists) and organizations (e.g., health authorities and privately-owned community imaging clinics); (b) US clinical urgency categories and wait time benchmarks; (c) telemetry and point-of-care (POC) technologies and how they are impacting provision of US services; and (d) MSC policies/requirements relating to approvals to bill MSP for US services.

Research Questions

To guide the project, research questions were developed.

A. Current Practice in BC

1. How is US currently being used?
2. In what settings is US used?
3. Which health care providers use US and what are their roles?
4. What is the professional regulatory environment and are there any concerns?
5. Are there issues unique to rural and remote communities?

[8] A summary of the ACDF Modernization Project is available at: http://www.health.gov.bc.ca/msp/infoprac/diag.html#acdf-modernization

[9] A single, concise, comprehensive, universally-accepted definition of medical appropriateness does not exist. Please see **Appendix A** for an overview and resources related to definition and measurement of "medical appropriateness".

[10] In future phases of the policy review, MoH staff members plan to examine and analyze policy and practice from other perspectives including cost, health human resources, and service delivery model considerations.

B. The Evolving Landscape

6. How are the clinical indications for US evolving and is clinical practice in BC keeping up?
7. How is digital imaging/telemetry impacting US service delivery and practice in BC?
8. Do other Canadian jurisdictions employ US clinical urgency categories?

C. MSC Requirements:

9. Is there a medical basis for the current requirements that must be met to receive a Certificate of Approval to bill MSP for outpatient US services?
10. Is there a medical basis for the different categories of US approval currently used?
11. Is there a medical basis for the current restrictions on Doppler studies and echocardiography, i.e., studies are limited to public diagnostic facilities/hospitals?
12. Is there a medical basis for the current requirements that must be met to receive a Certificate of Approval to bill MSP for outpatient US telemetry services, i.e. both sending and receiving locations must be public diagnostic facilities/hospitals?

Methods

Literature Review

A literature search was conducted in May 2014 by an experienced health information specialist covering the international literature included in the PubMed database and the Centre for Reviews and Dissemination Health Technology Assessment (HTA) database at the University of York in the United Kingdom. Medical Subject Headings (MeSH) terms such as "ultrasonography" were used along with free text terms such as "ultrasound." The search sought English language studies or reviews, published within the past five years, that discussed new or accepted uses of US in medicine, its use by different health care professions, and, in particular, its use in tertiary care and telehealth. With respect to Canadian resources, the search for grey literature included the web sites of Canadian medical US associations, the Canadian Agency for Drugs and Technologies in Health (CADTH), and the Society of Obstetricians and Gynaecologists of Canada (SOGC).

Jurisdictional Survey

In early June 2014, medical consultants at the Ministries / Departments of Health from the other nine Canadian provinces were contacted by e-mail, with the following questions posed:

1. *Do you have clinical urgency categories or wait time benchmarks for US services?*
2. *What MoH requirements must be met for a facility to bill the public plan for outpatient US services (or be funded by government if not in a fee-for-service environment)?*
3. *Are there different rules for publicly- versus privately-owned facilities in terms of US tests they can perform?*
4. *Do you have US telemetry? If so, under what circumstances? What allows US telemetry services on outpatients to be billed to the public medical plan?*

Interviews of Experts and Stakeholders

It was assumed that most valuable information would be obtained via telephone interviews with key experts and stakeholders and, to that end, 44 telephone interviews were conducted including:

- Eight radiologists (11 interviews).
- Three cardiologists.
- All five regional health authority Diagnostic Imaging (DI) Department managers (8 interviews).
- Representatives of five US equipment manufacturers (General Electric, Siemens, Toshiba, Philips and Sonosite [manufacturer of hand-held devices only]).
- Three US technologists.
- Management staff from four privately-owned community imaging clinics.
- Ten others: BC MoH (2); Ontario MoH (2); College of Physicians and Surgeons of BC (CPSBC) (2); Diagnostic Accreditation Program of BC (DAP) (1); an Emergency Department (ED) physician knowledgeable about US training (1); BCIT (1 call with 3 people); and the Canadian Association of Radiologists (CAR) (1).

Findings

Literature Review

The focus of the literature review was on recent developments and innovations in US, particularly with respect to provider groups and settings. Initial searching identified 145 articles of potential relevance. More detailed review of citations and abstracts shortened the list to 67 articles. Information was generally gleaned from abstracts, i.e., full text articles were not retrieved aside from those that were open access. **Appendix B** displays the findings in tabular form. Below is a summary of findings from the literature review, focusing on US providers and settings:

- All included articles were generated by authors in the 'developed' world with 14 countries represented: USA (28 articles); Canada (8); Italy (8); Australia (6); Austria (4); UK (4); Norway (2); and one each from France, Germany, Greece, Iran, Ireland, Portugal, and Romania.
- Most articles (59 of 67; 88%) described applications for – or use of – POC US; only six (9%) focused on traditional US while two covered both POC and traditional US.
- Settings for US use varied widely, including: inpatient; intensive care; ED; operating room; transport (ambulance, airplane and helicopter); and outpatient (including unusual or remote situations such as battlefields and mountaintops).
- Ten provider groups reported on use of US – nine physician specialties and one non-physician group.
    - *Anaesthesiologists*: for US-guided procedures.
    - *ED physicians*: for many applications such as US-guided procedures, diagnosis of abdominal aneurysm, assessment of cardiac structure and function (including during cardiac arrest), fracture diagnosis, gallbladder disease, and lung disorders such as pneumothorax.
    - *Family medicine*: in remote locations, in particular.

- *Intensive care unit (ICU)*: many applications such as ICU echo, pulmonary assessment, and renal imaging.
- *Internal medicine specialties*, including cardiology, endocrinology, gastroenterology, respiratory medicine and rheumatology across a large number of applications.
- *Medical students and trainees*
- *Pediatrics*: for ED and ICU applications, as well as echocardiography.
- *Sports medicine*: for diagnosis of musculoskeletal conditions.
- *Surgical specialties*, including general surgery, orthopedics, surgical ICU, thoracic surgery, urology and vascular surgery across a large number of applications.
- The non-physician group included: military medical teams for battlefield trauma; remote tele-monitored lung US administered by remote providers on mountains and in airplanes; and pre-hospital care provided by paramedics and other types of first responders.

- Several references compared the accuracy of POC US use with traditional practices, e.g.:
  - In the hands of ED physicians, successful internal jugular central venous catheter placement was significantly more likely when guided by POC US (94%) versus landmarks on the neck (79%), and complication rates were much more favourable (5% versus 17%). (Mehta et al., 2013)
  - In diagnosing ruptured abdominal aortic aneurysm (AAA) in ED patients with POC US, a systematic review of seven studies calculated sensitivity of 99% and specificity of 98%. This means POC US picked up 99% of AAAs that were present and only misdiagnosed an AAA where none was present in 2% of cases. The reference standards included one or more of: CT, MRI, aortography, traditional US performed by a radiologist, ED US reviewed by a radiologist, exploratory laparotomy, or autopsy. (Rubano et al., 2013)
  - A systematic review of eight studies compared surgeon-performed US to the reference standard of pathological examination or radiologist-performed US for (a) suspected appendicitis or (b) suspected gallstone disease. For suspected appendicitis, the sensitivity was 92% and specificity was 96%; for suspected gallstone disease, the sensitivity was 96% and specificity was 99%. (Carroll et al., 2013)
  - For the diagnosis of deep vein thrombosis, a systematic review of 16 studies calculated the accuracy of POC US by ED physicians compared to colour-flow duplex US performed by a radiology department or vascular laboratory, or to angiography. Compared to the reference imaging, results showed weighted mean sensitivity of POC US of 91% and specificity of 97%. (Pomero et al., 2013)
  - A meta-analysis examined the performance of POC US in the ED for diagnosis of pneumothorax versus chest x-ray as the gold standard. Results showed that POC US performed by physicians had higher sensitivity (88% versus 52%) and similar specificity (99% versus 100%) than chest X-ray, although US accuracy depended on the skill of the operators. (Ding et al., 2011)
  - The performance of POC US by ED physicians to diagnose gallstones was investigated via a systematic review including eight studies. The reference standard was radiology-performed US,

CT, MRI, or surgical findings. The pooled estimates for POC US sensitivity and specificity were 90% and 88%, respectively. (Ross et al., 2011)

Jurisdictional Survey

Of the nine provinces contacted, six medical consultants responded (67%) from Alberta (AB), Saskatchewan (SK), Manitoba (MB), Ontario (ON), New Brunswick (NB), and Newfoundland & Labrador (NL). **Table 1** displays the responses.

Table 1: Information from the Responding Provinces

Question	AB	SK	MB	ON	NB	NL
Do you have US urgency categories?	No – developing them with anticipated completion mid-2015	Yes. Provincial guidelines (for US, CT, MRI) that can be locally adapted.[11]	Not at the provincial level; it is unknown but possible that there are at the local or regional level	No	Not at the provincial level; it is unknown but possible that there are at the local or regional level	Not at the provincial level; it is unknown but possible that there are at the local or regional level
What are the MoH requirements for outpatient facilities to bill the plan?	CPSA accreditation & radiologist licensure with AB – nothing else is required (agreement with AMA)	Facility must be licensed and physicians credentialed by CPSS	No private system – all imaging is in hospitals	Facility must be licensed and physicians credentialed by CPSO. MDs may bill a professional fee for US in private offices but not the technical fee.	No private system – all imaging is in hospitals	No private system – all imaging is in hospitals
Are there different rules for privately owned versus public facilities?	No, as long as there is a SMB fee	No	No private system – all imaging is in hospitals	The *IHFA* outlines the types of US allowed in a private facility (about 40 fee items)[12]	No private system – all imaging is in hospitals	No private system – all imaging is in hospitals
Do you have US telemetry in the province + what are the billing details?	Not needed - for rural reading when using PACS, radiologists are considered to be on site	Not needed - radiologists licensed in SK may interpret from anywhere	Not needed - radiologists licensed in MB may interpret from anywhere	There is a special lower fee for US interpretation if radiologist is not on-site.[13]	Not needed - radiologists licensed in NB may interpret from anywhere (this is also true in NS)	Not needed - radiologists licensed in NL may interpret from anywhere

KEY: AMA=Alberta Medical Association; CPSA=College of Physicians & Surgeons of Alberta; CPSO=College of Physicians & Surgeons of Ontario; CPSS=College of Physicians & Surgeons of Saskatchewan; CT=Computed tomography; IHFA=*Independent Health Facilities Act*; MoH=Ministry of Health; MRI=Magnetic resonance imaging; PACS=Picture Archiving and Communication System; SMB=Schedule of Medical Benefits; US=ultrasound

[11] See **Table 2** on p. 15 for US urgency categories and wait time benchmarks in SK.

[12] The January 2013 list of (and compensation for) US fee items available for Ontario Independent Health Facilities (IHFs) is at: http://www.health.gov.on.ca/english/providers/program/ohip/sob/facility/diagnostic_ultrasound.pdf. Note: IHFs include privately owned facilities that may be publicly- or privately-funded (excludes hospitals).

[13] While there is no policy requiring prior authorization to perform and bill for "distance reading" there are parameters, such as: (1) the interpreting physician must be in Ontario; and (2) CPSO Clinical Practice Parameters set out requirements for equipment that must be used when a physician is interpreting an image. (Personal communication: Ontario MOHLTC, Provider Payment Unit, SOB Fee Schedule Officer, January 13, 2015.)

In addition, a BC MoH provincial survey in late 2013 obtained information from Ontario and Nova Scotia and noted that urgency categories for US did not exist in these provinces.

Questions posed about issues related to privately-owned/publicly-funded diagnostic facilities were relevant only to a few provinces, i.e., Alberta, Saskatchewan, and Ontario.[14] The four Atlantic provinces, three territories, and Manitoba do not have fee-for-service (FFS) private facilities. Likewise, in jurisdictions where there are no provincial urgency categories or wait time benchmarks, questions such as those related to wait times were not answerable by MOH staff members; however, there may be policies that are region- or hospital-specific and not known to, or applied at, the provincial level.

Findings Specific to the Research Questions

The findings below bundle together information gleaned primarily from the stakeholder interviews, with some information from the literature review.

Current Practice in BC

Questions 1, 2 & 3: How is US being used, in what settings, and who uses it?

Questions #1-3 were addressed primarily via the literature review (detail is contained in **Appendix B**). The greatest recent innovation in US is the use of smaller, less expensive,[15] mobile POC units in the hands of various types of physicians (and non-physicians), versus the traditional paradigm involving primarily fixed devices[16] operated by US technologists with images interpreted by radiologists. These devices evolved from small durable devices developed in the mid-1990s for battlefield applications. POC US appears to have expanded greatly in the past few years.[17] It is now being used by several dozen physician specialties, both to diagnose and to guide various procedures such as biopsies, insertion of lines and needle-guided nerve blocks.

[14] Ontario has had a moratorium on issuing licenses for new privately-owned imaging facilities since 1999; there are currently 934 IHFs with licenses issued by the MoH (Personal communication with a QA & Inspection Analyst, Independent Health Facilities Program, Ontario MoH, September 12, 2014).

[15] A POC unit costs $30,000 - $55,000 versus a traditional US unit at $150,000 to $200,000+, depending on the number of probes and other various purchased add-ons. According to recent lifecycle guidelines issued by the CAR, the expected life of a traditional US device is 7 to 9 years, depending on how intensively it is used. A vendor confirmed that the lifecycle of POC US devices is similar.

[16] Some of the traditional US devices can be moved to the bedside or elsewhere but this is not common as it is time-consuming and awkward and also means the device is not available in the DI department.

[17] In the year 2000 there were three suppliers of POC US devices, versus 23 in 2013. Reference: Ridley EL. Is radiology losing its grip on compact ultrasound? 2013 Feb. Available at: http://www.auntminnie.com/index.aspx?sec=ser&sub=def&pag=dis&ItemID=102438

This new POC paradigm generally avoids the need for an US technologist, with a non-radiologist physician both performing and interpreting the US in 'real time'. POC US was described both by interviewees and in the literature[18] as being like an extension of the stethoscope, i.e., it allows the examiner to take a further step in assessing a patient. Generally POC US is used for triage, particularly to quickly rule out worrisome conditions (e.g., to determine whether a deep vein thrombosis or ectopic pregnancy is present) with examinations being quick and, aside from notes in the chart (which may or may not be made), undocumented. In particular, there is no storage of images and no entry of these images into the main DI Picture Archiving and Communication (PACS) system.

Via POC, the examiner can determine whether the patient requires no further imaging – or requires a detailed US in the hands of a technologist and radiologist via the traditional method. A number of radiologist interviewees noted that they have not seen a decrease in traditional US requests due to POC imaging use in the ED, in part due to the significant backlog of requested appointments and also because an ED physician can rule out urgent conditions with POC but often cannot make a diagnosis. One radiologist noted (anecdotally) that there are fewer inappropriate urgent US requests to the DI department since POC US has been used to rule out suspicious conditions.

POC US is increasingly used to guide procedures such as line placement (versus the traditional reliance on body surface landmarks); it was suggested this has become a "standard of care" in some situations due to its high degree of accuracy. There was a sense that such US use may have decreased use of more expensive technologies such as CT and MRI in image-guidance procedures.

It appears that radiologists do not get involved in the use of POC US. Additionally, the DI department of a hospital is not involved with POC purchase or maintenance. Interviewees believed these devices are purchased by other departments, perhaps with money from hospital foundations, i.e., their purchase is not part of an institution's capital equipment plan.

In an attempt to acknowledge this new technology, the CAR has developed a (July 2013) position statement on POC US, in collaboration with the SOGC.[19] The document has also been endorsed by the Canadian Interventional Radiology Association and the Canadian Society of Echocardiography. The CAR position is to recognize the value of POC US in the hands of non-radiologists, while stressing the need to minimize potential negative consequences of its use through appropriate quality assurance and user training. Similarly, the DAP is aware of the growing use of POC but at present has not included mobile POC technology within the scope of its accreditation activities.

Although provincial data are not available, a general sense of the numbers of POC devices in BC may be inferred from Interior Health Authority (IHA) data. In the IHA, POC devices are regularly maintained by the Biomedical Department and department data were made available for this report. With a population of roughly 750,000 people, IHA is about 16% of the BC population.

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[18] For example: Wittenberg M. *Will ultrasound scanners replace the stethoscope?* BMJ. 2014 May 29;348, and Gillman LM, Kirkpatrick AW. *Portable bedside ultrasound: the visual stethoscope of the 21st century*. Scand J Trauma Resusc Emerg Med. 2012 Mar 9;20:18.

[19] The July 2013 CAR position paper is available at:
http://www.car.ca/uploads/standards%20guidelines/point_of_care_ultrasound_position_statement_20140527.pdf

The most recent information (mid-2014) shows that IHA has 75 POC US units; this extrapolates to about 450 units for the Province. All but three of the IHA POC devices were manufactured by a single vendor. They were acquired between 2001 and 2014 with purchase prices ranging from about $20,000 to $70,000. In all, POC devices are located in 27 of IHA's facilities, ranging from smaller outpatient clinics (e.g., Sparwood) with one device to the largest site, Kelowna General, with 14. The devices are spread across many types of units such as the ED, ICU, wards (including obstetrics), and ambulatory care.

User training is an interesting issue. Whereas radiologists spend about six months of their four-year residency learning US interpretation, the various users of POC devices generally learn via a half-day course at a conference, or possibly at a weekend course. With the exception of standards developed by the Canadian Emergency Ultrasound Society (CEUS),[20] there may not be requirements or standards for POC users at this time.

Physicians in BC are not additionally compensated for doing POC US exams; however, ED physicians have been compensated in the province of PEI since October 2014 via fee item 2900 at $30.00 per exam. Via fee item H100, the Ontario Health Insurance Plan (OHIP) has been paying ED physicians $19.65 for performing and interpreting POC US since June 2011. In fiscal year 2012, 18,967 H100s were billed to OHIP, increasing to 23,540 in fiscal year 2013 ($372,700 in 2012 and $462,560 in 2013). It is not clear what proportion of all POC US exams were performed in the ED, as there is no regular record of POC US performed unless OHIP billing is involved.

A number of rules apply to billing an H100 in Ontario:[21]

- The ED physician must "meet standards for training and experience to render the service" (as per the requirements set down by CEUS).
- A radiologist must not be immediately available to provide an interpretation.
- The US technology must meet certain minimum standards.
- A permanent record of the image(s) and an interpretative report must be supplied.
- No more than two of these procedures may be carried out on the same patient in a day.
- Only suspicion of certain clinical situations is compensated including ruptured aortic aneurysm or ectopic pregnancy, pericardial tamponade, intraperitoneal hemorrhage due to trauma, and cardiac standstill.

With respect to innovation in US, aside from the increase in use of POC, radiologist and US technologist interviewees suggested several examples of changes over the past decade or so:

- Increasing resolution accompanies newer US technology. Increased resolution has allowed new US applications, particularly in musculoskeletal conditions (most recently, imaging of the shoulder, ankle tendons and knee ligaments) – of interest to rheumatologists, orthopedic

[20] CEUS, formed in 2000, has established standards for certification as an 'independent practitioner' (IP) based on training via a one-day introductory course, 50 supervised cases and an exam. Of 14,000 ED physicians in Canada, 8000 have taken the introductory courses and 2000 are IPs.

[21] Ontario Schedule of Benefits for Physician Services under the Health Insurance Act – May 2014. Page A13.

surgeons and sports medicine specialists. Several BC radiologists opined that these indications have expanded in part due to limited access to MRI scanning.

- Another innovation is first trimester nuchal translucency scanning to rule out Down syndrome and other congenital conditions. Nuchal translucency scanning augments and may ultimately replace many invasive amniocentesis and chorionic villus sampling procedures. (Only radiologists and obstetricians may interpret these images and they must be specially credentialed to do so by the CPSBC; likewise, technologists must be specially credentialed to perform the exams.)
- Sonographic contrast is another innovation, particularly in liver disease. Elastography is an emerging technology for liver disease and other applications.
- Notably, as the technology has become more advanced, the price of mid- and high-end devices has come down. User-friendliness has also been enhanced.

Question 4: What is the professional regulatory environment and are there any concerns?

Physicians

- A physician wishing to bill MSP for interpreting US must have special credentialing granted by the CPSBC.[22] Radiologists who hold a CPSBC license to practice radiology in BC are exempt as it is acknowledged that their training includes six months in US. However, other physicians (primarily cardiologists and obstetricians) must apply to the CPSBC via completion of a detailed web-based application listing suitable training and experience. (This requirement is also in place in at least Alberta and Ontario.) When a physician is approved to bill for US interpretation, CPSBC notification goes to the physician, the relevant health authority and BC MoH Diagnostic Facilities Administration staff.
- The CPSBC has notified the MoH that as of March 31, 2015 the credentialing task will shift to the MoH or its delegate. The credentialing task is apparently being taken on by the health authorities, with one exception: the CPSBC will continue to credential those few physicians who wish to interpret US but who do not hold health authority facility privileges.
- An additional concern relates to the lack of uniform required training for POC US and the early stage of the learning paradigm for this skill: there is a significant gap between the half-day training for ED physicians and the six months of training for radiologists.

Technologists

- A regulatory body and licensing requirement for technologists do not exist in BC, although there are ongoing efforts to establish these (for medical imaging and laboratory technologists).
- One interviewee expressed concern about the quality of clinical skills of technologists due to lack of regulation, i.e., a candidate may be able to pass the exams but lack actual hands-on skills.

[22] Until December 2010, credentialing was carried out by DAP (a program of CPSBC); it was subsequently transferred to the Office of the Deputy Registrar at the CPSBC.

- A national professional society, Sonography Canada, was recently established through the amalgamation of the CSDMS (established in 1981) and the CARDUP (established in 2000). The Society:
  - Provides national credentials and entry-to-practice credentialing exams
  - Supports continuing medical education, primarily through a national conference and journal
  - Develops policies, professional practice guidelines, and a code of conduct
  - Advocates on behalf of the profession

Question 5: Are there issues unique to rural and remote communities?

The primary challenge identified by interviewees was recruitment and retention of US technologists. Although this is a challenge throughout the province (and beyond), it is particularly acute in smaller and more remote communities. An additional complication related to technologists is repetitive strain injuries and general 'burnout'. A rural US technologist described challenges such as lack of back-up help from colleagues for vacations or illness, need for the experience and confidence to work alone, limited opportunities for continuing education, and impossible schedules if on-call is required. Recruitment and retention of radiologists can also be a challenge, although the possibility of US telemetry makes this challenge more manageable.

The Evolving Landscape

Question 6: How are indications for ultrasound evolving and is clinical practice in BC keeping up?

This question is addressed in part via the response to Questions 1, 2 & 3 above. Interviewees noted that, as US resolution continues to get better, indications for US are changing. Examples of the changing scope of US (mainly traditional US, with some exceptions, particularly in [d]) are: (a) expansion into use for musculoskeletal conditions, particularly for imaging the shoulder, ankle and knee; (b) the advent of first trimester nuchal translucency prenatal scanning, particularly for detection of Down syndrome and other congenital anomalies, which may replace much of the need for invasive amniocentesis and chorionic villus sampling procedures; (c) visualization of very small structures, e.g., the carotid artery wall, foreign bodies in the eye, and detached retinas; and (d) increasing use for image-guided procedures such as biopsies, placement of lines, and needle-guided nerve blocks. There was no indication from interviews with technologists, clinicians and industry representatives that BC is not keeping up with clinical practice developments.

Question 7: How is digital imaging/telemetry impacting ultrasound service delivery (practice) in BC?

Digital imaging is well established in BC and continues to move forward. Most imaging is captured digitally regardless of specific technology, e.g., CT and MRI. There are many advantages to digital capture, including instantaneous sharing of images and information and long-term image storage.

Telemetry in this context is the performance and capture of US images in one location (without a radiologist on site), with the electronic transmission of those images to another location to be read by a radiologist. Through modern PACS, images are no longer being actually transmitted *per se;* rather they are being uploaded to a central server that stores a database containing the images. A radiologist then

logs on to the system to view the image and record an interpretation. Once uploaded, the image is stationary and the viewer comes to the image, it is not transmitted to them. However, from a policy perspective, an image is still being read at a different physical location than where it was captured.

Generally, having a radiologist on-site when US is performed is a requirement to bill MSP, but an exception may be made and a Certificate of Approval for telemetry awarded. According to the most recently published (November 2014) policy governing the ACDF (the "Policies and Guidelines"),[23, 24] which addresses telemetry, the following requirements must be met before the ACDF may grant a telemetry approval:

- Transmitting and receiving sites are specified in the application and are public diagnostic facilities.
- The volume of diagnostic US services does not currently justify a full-time radiologist's coverage at the diagnostic facility.
- The use of diagnostic US telemetry will not negatively affect the existing on-site visit schedules of radiologists.
- The majority of US scans will continue to be scheduled when the visiting radiologist is on-site for the purpose of supervision.

MoH data from January 2014 record 34 hospitals with Certificates of Approval to transmit US images to 17 receiving hospitals, e.g., the Castlegar and District Hospital transmitting images to the Trail Regional Hospital, the Whistler Health Care Centre transmitting to Lion's Gate Hospital in North Vancouver, and Lady Minto Hospital on Salt Spring Island transmitting to the Royal Jubilee Hospital in Victoria. Telemetry allows US to be offered without a radiologist present daily. The pattern of care described at one small hospital was:

- An US technologist is employed in the small hospital and performs inpatient and outpatient US exams about four days a week.
- The radiologist visits the hospital one day per week and at that time the more complex US are performed, including US-guided procedures.
- On days when the radiologist is not on-site, the US technologist uploads the images to the health authority's PACS.
- The radiologist reads the US images from the receiving site at some point during the day and dictates reports. If needed, a verbal report is available to the small hospital's technologist or referring physician. The radiologist is also available by phone if the technologist needs to consult on an urgent basis. If the radiologist's response is not immediate, the patient may be asked to wait until the radiologist responds.

[23] "Policies and Guidelines of the Medical Services Commission's Advisory Committee on Diagnostic Facilities", British Columbia Medical Service Commission, November 2014 (the "Policies and Guidelines"). Available at: http://www.health.gov.bc.ca/msp/infoprac/ACDF%20Policy%20Guidelines_June%201%202014.pdf.

[24] Note: In addition to these telemetry-specific requirements, US service provision in privately-owned facilities must also meet the following: (a) the diagnostic facility has one or more appropriately credentialed radiologists; and (b) the diagnostic facility already holds a Certificate of Approval that permits radiology Category IV services.

Generally the radiologists providing telemetry services visit the hospital/public diagnostic facility every week although there are exceptions, including once a month (in the Interior) and once a year (in the North Health Authority [NHA]). In the NHA, resident radiologists are only present in Prince George, Terrace and Dawson Creek. Ten other NHA sites that perform US have visiting radiologists. Day-to-day, NHA technologists perform US and upload images to the PACS; most are read by a radiologist in Prince George. In these cases, US technologists are operating alone much of the time although many are senior technologists and mentoring systems are in place. Up to 2014, on-site visits were generally performed by a senior technologist on an occasional basis but a new regional radiologist lead recently visited every NHA site to ensure technologist competence and note where improvement was needed.

In a number of small Lower Mainland hospitals, US is performed 5 days per week with the radiologist on-site one of those days. If the radiologist is not present and the technologist has a concern, a call to the radiologist allows both the technologist and the radiologist to view the PACS images simultaneously to determine whether more images are needed before the patient is released. The radiologist must be available to respond remotely within 5 minutes and to be on-site within 30 minutes. Situations can be fluid year-to-year, e.g., at one point, the hospital in Powell River sent US images to Lion's Gate Hospital for interpretation but now there is a resident radiologist in Powell River. This was also the case with the Whistler Health Care Centre and Squamish Hospital, but now a local radiologist travels between the two sites day-to-day.

With respect to the impact of telemetry on provision of US in BC, four radiologists providing US telemetry services were interviewed and described the use of telemetry as an excellent and necessary model. Also, the requirement for radiologists to be present on-site on a regular (visiting) basis when US are performed seemed to be well supported due to the desirability of an established relationship between the radiologist(s) and technologist(s), the occasional need for them to speak in person and the availability of a radiologist to be 'hands-on' with some patients. The comment was made that, ideally, specific radiologist(s) are associated with a US telemetry site, with regular visits to do complex cases, provide hands-on when needed, ensure quality processes, and maintain a relationship with the technologist(s).

Question 8: Do other jurisdictions employ ultrasound clinical urgency categories?

The Policies and Guidelines set a benchmark for urgent, non-emergency US to be done within 10 working days. As noted previously, information gathered through a jurisdictional survey indicated that only Saskatchewan has a provincial benchmark for US wait times (**Table 2**, below), although Alberta is in the process of benchmark development with anticipated completion mid-2015. One BC radiologist noted that benchmarks can be beneficial as they can drive efforts to contain or improve wait times and wait lists.

Table 2: Urgency wait time policy for CT, MRI and US in Saskatchewan

Level	Description	Wait time
1	Immediately necessary to diagnose &/or treat life-threatening disease	STAT to 24 hours
2	Indicated to resolve a clinical management imperative	2 to 7 days
3	Indicated to investigate symptoms of potentially life-threatening importance	8 to 30 days
4	Indicated for long-range management or for prevention	31 to 90 days

Although current BC wait time measurement and performance were not direct objectives of this report, some Information pertaining to wait time benchmarks and issues was provided by interviewees. For example, a radiologist at a large Lower Mainland hospital reported the following:

- Emergency patients are scanned within an hour (during normal working hours).[25]
- Inpatients are scanned the day of the request or the next day.
- Urgent patients from associated clinics (i.e., 'feeder clinics') are scanned within two weeks.
- Data collected late May 2014 for next available appointments showed routine outpatient booking to involve, on average, a four-month wait, ranging from 10 days for abdomen to 7 months for shoulder.

MSC Requirements

Questions #9-12 relate to current ACDF US policy.[26]

Question 9: Is there a medical basis for the current requirements that must be met to receive a Certificate of Approval to bill MSP for outpatient US services?

As in the previous version of the policy, a recent update contains the same requirements to obtain approval to bill MSP for US services:

(a) The diagnostic facility has one or more radiologists who are appropriately credentialed.

(b) The diagnostic facility holds a Certificate of Approval that permits radiology Category IV services.

OPINION:

(a) *Requirement that a facility has one or more radiologists*: The original rationale for the requirement that a facility have one or more radiologists appears to be that a radiologist's knowledge and experience were viewed as essential from a quality assurance standpoint. There were varying perspectives as to whether this rationale (and the requirement) remains medically and clinically valid. Some interviewees did not feel there was a medical basis for the existing requirement;

[25] US is provided after 5:30 by radiology residents and fellows as US technologists are not on call.

[26] Due to the specific nature of these questions, and the limited availability of empirical or other evidence in the research literature, answers are based primarily on expert opinion.

however, no significant evidence regarding the current medical appropriateness of this requirement could be discerned and there was no consensus on this topic across physician specialties.

An emerging consideration is the possibility that, if various other policies are changed, an imaging facility may not require an affiliated radiologist. For example, if echocardiography was no longer limited to hospitals, a privately-owned community imaging clinic or cardiologist's office could become an echocardiography site and the cardiologist(s) could be the responsible physicians. Similarly, the role/scope of MFM physicians could be expanded to include the ownership or management of privately-owned, publicly-funded obstetrical US facilities.

With sufficient checks and balances in place (e.g., technologist and physician credentialing and DAP accreditation), quality of care could be monitored and maintained; however, a concern is the potential for conflict-of-interest with cardiologists and MFMs self-referring for US exams. In fact, a multitude of specialties (in addition to radiologists, MFMs, and cardiologists) currently use US in their practices, so, hypothetically, they could bill MSP for these US services if policy was changed. Thus, the potential for conflict-of-interest may arise in a number of settings, and there are also potential impacts on utilization and MSP billing. Conflict-of-interest concerns arising in such clinical settings could potentially be managed via existing MoH conflict-of-interest policy.[27]

(b) *Requirement for a facility to hold a Category IV approval:* Unfortunately, interviewees were not familiar enough with the policy details to state opinions about this. The only current situation where this requirement would be an issue is for Category II (obstetrical US), as Category III (echocardiography) is not currently permitted outside a hospital/public diagnostic facility.

[27] See the following policies: (1) Policy 2.4.4 of the ACDF Policies and Guidelines at: http://www.health.gov.bc.ca/msp/infoprac/acdf-policy-manual.pdf; and (2) the Diagnostic Facility Conflict of Interest Policy at: http://www.health.gov.bc.ca/msp/infoprac/DiagnosticFacilityConflictOfInterest.pdf

Question 10: Is there a medical basis for the different categories of US approval currently used?

A multi-category system for types / body sites of US is used by MSP and ACDF/MSC diagnostic facility approvals (**Table 3**).[28]

Table 3: Classification of US approval categories (abbreviated)

Category	Description	Notes
I	Ophthalmic B-scan (1 fee item)	May soon be unnecessary as it is only used for one 'grandfathered' eye care centre
II	OB / Gyn (7 fee items such as guided amniocentesis and obstetrical B-scan)	Most facilities performing US have been awarded Category IV; therefore, several interviewees queried the utility of this category
III	Echocardiography (5 fee items such as echo-real time and guided pericardiocentesis)	A 'stand-alone' category specific to echocardiography. By policy, permitted in public diagnostic facilities and hospitals only.
TEE	Trans Esophageal Echocardiography - contains 1 fee item	A 'stand-alone' category separate from Category III Echocardiography. By policy, permitted in public diagnostic facilities / hospitals only.
IV limited	Contains 13 fee items such as thoracic, renal and abdominal scans	Includes most of Category II fee items. May apply to smaller hospitals who do not wish to apply for a full Category IV due to maintaining equipment and expertise, credentialing physicians, and accreditation fees
IV full	Contains 4 additional fee items including guided thoracentesis, guidance for biopsy or cyst puncture, B scan of the brain and miscellaneous	Performance of all types of US including those in Categories I, II and limited IV
Doppler studies	Contains 11 fee items such as treadmill stress, peripheral venous, carotid imaging-duplex scanning of neck vessels.	By policy, permitted only in public diagnostic facilities / hospitals.
Nuchal trans-lucency (NT)	Contains 2 fee items –obstetrical B Scan less than 14 weeks with NT measurement for singles or multiples/each additional fetus.	Specialized prenatal screening for determining the incidence of Down syndrome, trisomy 18 or an open neural tube defect. Currently approved for 17 public and private diagnostic facilities in BC.

OPINION: Most interviewees were unaware of the categories (management staff members at privately-owned community imaging clinics were an exception). Interviewees often thought the current categories were awkward, but there was no uniform consensus about how the system could be improved. Several comments:

- Category I: Ophthalmic B-scanning is pretty much outdated and it will soon disappear anyway.
- Category II: If it becomes possible for MFMs to oversee privately-owned community prenatal US facilities (without the need for a radiologist), a case could be made for retaining this category – otherwise its utility is uncertain.

[28] http://www.health.gov.bc.ca/msp/infoprac/physbilling/payschedule/ultracatlist.pdf (June 2012)

- Category III: Most thought it was unclear why as to why echocardiography stands on its own as it could be rolled into Category IV. Although special training and credentialing for echocardiography are required for technologists and physicians, there are other processes to ensure these requirements are met, e.g., CPSBC, health authority and accreditation processes.
- Category IV – two sub-types, 'limited' and 'full': No interviewees really understood why the two category sub-types were required unless, as one manager noted, the 'limited' sub-type served to restrict radiologists at smaller facilities from performing more advanced techniques. However, there are other processes to ensure care is appropriate.
- Doppler studies: As noted under the Question 11 comments, below, there was broad support from a medical perspective for removing the restriction on Doppler to being public diagnostic facility/hospital-based only, although there were some concerns expressed about possible changes in utilization.[29] At one time, Doppler capability was an 'add-on' when US devices were purchased, but now all new US machines are Doppler-capable and radiologists and technologists are trained in its use.
- NT: As a fairly new US advance, NT raised interesting questions about management of new technologies. Some felt NT could be bundled under Category IV as there are other processes to ensure care is appropriate (e.g. credentialing and accreditation), while others thought its uniqueness and limited distribution justified retaining a special category. Regardless, it was suggested that there should be a 'sunset clause' for new technologies, at which point they would not be excluded from a general investigation category (i.e., Category IV).

The most common opinion was that the categories could be collapsed into just one (Category IV) or at least significantly fewer categories than the current eight; in other words, the somewhat *ad hoc* system of multiple categories that is now in place could be consolidated and rationalized. Quality mechanisms such as credentialing and accreditation would be required to ensure quality of care and medical appropriateness; however, some concern was expressed that quality monitoring and assurance might not be sufficient for privately-owned community imaging clinics as associated radiologists could potentially not be affiliated with any health authority.

[29] Many interviewees said that colour Doppler is often employed now in privately-owned community imaging clinics to aid diagnosis but there is no fee item for this feature. There was concern about increasing utilization if fee items are developed.

Question 11: Is there a medical basis for the current restrictions on Doppler studies and echocardiography (e.g., a requirement that these studies are limited to public diagnostic facilities / hospitals)?

Currently, according to the Policies and Guidelines, all Doppler and echocardiography studies must be performed in public diagnostic facilities/hospitals.[30] This has been the case for several decades although it is not clear why these restrictions were established. There is no parallel restriction in at least Alberta and Ontario. A number of interviewees suggested the following potential rationales for why this policy may have been adopted:

- When the policy was established the technologies were new and or of variable quality
- Technologists were not consistently trained in use of the technology
- Control of utilization may have been desired
- Possible pressure from hospitals seeking to retain the services to earn the technical fees.

OPINION: Interviewees were asked whether they could see a *medical reason* to continue the public diagnostic facility/hospital-only restriction, and the answer was generally "no". Interviewees often mentioned that this limitation means hospital-based US departments are dominated by echocardiography and Doppler, leaving little booking room for other types of US that, consequently, often must be done by the privately-owned community imaging clinics. A Doppler application particularly useful outside public diagnostic facility/hospital settings is suspicion of deep vein thrombosis, where a delay in booking can affect patient outcomes.

Potential advantages of changing the policy to allow echocardiography in non-hospital settings, i.e., privately-owned community imaging clinics, are: improved access, with the potential for shorter wait times and increased convenience for patients. However, potential areas of concern with respect to a policy change were identified, including:

- Potential flow of technologists to the private sector due to increased demand for their services at privately-owned community imaging clinics.
- Increased utilization of echocardiography.
- Exacerbation of the 'turf battle' between radiologists and cardiologists for echocardiography interpretation service fees.
- Lack of training spots for radiologists and cardiologists to gain echocardiography competency and certification.
- Flow of routine echocardiography referrals to the private sector leaving the more complex stress echocardiography and trans-esophageal echocardiography to the public diagnostic facilities/hospitals (these constitute about 5% of exams and are more time consuming and intensive, relatively less remunerative, need a nurse present, and involve higher-risk patients).

[30] A very few exceptions have been granted, e.g., the Oceanside Clinic in Parksville, and a health-authority-owned outpatient facility in Kelowna (not currently being used).

- Potential quality of care issues if echocardiography is set up in private offices without sufficient quality oversight.
- Potential privacy/information security issues if images move between health authority sites and privately-owned community imaging clinics.

Several interviewees suggested that any potential loosening of the public diagnostic facility/hospital-based restriction could be tied to a requirement that privately-owned community imaging clinics that wish to offer Doppler and/or echocardiography be obliged in return to participate in clinical training of technologists.

Question 12: Is there a medical basis for the current requirements that must be met to receive a Certificate of Approval to bill MSP for outpatient US telemetry services?

The current requirements for US telemetry in the Policies and Guidelines are:

- Transmitting and receiving sites are specified in the application and are public diagnostic facilities.
- The volume of diagnostic US services does not currently justify a full-time radiologist's coverage at the diagnostic facility.
- The use of diagnostic US telemetry will not negatively affect the existing on-site visit schedules of radiologists.
- The majority of US scans rendered at the diagnostic facility will continue to be scheduled when the visiting radiologist is on-site for the purpose of US supervision.
- A Certificate of Approval may only be granted for a period of two years or less.

Interviewees included four radiologists and several imaging managers with US telemetry experience. Their responses to its benefit were positive, with the point made that telemetry made US possible in smaller communities and this enhances patient access, particularly in circumstances where radiologists make regular visits to the small imaging departments to ensure quality care and also to schedule complex examinations when they are present. However, there is significant variation in the frequency of radiologist visits to different imaging sites, ranging from several times per week to once a year.

OPINION: There was general support for approval/use of US telemetry, particularly when employed in hospitals/public diagnostic facilities with regular visits by radiologists, as specified in MSC policy, although it was noted that there is really no medical reason to restrict receiving sites to public diagnostic facilities as long as facilities in question satisfy suitable quality processes. In particular, most interviewees could see the practicality of extending reading sites to DAP-accredited non-hospital sites, i.e., privately-owned diagnostic facilities/community imaging clinics.

Discussion

The project's purpose was to explore US provision in BC because issues of concern to the MSC and MoH have led to a moratorium on applications for new, expanded or relocated outpatient US facilities until June 1, 2015. The medical appropriateness of various MoH US policies drove development of research questions ranging from changes and innovations in US delivery (focusing on settings and providers) to use of US telemetry and urgency categories.

Changes and innovations in US delivery

Over the past decade there has been a marked increase in use of POC US. In some cases this has added another layer of US examinations as performed by a wide-range of physician (and non-physician) providers. POC settings range from ICU and the ED to mountaintops and battlefields. Anecdotally, this has not resulted in a decrease in numbers of traditional US exams performed by US technologists and interpreted by radiologists. POC US is increasingly used to guide procedures such as line placement, biopsies and nerve blocks and has been described by some as a new standard of care in certain settings. The latter application involves a number of non-radiologist physician specialties, e.g., anesthesiologists and ED physicians. However, the place in care of POC US is still evolving. Although POC US provides a triage tool, there are associated challenges related to quality, e.g., training providers, maintaining devices, and storing images. At this time, POC US provider compensation is not a high-profile, active issue in BC; however, it may become so with examples of US POC billing by ED physicians being set in Ontario and PEI.

Changes and innovation in traditional US have also occurred, such as increasing resolution that has allowed new US applications, particularly in musculoskeletal conditions (most recently, imaging of the shoulder, ankle tendons and knee ligaments). Another innovation is first trimester nuchal translucency, i.e., scanning to rule out Down syndrome and other congenital conditions that may replace invasive amniocentesis and chorionic villus sampling.

Issues for rural and remote communities

The primary issue for small communities is recruitment and retention of US technologists – but also recruitment and retention of radiologists. US technologist supply is a major issue all across BC (and beyond), despite the efforts of the training program at BCIT. Although the number of entry seats increased from 24 to 30 in 2010, optimal numbers are not known and BCIT staff members have expressed a desire for some longer-term, strategic planning for program capacity. Beyond challenges associated with the educational program, there are ongoing challenges related to hands-on training positions, as the burden of industry/sector training is placed mainly on publicly-owned facilities and hospitals with little participation by privately-owned community imaging clinics.

Urgency categories

As for all imaging requests, there is a spectrum of urgency in response to patient need, ranging from emergency and inpatient through urgent to non-urgent/elective. In BC, the Policies and Guidelines provide a wait time target/benchmark for urgent (but non-emergency) US, with the US service to be

completed within 10 working days.[31] At least some BC radiologist leaders are sensitive to this target and go to great efforts to meet it – in part, to decrease the likelihood that potential US competitors could be granted approval to provide US services nearby or receive approval to significantly increase their capacity. A cross-Canada survey of provincial medical consultants queried whether US urgency categories are established in other jurisdictions but, aside from Saskatchewan where categories exist, and Alberta where categories are under development, other provinces have not taken this route. However, staff members from other jurisdictions noted that urgency categories may exist at the hospital or regional levels without the knowledge of their respective ministries of health.

MSC policy issues

For this project, four questions (Questions #9 through 12) were posed related to current MSC policies: (1) requirements to receive a Certificate of Approval to bill MSP for outpatient US; (2) categories of US approval; (3) Doppler studies and echocardiography restricted to public diagnostic facilities/hospitals; and (4) requirements to receive a Certificate of Approval to bill MSP for outpatient US via telemetry. In brief:

- *Requirements to receive a Certificate of Approval to bill MSP for outpatient US*: A key issue is related to the current requirement for a radiologist to be affiliated with a privately-owned community imaging clinic. An emerging issue is that, if various other policies are changed, it could be possible for cardiologists (in the case of echocardiography) and MFMs (in the case of obstetrical US) to be the responsible physicians without the need for an affiliated radiologist. Interviewees expressed discomfort with this change for several reasons: (a) quality of care (although, with the current requirement for technologist and physician credentialing and DAP accreditation, perhaps quality of care could be assured); and (b) conflict of interest concerns with cardiologists, MFMs, and other physician specialties that would be in a position to self-refer for US exams.
- *Categories of US approval*: Many interviewees were unaware of the details of the current system (Categories I to IV plus TEE, Doppler Studies and NT). General consensus was that perhaps the categories could be collapsed into several with mechanisms such as credentialing and accreditation ensuring appropriateness; however, some concern was expressed that quality monitoring and assurance might not be sufficient for privately-owned community imaging clinics with radiologists potentially not affiliated with health authorities.
- *Doppler and echocardiography restricted to hospitals/public diagnostic facilities*: Most interviewees felt it was worth considering a loosening or elimination of the current restriction, particularly for Doppler. Many commented that there was no medical reason to limit the location of these services and that the restriction results in domination of public diagnostic facility/hospital-based US by echocardiography and Doppler studies so that hospitals cannot offer the full range of US services. However, a number of possible negative consequences associated with loosening or eliminating current restrictions were identified, including: quality impacts, increased utilization, and increased movement of technologists from the public to private sectors.

[31] See, Policies and Guidelines, Appendix 1, p. 47.

- *Requirements to receive a Certificate of Approval to bill MSP for outpatient US via telemetry*: There was general support for the current requirements established to allow US telemetry in BC, particularly where radiologist visits are regular to ensure quality care and also to schedule complex examinations. However, although in some US telemetry situations a radiologist visits the sending facility once or more per week, there is wide variation in practice, with no minimum visit frequency. Across Canada (according to the provincial medical consultants who responded to a survey), due to the prevalence of PACS systems, no other province requires a radiologist to be on-site (or in some cases even have a regular visiting schedule) in order for US billing to take place. In Ontario's case, a special lower fee is paid for distance reading/interpreting.

References

Abo A, Kelley K, Kuppermann N, Cusick S. Ultrasound equipment for the pediatric emergency department: a review. Pediatr Emerg Care. 2011 Mar;27(3):220-6

Adelman S, Fishman P. Use of portable ultrasound machine for outpatient orthopedic diagnosis: an implementation study. Perm J. 2013 Summer;17(3):18-22.

Andersen GN, Haugen BO, Graven T, Salvesen O, Mjølstad OC, Dalen H. Feasibility and reliability of point-of-care pocket-sized echocardiography. Eur J Echocardiogr. 2011 Sep;12(9):665-70.

Andrade RS. Relevance of endobronchial ultrasonography to thoracic surgeons. Semin Thorac Cardiovasc Surg. 2010 Summer;22(2):150-4.

Arntfield RT, Millington SJ. Point of care cardiac ultrasound applications in the emergency department and intensive care unit--a review. Curr Cardiol Rev. 2012 May;8(2):98-108.

Au SM, Vieillard-Baron A. Bedside echocardiography in critically ill patients: a true hemodynamic monitoring tool. J Clin Monit Comput. 2012 Oct;26(5):355-60.

Barillari A, Fioretti M. Lung ultrasound: a new tool for the emergency physician. Intern Emerg Med. 2010 Aug;5(4):335-40.

Beggs AD, Thomas PR. Point of use ultrasound by general surgeons: review of the literature and suggestions for future practice. Int J Surg. 2013;11(1):12-7.

Bharucha T, Mertens L. Recent advances in pediatric echocardiography. Expert Rev Cardiovasc Ther. 2013 Jan;11(1):31-47.

Blyth L, Atkinson P, Gadd K, Lang E. Bedside focused echocardiography as predictor of survival in cardiac arrest patients: a systematic review. Acad Emerg Med. 2012 Oct;19(10):1119-26.

Carroll PJ, Gibson D, El-Faedy O, Dunne C, Coffey C, Hannigan A, Walsh SR. Surgeon-performed ultrasound at the bedside for the detection of appendicitis and gallstones: systematic review and meta-analysis. Am J Surg. 2013 Jan;205(1):102-8.

D'Agostino MA, Terslev L. A brief history of ultrasound in rheumatology: where are we going. Clin Exp Rheumatol. 2014 Jan-Feb;32(1 Suppl 80):S106-10.

Dalen H, Haugen BO, Graven T. Feasibility and clinical implementation of hand-held echocardiography. Expert Rev Cardiovasc Ther. 2013 Jan;11(1):49-54.

Dalziel PJ, Noble VE. Bedside ultrasound and the assessment of renal colic: a review. Emerg Med J. 2013 Jan;30(1):3-8.

Darge K, Chen A. Ultrasonography of the lungs and pleurae for the diagnosis of pneumonia in children: prime time for routine use. JAMA Pediatr. 2013 Feb;167(2):187-8.

Davidson J, Jayaraman S. Guided interventions in musculoskeletal ultrasound: what's the evidence? Clin Radiol. 2011 Feb;66(2):140-52.

Ding W, Shen Y, Yang J, He X, Zhang M. Diagnosis of pneumothorax by radiography and ultrasonography: a meta-analysis. Chest. 2011;140(4):859-66.

El-Khuffash AF, McNamara PJ. Neonatologist-performed functional echocardiography in the neonatal intensive care unit. Semin Fetal Neonatal Med. 2011 Feb;16(1):50-60.

Engel C, Silva C, Baker K, Goodman TR. Underutilized ultrasound applications in the neonatal intensive care unit. Ultrasound Q. 2012 Dec;28(4):299-304.

Evans N, Gournay V, Cabanas F, Kluckow M, Leone T, Groves A, McNamara P, Mertens L. Point-of-care ultrasound in the neonatal intensive care unit: international perspectives. Semin Fetal Neonatal Med. 2011 Feb;16(1):61-8.

Fusaroli P, Kypraios D, Caletti G, Eloubeidi MA. Pancreatico-biliary endoscopic ultrasound: a systematic review of the levels of evidence, performance and outcomes. World J Gastroenterol. 2012 Aug 28;18(32):4243-56.

Galvan DA, Matsushima K, Frankel HL. Ultrasound in the surgical intensive care unit. Isr Med Assoc J. 2011 Sep;13(9):566-70.

Gardelli G, Feletti F, Nanni A, Mughetti M, Piraccini A, Zompatori M. Chest ultrasonography in the ICU. Respir Care. 2012 May;57(5):773-81.

Gargani L. Lung ultrasound: a new tool for the cardiologist. Cardiovasc Ultrasound. 2011 Feb 27;9:6.

Griffin J, Nicholls B. Ultrasound in regional anaesthesia. Anaesthesia. 2010 Apr;65 Suppl 1:1-12.

Haji DL, Royse A, Royse CF. Review article: Clinical impact of non-cardiologist-performed transthoracic echocardiography in emergency medicine, intensive care medicine and anaesthesia. Emerg Med Australas. 2013 Feb;25(1):4-12.

Heegaard W, Hildebrandt D, Spear D, Chason K, Nelson B, Ho J. Prehospital ultrasound by paramedics: results of field trial. Acad Emerg Med. 2010 Jun;17(6):624-30.

Hile DC, Morgan AR, Laselle BT, Bothwell JD. Is point-of-care ultrasound accurate and useful in the hands of military medical technicians? A review of the literature. Mil Med. 2012 Aug;177(8):983-7.

Hooley RJ, Scoutt LM, Philpotts LE. Breast ultrasonography: state of the art. Radiology. 2013 Sep;268(3):642-59.

Hoyer HX, Vogl S, Schiemann U, Haug A, Stolpe E, Michalski T. Prehospital ultrasound in emergency medicine: incidence, feasibility, indications and diagnoses. Eur J Emerg Med. 2010 Oct;17(5):254-9.

Hudaverdi M, Hamilton-Craig C, Platts D, Chan J, Burstow DJ. Echocardiography for the clinician: a practical update. Intern Med J. 2010 Jul;40(7):476-85.

Joshi N, Lira A, Mehta N, Paladino L, Sinert R. Diagnostic accuracy of history, physical examination, and bedside ultrasound for diagnosis of extremity fractures in the emergency department: a systematic review. Acad Emerg Med. 2013 Jan;20(1):1-15.

Joshua F. Ultrasound applications for the practicing rheumatologist. Best Pract Res Clin Rheumatol. 2012 Dec;26(6):853-67.

Kangelaris GT, Kim TB, Orloff LA. Role of ultrasound in thyroid disorders. Otolaryngol Clin North Am. 2010 Dec;43(6):1209-27.

Karabinis A, Fragou M, Karakitsos D. Whole-body ultrasound in the intensive care unit: a new role for an aged technique. J Crit Care. 2010 Sep;25(3):509-13.

Labovitz AJ, Noble VE, Bierig M, Goldstein SA, Jones R, Kort S, Porter TR, Spencer KT, Tayal VS, Wei K. Focused cardiac ultrasound in the emergent setting: a consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. J Am Soc Echocardiogr. 2010 Dec;23(12):1225-30.

Leeson K, Leeson B. Pediatric ultrasound: applications in the emergency department. Emerg Med Clin North Am. 2013 Aug;31(3):809-29.

Lyn-Kew KE, Koenig SJ. Bedside ultrasound for the interventional pulmonologist. Clin Chest Med. 2013 Sep;34(3):473-85.

Marhofer P, Willschke H, Kettner S. Current concepts and future trends in ultrasound-guided regional anesthesia. Curr Opin Anaesthesiol. 2010 Oct;23(5):632-6.

Marum S, Price S. The use of echocardiography in the critically ill; the role of FADE (Fast Assessment Diagnostic Echocardiography) training. Curr Cardiol Rev. 2011 Aug;7(3):197-200.

McBeth PB, Crawford I, Blaivas M, Hamilton T, Musselwhite K, Panebianco N, Melniker L, Ball CG, Gargani L, Gherdovich C, Kirkpatrick AW. Simple, almost anywhere, with almost anyone: remote low-cost telementored resuscitative lung ultrasound. J Trauma. 2011 Dec;71(6):1528-35.

Mehta N, Valesky WW, Guy A, Sinert R. Systematic review: is real-time ultrasonic-guided central line placement by ED physicians more successful than the traditional landmark approach? Emerg Med J. 2013 May;30(5):355-9.

Micu MC, Alcalde M, Sáenz JI, Crespo M, Collado P, Bolboacă SD, Naredo E. Impact of musculoskeletal ultrasound in an outpatient rheumatology clinic. Arthritis Care Res (Hoboken). 2013 Apr;65(4):615-21.

Moslemi MK, Mahfoozi B. Urologist-operated ultrasound and its use in urological outpatient clinics. Patient Prefer Adherence. 2011 Jan 24;5:85-8.

Murthi SB, Frankel HL, Narayan M, Lissauer M, Furgusen M, Fatima SH, Scalea TM. Making the financial case for a surgeon-directed critical care ultrasound program. J Trauma Acute Care Surg. 2014 Feb;76(2):340-44; discussion 344-6.

Narasimhan M, Koenig SJ, Mayo PH. Advanced echocardiography for the critical care physician: part 1. Chest. 2014 Jan;145(1):129-34.

Nations JA, Browning RF. Battlefield applications for handheld ultrasound. Ultrasound Q. 2011 Sep;27(3):171-6.

Owen AR, Roditi GH. Peripheral arterial disease: the evolving role of non-invasive imaging. Postgrad Med J. 2011 Mar;87(1025):189-98.

Pomero F, Dentali F, Borretta V, Bonzini M, Melchio R, Douketis JD, Fenoglio LM. Accuracy of emergency physician-performed ultrasonography in the diagnosis of deep-vein thrombosis: a systematic review and meta-analysis. Thromb Haemost. 2013 Jan;109(1):137-45.

Rahman NM, Singanayagam A, Davies HE, Wrightson JM, Mishra EK, Lee YC, Benamore R, Davies RJ, Gleeson FV. Diagnostic accuracy, safety and utilisation of respiratory physician-delivered thoracic ultrasound. Thorax. 2010 May;65(5):449-53.

Raymond-Dufresne É, Ghanayem H. Towards evidence-based emergency medicine: best BETs from the Manchester Royal Infirmary. BET 2: Can emergency physicians safely rule in or rule out paediatric intussusception in the emergency department using bedside ultrasound? Emerg Med J. 2012 Oct;29(10):854-5.

Ross M, Brown M, McLaughlin K, Atkinson P, Thompson J, Powelson S, Clark S, Lang E. Emergency physician-performed ultrasound to diagnose cholelithiasis: a systematic review. Acad Emerg Med. 2011 Mar;18(3):227-35.

Royse CF, Canty DJ, Faris J, Haji DL, Veltman M, Royse A. Core review: physician-performed ultrasound: the time has come for routine use in acute care medicine. Anesth Analg. 2012 Nov;115(5):1007-28.

Rubano E, Mehta N, Caputo W, Paladino L, Sinert R. Systematic review: emergency department bedside ultrasonography for diagnosing suspected abdominal aortic aneurysm. Acad Emerg Med. 2013 Feb;20(2):128-38.

Russell TC, Crawford PF. Ultrasound in the austere environment: a review of the history, indications, and specifications. Mil Med. 2013 Jan;178(1):21-8.

Schirmer M, Duftner C, Schmidt WA, Dejaco C. Ultrasonography in inflammatory rheumatic disease: an overview. Nat Rev Rheumatol. 2011 Jul 12;7(8):479-88.

Schneider A, Johnson L, Goodwin M, Schelleman A, Bellomo R. Bench-to-bedside review: contrast enhanced ultrasonography--a promising technique to assess renal perfusion in the ICU. Crit Care. 2011;15(3):157.

Sicari R, Galderisi M, Voigt JU, Habib G, Zamorano JL, Lancellotti P, Badano LP. The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography. Eur J Echocardiogr. 2011 Feb;12(2):85-7.

Srinivasan S, Cornell TT. Bedside ultrasound in pediatric critical care: a review. Pediatr Crit Care Med. 2011 Nov;12(6):667-74.

Taylor J, McLaughlin K, McRae A, Lang E, Anton A. Use of prehospital ultrasound in North America: a survey of emergency medical services medical directors. BMC Emerg Med. 2014 Mar 1;14:6.

Terkawi AS, Karakitsos D, Elbarbary M, Blaivas M, Durieux ME. Ultrasound for the anesthesiologists: present and future. ScientificWorldJournal. 2013 Nov 20;2013:683685.

Testa A, Lauritano EC, Giannuzzi R, Pignataro G, Casagranda I, Gentiloni Silveri N. The role of emergency ultrasound in the diagnosis of acute non-traumatic epigastric pain. Intern Emerg Med. 2010 Oct;5(5):401-9.

Turner JP, Dankoff J. Thoracic ultrasound. Emerg Med Clin North Am. 2012 May;30(2):451-73.

Vieira RL, Bachur R. Bedside ultrasound in pediatric practice. Pediatrics. 2014 Jan;133(1):1-3.

Yim ES, Corrado G. Ultrasound in athletes: emerging techniques in point-of-care practice. Curr Sports Med Rep. 2012 Nov-Dec;11(6):298-303.

Volpicelli G. Lung sonography. J Ultrasound Med. 2013 Jan;32(1):165-71.

Vrablik ME, Snead GR, Minnigan HJ, Kirschner JM, Emmett TW, Seupaul RA. The diagnostic accuracy of bedside ocular ultrasonography for the diagnosis of retinal detachment: a systematic review and meta-analysis. Ann Emerg Med. 2014 Mar 27.

Wilkerson RG, Stone MB. Sensitivity of bedside ultrasound and supine anteroposterior chest radiographs for the identification of pneumothorax after blunt trauma. Acad Emerg Med. 2010 Jan;17(1):11-7.

Appendix A: Definitions / Resources Related to Medical Appropriateness

Medical appropriateness is a concept that can only be usefully understood and applied contextually.[32] While interventions and health care settings may at times be clearly appropriate or inappropriate, often intervention and setting fall somewhere in between on an appropriateness spectrum.[33] A general definition and approach to measuring appropriateness, frequently cited and applied in the research and academic literature, was proposed by RAND Corporation/UCLA researchers[34] where the author's define appropriate as meaning:

> *…the expected health benefit (i.e., increased life expectancy, relief of pain, reduction in anxiety, improved functional capacity) exceeds the expected negative consequences (i.e., mortality, morbidity, anxiety of anticipating the procedure, pain produced by the procedure, misleading or false diagnosis, time lost from work) by a sufficiently wide margin that the procedure is worth doing.*

However, this simplistic definition does not include important, relevant dimensions that should be considered, including the individuality of the patient under consideration (e.g., comorbid considerations) and the availability of health care resources (ensuring maximally beneficial, or at least reasonably efficient and equitable, allocation of finite health care dollars). For two excellent critical analyses and better (albeit more complex definitions of the concept), see:

- 1993 National Health Service: [35] The authors stress that appropriateness is "*ultimately constrained by finite resources*." Thus, they draw a helpful "*distinction between population appropriateness, similar to effectiveness but constrained by societal judgments of the value of different interventions and by available resources, and appropriateness at an individual level, which is effectiveness modified by patient characteristics and patient preference*."
- Buetow et al.:[36] The authors define appropriateness as "*the outcome of a process of decision-making that maximizes net individual health gains within society's available resources*."

[32] See, for example: Wienberg SL. On the elusive quest for medical appropriateness. The American Health Hospital Journal. 2004 Summer;2(3):129-31.

[33] For an example and discussion from the diagnostic imaging context see Butler GJ, Stolberg HO. The use of cross-sectional diagnostic imaging in a major Canadian health care centre. CAR Journal. 2004;55(3):174-7.

[34] Kahn KL, Kosecoff J, Chassin MR, Flynn MF, Fink A, Pattaphongse N, et al. Measuring the clinical appropriateness of the use of a procedure: can we do it? Med Care. 1988;26:415-22,

[35] What do we mean by appropriate health care? Report of a working group prepared for the Director of Research and Development of the NHS Management Executive Quality in Health Care. 1993 June;2:117-23.

[36] Buetow SA, Sibbald B, Cantrill J, Halliwell S. Appropriateness in health care: application to prescribing. Soc Sci Med. 1997;45(2):261-71.

In the DI context, a number of important works have looked at appropriateness and inappropriateness:

- Fraser and Reed:[37] The authors note that quality, patient safety and cost-effectiveness are important aspects of appropriateness: imaging "*can be deemed inappropriate for a number of reasons, including its inability to contribute to patient management [i.e. poor clinical utility], the performance of an examination at the wrong time, or failure to obtain imaging when it is needed*."
- Mayo:[38] The author discusses appropriateness/inappropriateness in the context of CT. He begins with the dictionary definition of "appropriate"—suitable, acceptable, or correct for particular circumstances—and then illustrates the concept of inappropriateness. "Clearly inappropriate" examples include: "*duplicate ordering, absent or nonsupportive [sic.] clinical information, repeated examinations not supported by randomized clinical trial evidence, and examinations ordered before patient examination*." The larger percentage of inappropriate CTs, and the more challenging to detect and avoid "*includes scans with questionable clinical utility, where anatomic changes are unlikely, or imaging results will not affect clinical management*."
- Lavis and Anderson:[39] The authors essentially adopt the overly narrow RAND/UCLA definition of appropriateness; however, they explain that appropriateness is not a single concept and it relates to two key dimensions: appropriateness of a service/intervention and appropriateness of setting. Regarding the latter, the authors observe that appropriateness of setting is related to cost effectiveness; appropriateness in this context:

  > *...is determined by whether the patient's clinical characteristics and the services required for his or her care, match the setting in which the care is provided. Setting is a proxy measure of the resources used to provide care. Just as effective care can be provided in a way that is not cost-effective, appropriate services can be provided in inappropriate settings*.

For examples of studies that have attempted to measure appropriateness in DI, see:

- Eddy K, Ednie A, Connell C, Eddy R, Eaton K, Mathieson J. Appropriate use of CT and MRI in British Columbia. BC Medical Journal. 2013;55(1):22-5. Available at: http://www.bcmj.org/articles/appropriate-use-ct-and-mri-british-columbia
- Silverman G, Vyse S, Silverman DI. Inappropriately ordered echocardiograms are related to socioeconomic status. Am J Med Quality. 2012;27:487-92.
- Willens HJ, Nelson K, Hendel RC. Appropriate use criteria for stress echocardiography. JACC: Cardiovascular Imaging; 6(3):297-309.

[37] Fraser J, Reed M. Appropriateness of Imaging in Canada. CAR Journal. 2013;64:82-4.

[38] Mayo J. Towards clarity: what does "inappropriate imaging" really mean? CRA Journal. 2010;61:250-1.

[39] Lavis J, Anderson G. Appropriateness in health care delivery: definitions, measurement and policy implications. CMAJ. 1994 Feb;154(3):321-8.

Appendix B: Literature review (focus was to identify recent developments in US, particularly related to setting of use and providers involved)

Application	Traditional or POC?	Provider(s)	Setting	Notes	Source(s) (year); country
Anaesthesiology					
Multiple	POC	Anaesthesiologists	OR +	Primarily used for US-guided peripheral nerve blockade, vascular access and pain treatment	Terkawi et al (2013); USA
Regional anaesthesia	Presumed POC	Anaesthesiologists	OR	" US-guided regional anesthesia will become the 'GOLD' standard for performance of regional anesthesia"	• Marhofer et al (2010); Austria • Griffin & Nicholls (2010); UK
Care provided by non-MDs					
Military medical teams	POC	Unclear	OP (remote)	Battlefield trauma	Nations & Browning (2011); USA
Pre-hospital care	POC	Military medics	OP	Literature review of clinical applications including evaluation of cardiac activity, pneumothorax and fractures	Hile et al (2012); USA
Pre-hospital care	POC	Emergency medical providers (non-MDs)	OP	Survey in Canada and USA; only 4% of sites reported use but 21% are considering; most common for Focused Abdominal Sonography for Trauma (FAST) and assessment of pulseless electrical activity (PEA)	Taylor et al (2014); Canada
Pre-hospital care	POC	Emergency medical providers (non-MDs)	Transport	US was used to assess results of trauma during transport in helicopters and an ambulance	Hoyer et al (2010); Germany
Pre-hospital care	POC	9-1-1 paramedics	Ambulance	Paramedics were trained to perform and interpret the Focused Assessment Sonography in Trauma (FAST) and abdominal aortic (AA) exams with images then reviewed by a blinded MD (100% agreement).	Heegaard et al (2010); USA
Remote telementored lung US	POC	Remote providers with little or no US experience 'beaming' to experts	OP (remote)	Technology included Skype and iPhone. Remote sites included on-mountain, airplane in flight, and a Calgary household. Base sites were in Pisa, Rome, Philadelphia, and Calgary	McBeth et al (2011); Canada

Application	Traditional or POC?	Provider(s)	Setting	Notes	Source(s) (year); country
Emergency medicine					
Abdominal aortic aneurysm (AAA)	POC	ED physicians	ED	Systematic review of 7 studies comparing POC to reference standard (traditional US, CT, RI, etc.) for diagnosis of AAA: sensitivity 99% and specificity 98%	Rubano et al. (2013); USA
Cardiac arrest	POC	ED physicians	ED	Transthoracic echo (TTE) during cardiac arrest to determine the presence or absence of kinetic cardiac activity and follow-up to determine return of spontaneous circulation	• Blyth et al (2012): Canada
Cardiac echo	POC	ED physicians	ED	To quickly assess cardiac structure and function to improve diagnosis and patient flow; to address clinical questions to inform immediate management decisions	• Dalen et al (2013); Norway • Arntfield & Millington (2012); Canada • Labovitz et al (2010); USA
Cardiac echo	POC	ED physicians & others	Various	Guidelines for use of pocket-sized echo devices, i.e., (1) range of indications is limited, (2) sore & report findings in patient record, (3) ensure training and certification are adequate, (4) inform the patient that findings are limited.	Sicari et al (2011); Italy (European Association of Echocardiography)
Central venous catheter (CVC) placement	POC	ED physicians	ED	Compared CVC placement with US versus use of conventional landmarks	Mehta et al (2013); USA
Cholelithiasis	POC	ED physicians	ED	Suitability for detecting gallbladder disease (systematic review)	Ross et al (2011); Canada
Deep vein thrombosis (DVT)	POC	ED physicians	ED	Systematic review of 16 studies comparing POC to traditional duplex scanning for lower limb DVT	Pomero et al (2013); Italy
Epigastric pain	POC	ED physicians	ED	Acute non-traumatic epigastric pain evaluation to reduce the wait for diagnosis and the over-usage of second-line imaging	Testa et al (2010); Italy
Extremity fractures	POC	ED physicians	ED	Systematic review of 9 studies comparing POC to plain films for fracture diagnosis	Joshi et al (2013); USA
Pneumothorax detection (after blunt trauma)	POC	ED physicians	ED	Systematic review of 4 studies showed bedside US was superior to chest Xray	Wilkerson & Stone (2010); USA
Pulmonary medicine	POC	ED physicians	ED / ICU	Accurate diagnosis of many lung disorders, particularly interstitial, alveolar, and pleural syndromes	• Volpicelli (2013); Italy • Turner & Dankoff (2012); Canada • Barillari & Fioretti (2010); Italy
Transthoracic echo (TTE)	POC	Ed physicians, intensivists, anaesthesiologists	Various	For diagnosis of cardiovascular pathologies by non-cardiologists	Haji et al (2013); Australia
Ophthalmology	POC	ED physicians	ED	Retinal detachment	Vrablik et al (2014); USA
Renal colic	POC	ED physicians	ED	Literature review of results compared with CT	Dalziel & Noble (2013); USA

Application	Traditional or POC?	Provider(s)	Setting	Notes	Source(s) (year); country
Family medicine					
"Austere and deployed environments"	POC	?	Remote locations	"US performs well in the diverse environments of space, swamp, jungle, mountain, and desert…Clinically useful for assessment of pneumothorax, pericardial effusion, blunt abdominal trauma, musculoskeletal trauma, high-altitude pulmonary edema, ocular injury, and obstetrics."	Russell & Crawford (2013); USA
Intensive Care					
ICU echo	POC	Critical care MDs	ICU	• Two-part series about advanced critical care echo techniques • Use of bedside echo as an ICU hemodynamic monitoring tool	• Narasimhan et al (2014); USA • Au & Vieillard-Baron (2012); France • Marum & Price (2011); Portugal
Pulmonary assessment	POC	Critical care MDs	ICU	Alternative to CXR and CT to assess for pneumothorax, consolidations, pleural effusions, ARDS, and pulmonary edema	Gardelli et al (2012); Italy
Renal imaging	Traditional	Radiologists	ICU	Contrast-enhanced US to assess renal perfusion in ICU (currently a research tool)	Schneider et al (20110: Australia
Surgical ICU	POC	Surgical intensivists	SICU	FAST (Focused Assessment with Sonography in Trauma) for visualizing, characterizing and treating life-threatening conditions	Galvan et al (2011); USA
Whole body US	POC	Critical care MDs	ICU	"…enables early recognition of neurological emergencies, assists the diagnosis of abdominal and lung pathologies, provides real-time information on cardiac performance, detects possible infectious sites and renders therapeutic invasive procedures more convenient and less complicated"	Karabinis et al (2010); Greece

Application	Traditional or POC?	Provider(s)	Setting	Notes	Source(s) (year); country
Internal medicine specialties					
Cardiology	POC	Cardiologists	Inpatients	Assessed function of valves pericardium and pleura + measurements of IVC and AA – compared with exam in echo lab	Andersen et al (2011); Norway
Cardiology – to assess the lung	POC or traditional	Cardiologists	Various	Lung US is proving to be a useful tool for the evaluation of many pulmonary conditions in cardiovascular disease	Gargani (2011); Italy
Cardiac echo	POC	Cardiologists	Various	Recent advances in echo contribute to improving accuracy and reproducibility of measurements of left ventricular volumes and ejection fraction…clinicians should be actively encouraged to adopt these technologies to improve the diagnostic quality and reproducibility of echo.	Hudaverdi et al (2010); Australia
Endocrinology	POC	Endocrinologists	Various	Use for assessment of thyroid diseases	Kangelaris et al (2010); USA
Gastroenterology	Traditional	Presumed radiologists	Various	Reported utility of US versus CT and MRI in detecting disorders like pancreatitis and biliary tract abnormalities + use in therapeutic procedures such as cyst drainage	Fusaroli et al (2012): Italy, Greece and Lebanon
Respiratory medicine	POC	Interventional pulmonologists	?	Lung US, percutaneous tracheostomy, pleural effusion, etc.	• Lyn-Kew & Koenig (2013); USA • Rahman et al (2010); UK
Rheumatology	POC & traditional	Rheumatologist	Rheumatology department & OP	Use of musculoskeletal US for diagnosis and follow-up plus US-guided procedures	• D'Agostino & Terslev (2014); USA • Micu et al (2013); Romania • Joshua (2013); Australia • Schirmer et al (2011); Austria
Multiple physician groups					
Many physician specialties, starting with medical students	POC	Anaesthesiology, intensive care, ED medicine, and surgery	Multiple	"In the future … US will be integrated into everyday clinical practice as US-assisted examination and US-guided procedures … There is evidence that diagnosis is improved, yet data showing change in management and improvement in patient outcome are few and an important area for future research."	Royce et al (2012); Australia

Application	Traditional or POC?	Provider(s)	Setting	Notes	Source(s) (year); country
Pediatrics					
ED applications	POC	Pediatric ED physicians	ED	To guide invasive procedures + assess critically ill patients (one article discussed diagnosis of pneumonia)	• Vieira & Bachur (2014); USA • Leeson & Leeson (2013); USA • Darge & Chen (2013); USA • Abo et al (2011); USA
ICU applications	POC	Pediatric intensivists	ICU	Use for diagnosis (e.g., necrotizing enterocolitis and diaphragmatic abnormalities) and line placement (central venous, radial artery, difficult peripheral venous). Two papers discuss use in neonatal ICU	• Engel et al (2012): USA • Srinivasan & Cornell (2012); USA • Evans et al (2011); Australia • El-Khuffash & McNamara (2011); Australia
Intussusception	POC	ED physicians	ED	Diagnosis in ED	Raymond-Dufresne & Ghanayem (2012); Canada
Pediatric echo	Traditional	Pediatric cardiologists	?	Advances, e.g., 3D echo, pediatric probes, myocardial tissue Doppler velocities and deformation imaging	Bharucha & Mertens (2013); Canada
Sports medicine					
Care of athletes	POC	Sports medicine MDs	OP	Diagnosis of MSK conditions but also splenic enlargement, cardiopulmonary processes, hydration status, deep vein thrombosis, and bone mineral density	Yim & Corrado (2012); USA
New uses of US for musculoskeletal issues	Traditional	Radiologists	Various	Procedures for soft tissue injuries benefit from image guidance; in athletes it is important to understand prohibited substances and methods, e.g., related to doping	Davidson & Jayaraman (2011); UK

Application	Traditional or POC?	Provider(s)	Setting	Notes	Source(s) (year); country
Surgical specialties					
General surgery	POC	General surgeons	ED / ward	Systematic review of studies examining accuracy for diagnosis of appendicitis and gallstones (versus traditional US or pathology results)	Carroll et al (2013); Ireland
General surgery	POC	General surgeons	Ward	Literature review: Strong evidence for use for gallbladder, thyroid, parathyroid, DVT and trauma; weaker evidence for aortic, hernia, breast, arterial and venous scanning	Beggs & Thomas (2013); UK
General surgery	Traditional	Radiologists	OP breast mass diagnosis + some screening	Complementary to mammography & MRI; to assess solid and cystic masses; to guide breast biopsies; for supplemental screening in women with dense breasts	Hooley et al (2013); USA
Orthopedic surgery	POC	Orthopedic surgeon	OP	Shoulder examinations	Adelman & Fishman (2013); USA
Surgical ICU	POC (standard + cardiac) devices	Sonographer + surgeon	Surgical ICU	USA economic analysis – showed break-even by Year 3 and income generating by Year 5	Murthi et al (2014); USA
Thoracic surgery	POC	Thoracic surgeons	OR	Endobronchial US "is an excellent diagnostic tool available to thoracic surgeons to optimize patient care"	Andrade (2010); USA
Urology	POC	Urologists	Inpatients at a private clinic	For patients with urological emergencies, POC findings were compared with subsequent imaging; sensitivity was 99.6% (724 patients)	Moslemi & Mahfoozi (2011); Iran
Vascular surgery	Traditional	Radiologists		Duplex US, CT angiography and MR angiography are compared for peripheral artery disease	Owen & Roditi (2011); Australia