Physicians' Vascular Interpretation

Practice Analysis Detailed Report

Submitted for APCA approval January 2021

Contents

Revision History:

2021-02-22	Added APCA approval and made minor edit to fix type in Content Outline (5.C)

ACKNOWLEDGEMENTS

Thank you to the subject matter expert volunteers who spent many hours developing the task inventory, evaluating the survey and responses, and reviewing the final content outline. Also, thank you to the 262 Registered Physician in Vascular Interpretation (RPVI) registrants around the world who took the time to participate in the practice analysis survey. This study was completed through the efforts of many individuals at Inteleos, who worked together to construct the survey, administer the survey, and analyze the data.

EXECUTIVE SUMMARY

The Alliance for Physician Certification and Advancement (APCA), part of the Inteleos family of certifications, is dedicated to serving physicians in their enduring commitment to continual learning and providing high-quality and compassionate patent care through certification. Conducting practice analyses at the national levels allows APCA to evaluate the current practice expectations and performance requirements within the field. The Physicians' Vascular Interpretation (PVI) practice analysis collected information on the basic knowledge and skills essential to physicians who interpret ultrasound when practicing vascular surgery and vascular medicine. The practice analysis workshop was held in September 2019. The practice analysis survey was administered in 2020. The analysis and discussion of results by the PVI 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 PVI examination based on the results of the practice analysis.

BACKGROUND OF STUDY

APCA recognizes that diagnostic medical sonography is a valuable tool in the healthcare industry. There are several healthcare professions that utilize ultrasound in practice to increase the efficacy of their patient care. A passing score on the Physicians' Vascular Interpretation (PVI) examination indicates basic vascular knowledge and skills essential to physicians practicing vascular surgery and vascular medicine. The PVI examination assesses candidates' understanding of vascular anatomy and hemodynamics as well as interpretation of ultrasound results.

METHODOLOGY

Practice Analysis Panel

A practice analysis panel consisting of seven subject matter experts (SMEs) led this project. The seven panel members were volunteers, and some were members of the current PVI Assessment Committee (see Appendix A). The panel was chosen to be representative of the practice to the extent possible and all panel members held the RPVI certification.

Panel Interviews and Workshop

Structured interviews were scheduled with panel members as schedules allowed to provide the facilitator background information about the practice. Panel members attended a workshop on September 5-7, 2019. 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 that comprise the practice of an RPVI certified physician. Using the results of these activities and discussions, the panel then developed a preliminary task inventory. This task inventory was used as the basis for a field survey to determine the frequency and importance of the tasks identified by the panel.

Survey

Survey Questionnaire Development

Working with members of the PVI Assessment Committee, Inteleos staff made minor edits to the preliminary task inventory. The inventory was compared with the existing content outline to verify that no topics were inadvertently omitted. The final task inventory was approved by the PVI Assessment Committee and used to build the practice analysis survey.

Survey participants were asked to rate each task on scales of importance and frequency. Appendix B contains the instructions and scales used in the survey.

Survey Administration Procedure and Response Rate

The survey was initially sent to 1,000 RPVI Registrants randomly selected from the RPVI database and was open

from July 17- 31, 2020. However, only 35 individuals completed the survey. The same survey was sent to the remaining 3,777 RPVI registrants. 227 of these individuals completed the survey. Since the survey questions were identical, the responses were combined for the survey analysis for a total of 262 completed responses. The survey was made available to participants as a web-based survey through the survey platform Qualtrics®. All responses to the survey were kept confidential except for a question asking if the participant was interested in item writing or other volunteer activities. A list of those who responded "yes" to that question was shared with the exam program manager and the volunteer engagement team.

RESULTS

Data Analysis

Respondents were asked the following questions for each task: 1) In your role as a Registered Physician in Vascular Interpretation, how often do you perform this task, and 2) How important is it for a Registered Physician in Vascular Interpretation to successfully perform this task? The frequency and importance rating scales were scored 1-5. The response options for the frequency scale were: Never (1), Rarely (2), Occasionally (3), Often (4), and Frequently (5). The response options for the importance scale were: Not important (1), Somewhat important (2), Important (3), Very Important (4), and Extremely Important (5). See Appendix B for instructions provided to candidates regarding how to apply the scale.

The frequency and importance rating scales were combined into a single measure of overall criticality (ranging from 0-16) using a hierarchical method in which values on the importance scale outweigh or outrank all values on the frequency scale, except for 'Never' (see Appendix C). Higher criticality values indicate the most critical tasks. These criticality values were averaged for each task (see Appendix D). In addition, the criticality values were summed within each domain. The sum of criticality for each domain was divided by the overall criticality score to determine the initial percentages of the examination content in each domain (see Appendix E).

Responses to demographic questions were also analyzed. Appendix D contains highlights from the demographic analysis. The majority of the RPVI Registrant population is made up of physicians who hold three main medical subspecialties: Vascular Surgery/Vascular Medicine (43%), Cardiology (37%), and Radiology (7%).The response rate for the survey was fairly well representative of these subspecialties at 48%, 24%, and 8% respectively. Inteleos calculated criticality scores for each of these specialties separately to highlight any differences in practice for the committee to consider during the subsequent discussion. These criticality scores can be found in Appendix D.

The task criticality score and the initial domain weightings were sent to the assessment committee in advance of the final review call.

Discussion of Results

Tasks were assigned to three categories to assist in discussing criticality scores. Tasks in the "Green" category had a criticality score of greater than or equal to nine. These were slated to be included on the content outline unless the committee could provide a strong rationale for not including them. Tasks in the "Yellow" category had a criticality score of greater than or equal to five and less than nine. The committee discussed the frequency and importance ratings and determined if the task should be included on the content outline. Tasks in the "Red" category had a criticality rating of below 5. These tasks were to be discussed by the committee and would only be included on the content outline if the committee had a strong rationale to defend that decision.

A conference call was held on October 6, 2020 with four members of the PVI Assessment Committee and members of Inteleos staff. The attendees reviewed the tasks and their criticality ratings, focusing on tasks with criticality weightings with values under nine. The attendees also evaluated the tasks for which the criticality rating was different among sub-specialties. The attendees on the call suggested some minor changes to the wording of tasks and approved the content weighting.

The committee decided to remove five tasks. Three of these tasks had criticality ratings under five ("Red" category). One task that was removed fell into the "yellow" category overall, but it was rarely done by cardiologists. The final task that was removed the committee determined was redundant. Appendix D lists committee decisions for each task. The panel reviewed the domain weightings with the five tasks removed and suggested minor changes. The recommended domain weightings can be found in Appendix E.

FINAL CONTENT OUTLINE

The revised content outline including domain weightings was provided to the PVI 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 APCA 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.

Council Approval

(Added 2/22/2021) Resolution 21502 "Physicians' Vascular Interpretation Practice Analysis and Content Outline Update" was approved on February 15, 2022 and states that this new content outline is approved and will be applied to the 2021 form build (2/22/2021 Edit).

Appendix A: Practice Analysis Panel

Table 1. Panelists

Name	Credential
Thomas Carruthers	MD, RPVI
Carolyn Donaldson	MD, RPVI
Robert Eberhardt	MD, RPVI, ABVM Vascular, RVT
Young Erben	MD, RPVI
Marie Gerhard-Herman	MD, RPVI, ABVM Vascular, RVT
Abiodun Olatidoye	MD, RPVI
Joseph Schneider	MD, RPVI, RVT

Table 2. Gender Identification of Population and Panel

Gender	Percent in Population	Panel	Percent of Panel
Female	18 %	3	43%
Male	82 %	4	57 %

Table 3. Specialty Represented within in Population and Panel

	Percent in Population	Number of Panel Members	Percent of Panel Members
Vascular Surgery or Vascular Medicine	43%	3	43%
Cardiology	37%	2	29%
Radiology	7%	1	14%

Appendix B: Survey Instructions and Scale

The survey began by asking demographic and practice setting questions. The second part of the survey asks respondents to rate each task on the task inventory in terms of frequency and importance. The instructions to the respondents are provided below.

In the next section of the survey, you will be examining tasks associated with being a Registered Physician in Vascular Interpretation and consider two questions:

1. In your role as a Registered Physician in Vascular Interpretation, how **often** do you …
   - Frequently (More than once a day)
   - Often (Weekly)
   - Occasionally (Every few weeks)
   - Rarely (Every few months or less frequently)
   - Never

2. How **important** is it for a Registered Physician in Vascular Interpretation to successfully …
   - Extremely important
   - Very important
   - Important
   - Somewhat important
   - Not important

Appendix C: Criticality Scale

Response Options		Overall Criticality Score
Importance	Frequency	
Critically Important (5)	Always (5)	16
	Often (4)	15
	Occasionally (3)	14
	Rarely (2)	13
Very Important (4)	Always (5)	12
	Often (4)	11
	Occasionally (3)	10
	Rarely (2)	9
Important (3)	Always (5)	8
	Often (4)	7
	Occasionally (3)	6
	Rarely (2)	5
Somewhat Important (2)	Always (5)	4
	Often (4)	3
	Occasionally (3)	2
	Rarely (2)	1
Not Important (1)	All options	0
All options	Never (1)	0

Appendix D: Criticality Values

Domain & Task	Overall Criticality Score	Keep?	Comment	Vascular Criticality Score	Cardiology Criticality Score	Radiology Criticality Score
CEREBROVASCULAR	11.43					
Interpret extracranial and intracranial ultrasound studies	11.43					
Assess vertebral artery	12.55	Yes		12.9	13.7	11.3
Grade bulb and internal carotid artery stenosis using velocity criteria	13.90	Yes		14.8	14.1	12.3
Assess plaque characteristics in the carotid arteries using gray scale and color	12.10	Yes		12.6	12.6	11.0
Evaluate the carotid artery stenosis when contralateral disease is present	13.05	Yes		13.7	13.8	11.3
Identify the effect of contralateral carotid artery disease on interpretation of internal carotid artery stenosis	12.27	Yes		13.0	12.8	10.4
Identify indirect findings for more proximal and distal disease during a carotid exam when there is a non-visualized area	12.03	Yes		12.8	12.3	10.9
Identify the result of cardiac disease on carotid artery waveforms	10.47	Yes		10.7	11.8	8.9
Assess common carotid artery	13.04	Yes		13.3	14.0	11.9
Assess external carotid artery	10.57	Yes		10.8	12.1	8.0
Identify incidental findings on cerebrovascular duplex exams	10.31	Yes		10.4	11.4	9.7
Assess nonatherosclerotic cerebrovascular disease within the carotid arteries	10.72	Yes		11.2	11.3	9.3
Assess carotid arteries after intervention, (i.e., carotid endarterectomy or stent)	12.95	Yes		14.0	13.0	10.7
Interpret intracranial cerebrovascular exams (e.g., identify emboli, stenosis, and vasospasm)	6.15	Yes	May not be done frequently but it is important	6.0	7.8	5.0
ABDOMINAL	9.09					
Interpret aortoiliac ultrasound studies	12.20					
Evaluate aneurysmal disease	13.57	Yes		14.4	13.1	12.6
Evaluate occlusive disease	13.39	Yes		14.2	13.3	12.3
Evaluate non-atherosclerotic and/or non-aneurysmal disease	11.18	Yes		11.5	11.7	9.7
Interpret post-endovascular aneurysm repair duplex exams	11.91	Yes	Critical for both Vascular and Cardiology	13.5	10.4	8.6
Use Doppler techniques to evaluate for endoleak	10.94	Yes	Critical for both Vascular and Cardiology	12.6	10.0	4.7
Interpret hepatoportal ultrasound studies	4.48					
Evaluate arterial hepatoportal system	4.79	No	Outdated	4.7	3.6	9.9
Evaluate venous hepatoportal system	4.85	No	Outdated	4.5	3.6	11.0
Evaluate post-intervention to the hepatoportal system (e.g., TIPS)	3.79	No	Outdated	3.2	3.2	9.7
Interpret mesenteric ultrasound studies	8.06					

Assess for celiac compression	8.08	Yes	Important for all to know	9.9	5.4	7.4
Evaluate mesenteric arteries	9.60	Yes		12.1	5.8	8.2
Evaluate mesenteric veins	5.84	No	Only rarely in cardiology, and not often in Vascular	6.9	4.0	5.5
Identify stenosis post-visceral intervention	8.72	Yes	Important for all to know	11.3	5.2	6.0
Interpret renal vascular studies	9.59					
Evaluate renal artery stenosis (e.g., velocity, renal aortic-ratio, resistive indices, etc.)	11.47	Yes		12.7	10.3	11.0
Interpret renal resistive indices to determine the presence of parenchymal renal disease	10.48	Yes		11.3	9.6	11.5
Evaluate non-stenotic renal artery disease (e.g., FMD, aneurysm, etc.)	10.08	Yes		10.8	10.0	9.3
Assess renal allografts	6.50	Yes	May not be done frequently but it is important	6.8	6.2	8.4
Evaluate renal vasculature post intervention	9.42	Yes		11.1	8.0	7.4
PERIPHERAL ARTERIAL	11.26					
Interpret peripheral arterial duplex studies	12.12					
Interpret peripheral arterial ultrasound studies of native vessels	14.10	Yes		14.9	13.8	13.2
Interpret velocity and waveform morphology within upper extremity peripheral arteries to determine stenosis	13.39	Yes		14.5	13.1	10.7
Interpret velocity and waveform morphology within lower extremity peripheral arteries to determine stenosis	14.12	Yes		15.0	13.8	13.0
Assess peripheral arteries dimensions to detect aneurysm	13.22	Yes		14.2	12.8	11.6
Assess for non-atherosclerotic disease within peripheral arteries	11.49	Yes		12.1	11.5	9.7
Assess for arterial trauma	10.08	Yes		11.0	9.4	8.7
Interpret arterial testing during provocative maneuvers to identify dynamic arterial obstruction	10.49	Yes		11.4	9.4	9.9
Identify incidental findings during peripheral arterial studies to detect non-vascular pathologies	10.27	Yes		10.9	9.6	9.7
Identify and treat peripheral artery pseudoaneurysms	11.87	Yes		12.8	11.1	11.0
Interpret bypass graft and stent ultrasound studies	12.91					
Interpret peripheral arterial duplex after endovascular/minimally invasive intervention	12.88	Yes		14.4	11.0	12.0
Interpret duplex after bypass grafts within peripheral arteries (vein conduit and prosthetic conduit)	12.95	Yes		14.6	10.7	12.3
Interpret dialysis access graft ultrasound studies	10.17					
Interpret pre-dialysis vascular imaging to determine access site suitability (arterial and venous)	10.81	Yes		13.5	5.9	10.8
Interpret post-arteriovenous access dialysis graft exam (e.g., restenosis aneurysm, patency, and complications, etc.)	10.71	Yes		13.4	6.0	10.6

Apply volume flow measurements when evaluating arteriovenous dialysis access	9.73	Yes		12.1	5.7	9.0
Use volume flow measurements of arteriovenous dialysis access to determine suitability for use in hemodialysis	9.42	Yes		11.8	5.6	7.9
Interpret physiologic vascular studies	10.66					
Interpret arterial Doppler waveform analysis on physiologic studies to detect arterial disease	13.55	Yes		14.5	13.0	12.2
Interpret upper extremities segmental pressure studies	11.17	Yes		11.9	11.4	7.8
Interpret lower extremities segmental pressure studies	12.64	Yes		13.0	13.1	11.6
Interpret pulse volume recordings of upper extremities	10.51	Yes		11.0	11.4	8.1
Interpret pulse volume recordings of lower extremities	11.80	Yes		12.2	12.6	10.5
Interpret exercise arterial studies	11.85	Yes		12.7	11.9	9.5
Interpret toe pressures	12.17	Yes		13.2	11.7	10.0
Interpret digital waveforms to detect both fixed and dynamic arterial disorders	11.37	Yes		12.5	10.7	8.2
Interpret provocative testing for thoracic outlet syndrome using physiologic methods	8.92	Yes	Important for all to know	10.1	7.6	7.1
Interpret transcutaneous oxygen tension (TcPo2) testing	5.77	Yes	Important for all to know	6.1	5.6	5.0
Interpret Raynaud disease testing	7.50	Yes	Important for all to know	8.5	6.0	7.1
PERIPHERAL VENOUS	12.36					
Interpret vein mapping studies	11.69					
Interpret vein mapping to determine patency, size, and suitability of use	12.04	Yes		13.9	8.9	10.6
Assess for anatomic venous variants related to vein mapping	11.34	Yes		12.8	8.9	9.8
Interpret venous duplex studies for thrombosis/obstruction	12.03					
Assess upper extremity veins with compression and flow for deep vein thrombosis	13.06	Yes		13.9	11.3	13.3
Assess upper extremity veins with compression and flow for superficial vein thrombosis	12.68	Yes		13.5	11.2	12.3
Assess lower extremity veins with compression and flow for deep vein thrombosis	13.94	Yes		14.7	12.5	13.7
Assess lower extremity veins with compression and flow for superficial vein thrombosis	13.51	Yes		14.2	12.4	13.3
Assess veins and surrounding structures using venous waveforms and venous waveforms for extrinsic venous compression	12.24	Yes		12.8	11.4	12.0
Assess for central venous obstruction using venous waveforms	11.79	Yes		12.3	10.7	11.0
Assess venous structures and flow for non-thrombotic venous disease	11.14	Yes		11.6	10.6	9.5
Assess venous waveforms to recognize impact of cardiac comorbidities	10.62	Yes		11.1	10.1	9.7
Assess inferior vena cava and iliac veins	11.33	Yes		11.9	10.3	11.2
Asses for anatomic variants related to the peripheral veins	10.04	Yes		10.5	9.1	9.3
Interpret venous insufficiency studies	13.28					
Assess for superficial venous reflux	13.69	Yes		14.8	11.8	11.9
Assess for deep venous incompetence	13.73	Yes		14.8	11.8	12.3
Assess for perforating veins	12.72	Yes		13.7	10.8	11.3
Assess for superficial venous thrombosis during venous insufficiency testing	13.39	Yes		14.3	11.7	12.0

Evaluate using venous duplex following venous ablation procedures	12.85	Yes		14.2	10.6	10.5
Laboratory Technology and Operations	11.61					
Physics and Instrumentation	11.06					
Identify bioeffects (e.g., cavitation, tissue heating)	7.64	Yes	Need to know for patient safety	7.1	8.6	6.8
Modify output power following ALARA principle	7.68	Yes	Need to know for patient safety	6.9	9.1	6.4
Recognize artifacts	12.03	Yes		11.7	12.7	12.1
Identify pulsed wave (spectral) Doppler waveform characteristics	12.57	Yes		12.5	12.6	13.0
Identify color Doppler waveform characteristics	12.84	Yes		12.9	12.8	12.6
Identify power Doppler waveform characteristics	11.55	Yes		11.4	12.0	11.2
Identify continuous wave Doppler waveform characteristics	12.12	Yes		12.2	12.7	11.2
Identify gray-scale characteristics	12.64	Yes		12.7	12.5	12.9
Select appropriate transducer for requested examination	10.45	Yes		10.2	10.7	10.3
Patient Care and Quality Assurance	12.32					
Apply generally accepted infection control precautions and disinfectant techniques	12.26	Yes		12.3	12.5	11.4
Recognize and communicate critical findings to referring provider to facilitate appropriate and timely clinical management	13.68	Yes		14.0	13.5	13.1
Participate in quality assurance program (e.g., providing feedback regarding acquisition technique, determine agreement between preliminary and final reports)	13.01	Yes		13.6	12.6	11.4
Correlate findings with adjunct imaging modalities	13.02	Yes		13.3	13.0	12.3
Determine agreement between preliminary and final reports	12.97	No	Covered in "Participate in quality …". Add as an example.	13.4	12.6	11.5
Assess study indications to ensure appropriateness of selected test	12.40	Yes		12.5	12.7	11.4
Calculate specificity, sensitivity, predictive value, and accuracy to compare with a referenced standard	8.89	Yes	Less important now than in the past but keep.	9.0	10.1	6.1

As explained, in the "Discussion of Results" section, tasks in the "Green" category have a criticality score of greater than or equal to nine. Tasks in the "Yellow" category have a criticality score of greater than or equal to five and less than nine. Tasks in the "Red" category have a criticality rating of below 5. In general, all "green" tasks are kept, and "red" tasks are removed. The committee's decisions are recorded above. This table also includes the criticality score for the three major sub-specialties of the RPVI population.

Appendix E: Domain Weighting

Domain	# Tasks*	Criticality Sum	% of Total	Committee Recommendation
Cerebrovascular	13	150.12	16%	**15%**
Abdominal	13	135.34	14%	**15%**
Peripheral Arterial - Duplex Imaging	15	175.54	18%	**20%**
Peripheral Arterial - Physiologic	11	117.26	12%	**15%**
Peripheral Venous	17	210.11	22%	**20%**
Laboratory Technology and Operations	15	172.80	18%	**15%**
Total	*84*	*961*	*100%*	**100%**

**Initially included tasks marked green or yellow from survey. Updated from call with committee and does not include tasks that the committee decided to remove.*

Appendix F: Demographics of Survey Respondents

Figure 1. Gender Identification of RPVI Population Compared to Survey Respondents

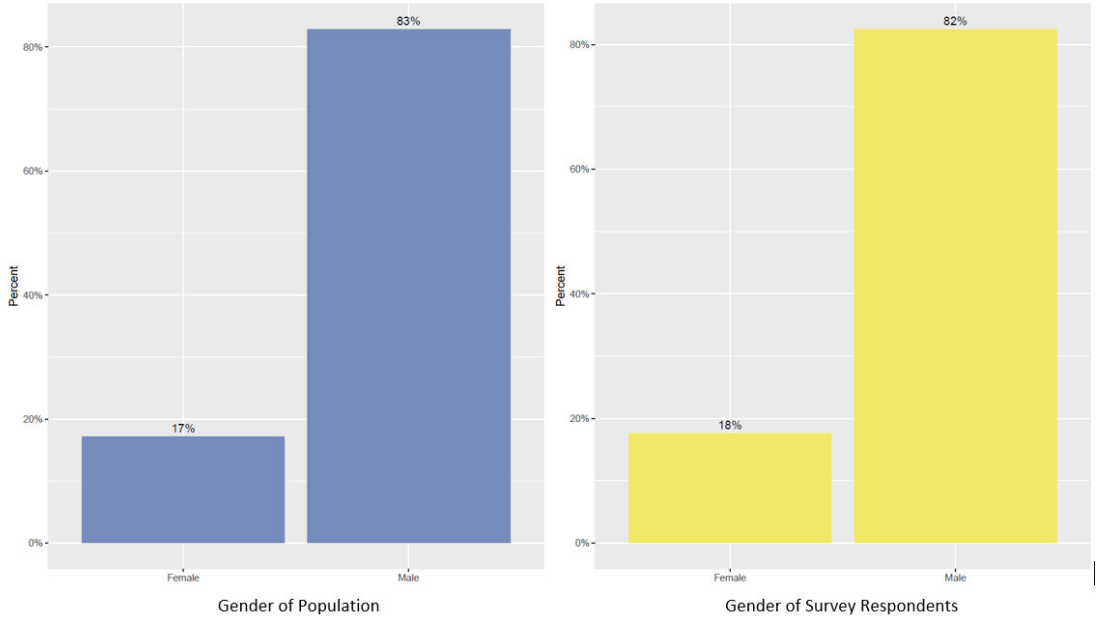


Figure 2. Age of Population Compared to Survey Respondents

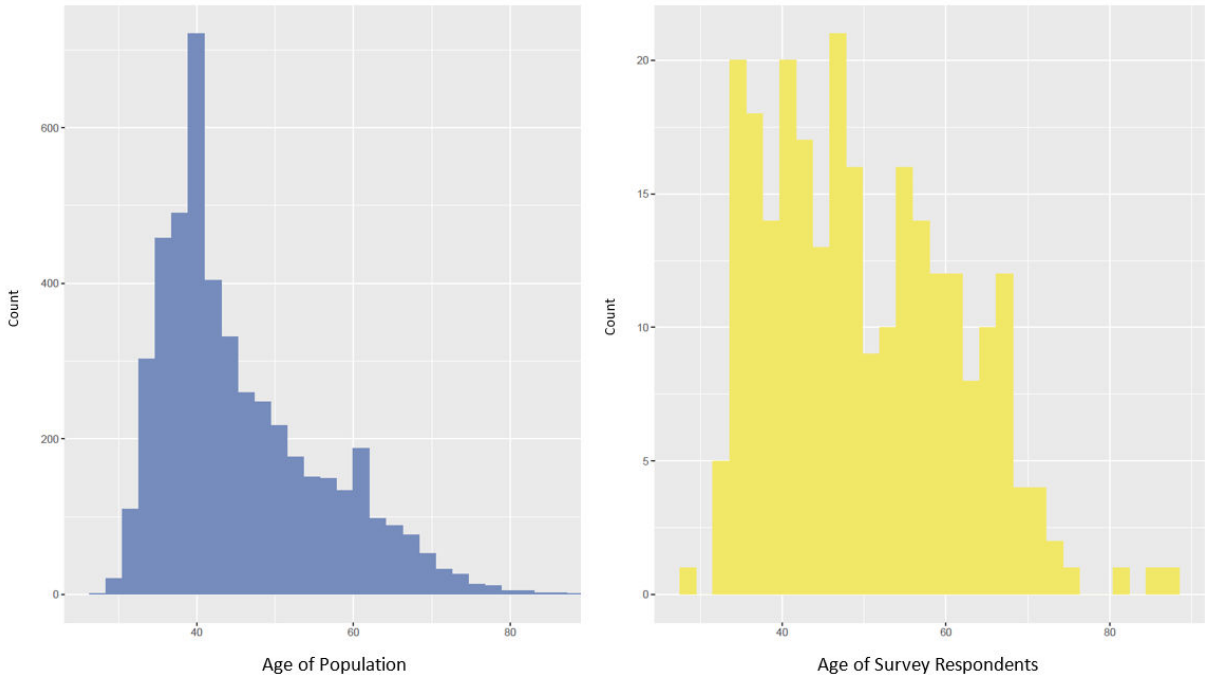


Figure 3. Comparison of Country of Residence for Population and of Survey Respondents

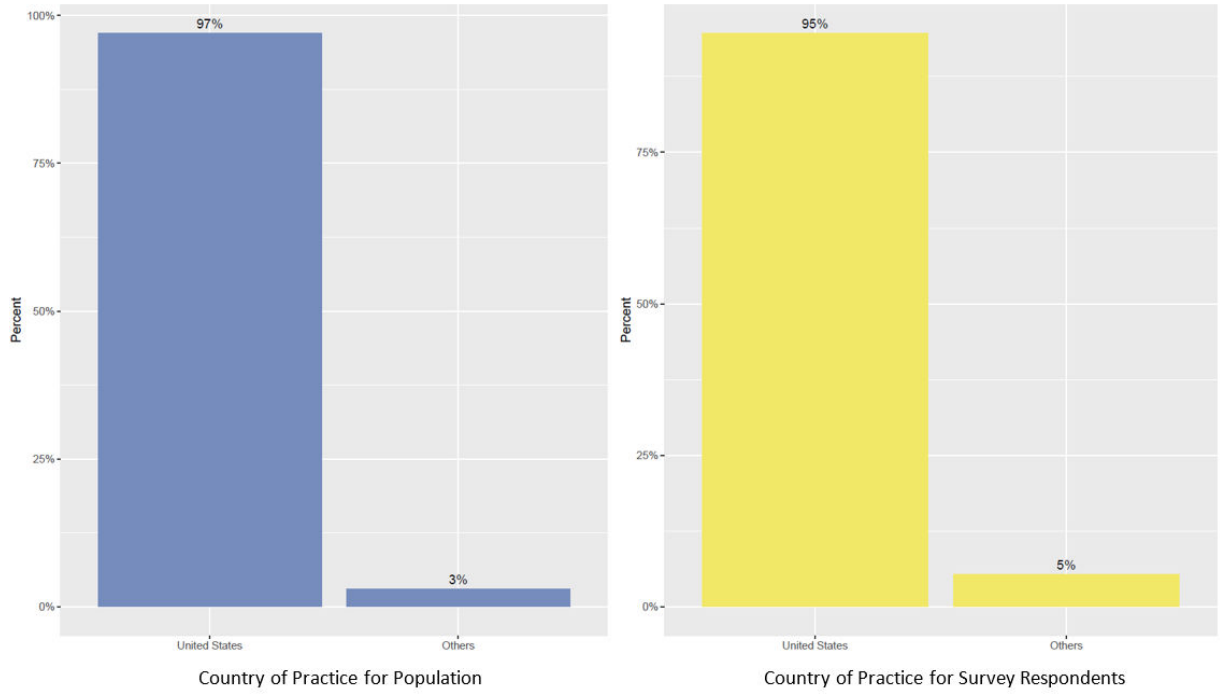


Figure 4. Comparison of U.S. Census Region of Population and Survey Respondents

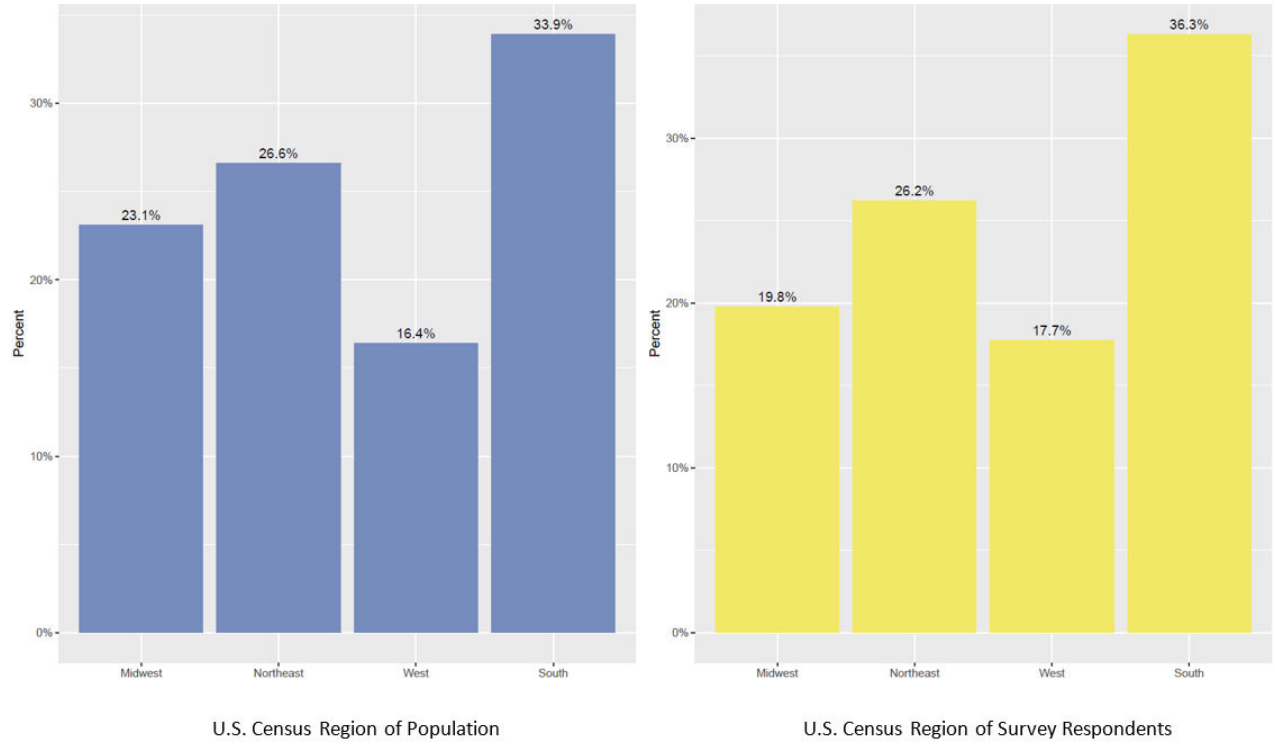
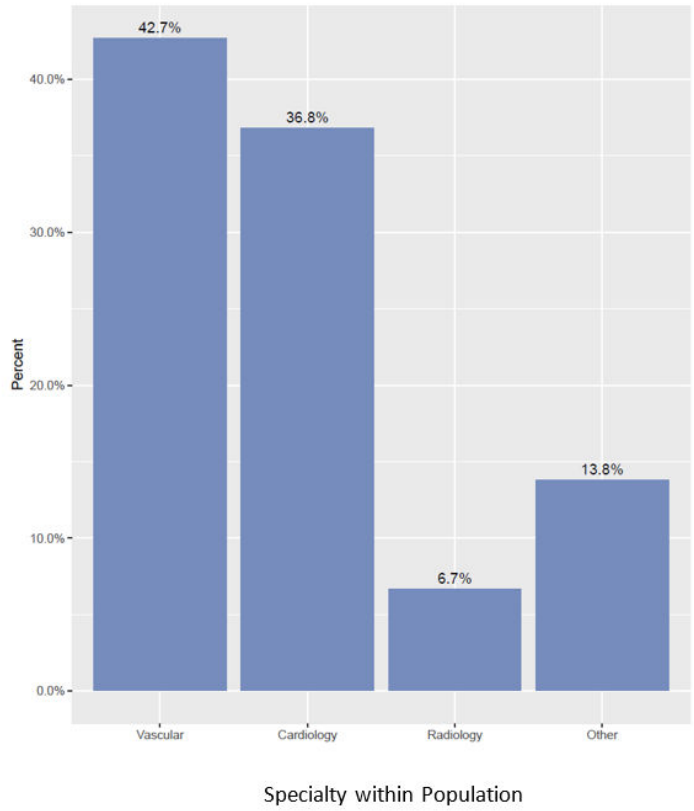
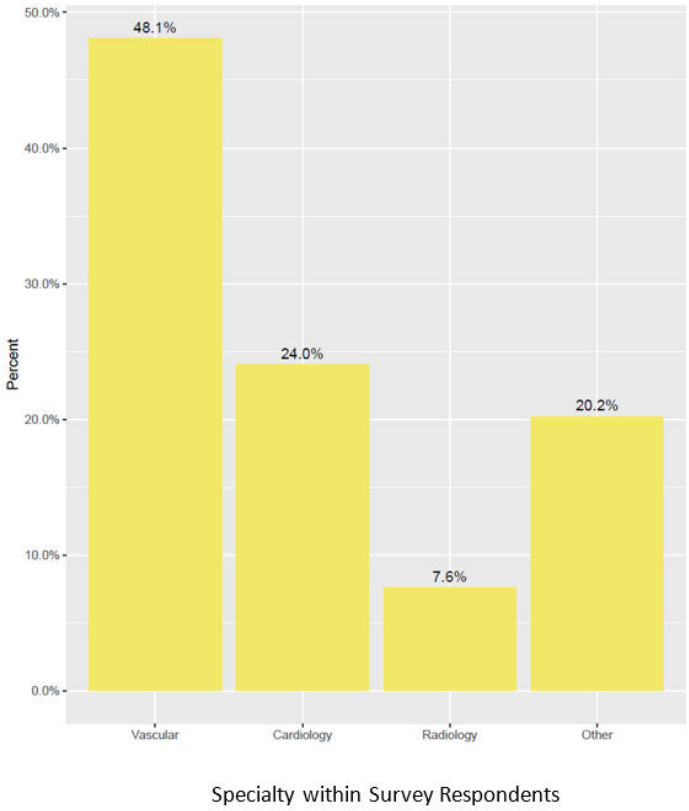


Figure 5. PVI Specialty of Population and Survey Respondents



Specialty within Population



Specialty within Survey Respondents

Appendix G: Content Outline

Physicians' Vascular Interpretation Examination Content Outline

(Outline Summary)

#	Domain	Subdomain	Percentage
1	Cerebrovascular	▪ *Interpret extracranial and intracranial ultrasound studies*	15%
2	Abdominal	▪ *Interpret aortoiliac ultrasound studies* ▪ *Interpret mesenteric ultrasound studies* ▪ *Interpret renal vascular studies*	15%
3	Peripheral Arterial – Duplex Imaging	▪ *Interpret peripheral arterial duplex studies* ▪ *Interpret bypass graft and stent ultrasound studies* ▪ *Interpret dialysis access graft ultrasound studies*	20%
4	Peripheral Arterial – Physiologic	▪ *Interpret physiologic arterial studies*	15%
5	Peripheral Venous	▪ *Interpret vein mapping studies* ▪ *Interpret venous duplex studies for thrombosis/obstruction* ▪ *Interpret venous insufficiency studies*	20%
6	Laboratory Technology and Operations	▪ *Physics and Instrumentation* ▪ *Patient Care and Quality Assurance*	15%

(Detailed Outline)

1.	Cerebrovascular 15%
1.A.	***Interpret extracranial and intracranial ultrasound studies***
1.A.1.	Assess vertebral artery
1.A.2.	Grade bulb and internal carotid artery stenosis using velocity criteria
1.A.3.	Assess plaque characteristics in the carotid arteries using gray scale and color
1.A.4.	Evaluate the carotid artery stenosis when contralateral disease is present
1.A.5.	Identify the effect of contralateral carotid artery disease on interpretation of internal carotid artery stenosis
1.A.6.	Identify indirect findings for more proximal and distal disease during a carotid exam when there is a non-visualized area
1.A.7.	Identify the result of cardiac disease on carotid artery waveforms
1.A.8.	Assess common carotid artery
1.A.9.	Assess external carotid artery

1.A.10.	Identify incidental findings on cerebrovascular duplex exams
1.A.11.	Assess nonatherosclerotic cerebrovascular disease within the carotid arteries
1.A.12.	Assess carotid arteries after intervention, (i.e., carotid endarterectomy or stent)
1.A.13.	Interpret intracranial cerebrovascular exams (e.g., identify emboli, stenosis, and vasospasm)
2.	**Abdominal 15%**
2.A.	***Interpret aortoiliac ultrasound studies***
2.A.1.	Evaluate aneurysmal disease
2.A.2.	Evaluate occlusive disease
2.A.3.	Evaluate non-atherosclerotic and/or non-aneurysmal disease
2.A.4.	Interpret post-endovascular aneurysm repair duplex exams
2.A.5.	Use Doppler techniques to evaluate for endoleak
2.B.	***Interpret mesenteric ultrasound studies***
2.B.1.	Assess for celiac compression
2.B.2.	Evaluate mesenteric arteries
2.B.3.	Identify stenosis post-visceral intervention
2.C.	***Interpret renal vascular studies***
2.C.1.	Evaluate renal artery stenosis (e.g., velocity, renal aortic-ratio, resistive indices, etc.)
2.C.2.	Interpret renal resistive indices to determine the presence of parenchymal renal disease
2.C.3.	Evaluate non-stenotic renal artery disease (e.g., FMD, aneurysm, etc.)
2.C.4.	Assess renal allografts
2.C.5.	Evaluate renal vasculature post intervention
3.	**Peripheral Arterial – Duplex Imaging 20%**
3.A.	***Interpret peripheral arterial duplex studies***
3.A.1.	Interpret peripheral arterial ultrasound studies of native vessels
3.A.2.	Interpret velocity and waveform morphology within upper extremity peripheral arteries to determine stenosis
3.A.3.	Interpret velocity and waveform morphology within lower extremity peripheral arteries to determine stenosis
3.A.4.	Assess peripheral arteries dimensions to detect aneurysm
3.A.5.	Assess for non-atherosclerotic disease within peripheral arteries
3.A.6.	Assess for arterial trauma
3.A.7.	Interpret arterial testing during provocative maneuvers to identify dynamic arterial obstruction
3.A.8.	Identify incidental findings during peripheral arterial studies to detect non-vascular pathologies

3.A.9.	Identify and treat peripheral artery pseudoaneurysms
3.B.	***Interpret bypass graft and stent ultrasound studies***
3.B.1.	Interpret peripheral arterial duplex after endovascular/minimally invasive intervention
3.B.2.	Interpret duplex after bypass grafts within peripheral arteries (vein conduit and prosthetic conduit)
3.C.	***Interpret dialysis access graft ultrasound studies***
3.C.1.	Interpret pre-dialysis vascular imaging to determine access site suitability (arterial and venous)
3.C.2.	Interpret post-arteriovenous access dialysis graft exam (e.g., restenosis aneurysm, patency, and complications, etc.)
3.C.3.	Apply volume flow measurements when evaluating arteriovenous dialysis access
3.C.4.	Use volume flow measurements of arteriovenous dialysis access to determine suitability for use in hemodialysis
4.	**Peripheral Arterial – Physiologic 15%**
4.A.	***Interpret physiologic arterial studies***
4.A.1	Interpret arterial Doppler waveform analysis on physiologic studies to detect arterial disease
4.A.2.	Interpret upper extremities segmental pressure studies
4.A.3.	Interpret lower extremities segmental pressure studies
4.A.4	Interpret pulse volume recordings of upper extremities
4.A.5.	Interpret pulse volume recordings of lower extremities
4.A.6.	Interpret exercise arterial studies
4.A.7.	Interpret toe pressures
4.A.8.	Interpret digital waveforms to detect both fixed and dynamic arterial disorders
4.A.9.	Interpret provocative testing for thoracic outlet syndrome using physiologic methods
4.A.10.	Interpret transcutaneous oxygen tension (TcPo2) testing
4.A.11.	Interpret Raynaud disease testing
5.	**Peripheral Venous 20%**
5.A.	***Interpret vein mapping studies***
5.A.1.	Interpret vein mapping to determine patency, size, and suitability of use
5.A.2.	Assess for anatomic venous variants related to vein mapping
5.B.	***Interpret venous duplex studies for thrombosis/obstruction***
5.B.1.	Assess upper extremity veins with compression and flow for deep vein thrombosis
5.B.2.	Assess upper extremity veins with compression and flow for superficial vein thrombosis
5.B.3.	Assess lower extremity veins with compression and flow for deep vein thrombosis
5.B.4.	Assess lower extremity veins with compression and flow for superficial vein thrombosis

5.B.5.	Assess veins and surrounding structures using venous waveforms for extrinsic venous compression
5.B.6.	Assess for central venous obstruction using venous waveforms
5.B.7.	Assess venous structures and flow for non-thrombotic venous disease
5.B.8.	Assess venous waveforms to recognize impact of cardiac comorbidities
5.B.9.	Assess inferior vena cava and iliac veins
5.B.10.	Asses for anatomic variants related to the peripheral veins
5.C.	***Interpret venous insufficiency studies***
5.C.1.	Assess for superficial venous reflux
5.C.2.	Assess for deep venous incompetence
5.C.3.	Assess for perforating veins
5.C.4.	Assess for superficial venous thrombosis during venous insufficiency testing
5.C.5.	Evaluate using venous duplex following venous ablation procedures
6.	**Laboratory Technology and Operations 15%**
6.A.	***Physics and Instrumentation***
6.A.1.	Identify bioeffects (e.g., cavitation, tissue heating)
6.A.2.	Modify output power following ALARA principle
6.A.3.	Recognize artifacts
6.A.4.	Identify pulsed wave (spectral) Doppler waveform characteristics
6.A.5.	Identify color Doppler waveform characteristics
6.A.6.	Identify power Doppler waveform characteristics
6.A.7.	Identify continuous wave Doppler waveform characteristics
6.A.8.	Identify gray-scale characteristics
6.A.9.	Select appropriate transducer for requested examination
6.B.	***Patient Care and Quality Assurance***
6.B.1.	Apply generally accepted infection control precautions and disinfectant techniques
6.B.2.	Recognize and communicate critical findings to referring provider to facilitate appropriate and timely clinical management
6.B.3.	Participate in quality assurance program (e.g., providing feedback regarding acquisition technique, determine agreement between preliminary and final reports)
6.B.4.	Correlate findings with adjunct imaging modalities
6.B.5.	Assess study indications to ensure appropriateness of selected test
6.B.6.	Calculate specificity, sensitivity, predictive value, and accuracy to compare with a referenced standard