



Position statement: minimum archiving requirements for emergency medicine point-of-care ultrasound—a modified Delphi-derived national consensus

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Introduction

Point-of-care ultrasound (PoCUS) has become standard practice in emergency departments (EDs) ranging from remote rural hospitals to well-resourced academic centres. ED PoCUS comprises a set of focused applications to facilitate early diagnosis, guide invasive procedures, and inform safe management and disposition decisions for patients [1]. To mitigate the risk of image misinterpretation, the Canadian Association of Emergency Physicians (CAEP) has made strong recommendations for image archiving to facilitate appropriate documentation and downstream quality improvement and assurance programs [1, 2]. Despite this, archiving practices in Canadian EDs remain heterogeneous due to a lack of infrastructure and national standards for image requirements.

Our objective was to establish a minimum image archiving standard for the basic PoCUS indications; one that all PoCUS-competent emergency physicians should meet as infrastructure allows. To do so, we conducted a modified Delphi survey with the 13 emergency physicians and

educators elected from the CAEP membership to promote training, competence and research in PoCUS. This committee includes rural, urban, pediatric and adult emergency medicine representation [3]. Detailed methods are available in "Appendix".

List of recommendations

Table 1 summarizes the minimum archiving requirements. Given the diversity of contexts in which standard PoCUS scans are used, additional images may be required to support a diagnosis, commensurate with the operator's training, clinical context and pre-test probability. Institutions and physician groups may choose to set institutional standards above this to facilitate local quality assurance and improvement processes.

For indications beyond the core competencies discussed below, we recommend engaging with the departmental or local PoCUS lead for context-specific recommendations.

Abdominal aortic aneurysm (AAA)

Previous work reporting 99% sensitivity and specificity for bedside abdominal aorta ultrasound required visualization of the entire aorta from the diaphragmatic hiatus to the bifurcation [4]. Representative images of this process should be archived using either still images or cine-clips. If no AAA is present, archiving should include transverse images at the level of the proximal aorta, mid aorta, distal aorta, and bifurcation. Longitudinal imaging is not routinely required but may be helpful depending on bowel gas and patient anatomy. If a AAA is present, a single archived image is sufficient

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Table 1 Consensus minimum image archiving requirements by PoCUS indication

Indication	Modality	Minimum archiving requirement
Abdominal aortic aneurysm	Still or cine-clip	<ul style="list-style-type: none"> • If no AAA present, transverse images of the proximal, mid, distal, and bifurcation of the aorta • If AAA present, single transverse image
Cardiac arrest	Cine-clip	<ul style="list-style-type: none"> • Best possible view
Left ventricular function	Cine-clip	<ul style="list-style-type: none"> • Parasternal long-axis view
Right ventricular function	Cine-clip	<ul style="list-style-type: none"> • Apical four-chamber view
Pericardial effusion	Cine-clip	<ul style="list-style-type: none"> • Best possible view, subxiphoid is the most common
Focused assessment with sonography for trauma	Still or cine-clip	<ul style="list-style-type: none"> • Entire hepatorenal interface to the tip of the liver (Morison's pouch) • Diaphragm–liver interface up to the 9 o'clock position (including R pleural effusion) • Entire splenorenal interface including the caudal spleen tip • Diaphragm–spleen interface up to the 9 o'clock position (including L pleural effusion) • Transverse view of the pelvis • Best possible cine-clip to assess for pericardial effusion
Pneumothorax	Cine-clip or M-mode	<ul style="list-style-type: none"> • Bilateral sagittal scans at the mid-clavicular line, third intercostal space
Pulmonary edema	Cine-clip	<ul style="list-style-type: none"> • Minimum of two representative zones, bilaterally
Pregnancy of unknown location	Still or cine-clip	<ul style="list-style-type: none"> • Sagittal and transverse views of the uterus and bladder • Gestational sac in the uterus, if present • Fetal pole and yolk sac, if present • Myometrial mantle measurement if it appears abnormal • Fetal heart rate documentation, if present, using M-mode still or cine-clips
Cholelithiasis and cholecystitis	Still or cine-clip	<ul style="list-style-type: none"> • Long-axis view • Short-axis view • In the context of cholecystitis, measurement of the anterior wall of the gallbladder
Hydronephrosis	Still or cine-clip	<ul style="list-style-type: none"> • Long-axis view of bilateral kidneys • Transverse view of the bladder
Above knee lower extremity deep venous thrombosis	Cine-clip, with and without compression	<ul style="list-style-type: none"> • Zone 1 <ul style="list-style-type: none"> • Common–femoral vein • Saphenous–femoral junction • Femoral vein beyond the deep femoral branch • Zone 2 <ul style="list-style-type: none"> • Distal femoral vein • Popliteal vein • Popliteal vein trifurcation
Central line insertion	N/A	<ul style="list-style-type: none"> • No routine archiving necessary; if choosing to archive, a confirmatory image of wire in the vein

with subsequent comprehensive imaging and management as clinically indicated. No consensus was reached for routine measurement of the aorta.

Cardiac

Cine-clips are obligatory for all cardiac scans. The American Society of Echocardiography recommends routine use of multiple views for PoCUS to maximize accuracy [5]. We agree that multiple views are always superior. However, views may be limited by poor echocardiographic windows and limitations in patient positioning. These minimum archiving requirements reflect that even if a single view is

available for an assessment, it should be recorded and interpreted with caution in keeping with the clinical context.

During cardiac arrest, an assessment for the presence of cardiac activity should be archived. Previous studies have used various views; however, the time sensitivity of an intra-arrest evaluation and need to minimize pauses in compressions must be prioritized [6]. Thus, the consensus minimum archiving requirement is the single best available view.

The most well-studied PoCUS assessments of left ventricular (LV) function are fractional shortening and end point septal separation, both of which may be visualized by archiving a representative single parasternal long-axis view [7, 8].

In assessing right ventricular (RV) function, one must archive an apical four-chamber view. This view allows for the assessment of RV size compared to LV size, tricuspid annular plane systolic excursion, free wall hypokinesis and septal movement [9]. In assessing for the presence of pericardial effusion, the minimum archiving requirement is the best available view to represent the finding. The subxiphoid view is commonly used.

Focused assessment with sonography for trauma (FAST)

With the exception of pericardial effusion as described above, the use of either stills or cine-clips is reasonable to archive elements of the FAST exam. In line with other guidelines, minimum images for archiving a FAST scan should include the following [10].

- The entire hepatorenal interface to the tip of the liver (Morison's pouch)
- The diaphragm–liver interface up to the 9 o'clock position (includes R pleural effusion)
- The splenorenal interface including the caudal spleen tip
- The diaphragm–spleen interface up to the 9 o'clock position (includes L pleural effusion)
- A transverse view of the pelvis
- The best possible cine-clip to assess for pericardial effusion as described above

Pneumothorax

In one study with trauma patients in the supine position, detection of clinically significant traumatic pneumothorax for each lung was similar with a single view at the third intercostal space, mid-clavicular line as a four-view protocol [11]. The minimum requirement for archiving is thus a single-view sagittal scan at the midclavicular line, third intercostal space, using either cine-clips or M-mode. Bilateral imaging is required.

Thoracic B-line assessment for pulmonary edema

Cine-clips are mandatory for archiving an assessment of thoracic B-lines. The most well-studied protocol requires the assessment of four zones of the chest, bilaterally [12]. Three B-lines in two bilateral lung zones are required for a diagnosis of pulmonary edema. Thus, to archive images to support this diagnosis, a minimum of two representative zones in each lung are required.

Pregnancy of unknown location

The use of either stills or cine-clips is reasonable for this indication. In line with other guidelines, archiving requirements should include still images or cine-clips of the following views [13–15].

- Sagittal and transverse views of the uterus and bladder
- Gestational sac in the uterus, if present
- Yolk sac and fetal pole, if present
- Myometrial mantle measurement if it appears abnormal
- Fetal heart rate documentation, if present, using M-mode or cine-clips

Cholelithiasis and cholecystitis

Minimum archiving requirements include views of the long- and short-axis views of the gallbladder. In the context of cholecystitis, the anterior gallbladder wall thickness should be measured. These views allow for the assessment of cholelithiasis and the secondary signs of cholecystitis [16–18]. Measurement of the gallbladder wall when cholecystitis is not suspected and measurement of the common bile duct are not routinely necessary.

Hydronephrosis

Minimum archiving requirements include a long-axis view of bilateral kidneys and a transverse view of the bladder. Routine use of the short-axis view of the kidneys or Doppler imaging of the kidney and bladder is not mandatory but may be helpful depending on the clinical context.

Above knee lower extremity deep venous thrombosis (DVT)

To optimize test characteristics, complete venous compressibility must be demonstrated for the popliteal vein and the entire femoral vein, from the common femoral vein proximally, beyond the deep femoral vein branch distally [19, 20]. Minimum archiving requirements reflect this process with a two-zone technique—views with and without compression are required at the following points. Zone 1: common femoral vein, saphenous–femoral junction and femoral vein beyond the deep femoral branch; Zone 2: distal femoral vein (in the popliteal fossa), popliteal vein and popliteal vein trifurcation.

Central vascular access

PCUS is used to increase safety and accuracy in obtaining central vascular access by direct visualization of the

anatomy and assessing for thrombus. Archiving images for ultrasound-guided central line placement is not mandatory as it often requires a second operator to be present. Should archiving be desired; however, an image of the wire in the vessel is reasonable.

Pediatrics

Although the core skills and applications are similar, the clinical context, physiology and pathology of pediatric patients differ, and thus, the practice of PoCUS differs. The use of cine-clips for archiving requirements is favoured, as it allows for quick capture of the target anatomy and pathology for subsequent review. This is key as pediatric patients are small, tend to move and anatomical movements (e.g. cardiac and lung) are faster. Subtle relationships between small anatomical parts are often better differentiated when movement is apparent.

Going forward

Efforts to adopt infrastructure for image archiving are encouraged. Each ED should coordinate image archiving capability with hospital information technology infrastructure and other specialties as needed. Dedicated image archiving software facilitates easy access for quality assurance, training, credentialing, and education. Alternatively, there are low-cost models that can be used: direct upload to a picture archiving and communication system (PACS), or a high capacity USB drive, to be regularly uploaded to a secure hospital hard drive or server. As electronic medical records become increasingly mandated across Canada, dedicated archiving software or a direct-to-PACS model may be the best practice to allow for integration with the patient chart.

As the use of portable devices increases in Canada, determining how to integrate archiving with both personal and hospital-owned devices warrants further consideration in collaboration with local PoCUS leaders and hospital information technology infrastructure.

Conclusion

Our modified Delphi-derived consensus represents the first national minimum archiving requirements for emergency department PoCUS. Additional images may be required beyond this minimum standard to support a diagnosis, as determined by the clinical context.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s43678-021-00109-8>.

Compliance with ethical standards

Conflict of interest Drs. Wong, Olszynski, Cheung, Pageau, Lewis and Kwan report no conflicts of interest. Dr. Woo reports that he holds a role as the Acute Care PoCUS Fellowship Director, University of Ottawa and The Ottawa Hospital and the Teaching Chair—PoCUS, Undergraduate Medical Education, University of Ottawa.

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