![ARDMS logo]

Sonography Principles & Instrumentation
Practice Analysis Detailed   Report

ARDMS Council approved November 29,2022.

CONFIDENTIALITY NOTICE

Contents

Revision History:

2022-11-XX   Added ARDMS Council Approval

Inteleos

ACKNOWLEDGEMENTS

EXECUTIVE SUMMARY

The American Registry for Diagnostic Medical Sonography (ARDMS), part of the Inteleos family of certifications, is the globally recognized standard of excellence in sonography. The ARDMS is responsible for the preparation of valid and reliable certification examinations in the field of sonography. Conducting practice analyses at the national and international levels allows the ARDMS to evaluate the current practice expectations and performance requirements within the field. The Sonography Principles and Instrumentation (SPI) practice analysis collected information on the requisite SPI knowledge, skills, and abilities essential to sonography professionals. The practice analysis kicked off with a workshop held in November 2020. The practice analysis survey was administered in March 2022. The analysis and discussion of results by the SPI Assessment Committee led to the recommended content outline found in Appendix G. This report details the methodology, data collection, analysis, and the recommended updated test content outline for the SPI examination based on the results of the practice analysis.

BACKGROUND OF STUDY

The ARDMS recognizes that diagnostic medical sonography is a valuable tool in the healthcare industry. There are several healthcare professions that utilize sonography in practice to increase the efficacy of their patient care. Successful mastery and demonstration of the knowledge and skills required to hold ARDMS sonographer credentials will provide sonographers with an additional source of validation. This will support the veracity of the diagnostic medical sonography exams that these practitioners perform. The SPI examination assesses the knowledge, skills, and abilities in the areas of perform ultrasound examinations, manage ultrasound transducers, optimize sonographic images, apply Doppler concepts, and perform clinical safety, patient care, and quality assurance.

METHODOLOGY

Selection and Profile of Subject Matter Experts

Workshop Panel
A panel of 10 subject matter experts (SMEs) attended a virtual workshop. The panel members were volunteers, and some were members of the SPI Assessment Committee (see Appendix A). The panel was chosen to be representative of the practice to the extent possible (demographic information can be found in Appendix A). A description of the workshop is below.

DACUM Workshop

Inteleos used a consultant, Joy Matthews-Lopez (JML Measurement, LLC) to facilitate the DACUM workshop. Materials were sent out to panelists ahead of the workshop to orient the group to the process and gather initial feedback regarding tasks, behaviors, tools, knowledge, skills, future trends and acronyms that are necessary in the role of a pediatric sonographer (see Appendix C for the Pre-Workshop Activity). The facilitator combined all of the input from the meeting attendees for review at the workshop.

Panel members attended a remote DACUM workshop via Zoom on November 13 and 14, 2020. The agenda for the workshop can be found in Appendix D. DACUM is an acronym for 'developing a curriculum.' The process provides a picture of what a practitioner does in terms of duties, tasks, knowledge, skills, and traits. Although originally designed to develop professional training and education, the DACUM process has been used successfully by certification organizations to provide the foundation for a practice analysis (Center on Education and Training for Employment, 2021).

The facilitator provided an orientation on the DACUM process. Next, the group reviewed some of the pre-workshop activity responses and drafted the major duties of the job. The facilitator worked with the group to develop a list of tasks that comprise the practice of a sonographer. The group also identified knowledge, skills, abilities, behaviors, tools, future trends, concerns, and acronyms that apply to Sonography Principles and Instrumentation. Appendix E contains the report compiled by the facilitator detailing the outcomes of the DACUM workshop.

Panelist Interviews and Workshop

Structured interviews were scheduled with panel members as schedules allowed to provide the facilitator background information about the practice. Workshop panel members attended a virtual workshop November 13 and 14, 2020. See Appendix B for the workshop agenda. The facilitator briefed the panel on the purpose and methods of practice analyses. Panel members were led through activities to determine broad categories of work and tasks for entry level sonographers. Using the results of these activities and discussions, the panel then developed a preliminary task inventory.

Field Survey

Field Survey Development

Working with members of the SPI Assessment Committee, Inteleos staff combined results from the remote panel and the initial task inventory from the workshop. The inventory was compared with the existing content outline to verify that no topics were inadvertently omitted and was edited as appropriate. The final task inventory was reviewed by the SPI Assessment Committee and used to build the practice analysis survey. A second survey was sent to registrants and the tasks included in the second survey are listed here:

E-1	Apply universal infection control protocols
E-2	Manage initial patient encounter (e.g., verify ID, medical history, verify appropriateness of order)
E-3	Analyze clinical history and previous imaging studies
E-4	Demonstrate appropriate patient care and communication skills (e.g., privacy, confidentiality, safety)
E-5	Document preliminary findings and images (e.g., paper-based, digital)
E-6	Document QA check on ultrasound machine

Field Survey Structure and Instructions to Survey Participants

The field survey was divided into two parts: demographic items and the task inventory items. A screening item was used at the beginning of the survey to ensure only those actively practicing ultrasound in a clinical setting responded to the survey: "*Do you currently scan patients in a clinical setting?*" Participants who selected "No" were thanked for their time and their survey ended.

For the task inventory portion of the field survey, participants were asked to rate each task on scales of importance. The instructions for this section were:

In the next section of the survey, you will be examining tasks associated with being a Sonographer, and consider the following questions:

How important *is this task to your practice of sonography...*

- *Absolutely essential*
- *Very important*
- *Of average importance*
- *Of little importance*
- *Not important at all*

How often is this task performed in *your* practice of sonography...

- *Frequently*

- *Often*

- *Occasionally*

- *Rarely*

- *Never*

The rating scale and weighting calculations are described in the *Data Analysis* section below.

Survey Administration Procedure and Response Rate

The survey was initially sent to 69,011 registrants. The survey was open from February 15- March 2, 2022. The survey was available to participants as a web-based survey through the survey platform Qualtrics®. All responses to the survey were kept confidential. 2,761 registrants completed 100% of this survey. A second survey was sent to a random sampling of 3,000 registrants and was open from April 25- May 12, 2022. All responses to the survey were kept confidential. 229 registrants completed 100% of this survey. This second survey included tasks in the Perform Clinical Safety, Patient Care, & Quality Assurance section only. Responses from participants who did not complete the task inventory were not used as part of the data analysis.

Data Analysis

Task Inventory Analysis

Respondents were asked the following questions for each of 78 tasks: How often is this task performed in your practice of Sonography, and How important is this task to your practice of Sonography? The frequency and importance rating scales were scored 1-5. The response options for the frequency scale were Never, Rarely, Occasionally, Often, and Frequently. The response options for the importance scale were Not Important at all, Of little importance, Of average important, Very important, and Absolutely essential.

Response Scales		Overall Criticality Score	
Importance	Frequency		
Absolutely essential (5)	Frequently (5)	16	These tasks are either frequently performed, very important, or both. As a result, most of these tasks should be kept. A rationale is required for any of these tasks that are removed. **Items should be reviewed if "Importance" is below 3.**
	Often (4)	15	
	Occasionally (3)	14	
	Rarely (2)	13	
Very Important (4)	Frequently (5)	12	
	Often (4)	11	
	Occasionally (3)	10	
	Rarely (2)	9	
Important (3)	Frequently (5)	8	These tasks may be kept or removed. A rationale is required for any of these tasks that are removed.
	Often (4)	7	
	Occasionally (3)	6	
	Rarely (2)	5	
Of average importance (2)	Frequently (5)	4	These tasks are either infrequently/never performed, of little importance, or both. As a result, most of these tasks should be considered for removal. A rationale is required for any of these tasks that are kept.
	Often (4)	3	
	Occasionally (3)	2	
	Rarely (2)	1	
Not Important (1)	All options	0	
All options	Never (1)	0	

For each survey participant and each task, a criticality score is created from the frequency and importance scales using the table above. These criticality scores are then averaged over all participants for each individual task (see Appendix D). These averaged scores are what you will be using in making your determination about whether each task should be kept on the final content outline. The table above also provides some guidance in how these scores can be made to make that determination.

Most of the SPI tasks fell into the "green" category. Seven tasks fell into the "yellow" category and two were "red" category tasks.

Three subgroups were identified: 1. Canadians, 2. Those that practice VT only, and 3. Those who practice either PE or AE only. The criticality score for each task was calculated for the subgroups and if there were significant differences, these were discussed on the call.

Initial Domain Weightings

The overall criticality scores for each task were summed within each domain. The sum of the overall criticality score for each domain was divided by the total overall criticality score to determine the initial domain weightings (Table 1).

Table 1. Initial Domain Weightings (Prior to Committee Call)

Domain	# Tasks	Criticality Sum	Initial Domain Weightings
Perform Ultrasound Examinations	16	195.38	20%
Manage Ultrasound Transducers	12	137.07	14%
Optimize Sonographic Images	16	202.52	21%
Apply Doppler Concepts	22	302.68	31%
Perform Clinical Safety, Patient Care, & Quality Assurance	10	133.41	14%
Total	76	971	100%

Demographic Analysis

Responses to demographic questions were also analyzed. Appendix E contains highlights from the demographic analysis. The analysis shows the survey respondents are representative across the dimensions of gender identification, age, location, and primary job function. The demographic analysis also provided information regarding years of experience, country of education, volume of exams performed, work setting, and the specialty practiced by the participants.

Discussion of Results

A conference call was held on April 4, 2022, with six members of the SPI Assessment Committee and members of Inteleos staff. Prior to the call, the results of the data analysis and initial content outline weightings were shared with the assessment committee. During the call, the attendees reviewed the tasks and mean criticality score, focusing on the 8 tasks with criticality scores less than four and tasks that were flagged by ultrasound specialty track. The committee recommended removing four tasks. Three of these tasks were in the yellow category. One task the committee recommended removing was a red task.

Table 2. Final Committee Recommended Domain Weightings and New Domain Names

Domain (Original Domain Name)	# Tasks	Criticality Sum	% of Total
Perform Ultrasound Examinations	10	117.27	15%
Manage Ultrasound Transducers	5	56.99	7%
Optimize Sonographic Images	16	202.52	26%
Apply Doppler Concepts	19	259.80	34%
Perform Clinical Safety, Patient Care, & Quality Assurance	10	133.41	17%

FINAL CONTENT OUTLINE

The revised formatted content outline including domain weightings was provided to the SPI Assessment Committee for final review and approval. This report, including the final version of the content outline recommended by the Assessment Committee will go to the ARDMS Council for approval. Upon approval of the content outline, this report will be amended to include the approval date. The final recommended content outline can be found in Appendix G.

Appendix A: Practice Analysis Panelists

Table 3. Workshop Panel

First Name	Last Name	Certifications
Jessica	Cooney	BS, RDMS(AB, OB/GYN, FE)
Christine	Damar	RDMS(AB, OB/GYN, BR, VT), RVT
Maria	Gonzalez	RDMS(AB), RVT, RDCS (AE, PE)
Bradley	Murphy	RDCS (AE, PE)
JoAnn	Musselman	S,RDMS(AB, BR, OB/GYN), RVT
Homam	Saker	MD, RDMS (OB/GYN), RDCS (FE)
Cathie	Scholl	DHSc,RDMS (AB, OB/GNY, BR, PS), RVT, RCS,(AE)
Britt	Smyth	BA, RDMS (AB, OB/GYN, BR, PS), RVT, RDCS (FE)
Laurie	Vaughn	BS,RDMS(AB, OB/GYN, RVT, RCS(AE)
Suk Young	Woodridge	RDMS (AB, OB/GYN, RVT, CRT

Table 4. Gender Identification of Population and Panelists

Gender	Percent in Population	Panelists	Percent of Panelists
Female	89.6%	8	80.0%
Male	10.4%	2	20.0%

Table 5. U.S. Region or Country of Population and Panels

Region/Country	Percent in Population	Panelists	Percent of Panelists
Midwest	23.8%	2	20.0%
Northeast	18.9%	2	20.0%
South	35.8%	4	40.0%
West	21.1%	2	20.0%
Other	0.4%	0	0.0%

DACUM Workshop Agenda
Sonography Principles & Instrumentation (SPI)
Virtual Meeting
November 13 and 14, 2020

DAY 1: Friday, November 13
(All times are Eastern)

10:00 a.m.	Welcome and Introductions
	• Orientation to the DACUM Process
11:15 a.m.	Brainstorming the Job*
	• Develop Organizational Chart
12:00 p.m.	Identify the Major Duties
1:00 p.m.	BREAK (1 hour)
2:00 p.m.	Identify the Tasks
5:00 p.m.	Adjourn

DAY 2: Saturday, November 14
(All times are Eastern)

10:00 a.m.	Resume Identifying Tasks
1:00 p.m.	BREAK (1 hour)
2:00 p.m.	Resume and Complete Identifying Tasks
4:00 p.m.	Develop lists*: General Knowledge and Skills; Worker Behaviors; Tools, Equipment, Supplies and Materials; Future Trends and Concerns; Glossary of Acronyms
4:30 p.m.	Conduct DACUM Chart Refinement and Sequencing
5:00 p.m.	Conclusion of DACUM Workshop

*Refer to your pre-workshop assignments
** Brief breaks are available upon request

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Thank you for volunteering to participate as a panelist for the Sonography Principles and Instrumentation (SPI) Practice Analysis. At the workshop, we will be led by our facilitator, Joy López-Matthews in a process called DACUM. This process has been used for years in education to develop curricula (where the name comes from). We use it as a starting point for our practice analyses because it gives us rich information about the work you do and how you do it.

Your answers here, help us get a jump start on some of the conversations we will be having during the workshop and will help us make the most of our time together. This worksheet should take about an hour to complete.

Please complete all parts of this worksheet and email to: Joy@JMLTesting.com by November 3.

Part 1. Whole Job Brainstorming Exercise (15-20 minutes)

The purpose of this exercise is to think about and articulate what you do when performing an ultrasound examination (as well as tasks that you may perform in preparation, or after an examination).

Please think about your practice as a Registered Sonographer (i.e., RDMS, RDCS, RVT, RMSKS). Reflect on what you do when performing an ultrasound examination in relation to sonography principles and instrumentation. Consider things you do frequently (i.e. on a daily basis) as well as things you may not do as often but are still important.

Please use the space below to jot down about 20 of these tasks:

Part 2. Review Existing Content Outline (15-20 minutes)

Please review the existing content outline. Compare it to what you wrote in the last section. Which tasks should be kept on the next content outline? Which tasks are missing from the content outline that you think are important to include on the next content outline? Which tasks are no longer relevant? Put a K (Keep as Is), C (Change is Needed), A (Add a New Task), or an R (Remove- no longer relevant).

		Keep, Change, Add, Remove (K,C,A,R)	NOTES or NEW TASKS
1	**Clinical Safety, Patient Care, and Quality Assurance**		
1.A.	Clinical Safety		
1.A.1.	Apply generally accepted infection control precautions and disinfectant techniques		
1.A.2.	Apply ergonomic techniques throughout the workday		
1.A.3.	Modify output power following ALARA principle		
1.A.4.	Identify potential bioeffects		
1.B.	**Patient Care**		
1.B.1.	Demonstrate appropriate patient care and communication skills		
1.B.2.	Analyze clinical history and prior imaging studies		
1.C.	**Quality Assurance**		
1.C.1.	Apply concepts for conducting performance tests with Doppler flow phantoms and tissue-mimicking phantoms		
1.C.2.	Apply concepts for evaluation of statistical parameters		
1.D.	**New Technologies**		
1.D.1.	Identify tissue Doppler		
1.D.2.	Evaluate applicable uses of ultrasound contrast agents		
1.D.3.	Apply concepts related to elastography imaging		
1.D.4.	Identify ultrasound hybrid imaging, i.e., fusion imaging		
2	**Physical Principles**		
2.A.	**Physical Principles**		
2.A.1.	Modify the exam based on gray-scale artifacts		
2.A.2.	Differentiate the various interactions of		

	sound and matter		
2.A.3.	Modify technique based on knowledge of reflectors		
2.A.4.	Integrate concepts related to optimization of axial resolution		
2.A.5.	Integrate concepts related to optimization of lateral resolution		
2.A.6.	Integrate concepts related to optimization of temporal resolution		
2.A.7.	Integrate concepts related to optimization of elevational resolution		
2.A.8.	Apply concepts related to duty factor		
3	**Ultrasound Transducers**		
3.A.	**Transducers**		
3.A.1.	Select a specific transducer type based on the area being scanned		
3.A.2.	Evaluate and adjust transducer frequency based on the area being scanned		
3.A.3.	Evaluate transducer integrity		
3.A.4.	Apply concepts related to the use of curvilinear array transducers		
3.A.5.	Apply concepts related to the use of linear array transducers		
3.A.6.	Apply concepts related to the use of sector transducers (phased array)		
3.A.7.	Apply concepts related to the use of endocavity transducers		
3.A.8.	Apply concepts related to the use of two-dimensional array transducers		
3.A.9.	Distinguish components of the transducer		
3.A.10.	Apply concepts related to the use of nonimaging transducers		
3.A.11.	Apply concepts related to the use of 1.5-dimensional array transducers		
4	**Imaging Principles and Instrumentation**		
4.A.	**Instrumentation**		
4.A.1.	Demonstrate ability to perform accurate measurements		
4.A.2.	Apply concepts related to imaging depth		
4.A.3.	Apply concepts related to overall gain		
4.A.4.	Apply concepts related to focusing		
4.A.5.	Apply concepts related to gray scale		
4.A.6.	Apply concepts related to time gain		

	compensation		
4.A.7.	Apply concepts related to zoom		
4.A.8.	Apply concepts related to M-mode		
4.A.9.	Apply concepts related to harmonic imaging		
4.A.10.	Apply concepts related to dynamic range, e.g. compression		
4.A.11.	Apply concepts related to edge enhancement		
4.A.12.	Apply concepts related to persistence		
4.A.13.	Apply concepts related to frequency compounding		
4.A.14.	Apply concepts related to extended field of view, e.g., panoramic imaging		
4.A.15.	Apply concepts related to spatial compounding		
4.A.16.	Apply concepts related to coded excitation		
4.A.17.	Apply concepts related to the use of three-dimensional/four-dimensional imaging		
4.A.18.	Apply concepts related to imaging systems and storage		
5	**Doppler Imaging Concepts**		
5.A.	**Hemodynamics**		
5.A.1.	Obtain measurements of blood flow velocities		
5.A.2.	Apply concepts related to pulse repetition frequency		
5.A.3.	Apply concepts related to wall filter		
5.A.4.	Apply concepts related to pulsed wave Doppler		
5.A.5.	Evaluate spectral Doppler waveforms		
5.A.6.	Apply concepts related to continuous wave Doppler		
5.A.7.	Apply concepts related to spectral Doppler angle to flow		
5.A.8.	Apply concepts related to Doppler scale		
5.A.9.	Apply concepts related to spectral Doppler gain		
5.A.10.	Modify the exam based on spectral Doppler artifacts		
5.A.11.	Adjust sample size (volume)		
5.A.12.	Apply concepts related to color gain		
5.A.13.	Apply concepts related to color angle to flow		
5.A.14.	Apply concepts related to color scale		
5.A.15.	Modify the exam based on color artifacts		

5.A.16.	Apply concepts related to color maps		
5.A.17.	Apply concepts related to color packet size		
5.A.18.	Apply concepts related to power Doppler imaging		

<h2 style="text-align:center">Part 3. General Knowledge (5 minutes)</h2>

Think about things a Sonographer would need to KNOW in order to conduct their job. For example, are there content areas that a Sonographer needs to be knowledgeable in, such as laws of physics or techniques needed to diagnose or treat certain diseases or injuries? Functional knowledge of human anatomy? Knowledge of certain drugs or pharmaceuticals?

Please list 5-7 common or typical things that a Sonographer should KNOW or know about:

<h2 style="text-align:center">Part 4. Skills/Abilities (5 minutes)</h2>

What skills must a Sonographer possess? Example skills or abilities may include critical thinking, reading comprehension, oral communication, or time management.

Please list 5-7 common or typical skills/abilities that a Sonographer should possess:

<h2 style="text-align:center">Part 5. Future Trends and/or Concerns (5 minutes)</h2>

What do you think the job of a Sonographer will look like in 5 years? 10 years? Will different knowledge, skills or abilities be needed to conduct the job? Will different tools or equipment be needed?

Please list 5 trends or emerging issues that might affect how a Sonographer conducts their job in the future.

Are you concerned about anything that may impact the current or future role of a Sonographer? **If so, please indicate it here**:

<h2 style="text-align:center">Part 6. Behaviors (5 minutes)</h2>

What behaviors are reasonable to expect of a Sonographer? Examples of behaviors may include being professional, courteous, accurate, self-disciplined, or sensitive.

Please list 5 typical behaviors of a competent Sonographer:

<h2 style="text-align:center">Part 7. Equipment, Supplies, and Materials (5 minutes)</h2>

In addition to Diagnostic Ultrasound Systems, gel, and warmers, please list any additional equipment, supplies, and/or materials that a Sonographer needs to conduct their job or perform the tasks we have identified. Examples may include machines, transducers, and PACS.

<h2 style="text-align:center">Part 8. Your Information</h2>

Your name (as you want it to appear on our final report):

Your current title:

Company/Employer:

City/State:

Current Position:

Number of years you have worked in this position:

Area(s) of expertise:

Highest Level of Education:

Specialized Training:

Appendix D: Task Overall Criticality Score and Committee Decision

Tasks in the "Green" category have an overall criticality score of nine or greater. Tasks in the "Yellow" category have an overall criticality score of greater than or equal to eight and less than five. Tasks in the "Red" category have an overall criticality score of less than five. In general, all "green" tasks are kept, and "red" tasks are removed. The committee's decisions are recorded below (column D shows if they decided to keep it).

A. Tasks	B. Domain & Task	C. Overall Criticality Score	D. Keep?
A	**Perform Ultrasound Examinations**		
A.1	A-1 Visually assess area to be scanned (e.g. edema, erythema, surgical scars)	12.7	No
A.2	A-2 Provide patient care (e.g., comfort, safety)	15.6	Yes
A.3	A-3 Apply sonographer ergonomic techniques	14.9	Yes
A.4	A-4 Apply scanning protocols (e.g., dual screens, cine loops)	14.5	No
A.5	A-5 Choose anatomic sonographic windows	14.9	No
A.6	A-6 Perform measurements (e.g., anatomical, pathology)	15.5	No
A.7	A-7 Differentiate interactions of sound and matter (e.g., echogenicity, reflection)	14.1	Yes
A.8	A-8 Modify exam based on gray-scale artifacts (e.g., reverberation, shadowing)	14.0	Yes
A.9	A-9 Apply knowledge of reflectors to modify scanning technique	13.1	Yes
A.10	A-10 Assess pathology	15.4	No
A.11	A-11 Identify potential bioeffects	10.5	Yes
A.12	A-12 Apply beam steering concepts	11.3	Yes
A.13	A-13 Apply extended field of view function (e.g., panoramic imaging)	10.0	Yes
A.14	A-14 Apply elastography imaging concepts	5.0	No
A.15	A-15 Recognize hybrid imaging (e.g., fusion imaging)	4.5	No
A.16	A-16 Apply 3D/4D concepts	6.6	Yes
A.17	A-17 Apply coded excitation concepts	4.1	No
A.18	A-18 Apply contrast imaging concepts	7.1	Yes
B	**Manage Ultrasound Transducers**		
B.1	B-1 Verify transducer integrity	14.0	No
B.2	B-2 Select transducers for the test	14.9	Yes
B.3	B-3 Select transducer settings (e.g., preset or customized)	15.0	No
B.4	B-4 Adjust transducer frequency	14.0	Yes

B.5	B-5 Apply 2D array transducer concepts	13.3	Yes
B.6	B-6 Apply 3D/4D transducer concepts	7.4	Yes
B.7	B-7 Apply sector transducer concepts (e.g., phased array)	10.5	No
B.8	B-8 Apply linear array transducer concepts	11.6	No
B.9	B-9 Apply curvilinear array transducer concepts	12.1	No
B.10	B-10 Apply endocavity transducer concepts	10.7	No
B.11	B-11 Apply 1.5-dimensional array transducer concepts	6.1	No
B.12	B-12 Apply nonimaging transducer concepts	7.3	Yes
C	**Optimize Sonographic Images**		
C.1	C-1 Integrate optimization of axial resolution concepts	12.6	Yes
C.2	C-2 Integrate optimization of lateral resolution concepts (e.g., transmit focus, multiple focal zones)	13.4	Yes
C.3	C-3 Integrate optimization of elevational resolution concepts	11.5	Yes
C.4	C-4 Integrate optimization of temporal resolution concepts	12.1	Yes
C.5	C-5 Utilize magnification techniques (i.e., pre- and post-processing)	13.7	Yes
C.6	C-6 Optimize image brightness (e.g., overall gain, TGC)	15.3	Yes
C.7	C-7 Apply harmonic imaging concepts	13.7	Yes
C.8	C-8 Apply PRF concepts (e.g., depth, penetration, frame rate)	14.9	Yes
C.9	C-9 Apply output power concepts	11.6	Yes
C.10	C-10 Apply duty factor concepts	9.5	Yes
C.12	C-12 Apply dynamic range concepts (e.g., compression)	11.9	Yes
C.13	C-13 Apply spatial compounding concepts	10.7	Yes
C.14	C-14 Apply knowledge related to gray scale (e.g., colorized B-mode, frequency compounding, persistence)	13.0	Yes
C.15	C-15Apply edge enhancement concepts	11.4	Yes
C.16	C-16Apply imaging depth concepts	14.7	Yes
C.17	C-17 Apply M-mode concepts	12.6	Yes
D	**Apply Doppler Concepts**		
D.1	D-1 Apply Doppler angle to flow concepts	14.4	Yes
D.2	D-2 Apply Doppler wall filter concepts	13.0	Yes
D.3	D-3 Apply Doppler sample gate concepts	13.7	Yes
D.4	D-4 Apply PRF color Doppler concepts	14.0	No
D.5	D-5 Apply color priority over gray scale concepts	13.1	Yes
D.6	D-6 Apply concepts related to color Doppler map	13.3	Yes

D.7	D-7 Apply concepts to eliminate aliasing	14.2	Yes
D.8	D-8 Apply continuous wave Doppler concepts	12.3	Yes
D.9	D-9 Apply pulsed wave Doppler concepts	14.6	Yes
D.10	D-10 Apply color Doppler concepts	15.0	Yes
D.11	D-11 Apply power Doppler concepts	12.9	Yes
D.12	D-12 Evaluate spectral Doppler waveform concepts	14.3	Yes
D.13	D-13 Apply tissue Doppler concepts	11.6	Yes
D.14	D-14 Apply general hemodynamic concepts (e.g., pressure gradient, resistance)	12.3	Yes
D.15	D-15 Apply Doppler artifacts concepts	13.7	Yes
D.16	D-16 Apply color gain concepts	14.4	No
D.17	D-17 Apply Doppler scale concepts (e.g., color, pulsed wave)	14.5	No
D.18	D-18 Perform Doppler measurements (e.g., velocity)	14.6	Yes
D.19	D-19 Apply spectral Doppler gain concepts	14.0	Yes
D.20	D-20 Apply spectral Doppler scale concepts	14.0	Yes
D.21	D-21 Apply color Doppler gain concepts	14.4	Yes
D.22	D-22 Apply color Doppler scale concepts	14.3	Yes
E	**Perform Clinical Safety, Patient Care, & Quality Assurance**		
E.1	E-1 Apply universal infection control protocols	15.0	Yes
E.2	E-2 Manage initial patient encounter (e.g., verify ID, medical history, verify appropriateness of order)	15.5	Yes
E.3	E-3 Analyze clinical history and previous imaging studies	15.0	Yes
E.4	E-4 Demonstrate appropriate patient care and communication skills (e.g., privacy, confidentiality, safety)	15.5	Yes
E.5	E-5 Document preliminary findings and images (e.g., paper-based, digital)	15.0	Yes
E.6	E-6 Document QA check on ultrasound machine	11.4	Yes
E.7	E-7 Assess transducer integrity	14.1	Yes
E.8	E-8 Verify ultrasound machine integrity	13.9	Yes
E.9	E-9 Perform gray scale QA testing with tissue-mimicking phantoms	8.7	Yes
E.11	E-11 Apply statistical parameter concepts (e.g., sensitivity, specificity)	9.2	Yes

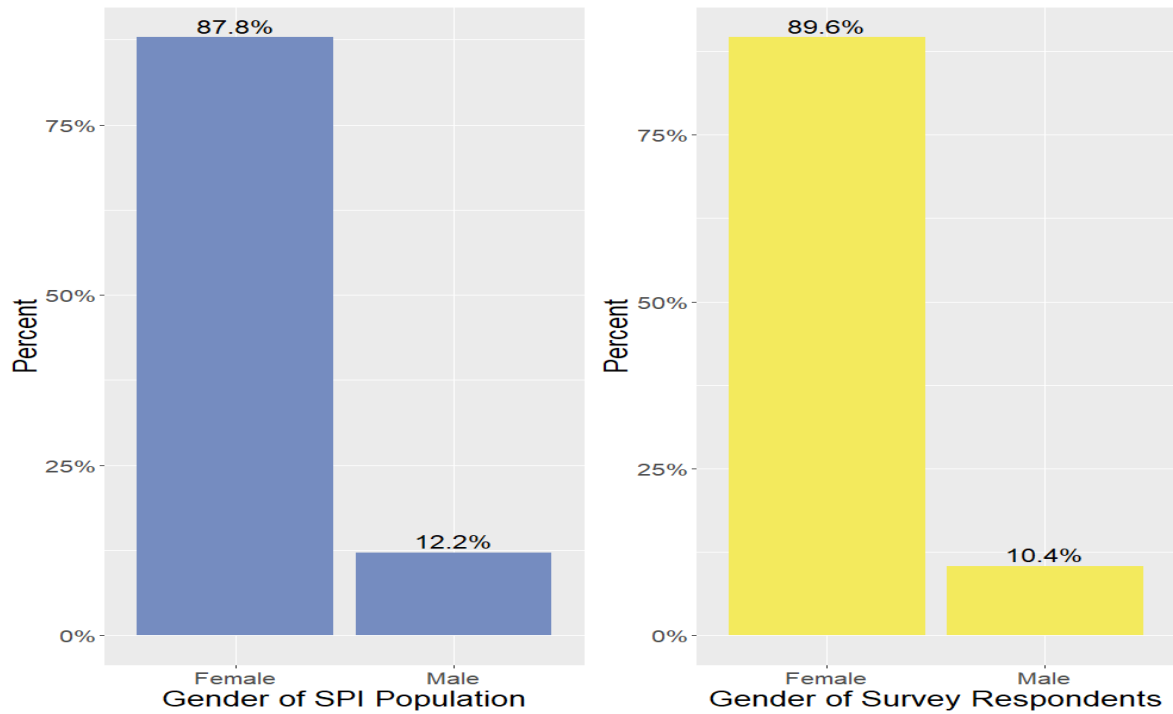Figure 1. Gender Identification of Population Compared to Survey Respondents

Figure 2. Age of Population Compared to Survey Respondents

Figure 3. Comparison of Country of Residence for Population and of Survey Respondents
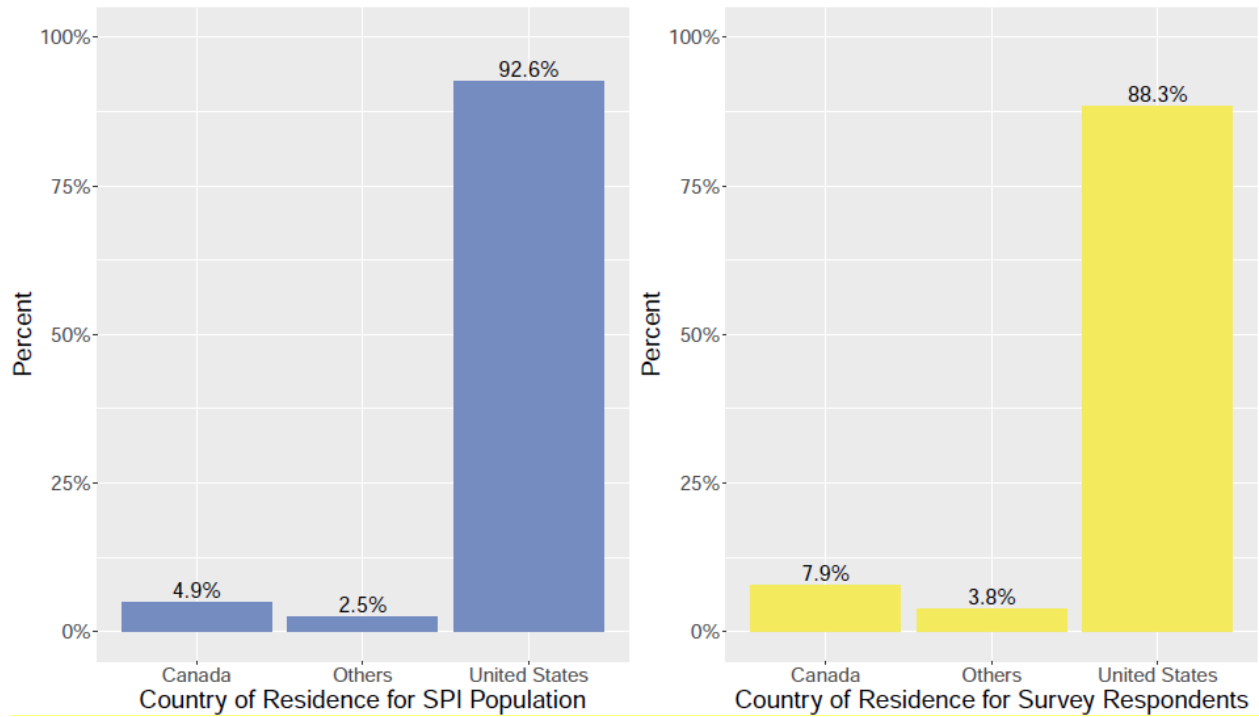
Country of Residence for SPI Population
- Canada: 4.9%
- Others: 2.5%
- United States: 92.6%

Country of Residence for Survey Respondents
- Canada: 7.9%
- Others: 3.8%
- United States: 88.3%

Figure 4. Comparison of U.S. Census Region of Population and Survey Respondents

U.S. Census Region of SPI Population
- Midwest: 21.5%
- Northeast: 19.5%
- West: 20.5%
- South: 38.3%
- Other: 0.2%

U.S. Census Region of Survey Respondents
- Midwest: 23.8%
- Northeast: 18.9%
- West: 21.1%
- South: 35.8%
- Other: 0.4%
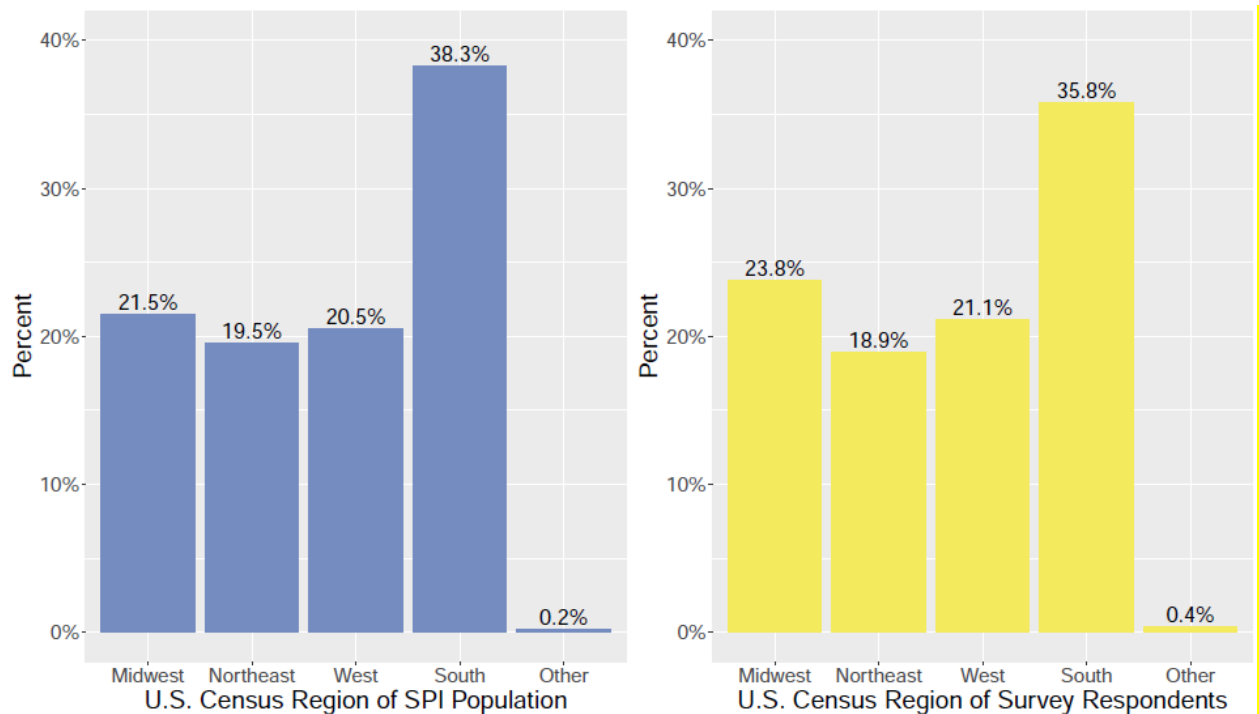
Figure 5. Primary Job Function of Population

Primary Job Function of SPI Population

- Sonographer — 65.1%
- Physician — 1.4%
- Applications Specialist — 0.3%
- Educator/Instructor — 0.7%
- Others — 32.5%

Percent
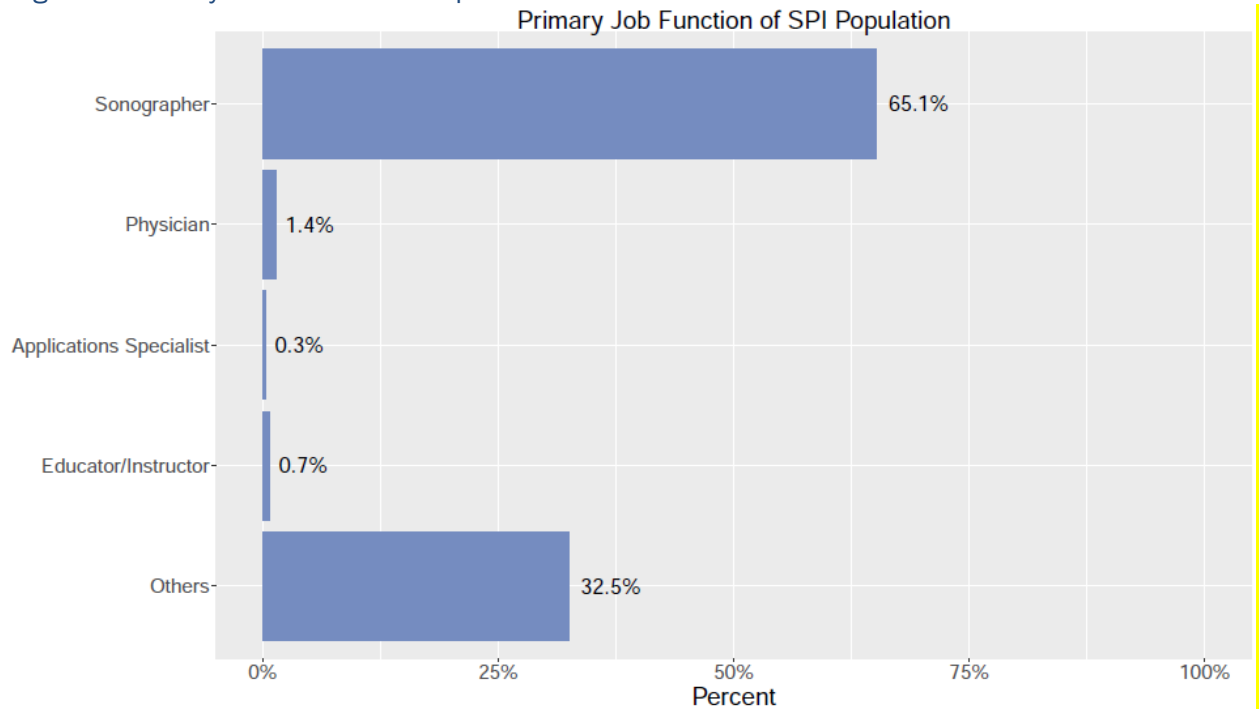
Figure 6. Primary Job Function of Survey Respondents

Primary Job Function of Survey Respondents

- Sonographer — 72.6%
- Physician — 1.5%
- Applications Specialist — 0.2%
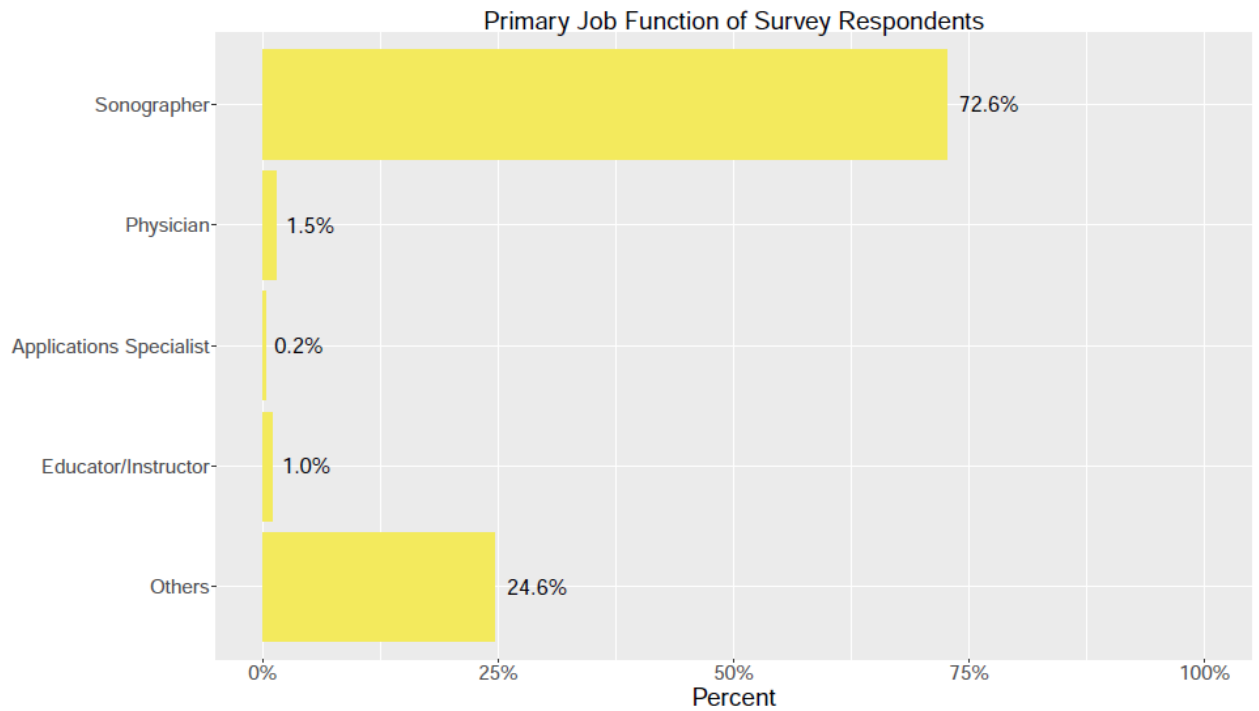- Educator/Instructor — 1.0%
- Others — 24.6%

Percent

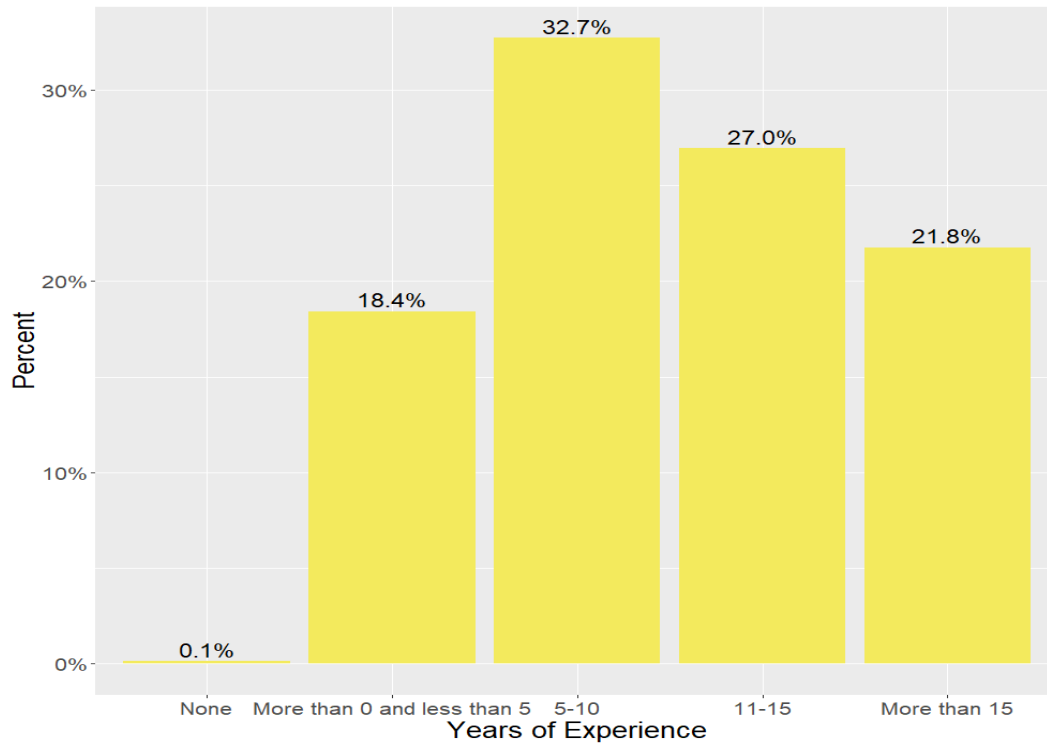Figure 7. Survey Respondents Years of Performing Ultrasound Examination

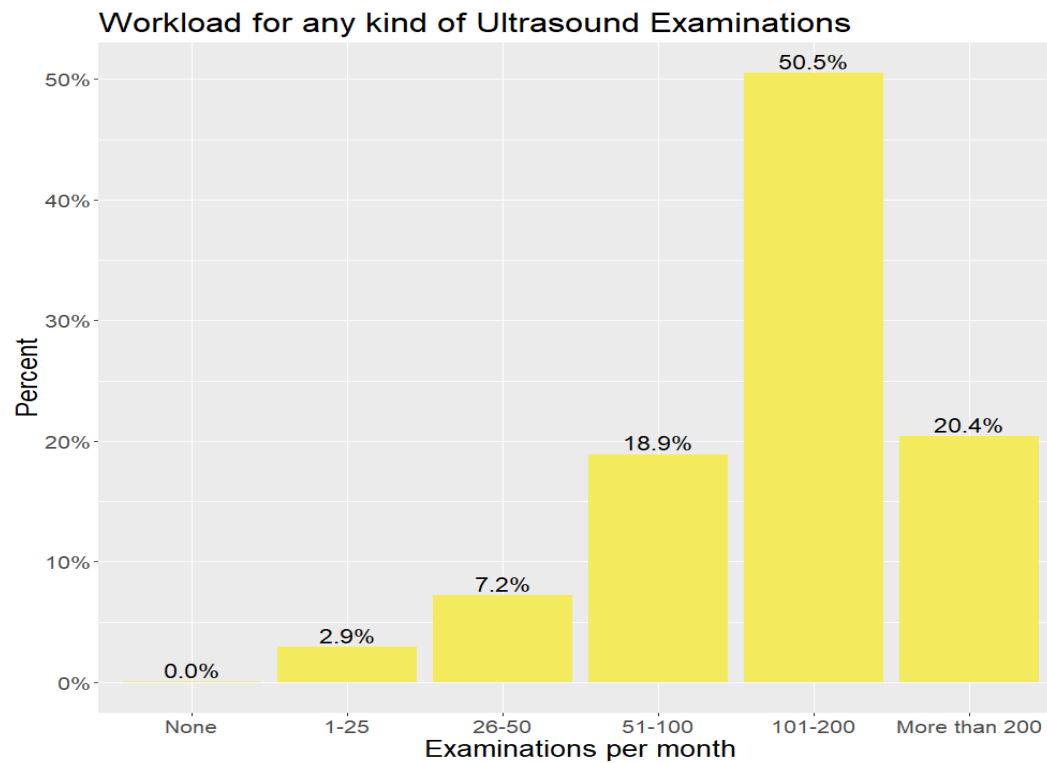Figure 8. Survey Respondents Number of Peforming Ultrasound Exams per Month

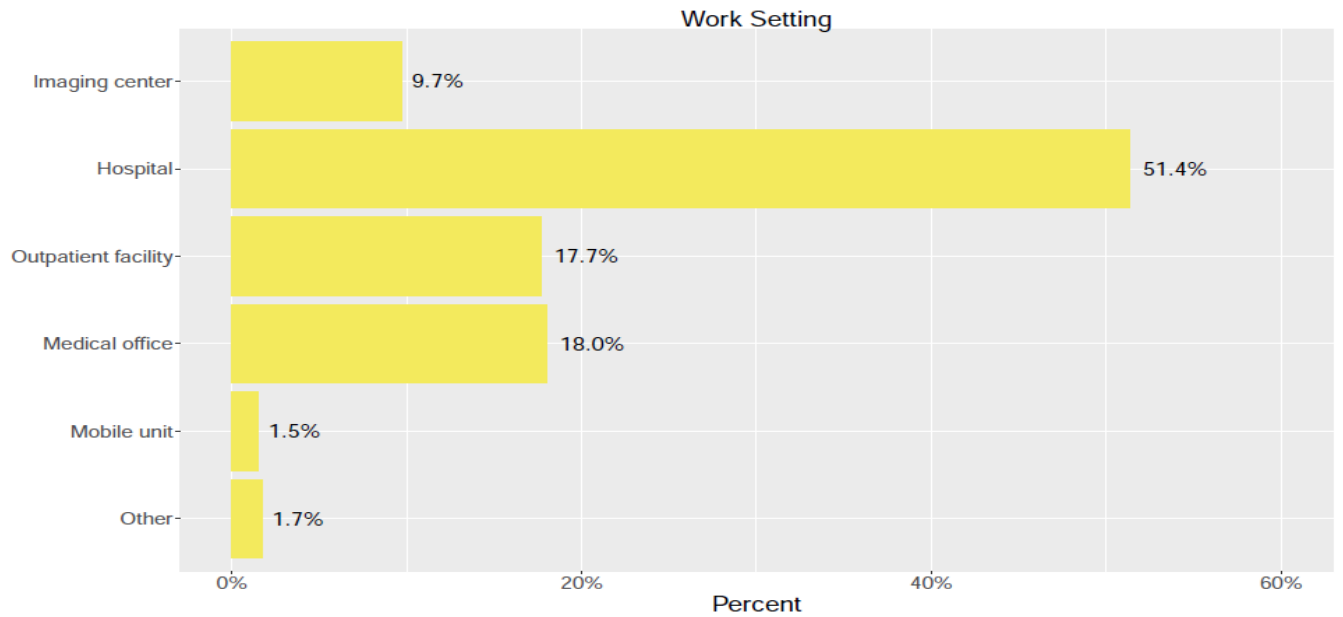Figure 9. Type of Facility Where Survey Respondents Perform Ultrasound Examinations

Work Setting

Work Setting	Percent
Imaging center	9.7%
Hospital	51.4%
Outpatient facility	17.7%
Medical office	18.0%
Mobile unit	1.5%
Other	1.7%

Figure 10. Country Where Survey Respondents Receive Their Ultrasound Education

Country of Education	Percent
Canada	6.6%
United States	88.4%
Others	5.1%

Specialty Practiced by Survey Respondents

ARDMS®

**American Registry for
Diagnostic Medical Sonography**

Sonography Principles and Instrumentation Examination Content Outline

(Outline Summary)

Domain Number	Domain	Percentage
1	**Perform Ultrasound Examinations**	**23%**
2	**Manage Ultrasound Transducers**	**7%**
3	**Optimize Sonographic Images**	**26%**
4	**Apply Doppler Concepts**	**34%**
5	**Provide Clinical Safety & Quality Assurance**	**10%**

(Detailed Outline)

Domains and Tasks		Knowledge, Skills & Abilities
1.	**Perform Ultrasound Examinations**	Knowledge of contrast agents
1.A.	Provide patient care (e.g., comfort, safety)	Knowledge of ergonomics
1.B.	Apply sonographic ergonomic techniques	Knowledge of established imaging protocols
1.C.	Differentiate interactions of sound and matter (e.g., echogenicity, reflection)	Knowledge of general patient care standards
1.D.	Modify exam based on gray-scale artifacts (e.g., reverberation, shadowing)	Knowledge of the interaction of sound and matter
1.E.	Apply knowledge of reflectors to modify scanning technique	Knowledge of metric system of measurement
1.F.	Identify potential bioeffects	Knowledge of tissue density, penetration and depth
1.G.	Apply beam steering concepts	Knowledge of ultrasound limitations
1.H.	Apply extended field of view function (e.g., panoramic imaging)	Knowledge of confidentiality & privacy guidelines
1.I.	Apply 3D/4D concepts	Ability to review medical/surgical history Ability to correct imaging artifacts
1J.	Apply contrast imaging concepts	
1.K.	Manage initial patient encounter (e.g., verify ID, medical history, verify appropriateness of order)	
1.L.	Analyze clinical history and previous imaging studies	
1.M.	Demonstrate appropriate patient care and communication skills (e.g., privacy, confidentiality, safety)	
1.N.	Document preliminary findings and images (e.g., paper-based, digital)	
2.	**Manage Ultrasound Transducers**	

2.A.	Select transducers for the test	Knowledge of the components of a transducer
2.B.	Adjust transducer frequency	
2.C.	Appy 2D array transducer concepts	Knowledge of frequency relationship in the selection of appropriate transducer
2.D.	Apply 3D/4D transducer concepts	
2.E.	Apply nonimaging transducer concepts	Ability to use different transducers
3.	**Optimize Sonographic Images**	
3.A.	Integrate optimization of axial resolution concepts	Knowledge of frequency, PRF, PRP and pulse duration
3.B.	Integrate optimization of lateral resolution concepts (e.g., transmit focus, multiple focal zones)	Knowledge of pre- & post-processing techniques
3.C.	Integrate optimization of elevational resolution concepts	Knowledge of the principles of 2D imaging
3.D.	Integrate optimization of temporal resolution concepts	Knowledge of sector widths
3.E.	Utilize magnification techniques (i.e., pre- & post-processing)	Knowledge of the concepts of scan lines, line density, frames and frame rate
3.F.	Optimize image brightness (e.g., overall gain, TGC)	Ability to optimize image beyond scan preset
3.G.	Apply harmonic imaging concepts	
3.H.	Apply PRF concepts (e.g., depth, penetration, frame rate)	
3.I.	Apply output power concepts	
3.J.	Apply duty factor concepts	
3.K.	Apply dynamic range concepts (e.g., compression)	
3.L.	Apply spatial compounding concepts	
3.M.	Apply knowledge related to gray scale (e.g., colorized B-mode, frequency compounding, persistence)	
3.N.	Apply edge enhancement concepts	
3.O.	Appy image depth concepts	
3.P.	Apply M-mode concepts	
4.	**Apply Doppler Concepts**	
4.A.	Apply Doppler angle to flow concepts	Knowledge of Doppler angle
4.B.	Apply Doppler wall filter concepts	Knowledge of Doppler effect
4.C.	Apply Doppler sample gate concepts	Knowledge of Doppler shift
4.D.	Apply color priority over gray scale concepts	Knowledge of hemodynamic principles
4.E.	Apply concepts related to color Doppler map	
4.F.	Apply concepts to eliminate aliasing	Knowledge of low flow areas
4.G.	Apply continuous wave Doppler concepts	Ability to optimize image in 2D color and Doppler
4.H.	Apply pulsed wave Doppler concepts	
4.I	Apply color Doppler concepts	Ability to interpret Doppler colors
4.J.	Apply power Doppler concepts	Ability to identify imaging artifacts
4.K.	Evaluate spectral Doppler waveform concepts	
4.L.	Apply tissue Doppler concepts	

4.M.	Apply general hemodynamic concepts (e.g., pressure gradient, resistance)	
4.N.	Apply Doppler artifacts concepts	
4.O.	Perform Doppler measurements (e.g., velocity)	
4.P.	Apply spectral Doppler gain concepts	
4.Q.	Apply spectral Doppler scale concepts	
4.R.	Apply color Doppler gain concepts	
4.S.	Apply color Doppler scale concepts	
5.	**Provide Clinical Safety & Quality Assurance**	
5.A.	Apply universal infection control protocols	Knowledge of CDC guidelines
5.B.	Document QA check on ultrasound machine	
5.C.	Assess transducer integrity	
5.D.	Verify ultrasound machine integrity	
5.E.	Perform gray scale QA testing with tissue-mimicking phantoms	
5.F.	Apply statistical parameter concepts (e.g., sensitivity, specificity)	