



www.cardup.org

Canadian Association of Registered Diagnostic Ultrasound Professionals
PO Box 119
Kemptville ON K0G 1J0

Canadian Society of Diagnostic Medical Sonographers
PO Box 1220
Kemptville ON K0G 1J0



www.csdms.com

NATIONAL COMPETENCY PROFILES

GENERALIST SONOGRAPHER

CARDIAC SONOGRAPHER

VASCULAR SONOGRAPHER

VERSION 4.2

APPROVED BY THE BOARDS OF CARDUP & CSDMS NOVEMBER 2008

**ACCEPTED BY THE CANADIAN MEDICAL ASSOCIATION COMMITTEE ON CONJOINT ACCREDITATION FOR USE
IN PROGRAM ACCREDITATION EFFECTIVE JANUARY 2010**

This document replaces all earlier versions of the National Competency Profiles; item numbering from the earlier versions has been retained in order that external references to the NCPs may remain accurate.

Copyright © 2004-2009, Canadian Association of Registered Diagnostic Ultrasound Professionals. All rights reserved.

INTRODUCTION

This document lists the occupational competencies (job skills) of the three categories of entry-level sonographer that have been identified by the Canadian Association of Registered Diagnostic Ultrasound Professionals (CARDUP) as the basis for establishing a Canadian controlled registry of practitioners. As well as defining national registration categories, the Competency Profiles have been accepted by the Canadian Medical Association for incorporation into the requirements for accreditation of training programs. Accredited programs must ensure that their graduates possess all the competencies listed in the Profile for the relevant practitioner category. The Profile is a minimum training standard and programs are free to include additional skills, at their discretion.

The three practitioner categories are:

- the Generalist Sonographer
- the Cardiac Sonographer
- the Vascular Sonographer.

The three Competency Profiles are integrated, and include a common core of skills possessed by all practitioner categories. Category-specific skills build upon the core:

Generalist Skills	Cardiac Skills	Vascular Skills
COMMON CORE OF SKILLS		

The job skills are grouped into Competency Areas as follows:

1. Communication
2. Professional Responsibilities
3. Patient Assessment and Care
4. Operation of Equipment
5. Critical Thinking and Problem Solving
6. Workplace Health and Safety
7. Imaging

The Competency Areas are subdivided into General Competencies and Specific Competencies.

General Competencies are broad skill statements.

Specific Competencies are skills that have "stand-alone, job-outcome" significance in the workplace, and will be recognizable by employers, physicians or patients.

Specific Competencies may of course be further broken down into component tasks (creating "sub-competencies" or "enabling competencies"). CARDUP has not carried out this sub-division, since it is more appropriately done by educators as part of the training program design process.

INTRODUCTION

Each Specific Competency is designated as "core" (applying to all three practitioner categories) or as applying to just one or two practitioner categories.

Appendices to the competency profiles list essential knowledge and skills in the areas of:

1. Sonographic examination techniques
2. Pathophysiology (this section is currently under review)
3. Physics and Instrumentation (this section is currently under review)

Development and Validation of the National Competency Profiles

The Competency Profiles were originally developed by expert committees of practitioners and educators, and validated through national surveys of practicing sonographers and employers. Development and validation took place over a period of approximately three years, with funding support from Human Resources Development Canada. The Profiles were first published in April 2003. Minor revisions based upon user feedback took place in 2004 and 2006.

A complete review and re-validation was undertaken over the period March - October 2007 through the following process.

National surveys of Generalist Sonographers, Cardiac Sonographers and Vascular Sonographers, to determine the frequency-of-use of competencies in practice; the proportions of registered sonographers who responded to the surveys were Generalist 18%, Cardiac 9%, Vascular 19%

Identification by a Steering Committee of proposed changes to the profiles based upon frequency-of-use and practice trends; changes included additions to and deletions from the profiles, and changes in performance environments

A national survey of clinical departments that employ sonographers, to obtain feedback on the importance of certain entry-to-practice competencies in assisting departments respond effectively to future service demands; 56 departments responded with input on competency needs for Generalist Sonographers, 31 for Cardiac Sonographers, and 43 for Vascular Sonographers

Consultation with all Canadian sonography education programs, about the feasibility of adjusting to proposed changes in the profiles

Consultation with CARDUP's National Education Advisory Committee

INTRODUCTION

Final recommendations for competency changes were determined by the Steering Committee, based upon the following overlapping criteria:

In general, a competency was considered for inclusion in the profile if it was rated as being used with medium or higher frequency (“medium” was defined as 50% or more survey respondents rating use as “very frequent” or “frequent”)

Competencies with higher frequencies were more likely to be required to be demonstrated in “clinical” performance environments

If employers rated a current low-frequency-competency as important for the future, it was considered for inclusion in the profile

In cases where an educational program identified a legitimate reason for being unable to provide a certain clinical competency to its students, this sometimes resulted in reduction to a “simulated” or “academic” performance environment

Consideration was given to the precision constraints on frequency-of-use data extrapolated from survey responses; the level of uncertainty was sometimes quite significant in cases of small population and / or sample size

Changes to the profiles were approved by the CARDUP and CSDMS Boards in November 2007, with minor revisions in November 2008.

ACKNOWLEDGEMENTS

The CARDUP and CSDMS Boards of Directors wishes to acknowledge the involvement and support of the following organizations and individuals in the development and validation of the competency profiles:

Alberta Association of Medical Diagnostic and Therapeutic Technologies (AAMDTT)
Canadian Society of Echocardiography (CSE)
Canadian Society of Vascular Technologists (CSVST)
Canadian Sonographers who participated in the Practitioners Surveys
Catalysis Consulting
College of Medical Radiation Technologists of Ontario (CMRTO)
CSDMS Accreditation Committee members
Employers and physicians who participated in the Employer Needs and Department Heads Surveys
Human Resources & Social Development Canada
Northern Alberta Institute of Technology, Learning Technology Department
Ordre des Technologues en Radiologie du Québec
Project Education Task Force members
Project Clinical Assessment Task Force members
Project Steering Committee members
R.A. Malatest & Associates Ltd.
Society of Diagnostic Medical Sonographers (SDMS)
Staff members of the CARDUP & CSDMS Head Offices
Ultrasound Training Programs in Canada:
 British Columbia Institute of Technology, Burnaby, BC
 Northern Alberta Institute of Technology, Edmonton, AB
 Southern Alberta Institute of Technology, Calgary, AB
 Health Sciences Centre, Winnipeg, MB
 Michener Institute, Toronto, ON
 Mohawk College, Hamilton, ON
 Queen Elizabeth II/Dalhousie, Halifax, NS
 College of the North Atlantic, St. John's, NL

For further information on contributors, see the CARDUP Website at www.cardup.org

PERFORMANCE ENVIRONMENTS

In the Competency Profiles the Performance Environment specifies the setting in which the practitioner must demonstrate competence.

A Performance Environment is identified for every Specific Competency in Areas 1-6, and for every examination technique listed in Appendix 1. The following notation and definitions apply:

Performance Environment	Definition
A	The practitioner must have demonstrated an <i>academic understanding</i> of the competency. This involves the assessment learning in the cognitive domain and (where applicable) the affective domain.
S	The practitioner must have demonstrated the competency in a <i>simulated setting</i> . This involves the assessment of learning in the cognitive domain, the psychomotor domain and (where applicable) the affective domain, utilizing any of the following: <ul style="list-style-type: none"> > practical scenario > skill station > ultrasound simulator > phantom > live subject
C	The practitioner must have demonstrated the competency in a <i>clinical setting</i> with a patient. This involves the assessment of learning in the cognitive domain, the psychomotor domain and (where applicable) the affective domain. An acceptable clinical setting is a hospital or a health clinic.

The Performance Environment applies to the final assessment of competence. Where a simulated setting is specified, it is expected that a training program will provide academic orientation prior to simulation. Where a clinical setting is specified, it is expected that a training program will provide academic orientation and, where appropriate, simulation prior to clinical training.

The Performance Environment specified is the minimum requirement. Training programs are free to implement higher-level performance environments than required for any Specific Competency.

ASSESSING COMPETENCE - GUIDELINES FOR EDUCATIONAL PROGRAMS

In the context of the Competency Profiles, *competence* is defined as follows:

For Specific Competencies requiring *Academic Understanding (A)*:

Competence must be demonstrated by the student passing a credit course in which the competency is included as an identified learning outcome.

For Specific Competencies requiring *Simulated (S)* competence:

Competence must be demonstrated through simulation. Criteria for successful performance must be pre-established.

For Specific Competencies requiring *Clinical (C)* competence:

When presented with multiple exposures to a variety of patients, the student is deemed competent when (s)he performs this skill:

- independently 80% of the time, and
- within a reasonable timeframe 80% of the time, and
- produces an accurate result 80% of the time, and
- meets specified Critical Competencies*.

*** Critical Competencies must be demonstrated at all times (ie 100% of the time). These occur in Areas 1-6 and are indicated by bold type.**

Student performance relative to this standard must be determined by a CARDUP-approved clinical examiner.

AREA 1: COMMUNICATION

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
1.1 Practice effective oral communication.					
	a Identify self to patient.	C			
	b Communicate with patient throughout examination, in manner appropriate to patient's ability to understand.	C			
	d Explain examination procedure to patient.	C			
	e Question patient to obtain relevant information regarding history and condition.	C			
	f Communicate departmental reporting procedures to patient.	C			
	g Respond to patient questions or concerns.	C			
	h Communicate with patient's relatives and / or support persons.	C			
	i Provide professional, accurate and relevant patient history to reporting physician.	C			
	j Provide professional, accurate and relevant oral report of preliminary findings to reporting physician as required.	C			
	k Communicate effectively with all other health care professionals.	C			
	l Use medical terminology in oral communication.	C			
	m Apply conflict resolution strategies.	A			
1.2 Practice effective written communication.					
	a Verify written, authorized directions for examination.	C			
	c Record accurate and relevant medical history.	C			
	d Record examination procedures and results.	C			
	e Provide written summary of technical findings to physician when required.	C			
	g Verify that documentation is timely, accurate, concise and complete.	C			
	h Write correct medical terminology and abbreviations.	C			
1.3 Practice effective non-verbal communication.					
	a Display respect toward patients based on cultural differences, as encountered.	C			
	b Display respect toward patients based on age and gender differences.	C			
	d Respond appropriately to non-verbal behaviours.	C			
	e Practice adaptability in communication techniques with patients who have special needs.	C			

AREA 2: PROFESSIONAL RESPONSIBILITIES

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
2.1 Comply with written directives.					
	a Adhere to relevant legislation and regulations.	A			
	b Adhere to professional scope of practice.	A			
	c Adhere to departmental job descriptions, policies and procedures.	C			
	d Verify that examination complies with departmental protocols and guidelines, and address concerns as appropriate.	C			
	e Perform examination according to protocols of department.	C			
2.2 Use professional judgement.					
	a Verify that requested procedure correlates with patient's clinical history and presentation, and address concerns as appropriate.	C			
	b Evaluate patient preparation for requested examination.	C			
	c Verify that examination requirements are within personal clinical expertise.	A			
	d Ask for guidance where appropriate.	C			
	e Evaluate for contraindications to procedure and address as appropriate.	C			
	f Record exceptions from established protocols and procedures.	C			
	g Identify urgent sonographic findings.	C			
	h Respond to urgent findings.	C			
2.3 Utilize professional conduct.					
	a Maintain professional appearance.	C			
	b Maintain personal hygiene.	C			
	c Maintain appropriate personal interactions with other members of health care team.	C			
	d Generate a positive and collaborative atmosphere with all members of health care team.	C			
	e Practice within acceptable professional standards and code of ethics.	C			
	f Communicate with interpreting physician according to department policies and procedures.	C			
	g Share knowledge and expertise with colleagues, students and other members of health care team according to department policies and procedures.	C			
	h Participate in patient education according to department and/or professional policies and procedures.	C			
	i Explain to others the basic mode operation of ultrasound equipment, the possible biologic effects from such equipment and its various clinical uses.	C			
	j Demonstrate reliability, flexibility and adaptability.	C			
	m Arrange for assistance from appropriate personnel for chaperoned procedures.		A		
	n Demonstrate awareness of professional liability.	A			
	o Ensure informed patient consent.	C			

AREA 2: PROFESSIONAL RESPONSIBILITIES

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
2.4 Maintain professional competence.					
	a	Demonstrate awareness of need for continuing professional development.	A		
2.5 Maintain medico-legal responsibilities.					
	a	Maintain patient confidentiality.	C		
	b	Provide a safe environment relative to patient's physical and emotional rights and needs.	C		

AREA 3: PATIENT ASSESSMENT AND CARE

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
3.1 Ensure patient safety.					
a	Verify patient identification.	C			
b	Transport and / or move patient.	S			
c	Assess patient's ability to tolerate examination.	C			
d	Employ aseptic technique as required.	C			
e	Employ sterile technique and infection control methods as required.	C			
f	Assess and monitor patient's physical and mental status prior to and during examination.	C			
g	Recognize and respond to emergency situations.	A			
h	Administer first aid or provide life support in emergency situations.	S			
i	Perform cardiopulmonary resuscitation.	S			
j	Demonstrate awareness of patient's accessory equipment (eg intravenous fluid, suction equipment, oxygen) and take action as required.	A			
3.2 Enhance patient comfort.					
a	Perform examination in a timely manner.	C			
b	Determine need for additional personnel to assist in examination.	C			
c	Create an environment that protects patient modesty.	C			
e	Assess and respond to patient condition and needs.	C			
f	Modify procedure according to changes in patient's clinical status during examination.	C			
3.3 Provide assistance with clinical procedures.					
l	Assist in transesophageal echocardiography			C	
n	Assist in current interventional procedures.	A			

AREA 3: PATIENT ASSESSMENT AND CARE

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
3.4 Carry out related techniques and procedures.					
	a Assess for signs of vascular disease.				C
	b Measure blood pressure.			A	C
	c Perform provocative maneuvers.	C			
	d Perform stress echocardiography.			A	
	e Perform plethysmography - photo.				C
	f Select pressure cuff and place appropriately.				C
	g Perform arterial pressure testing and indices.				C
	h Perform exercise testing.				C
	i Perform continuous wave Doppler velocimetry.				C
	j Perform palpation of pulses.				C
	k Perform palpation of area of interest.		C		C
	l Set up appropriate electrocardiogram (ECG).			C	

AREA 4: OPERATION OF EQUIPMENT

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
4.1 Set up equipment utilizing knowledge of principles of physics and instrumentation listed in Appendix 3.					
	a Select optimum system and transducer for examination considering patient's age and size, as well as structures being examined and specific indications for examination.	C			
	b Determine and select correct pre-set values.	C			
	c Record pertinent patient data using keyboard or other input device.	C			
4.2 Use equipment to perform examination utilizing knowledge of principles of physics and instrumentation listed in Appendix 3.					
	a Perform sonographic examinations using real-time 2-D scanning.	C			
	b Perform sonographic examinations using M-mode.		C	C	
	c Perform sonographic examinations using pulsed wave Doppler.	C			
	d Perform sonographic examinations using colour Doppler.	C			
	e Perform sonographic examinations using power / amplitude Doppler.	C			
	f Perform sonographic examinations using continuous wave Doppler.			C	C
	g Verify correct orientation of transducer.	C			
	h Manipulate transducer.	C			
	i Select optimal acoustic window.	C			
	j Adjust controls to optimize 2-D display.	C			
	k Adjust controls to optimize Doppler display.	C			
	l Adjust controls to optimize M-Mode display.		C	C	
	m Use and optimize harmonic imaging.	C			
	n Monitor output display indices and adjust power output in accordance with "as low as reasonably achievable" (ALARA) principle.	C			
	o Identify artifacts and adjust instrument controls to optimize image.	C			
	q Measure structures as necessary.	C			
	r Measure M-mode tracings.		C	C	
	s Measure Doppler waveforms.	C			
	t Perform calculations manually.	A			
	u Use software calculation packages.	C			
	v Record patient position and plane of section on images.		C		
	w Process and record patient data.	C			
	x Archive and retrieve patient data.	A			
	y Operate recording devices.	C			
	z Perform sonographic examinations using tissue Doppler.			C	

AREA 4: OPERATION OF EQUIPMENT

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
4.3 Maintain equipment utilizing knowledge of principles of physics and instrumentation listed in Appendix 3.					
	c	Perform instrument quality control using test objects / phantoms.	A		
	e	Identify degraded instrument performance.	C		
	f	Perform basic trouble shooting prior to calling for technical support.	A		

AREA 5: CRITICAL THINKING AND PROBLEM SOLVING

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
5.1 Plan examination procedures utilizing knowledge of structures and conditions listed in Appendices 2.1 - 2.8.					
	a Interpret history, signs & symptoms and other relevant information.	C			
	b Assess medical history and health status.	C			
	c Modify scope of examination based on clinical history.	C			
	d Formulate sonographic scanning strategies.	C			
	e Integrate knowledge of anatomy and disease processes.	C			
5.2 Integrate relevant available diagnostic data.					
	a Correlate results from laboratory tests	A			
	b Correlate results from aspirations and biopsies.	A			
	c Correlate results from amniocentesis.		A		
	d Correlate results from chorionic villus sampling.		A		
	e Correlate results from chromosome analysis.		A		
	f Correlate results from dilatation and curettage.		A		
	g Correlate results from radiography.	A			
	h Correlate results from angiography.	A			
	i Correlate results from computerized tomography.	A			
	j Correlate results from nuclear medicine studies.	A			
	k Correlate results from magnetic resonance studies.	A			
	l Correlate results from oximetry tests.			A	A
	m Correlate results from ECG studies.			A	
	n Correlate results from auscultation.			A	A
	o Correlate results from non-stress testing.		A		
	p Correlate results from Holter monitoring.			A	
	q Correlate results from stress ECG studies.			A	
5.3 Obtain high quality images.					
	a Adjust patient positioning to advantage.	C			
	b Use breathing techniques to advantage .	C			
	c Evaluate images for orientation, identification, and labeling.	C			
	d Analyze and evaluate images for quality.	C			
	e Modify scope of examination based on sonographic findings.	C			
	f Generate improvement to image quality.	C			
	g Evaluate completeness of examination.	C			
	h Recognize equipment limitations.	C			
	i Recognize technical limitations.	C			

AREA 5: CRITICAL THINKING AND PROBLEM SOLVING

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
5.4 Provide technical analysis of sonographic data for physician interpretation, utilizing knowledge of structures and conditions listed in Appendices 2.1 - 2.8.					
	a	Differentiate artifact from anatomic and pathologic findings.	C		
	b	Differentiate normal variants from pathology.	C		
	c	Use spatial reasoning to interpret images.	C		
	d	Formulate and prioritize differential findings.	C		
	e	Formulate technical impression.	C		
	f	Provide oral summary of technical findings to interpreting physician.	C		
	g	Provide written summary of technical findings to interpreting physician.	C		

AREA 6: WORKPLACE HEALTH AND SAFETY

GENERAL COMP	SPECIFIC COMPETENCY		Core	Generalist	Cardiac	Vascular
6.1 Ensure safety of work environment.						
	a	Maintain clean and orderly work area.	C			
	b	Recognize hazardous conditions in the work area, and act when required.	C			
	d	Demonstrate awareness of fire and disaster plans.	A			
	e	Locate emergency equipment.	C			
	g	Employ universal precautions for infection control.	C			
6.2 Protect self from work-related hazards.						
	a	Employ proper body mechanics when transferring, lifting, turning or transporting patient.	C			
	b	Practice musculoskeletal injury prevention techniques.	C			
	c	Follow Workplace Hazardous Materials Information System (WHMIS) protocols.	A			

AREA 7: IMAGING

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
7.1 Perform obstetrical sonography.					
	a	Perform sonographic examination of structures of interest using techniques listed in Appendix 1.1.		See App 1.1	
	b	Differentiate sonographic appearance of normal structures from anomalous and pathologic conditions.		C	
	c	Recognize sonographic appearance of anomalous and pathologic conditions listed in Appendix 2.1.		A	
	d	Produce diagnostic data documenting sonographic findings as appropriate, based on the techniques listed in Appendix 1.1.		See App 1.1	
7.2 Perform gynecological sonography.					
	a	Perform sonographic examination of structures of interest using techniques listed in Appendix 1.2.		See App 1.2	
	b	Differentiate sonographic appearance of normal structures from anomalous and pathologic conditions.		C	
	c	Recognize sonographic appearance of anomalous and pathologic conditions listed in Appendix 2.2.		A	
	d	Produce diagnostic data documenting sonographic findings as appropriate, based on the techniques listed in Appendix 1.2.		See App 1.2	
7.3 Perform abdominal sonography.					
	a	Perform sonographic examination of structures of interest using techniques listed in Appendix 1.3.		See App 1.3	
	b	Differentiate sonographic appearance of normal structures from anomalous and pathologic conditions.		C	
	c	Recognize sonographic appearance of anomalous and pathologic conditions listed in Appendix 2.3.		A	
	d	Produce diagnostic data documenting sonographic findings as appropriate, based on the techniques listed in Appendix 1.3.		See App 1.3	

AREA 7: IMAGING

GENERAL COMP	SPECIFIC COMPETENCY	Core	Generalist	Cardiac	Vascular
7.4 Perform sonography of superficial structures.					
	a	Perform sonographic examination of structures of interest using techniques listed in Appendix 1.4.		See App 1.4	
	b	Differentiate sonographic appearance of normal structures from anomalous and pathologic conditions.		C	
	c	Recognize sonographic appearance of anomalous and pathologic conditions listed in Appendix 2.4.		A	
	d	Produce diagnostic data documenting sonographic findings as appropriate, based on the techniques listed in Appendix 1.4.		See App 1.4	
7.5 Perform basic musculoskeletal sonography.					
	a	Perform sonographic examination of structures of interest using techniques listed in Appendix 1.5.		A	
	b	Differentiate sonographic appearance of normal structures from anomalous and pathologic conditions.		A	
	c	Recognize sonographic appearance of anomalous and pathologic conditions listed in Appendix 2.5.		A	
7.6 Perform cardiac sonography.					
	a	Perform sonographic examination of structures of interest using techniques listed in Appendices 1.6 and 2.6.b.			See App 1.6 & 2.6.b
	b	Differentiate sonographic appearance of normal structures from anomalous and pathologic conditions.			C
	c	Recognize sonographic appearance of anomalous and pathologic conditions listed in Appendix 2.6.a.			A
	d	Produce diagnostic data documenting sonographic findings as appropriate, based on the techniques listed in Appendix 1.6.			See App 1.6

AREA 7: IMAGING

GENERAL COMP	SPECIFIC COMPETENCY		Core	Generalist	Cardiac	Vascular
7.7 Perform vascular sonography.						
	a	Perform sonographic examination of structures of interest using techniques listed in Appendix 1.7.		See App 1.7.a		See App 1.7.b
	b	Differentiate sonographic appearance of normal structures from anomalous and pathologic conditions.		C		C
	c	Recognize sonographic appearance of anomalous and pathologic conditions listed in Appendix 2.7.		A (see App 2.7.a)		A (see App 2.7.b)
	d	Produce diagnostic data documenting sonographic findings as appropriate, based on the techniques listed in Appendix 1.7.		See App 1.7.a		See App 1.7.b

APPENDIX 1.1: EXAMINATION TECHNIQUES FOR OBSTETRICAL SONOGRAPHY

The table below applies to Specific Competency 7.1.a, and lists the techniques the practitioner should be able to utilize when examining the structures and characteristics noted.

STRUCTURE / CHARACTERISTIC	TECHNIQUE						
	real time assessment (transvesical)	measure (2D)	endovaginal	transperineal	Doppler assessment	measure (Doppler)	M-mode
Maternal Pelvis							
Relational anatomy	C		C				
Cervix	C	C	C	A			
Fallopian tubes	C		C				
Gestational sac	C	C	C				
Ligaments	C		C				
Maternal uterus	C	C	C				
Membranes	C		C				
Ovaries	C	C	C				
Uterine vessels	C		C		A		
Yolk sac	C	C	C				
Maternal vagina	C						
Determination of fetal age							
Abdominal circumference (AC)	C	C					
Biparietal diameter (BPD)	C	C	A				
Embryo: crown rump length	C	C	C				

APPENDIX 1.1: EXAMINATION TECHNIQUES FOR OBSTETRICAL SONOGRAPHY

STRUCTURE / CHARACTERISTIC	TECHNIQUE						
	real time assessment (transvesical)	measure (2D)	endovaginal	transperineal	Doppler assessment	measure (Doppler)	M-mode
Estimated fetal weight (EFW)	C	C					
Femur length (FL)	C	C					
Gestational sac size	C	C	C				
Head circumference (HC)	C	C					
Humerus length (HL)	C	A					
Fetal Head							
Anterior ventricles (AV)	C	A					
Cavum septum pellucidum	C						
Cerebellum	C	C					
Cerebral vessels	A				A		
Choroid plexus	C						
Cisterna magna (CM)	C	C					
Falx	C						
Posterior ventricles (PV)	C	C					
Skull	C						
Thalami	C						
Third ventricle	C						

APPENDIX 1.1: EXAMINATION TECHNIQUES FOR OBSTETRICAL SONOGRAPHY

STRUCTURE / CHARACTERISTIC	TECHNIQUE						
	real time assessment (transvesical)	measure (2D)	endovaginal	transperineal	Doppler assessment	measure (Doppler)	M-mode
Spine							
Cervical spine	C						
Lumbo-sacral spine	C						
Thoracic spine	C						
Fetal Face							
Facial profile	C						
Mouth / lips	C						
Nasal bones	C	A					
Orbits	C	A					
Fetal Neck							
Nuchal fold	C	C					
Nuchal translucency	C	A					
Fetal Chest / Thorax							
Diaphragm	C						
Lungs	C						
Thoracic shape	C						

APPENDIX 1.1: EXAMINATION TECHNIQUES FOR OBSTETRICAL SONOGRAPHY

STRUCTURE / CHARACTERISTIC	TECHNIQUE						
	real time assessment (transvesical)	measure (2D)	endovaginal	transperineal	Doppler assessment	measure (Doppler)	M-mode
Fetal Heart							
4 Chamber fetal heart	C						
Aortic arch	C						
Heart rate	C		C				C
Long axis	C						
Outflow tracts	C						
Short axis	C						
Fetal Abdomen							
Adrenals	C						
Aorta	C				C		
Bowel	C						
Gallbladder	C						
Kidneys	C	C					
Liver	C						
Renal pelvis	C	C					
Spleen	C						
Stomach	C						
Umbilical artery	C				C	C	

APPENDIX 1.1: EXAMINATION TECHNIQUES FOR OBSTETRICAL SONOGRAPHY

STRUCTURE / CHARACTERISTIC	TECHNIQUE						
	real time assessment (transvesical)	measure (2D)	endovaginal	transperineal	Doppler assessment	measure (Doppler)	M-mode
Fetal Pelvis							
Bladder	C						
Genitalia	C						
Fetal Skin							
Contour	C						
Thickness	C	C					
Fetal Musculoskeleton							
Feet	C	A					
Femurs	C	C					
Fibula	C	A					
Hands	C						
Humerus	C	A					
Radius	C	A					
Ribs	C						
Tibia	C	A					
Ulna	C	A					
Determination of:							
Amniotic fluid pocket depth	C	C					
Amniotic fluid index (AFI)	C	C					
Chorio-amnionity	C		A				

APPENDIX 1.1: EXAMINATION TECHNIQUES FOR OBSTETRICAL SONOGRAPHY

STRUCTURE / CHARACTERISTIC	TECHNIQUE						
	real time assessment (transvesical)	measure (2D)	endovaginal	transperineal	Doppler assessment	measure (Doppler)	M-mode
Cord insertion	C				C		
Fetal lie	C						
Fetal presentation	C						
Number of fetuses	C		A				
Placenta grading	C						
Placental location	C		A	A			
Placental thickness	C	A					
Umbilical vessels	C				C	C	
Biophysical Profile							
Amniotic fluid	C	C					
Breathing	C						
Fetal movement	C						
Fetal tone	C						

APPENDIX 1.2: EXAMINATION TECHNIQUES FOR GYNECOLOGICAL SONOGRAPHY

The table below applies to Specific Competency 7.2.a, and lists the techniques the practitioner should be able to utilize when examining the structures and characteristics noted.

STRUCTURE / CHARACTERISTIC	TECHNIQUE				
	real time assessment (transvesical)	measure (2D)	endovaginal	Doppler assessment	sonohysterography
Adnexa	C		C		
Cervix	C		C		
Cul-de-sacs	C		C		
Endometrium	C	C	C		A
Fallopian tubes	C		C		A
Muscles & ligaments of the female pelvis	A		A		
Ovaries	C	C	C	C	
Uterus	C	C	C	A	A
Vagina	C				
Vasculature of the female pelvis	C		C	C	
Urinary bladder	C				
Relational anatomy	C		C		

APPENDIX 1.3: EXAMINATION TECHNIQUES FOR ABDOMINAL SONOGRAPHY

The table below applies to Specific Competency 7.3.a, and lists the techniques the practitioner should be able to utilize when examining the structures and characteristics noted.

STRUCTURE / CHARACTERISTIC	TECHNIQUE				
	real time assessment	measure (2D)	Doppler assessment	measure (Doppler)	transrectal
Abdominal wall	C				
Adrenal gland	A				
Biliary tract - GB wall & lumen	C	C			
Biliary tract - intrahepatic ducts	C	C			
Biliary tract - extrahepatic ducts	C	C			
Chest and thorax	A				
Gastrointestinal tract	A				
Liver - capsule, hilum	C				
Liver - lobes, segments, parenchyma	C	A	A		
Liver - ligaments, fissures	C				
Liver - hepatic veins	C		S		
Liver - hepatic arteries	A		A		
Liver - portal veins	C	A	S		
Male pelvis - prostate	C	C			A
Male pelvis - seminal vesicles	C				A
Male pelvis - urinary bladder	C	A			
Pancreas - head, body, tail, parenchyma	C	A	A		
Pancreas -common bile duct, pancreatic duct	C	C			
Peritoneal, retroperitoneal cavities / spaces	C				
Renal and urinary tract - bilateral capsules, parenchyma, hila	C	C	A	A	
Spleen - capsule, parenchyma, hilum	C	C	A		

APPENDIX 1.3: EXAMINATION TECHNIQUES FOR ABDOMINAL SONOGRAPHY

Spleen - splenic vein	C		S		
Spleen - splenic artery	A		A		
Vascular - aorta	C	C	S		
Vascular - common iliac arteries	C	C	S		
Vascular - IVC	C		S		
Vascular - renal arteries and veins	C		A		

APPENDIX 1.4: EXAMINATION TECHNIQUES FOR SONOGRAPHY OF THE SUPERFICIAL STRUCTURES

The table below applies to Specific Competency 7.4.a, and lists the techniques the practitioner should be able to utilize when examining the structures and characteristics noted.

STRUCTURE / CHARACTERISTIC	TECHNIQUE		
	real time assessment	measure (2D)	Doppler assessment
Breast	S		A
Knee	A	A	
Groin	A		A
Parathyroid / neck	A		
Salivary glands	A		
Scrotum	C	C	C
Superficial tissues	A		
Thyroid	C	C	C

APPENDIX 1.5: EXAMINATION TECHNIQUES FOR MUSCULOSKELETAL SONOGRAPHY

The table below applies to Specific Competency 7.5.a, and lists the techniques the practitioner should be able to utilize when examining the structures and characteristics noted.

STRUCTURE / CHARACTERISTIC	TECHNIQUE
	real time assessment
Elbow	A
Foot and ankle	A
Hand and wrist	A
Knee	A
Shoulder	A

APPENDIX 1.6: EXAMINATION TECHNIQUES FOR CARDIAC SONOGRAPHY

The table below applies to Specific Competency 7.6.a, and lists the techniques the Cardiac Sonographer should be able to utilize when examining the structures and characteristics noted. Additional information concerning measurements is provided in Appendix 2.6b.

STRUCTURE / CHARACTERISTIC	TECHNIQUE									
	2-D real time assessment	measure (2D)	M-mode assessment	measure - M-mode	pulsed wave Doppler assessment	measure - pulsed wave Doppler	continuous wave Doppler assessment	measure - continuous wave Doppler	colour Doppler assessment	measure - colour Doppler
Aorta, arch & branches	C	C			C	A	C	C	C	
Aorta, ascending	C	C			C	A	C	C	C	
Aorta, descending	C	C			C	C	C	C	C	
Aorta, root	C	C	C	C	C	C	C	C	C	
Appendages	A									
Atrium, left	C	C	C	C					C	
Atrium, right	C	C							C	
Cardiac position	C									
Chest & thorax (adjacent, extra-cardiac)	C									
Coronary vessels	A	A							A	
Outflow tract, left	C	C			C	C	C	C	C	
Outflow tract, right	C	C			C	C	C	C	C	
Pulmonary artery	C	A			C	C	C	C	C	
Pulmonary artery, bifurcation	C				A	A	A	A	C	

APPENDIX 1.6: EXAMINATION TECHNIQUES FOR CARDIAC SONOGRAPHY

STRUCTURE / CHARACTERISTIC	TECHNIQUE									
	2-D real time assessment	measure (2D)	M-mode assessment	measure - M-mode	pulsed wave Doppler assessment	measure - pulsed wave Doppler	continuous wave Doppler assessment	measure - continuous wave Doppler	colour Doppler assessment	measure - colour Doppler
Pulmonary veins	C				C	C			C	
Septum, inter-atrial	C				C	C	C	C	C	
Septum, inter-ventricular	C	C	C	C	C	C	C	C	C	
Normal situs	C									
Valve, aortic	C		C	C	C	C	C	C	C	C
Valve, mitral	C		C	A	C	C	C	C	C	C
Valve, pulmonic	C				C	C	C	C	C	A
Valve, tricuspid	C				C	C	C	C	C	C
Vena cava, inferior	C	C			C		C		C	
Vena cava, superior	A								A	
Ventricle, left	C	C	C	C					C	
Ventricle, right	C	C	C	C					C	
Wall layers (endo, myo, pericardium)	C	C	C	C						
Wall segments	C	C	C							

APPENDIX 1.7.a: EXAMINATION TECHNIQUES FOR VASCULAR SONOGRAPHY (GENERALIST SONOGRAPHER)

STRUCTURE / CHARACTERISTIC	TECHNIQUES				
	real time assessment	measure (2D)	pulsed wave Doppler assessment	measure - pulse wave Doppler	colour Doppler assessment
Extracranial cerebral arteries (carotids, vertebrals)	S	S	S	S	S
Jugular veins	A				C
Peripheral veins - lower extremity	C		C		C
Peripheral veins - upper extremity	A		A		A

note: these items will become C in May 2011

APPENDIX 1.7.b: EXAMINATION TECHNIQUES FOR VASCULAR SONOGRAPHY (VASCULAR SONOGRAPHER)

The table below applies to Specific Competency 7.7.a, and lists the techniques the Vascular Sonographer should be able to utilize when examining the structures and characteristics noted.

Appendix 1.7.b was changed in its entirety, April 2006.

STRUCTURE / CHARACTERISTIC	TECHNIQUES				
	real time assessment	measure (2D)	pulsed wave Doppler assessment	measure - pulsed wave Doppler	colour Doppler assessment
Abdominal vascular					
Aorta / iliac artery	C	C	C	C	S
Celiac artery	S	A	S	S	S
Superior mesenteric artery	S	A	S	S	S
Inferior mesenteric artery	A	A	A	A	A
Renal artery	S	A	S	S	S
Inferior vena cava / iliac vein	C	A	A	A	A
Extracranial arteries					
Common carotid artery	C	C	C	C	C
Internal carotid artery	C	C	C	C	C
External carotid artery	C	C	C	C	C
Vertebral artery	C	C	C	C	C
Subclavian artery	C	C	C	C	C
Intracranial artery	A	A	A	A	A

APPENDIX 1.7.b: EXAMINATION TECHNIQUES FOR VASCULAR SONOGRAPHY (VASCULAR SONOGRAPHER)

STRUCTURE / CHARACTERISTIC	TECHNIQUES				
	real time assessment	measure (2D)	pulsed wave Doppler assessment	measure - pulsed wave Doppler	colour Doppler assessment
Peripheral arteries, upper extremity					
Innominate artery	S	S	S	S	S
Subclavian artery	S	S	S	S	S
Axillary artery	S	S	S	S	S
Brachial artery	S	S	S	S	S
Forearm arteries	S	S	S	S	S
Peripheral arteries, lower extremity					
Iliac artery	C	C	C	C	C
Femoral artery	C	C	C	C	C
Popliteal artery	C	C	C	C	C
Calf arteries	C	C	S	S	S
Peripheral veins, upper extremity					
Jugular vein	S	S	S		S
Innominate vein	S	S	S		S
Subclavian vein	S	S	S		S
Axillary vein	S	S	S		S
Brachial vein	S	S	S		S
Forearm veins	A	A	A		S
Basilic vein	S	S	S		S
Cephalic vein	S	S	S		S

APPENDIX 1.7.b: EXAMINATION TECHNIQUES FOR VASCULAR SONOGRAPHY (VASCULAR SONOGRAPHER)

STRUCTURE / CHARACTERISTIC	TECHNIQUES				
	real time assessment	measure (2D)	pulsed wave Doppler assessment	measure - pulsed wave Doppler	colour Doppler assessment
Peripheral veins, lower extremity					
External iliac vein	C	C	C		C
Femoral vein	C	C	C		C
Popliteal vein	C	C	C		C
Calf veins	A	A	A		A
Saphenous vein	C	C	C		C
Grafts	C	C	C	C	C

APPENDIX 2.1: PATHOPHYSIOLOGY FOR OBSTETRICAL SONOGRAPHY

The following list denotes the structures and conditions of which the practitioner should have knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competency 7.1.c.

STRUCTURE	CONDITION / PATHOLOGY
Maternal uterus	
	Abnormal uterine artery flow
	Cervical cerclage
	Ectopic pregnancy - cervix
	Ectopic pregnancy - interstitial
	Ectopic pregnancy treatment
	Fibroids
	Focal myometrial contractions
	Incompetent cervix
	Intrauterine contraceptive device (IUCD)
	Postpartum complications
	Pseudocyesis
	Pseudogestational sac (ectopic)
	Synechiae
Maternal pelvis	
	Corpus luteum cysts
	Ectopic pregnancy - fallopian tube
	Ectopic pregnancy - maternal abdomen
	Ectopic pregnancy - ovarian
	Free fluid / ascites
	Urinary retention / hydronephrosis
Gestational sac	
	Absent double sac sign
	Anembryonic gestation (blighted ovum)
	Complete abortion
	Distorted sac shape
	Incomplete abortion (retained products of conception, RPOC)
	Inevitable abortion
	Low position
	Missed abortion
	Septic abortion
	Spontaneous abortion
	Threatened abortion

APPENDIX 2.1: PATHOPHYSIOLOGY FOR OBSTETRICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
Yolk sac	
	Yolk sac abnormalities
Membranes	
	Amniotic band syndrome (ABS)
	Acquired chorion amnion separation (CAS)
	Premature rupture of membranes (PROM)
	Prolapsed membranes
Embryo / fetus	
	Fetal demise
	Subcutaneous edema
Number and chorio-amnionicity	
	Conjoined twins
	Dichorionic diamniotic
	Discordant growth
	Dizygotic twins
	Heterotopic multiples
	Monochorionic diamniotic
	Monochorionic monoamniotic
	Monozygotic twins
	Triplet and higher order multiples
Placenta	
	Abnormal cord insertions
	Abnormal shapes
	Abruption
	Chorioangioma
	Choriocarcinoma
	Circumvallate placenta
	Cretas
	Gestational trophoblastic disease
	Marginal hematoma
	Persistent trophoblastic disease
	Placental infarction
	Placental membranacea
	Previa
	Retroplacental hematoma

APPENDIX 2.1: PATHOPHYSIOLOGY FOR OBSTETRICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Subchorionic hematoma
	Succenturiate
Cord	
	Abnormal cord Doppler
	Abnormal insertion
	Abnormal length
	Associated fetal anomalies
	Cord masses
	Nuchal cord
	Prolapsed cord
	Two vessel cord
	Umbilical cord knot
	Umbilical cysts and / or neoplasia
	Vasa previa
Amniotic fluid	
	Oligohydramnios
	Polyhydramnios
Lie & presentation	
	Complete breech
	Footling breech
	Frank breech
	Transverse lie
Cranium, brain, spine	
	Acrania (exencephaly)
	Agenesis corpus callosum
	Anencephaly
	Arnold Chiari type II malformation
	Banana sign
	Brachycephaly
	Choroid plexus cysts
	Dandy-Walker malformations
	Dolicocephaly
	Encephalocele
	Holoprosencephaly
	Hydranencephaly

APPENDIX 2.1: PATHOPHYSIOLOGY FOR OBSTETRICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Hydrocephalus
	Intracranial calcifications
	Intracranial cysts
	Lemon sign
	Macrocephaly
	Meningomyelocele
	Microcephaly
	Sacral agenesis
	Sacroccocygeal teratoma (SCT)
	Spina bifida
	Strawberry sign
	Tumours
	Vein of Galen aneurysm
	Ventriculomegaly
Face and neck	
	Cleft lip
	Cleft palate
	Cystic hygroma
	Hypertelorism
	Hypotelorism
	Increased nuchal translucency
	Macroglossia
	Micrognathia
	Nasal bone
	Nuchal fold thickening
	Proboscis
Abdomen / pelvis	
	Adrenal pathology
	Anal atresia
	Ascites
	Asplenia / polysplenia
	Autosomal recessive polycystic kidney disease
	Bladder extrophy
	Cysts
	Duodenal atresia (double bubble)

APPENDIX 2.1: PATHOPHYSIOLOGY FOR OBSTETRICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Echogenic bowel
	Esophageal atresia
	Gastroschisis
	Hepatosplenomegaly
	Hydrocele
	Jejunal-ileal obstruction
	Multicystic dysplastic kidney
	Omphalocele
	Renal agenesis
	Urinary tract obstructions
Lungs, chest / thorax	
	Bronchogenic cyst
	Congenital diaphragmatic hernias
	Cystic adenomatoid malformations
	Lung tumours
	Mediastinal shift
	Pleural effusions
	Pulmonary hypoplasia
	Pulmonary sequestration
	Tracheoesophageal fistula
Heart	
	Abnormal size
	Abnormal orientation
	Arrhythmias
	Chamber abnormalities
	Congestive heart failure
	Ebstein anomaly
	Echogenic cardiac focus
	Ectopic cordis
	Great vessel abnormalities
	Pericardial effusion
	Rhabdomyoma
	Septal defects

APPENDIX 2.1: PATHOPHYSIOLOGY FOR OBSTETRICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
Musculoskeleton	
	Abnormal bone density
	Abnormal number
	Abnormal position
	Abnormal shape
	Abnormal size
	Absence
Biophysical profile	
	Abnormal cord waveforms
	Abnormal score
Syndromes / disorders	
	Achondrogenesis
	Amniotic band syndrome
	Beckwith-Wiedemann syndrome
	Caudal regression syndrome
	Fetal alcohol syndrome
	Heterozygous achondroplasia
	Hydrops
	Hypophosphatasia
	Meckel-Gruber syndrome
	Osteogenesis imperfecta
	Pentalogy of Cantrell
	Potter's syndrome
	Prune belly syndrome
	Situs inversus
	Stuck twin syndrome
	Thanatophoric dwarfism
	Twin-reversed arterial perfusion (TRAP) syndrome
	Triploidy
	Trisomy 13
	Trisomy 18 (Edward's)
	Trisomy 21 (Down's)
	Turner's syndrome
	Twin embolization syndrome (TES)
	Twin to twin transfusion syndrome

APPENDIX 2.1: PATHOPHYSIOLOGY FOR OBSTETRICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Vertebral defects, anal atresia, cardiac defects, tracheo-esophageal fistula with esophageal atresia, radial and renal defects (VACTERL)
Maternal disorders	
	Immune hydrops
	Diabetes
	Eclampsia
	Hemolytic anemia, elevated liver enzymes and low platelet count (HELLP)
	Hypertension
	Pre-eclampsia
	Teratogens
	Toxoplasma gondii, rubella virus, cytomegalo virus & herpes simplex type 2 infection (TORCH)
Fetal growth	
	Intrauterine growth restriction (IUGR)
	Macrosomia

APPENDIX 2.2: PATHOPHYSIOLOGY FOR GYNECOLOGICAL SONOGRAPHY

The following list denotes the structures and conditions of which the practitioner should have a knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competency 7.2.c.

STRUCTURE	CONDITION / PATHOLOGY
Uterus	
	Adenomyosis
	Arteriosclerosis (Monckeberg's)
	C-section scar
	Didelphic uterus
	Diethylstilbestrol (DES)
	Fibroids - intramural
	Fibroids - pedunculated
	Fibroids - submucosal
	Fibroids - subserosal
	IUCD - complications
	IUCD - location
	IUCD - types
	Leiomyosarcoma
	Monckeberg's arteriosclerosis
	Position / lie (abnormal)
	Uni / bicornuate uterus
	Uterus arcuatus
	Uterus septus
Fallopian tubes	
	Cysts of Morgagni
	Hydro / hemato / pyosalpinx
	Tubo-ovarian abscess (TOA)
Ovaries	
	Brenner tumour
	Endometrioma
	Follicular cysts
	Functional corpus luteum
	Granulosa cell tumour
	Hemorrhagic cyst

APPENDIX 2.2: PATHOPHYSIOLOGY FOR GYNECOLOGICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Metastatic spread (Krukenburg)
	Mucinous cystadenocarcinoma
	Mucinous cystadenoma
	Ovarian torsion
	Parovarian cysts
	Polycystic ovarian disease (PCOD)
	Serous cystadenocarcinoma
	Serous cystadenoma
	Sertoli leydig cell tumour
	Teratoma (solid and cystic)
	Theca lutein cysts
	Tubo-ovarian abscess (TOA)
Cervix	
	Hydro / hemato / pyometra
	Hydro / hemato / pyometracolpos
	Nabothian cysts
	Polyps
Vagina	
	Gartner duct cyst
	Hydro / hemato / pyometra
	Hydro / hemato / pyometracolpos
Endometrium	
	Carcinoma
	Endometrial atrophy
	Endometritis
	Hydro / hemato / pyometra
	Hyperplasia
	Polyps
Muscles & ligaments of the pelvic cavity	
	Pedunculated fibroids / extrinsic masses
	Pelvic ascites
Cul-de-sacs	
	Free fluid in anterior cul-de-sac
	Free fluid in posterior cul-de-sac

APPENDIX 2.2: PATHOPHYSIOLOGY FOR GYNECOLOGICAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
Infertility	
	Assisted reproductive technology
	Infertility - female factors
	Primary infertility
	Secondary infertility
Surgery	
	Cervical cerclage
	Endometrial ablation
	Oophorectomy
	Partial hysterectomy
	Salpingoophorectomy
	Total hysterectomy
Syndromes and conditions	
	Acute pelvic inflammatory disease (PID)
	Asherman's syndrome
	Chronic PID
	Endometriosis / endometrioma
	Meig's syndrome
	Ovarian hyperstimulation

APPENDIX 2.3: PATHOPHYSIOLOGY FOR ABDOMINAL SONOGRAPHY

The following list denotes the structures of which the practitioner should have a knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competencies 7.3.c.

STRUCTURE	CONDITION / PATHOLOGY
Abdominal wall	
	Abscess
	Hematoma - rectus sheath
	Hernia
	Trauma
	Tumour
Adrenal gland	
	Adenoma
	Adrenal lymphoma
	Carcinoma
	Congenital hyperplasia
	Cyst
	Hemorrhage
	Hyperadrenalism
	Hypoadrenalism
	Metastases
	Neuroblastoma
	Pheochromocytoma
Biliary tract	
	Biliary ascaris
	Biliary atresia
	Biliary obstruction
	Biliary sludge
	Caroli's disease
	Cholangiocarcinoma - Klatskin's tumour
	Cholangitis
	Cholecystitis
	Choledochal cyst
	Choledocholithiasis
	Cholelithiasis
	Gallbladder - agenesis
	Gallbladder - Courvoisier's

APPENDIX 2.3: PATHOPHYSIOLOGY FOR ABDOMINAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Gallbladder - duplication
	Gallbladder - porcelain
	Gallbladder adenocarcinoma
	Gallbladder adenoma
	Gallbladder adenomyomatosis
	Gallbladder cholesterolosis (strawberry)
	Gallbladder hydrops (mucocele)
	Gallbladder perforation
	Gallbladder polyp
	Gallbladder wall thickening
	Gallbladder -wall echo shadow (WES) sign
	Hematobilia
	Junctional fold
	Metastases
	Mirizzi's syndrome
	Phrygian cap
	Pneumobilia
Chest and thorax	
	Pleural effusion
Gastrointestinal tract	
	Acute appendicitis
	Apendiceal abscess
	Carcinoma
	Crohn's disease
	Diverticular disease
	Duplication cyst
	Hypertrophic pyloric stenosis
	Intussusception
	Lymphoma
	Mechanical bowel obstruction
	Metastases
	Mucocele of appendix
	Perforation of appendix
	Retrocecal appendix
	Ulcerative colitis

APPENDIX 2.3: PATHOPHYSIOLOGY FOR ABDOMINAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Wall thickening
Liver	
	Adenoma
	Amebic abscess
	Budd chiari syndrome
	Calcifications / granuloma
	Candidiasis
	Cirrhosis
	Fatty infiltration focal & diffuse
	Focal nodular hyperplasia
	Glycogen storage disease
	Hemangioma
	Hematoma / trauma
	Hepatic artery aneurysm
	Hepatitis - acute viral
	Hepatitis - chronic
	Hepatoblastoma
	Hepatocellular carcinoma
	Hepatomegaly
	Hydatid liver disease
	Lipoma
	Liver cyst - simple / congenital
	Metastatic disease
	Passive liver congestion
	Pneumocystis carinii (AIDS)
	Portal air
	Portal hypertension
	Portal vein thrombosis
	Pyogenic abscess
	Transplant
	Transjugular intrahepatic portosystemic shunt (TIPS)
Male pelvis	
	Abscess
	Benign prostatic hyperplasia
	Calcifications

APPENDIX 2.3: PATHOPHYSIOLOGY FOR ABDOMINAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Carcinoma
	Cyst
	Prostatitis
	Transurethral retrograde prostatectomy (TURP)
Pancreas	
	Abscess
	Adenocarcinoma
	Annular pancreas
	Congenital cysts
	Cystadenocarcinoma
	Cystadenoma
	Cystic fibrosis
	Islet cell tumour
	Metastases
	Pancreatic lithiasis
	Pancreatitis
	Pseudocyst
Peritoneal cavity	
	Abscess
	Ascites / free fluid
	Free air
	Implants - metastatic
	Mesenteric cyst
	Peritonitis
Retroperitoneum	
	Abscess
	Fluid collections
	Hemorrhage / hematoma
	Lymphadenopathy
	Lymphoma
	Retroperitoneal fibrosis
	Tumour
Renal and urinary tract	
	Abscess
	Acute renal failure

APPENDIX 2.3: PATHOPHYSIOLOGY FOR ABDOMINAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Acute tubular necrosis
	Angiomyolipoma
	Arteriovenous fistula
	Autosomal dominant (AD) polycystic kidney disease
	Autosomal recessive (AR) polycystic kidney disease
	Bladder - blood clot
	Bladder - diverticulum
	Bladder calculus
	Bladder diverticulum
	Bladder masses
	Bladder outlet obstruction
	Candidiasis
	Chronic renal failure
	Compensatory hypertrophy
	Congenital mega calyces
	Congenital megaureter
	Crossed renal ectopia
	Cyst
	Cystitis
	Duplex collecting system
	Ectopic kidney / renal ptosis
	Extra renal pelvis
	Fetal lobulation
	Hematoma - renal
	Horseshoe kidney
	Hydronephrosis
	Hypertrophied column of Bertin
	Junctional parenchymal defect
	Juxtaglomerular tumour
	Medical renal disease
	Medullary cystic disease
	Medullary sponge kidney
	Metastases
	Multicystic kidney disease
	Nephroblastoma

APPENDIX 2.3: PATHOPHYSIOLOGY FOR ABDOMINAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Nephrolithiasis
	Neurogenic bladder
	Obstruction - ureteropelvic junction (UPJ)
	Obstruction - ureterovesicle junction (UVJ)
	Oncocytoma
	Posterior urethral valves
	Pseudoaneurysm
	Pyelocaliectasis of pregnancy
	Pyelonephritis
	Pyonephrosis
	Renal artery stenosis
	Renal cell carcinoma
	Renal hypoplasia
	Renal infarction
	Renal lymphoma
	Renal sinus lipomatosis
	Renal stents
	Renal tuberculosis
	Renal vein thrombosis
	Staghorn calculus
	Supernumerary kidney
	Transitional cell carcinoma
	Transplants
	Tuberous sclerosis
	Unilateral renal agenesis
	Urachal anomalies
	Ureterocele
Spleen	
	Accessory spleen
	Calcifications
	Candidiasis
	Cyst
	Granulomatous disease
	Hemangioma
	Hematoma/trauma

APPENDIX 2.3: PATHOPHYSIOLOGY FOR ABDOMINAL SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Lymphoma
	Metastases
	Polysplenia
	Splenic abscess
	Splenic artery aneurysm
	Splenic infarction
	Splenomegaly
	Wandering spleen
Vascular - aorta / iliac arteries	
	Aneurysm - dissecting
	Aneurysm - fusiform
	Aneurysm - infected
	Aneurysm - saccular
	Aortic - ectasia
	Atherosclerosis
	Grafts
	Stenosis
Vascular - IVC	
	Caval filters
	Pseudoaneurysm
	Venous - thrombus
	Venous - tumour
	Venous compression due to extrinsic mass
	Venous distension due to cardiac pathology
Syndromes and conditions	
	Situs inversus

APPENDIX 2.4: PATHOPHYSIOLOGY FOR SONOGRAPHY OF THE SUPERFICIAL STRUCTURES

The following list denotes the structures and conditions of which the practitioner should have a knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competency 7.4.c.

STRUCTURE	CONDITION / PATHOLOGY
Breast	
	Augmentation / implants
	Calcifications
	Cysts
	Fibroadenoma
	Malignant tumour
	Mastitis / abscess
Knee (popliteal fossa)	
	Baker's cysts
	<i>Item deleted April 3 2004</i>
Groin	
	Hematoma
	Hernias
	Lymphadenopathy
	Pseudo aneurysm
Parathyroid / neck	
	Branchial cleft cyst
	Hyperparathyroidism
	Hyperplasia
	Lymphadenopathy
	Parathyroid adenoma
	Parathyroid carcinoma
	Thyroglossal duct cyst
Salivary glands	
	Calculi
	Mass
	Obstruction
Scrotum / testicle	
	Abscess
	Calculi
	Cryptorchidism

APPENDIX 2.4: PATHOPHYSIOLOGY FOR SONOGRAPHY OF THE SUPERFICIAL STRUCTURES

STRUCTURE	CONDITION / PATHOLOGY
	Cysts
	Epididymitis
	Hematocele
	Hernias
	Hydrocele
	Infarction
	Lymphoma
	Metastases
	Microlithiasis
	Orchitis
	Prosthesis
	Pyocele
	Spermatocele
	Torsion
	Trauma
Tumours	
Varicocele	
Superficial tissue	
	Foreign bodies
	Masses
Thyroid gland	
	Calcifications
	Benign nodules
	Congenital abnormalities
	Cysts
	Goiter
	Graves Disease
	Hemithyroidectomy
	Hyperplasia
	Hyperthyroidism
	Hypothyroidism
	Malignant nodules
	Metastases
	Thyroiditis

APPENDIX 2.5: PATHOPHYSIOLOGY FOR MUSCULOSKELETAL SONOGRAPHY

The following list denotes the structures of which the practitioner should have a knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competency 7.5.c.

STRUCTURE	CONDITION / PATHOLOGY
Shoulder (Rotator Cuff)	
	Acute / chronic tendinitis
	Partial / complete tear
	Effusion
Elbow	
	Bursitis
	Acute / chronic tendinitis
	Effusion
Hand/Wrist	
	Acute / chronic Tenosynovitis
Knee	
	Patellar bursitis
	Acute / chronic tendinitis (patellar tendon)
	Partial / complete tear (patellar tendon)
	Baker's cyst
	Effusion
Foot/Ankle	
	Calcaneal bursitis
	Acute / chronic Achilles tendinitis
	Partial / complete tear (Achilles tendon)

APPENDIX 2.6.a: PATHOPHYSIOLOGY FOR CARDIAC SONOGRAPHY

The following list denotes the structures of which the Cardiac Sonographer should have a knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competency 7.6.c.

STRUCTURE	CONDITION / PATHOLOGY
Cardiac position	
	Dextrocardia
	Dextroposition
	Mesocardia
Situs (cardiac, abdominal)	
	Situs inversus
Chambers	
	Cardiac catheters
	Chamber dysplasias / hypoplasias
	Chiari network
	Congestive heart failure
	Cor triatriatum dexter
	Dilatation of ventricle and / or atrium
	Double outlet right ventricle
	False tendons
	Hypertrophy of ventricle and / or atrium
	Myxomas and other tumours
	Pacemaker wires
	Thrombus / thrombi
Septi	
	Atrial septal defects
	Atrio-ventricular canals
	Endocardial cushion defects
	Persistent fetal circulation
	Ventricular septal defects
Valves	
	Ebstein's anomaly
	Endocarditis (vegetations)
	Flail / rupture of valves
	Mitral annular calcification
	Rheumatic heart disease
	Rupture of papillary muscles

APPENDIX 2.6.a: PATHOPHYSIOLOGY FOR CARDIAC SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Subvalvular stenosis (aortic, pulmonic)
	Supravalvular stenosis (aortic, pulmonic)
	Valvular atresia
	Valvular prolapse
	Valvular regurgitation
	Valvular rings (supra / sub)
	Valvular stenosis (congenital, acquired)
Great vessels	
	Aneurysms
	Coarctation of the aorta
	Dissections
	Patent ductus arteriosus
	Persistent left SVC
	Sinuses of valsalva (rupture, aneurysms)
	Transpositions of the great arteries
	Truncus arteriosus
Coronary vessels	
	Aneurysms
	Coronary artery disease
Pulmonary veins	
	Anomalous pulmonary venous return
Wall layers	
	Absent pericardium (congenital, acquired)
	Aneurysms
	Cardiac masses
	Dilated (congestive) cardiomyopathy
	Endocardial fibroelastosis
	Hypertrophic cardiomyopathy
	Idiopathic hypertrophic subaortic stenosis
	Infiltrative (restrictive) cardiomyopathy
	Obliterative (restrictive) cardiomyopathy
	Pericardial cysts
	Pericardial effusion
	Pericardial tamponade
	Pericarditis

APPENDIX 2.6.a: PATHOPHYSIOLOGY FOR CARDIAC SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Postpartum cardiomyopathy
	Pseudoaneurysms
Wall segments	
	Infarction
	Ischemia
	Wall motion abnormalities
Blood flow pattern (hemodynamic problems)	
	Diastolic dysfunction
	Eisenmenger's syndrome
	Inflow abnormalities
	Outflow abnormalities
	Pulmonic hypertension
	Systemic hypertension
	Systolic dysfunction
	Ventricular pressure overload
	Ventricular volume overload
Conduction pathway	
	Arrhythmias
	Atrio-ventricular blocks
	Bundle branch blocks (left, right)
Syndromes, other	
	Dressler's syndrome
	Kawasaki's syndrome
	Marfan's syndrome
	Tetralogy of Fallot
Chest & abdomen	
	Pleural effusion
	Pleural masses
	Subphrenic fluid
Post-operative	
	Coarctation repair
	Heart transplant
	Inter-chamber shunt assessment
	Mitral commissurotomy
	Patent ductus arteriosus (PDA) repair

APPENDIX 2.6.a: PATHOPHYSIOLOGY FOR CARDIAC SONOGRAPHY

STRUCTURE	CONDITION / PATHOLOGY
	Prosthetic valve assessment
	Rastelli-Fontan-Jatene switch
	Septal patches
	Tetralogy repair

APPENDIX 2.6.b: MEASUREMENTS IN CARDIAC SONOGRAPHY

The following list defines common measurements of which the Cardiac Sonographer should have knowledge, in order to perform general competencies 5.1 & 5.4, and specific competency 7.6.a. Further information regarding these measurements may be obtained from the American Society of Echocardiography and the Canadian Society of Echocardiography.

<http://www.csecho.ca/cardiomath/>

<http://www.asecho.org/>

Aortic Stenosis	
Peak and mean pressure gradient, corrected gradient V1/V2	
$\Delta P = P_2 - P_1 = 4(V_2^2 - V_1^2)$	
Where:	<p>V₁ Proximal velocity V₂ Distal velocity ΔP Instantaneous pressure gradient</p>
Aortic Valve Area by VTI or Vmax	
$AVA = \frac{\pi * (LVOT/2)^2 * VTI_1}{VTI_2}$	
Where:	<p>VTI₁ Subvalvular velocity time integral (V1) VTI₂ Maximum velocity time integral across the valve (V2) LVOT Left ventricular outflow tract diameter AVA Aortic valve area</p>
Aortic Regurgitation	
<p>Diastolic flow reversal in the descending aorta Diastolic flow reversal in the abdominal aorta Vena contracta</p>	

APPENDIX 2.6.b: MEASUREMENTS IN CARDIAC SONOGRAPHY

PFO / ASD

Peak gradient across the defect

Mitral Stenosis

Peak and mean pressure gradient, mitral valve area using pressure half time

$$MVA = \frac{220}{PHT}$$

Where:

PHT Pressure half time

MVA Mitral valve area

$$MVA = 2\pi r^2 \times (\alpha / 180) \times (V_r / V_{max})$$

$2\pi r^2$ Proximal isovelocity hemispheric surface area at a radial distance r from the orifice

V_r Aliasing velocity at the radial distance r

V_{max} Peak mitral stenosis velocity by CW

α Angle between two mitral leaflets on the atrial side [degree^o]

APPENDIX 2.6.b: MEASUREMENTS IN CARDIAC SONOGRAPHY

Mitral Regurgitation

Vena contracta

Pulmonary venous systolic flow reversal

A mitral valve E velocity of greater than 1.6 m/sec (indicates significant volume)

Effective regurgitant volume and regurgitant volume using PISA

$$VFR = 2 * \pi * r^2 * V_r$$

$$ERO = \frac{VFR}{V_{max}}$$

$$RVol = ERO * VTI$$

$2 * \pi * r^2$ Proximal isovelocity hemispheric surface area at a radial distance from the orifice

V_r Aliasing velocity at the radial distance r

V_{max} Peak velocity of the mitral regurgitant jet

VTI VTI of the mitral regurgitant jet

VFR Volume flow rate

ERO Effective regurgitant orifice

RVol Regurgitant volume

Tricuspid Stenosis

Peak and mean pressure gradient

Tricuspid Regurgitation

Calculation of estimated right ventricular systolic measurements

Add estimated RA pressure (determined by IVC size and respiratory reactivity) + TR maximum velocity

Pulmonary Stenosis

Peak and mean pressure gradient

APPENDIX 2.6.b: MEASUREMENTS IN CARDIAC SONOGRAPHY

Pulmonary Regurgitation

End diastolic velocity for estimation of pulmonary pressures

Diastolic Workup

Mitral Valve E and A wave peak velocity

E/A ratio

Mitral Valve deceleration time (E wave)

Mitral Valve A wave duration (ratio with Pulm. Ven)

Pulmonary venous flow (systolic, diastolic, and a wave reversal)

Mitral annular tissue Doppler septal and lateral peak Ea (or e')

E/Ea ratio <8 is very specific for a PCWP <15 mmHg while a ratio >15 is very specific for elevated pressures >15 mmHg. Between 8 and 15, there is a gray zone with overlapping of values for PCWP.

$$PWCP = 1.24 \frac{E}{Ea} + 1.9$$

Where:

E Mitral inflow E velocity

Ea Early diastolic velocity of mitral annulus

E/Ea E/Ea ratio

PCWP Mean pulmonary capillary wedge pressure

APPENDIX 2.7.a: PATHOPHYSIOLOGY FOR VASCULAR SONOGRAPHY (GENERALIST SONOGRAPHER)

The following list denotes the structures of which Generalist Sonographer should have a knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competency 7.7.c.

STRUCTURE	CONDITION / PATHOLOGY
Extracranial cerebral arteries (carotid, vertebral)	
	Aneurysm
	Atherosclerosis
	Carotid body tumour
	Collateral pathways
	Dissection
	Extrinsic masses
	Fibromuscular hyperplasia
	Intima-media thickening
	Occlusion
	Plaque, characterization
	Post-endarterectomy
	Pseudoaneurysm
	Stenosis
	Subclavian steal
Extracranial veins (jugular)	
	Extrinsic masses
	Thrombosis
Peripheral veins - upper extremity	
	Lines, catheters
	Thrombosis
Peripheral veins - lower extremity	
	Acute thrombosis
	Chronic thrombosis
	Collaterals
	Reflux

APPENDIX 2.7.b: PATHOPHYSIOLOGY FOR VASCULAR SONOGRAPHY (VASCULAR SONOGRAPHER)

The following list denotes the structures of which the Vascular Sonographer should have a knowledge of embryology, anatomy and physiology in order to perform general competencies 5.1 & 5.4, and specific competency 7.7.c.

STRUCTURE	CONDITION / PATHOLOGY
Intracranial cerebral arteries	
	Aneurysm
	Arteriovenous malformation
	Collateral pathways
	Embolism
	Occlusion
	Stenosis
	Vasospasm
Extracranial cerebral arteries	
	Aneurysm
	Arteritis
	Atherosclerosis
	Bypass grafts
	Carotid body tumour
	Collateral pathways
	Dissection
	Endarterectomy
	Extrinsic masses
	Fibromuscular hyperplasia
	Intima-media thickening
	Occlusion
	Plaque, characterization
	Pseudoaneurysm
	Stenosis
	Stents
	Subclavian steal
Extracranial veins	
	Extrinsic masses
	Thrombosis
Peripheral arteries - upper extremity	
	Aneurysm
	Arteriovenous (dialysis) fistula

APPENDIX 2.7.b: PATHOPHYSIOLOGY FOR VASCULAR SONOGRAPHY (VASCULAR SONOGRAPHER)

STRUCTURE	CONDITION / PATHOLOGY
	Arteritis
	Atherosclerosis
	Buerger's disease
	Bypass grafts
	Collateral pathways
	Hematomas
	Occlusion
	Pseudoaneurysm
	Raynaud's syndrome
	Stenosis
	Stents
	Subclavian steal
	Takayasu's disease
	Thoracic outlet syndrome
Peripheral veins - upper extremity	
	Lines / catheters
	Thoracic outlet syndrome
	Thrombosis
Aorta / iliac arteries	
	Aneurysm
	Bypass grafts
	Dissection
	Extrinsic masses
	Stenosis
	Stents
Mesenteric arteries	
	Bypass grafts
	Endovascular stents
	Fibromuscular hyperplasia
	Stenosis
Renal arteries	
	Bypass grafts
	Dissection
	Endovascular stents
	Fibromuscular hyperplasia

APPENDIX 2.7.b: PATHOPHYSIOLOGY FOR VASCULAR SONOGRAPHY (VASCULAR SONOGRAPHER)

STRUCTURE	CONDITION / PATHOLOGY
	Stenosis
Inferior vena cava / iliac veins	
	Extrinsic masses
	Filters
	Obstruction
	Pulmonary embolus
	Thrombosis
Peripheral arteries - lower extremity	
	Aneurysm
	Arteriovenous fistula
	Atherosclerosis
	Blue toe syndrome
	Buerger's disease
	Bypass grafts
	Collateral pathways
	Compartment syndrome
	Endovascular stents
	Extrinsic masses
	Hematomas
	Occlusion
	Pseudoaneurysm
	Raynaud's syndrome
	Stenosis
Peripheral veins - lower extremity	
	Acute thrombosis
	Chronic thrombosis
	Collateral pathways
	Extrinsic compression
	Venous insufficiency

APPENDIX 3: PHYSICS AND INSTRUMENTATION

The following list denotes the areas in Physics and Instrumentation of which all ultrasound practitioners should have knowledge in order to perform specific competencies listed in Area 4.

Mathematics	
	Prefixes, unit conversion, simple equations, measurements (length, width, height, area, volume), scientific notation
	Statistics
Physics of sound and diagnostic ultrasound	
	Acoustic impedance
	Acoustic interfaces
	Acoustic variables
	Amplitude, power, and intensity
	Attenuation and the attenuation coefficient
	Basic principles of sound (frequency, period, wavelength, propagation speed)
	Decibels
	Differentiation of pulsed ultrasound from continuous wave
	Pulsed ultrasound principles (pulse repetition period, pulse repetition frequency, pulse duration, duty factor, spatial pulse length)
	Range equation
	Refraction
	Scattering
	Spatial intensities
	Specular reflection
	Temporal intensities
	Total internal reflection
	Ultrasound terminology
	Wave interference
Ultrasound transducers	
	Crystal stimulation (spike voltage vs. burst voltage)
	Curie temperature
	Frequency bandwidth
	Frequency definitions (resonant vs. operating)
	Piezoelectric crystals
	Piezoelectric effect
	Quality factor
	Transducer construction (damping block, matching layer)
	Types of ultrasound transducers (mechanical, array)
Soundbeam characteristics	
	Beam area
	Beam diameter

APPENDIX 3: PHYSICS AND INSTRUMENTATION

	Beam focusing
	Beam profile
	Diffraction
	Grating lobes
	Huygen's principle
	Main beam
	Scanning gel
	Side lobes
	Sound field
	Spatial resolution (axial, lateral, slice thickness)
	Stand-off pad
Real-time (timing)	
	Range ambiguity
	Scanning frame rate (lines per frame, frame rate, scan line density)
	Temporal resolution
Instrumentation	
	3-D display
	B-colour
	B-flow
	Cine-loop
	Computer terminology and definitions
	Contrast resolution
	Digital memory
	Digital storage media
	Display formats
	Display modes (A-mode, B-Mode, M-Mode)
	Dynamic range
	Echo Rf signal
	Electronic beamformer (steering, aperture, apodization, etc)
	Extended-field-of-view
	Film processing
	Frame averaging
	Memory resolution
	Output power control
	Pulser circuitry
	Raster display
	Receiver functions (amplification, compensation, compression, demodulation, rejection)

APPENDIX 3: PHYSICS AND INSTRUMENTATION

	Recording devices (cameras, video printers, videocassette recorders, picture archiving and communication systems, other digital)
	Signal processing (analog-to-digital and digital-to-analog conversions, pre processing, postprocessing)
	Zoom (read, write)
Fluid dynamics	
	Bernoulli theorem
	Continuity theory
	Flow equation: $Q=P/R$
	Laminar flow
	Poiseuille's law
	Rouleaux effect
	Starling's law
	Stenosis (non-hemodynamically significant vs. hemodynamically significant)
	Turbulence
Doppler physics	
	Doppler angle
	Doppler effect
	Doppler equation
	Doppler shift frequency
Doppler instrumentation	
	Colour Doppler
	Multigating
	Autocorrelation
	Colour maps
	Colour box
	Colour aliasing
	Colour display (interpretation and optimization)
	Continuous wave Doppler (advantages and disadvantages)
	Doppler signal analysis (audio vs. spectral analysis)
	Doppler transducers
	Duplex ultrasound
	Quadrature phase detection
	Power Doppler
	Pulsed Doppler
	Receiver gating
	Sample volume
	Nyquist limit
	Aliasing

APPENDIX 3: PHYSICS AND INSTRUMENTATION

	High PRF Doppler
	Spectral display (optimization, and qualitative and quantitative assessment)
	Spectral display measurements: peak and mean velocity, resistive index, pulsatility index, S/D ratio, acceleration time, acceleration
	Triplex ultrasound
Contrast and harmonic imaging	
	Contrast harmonics
	Harmonic principles
	Tissue harmonics
	Ultrasound contrast
Image characteristics and artifacts	
	2D ultrasound artifacts (cause, appearance, significance)
	Colour Doppler artifacts
	Miscellaneous artifacts (electronic noise, camera artifacts, processor artifacts)
	Power Doppler artifacts
	Spectral Doppler artifacts
Quality assurance	
	Performance tests (sensitivity, uniformity, dead zone, axial resolution, lateral resolution, slice thickness, range accuracy, horizontal accuracy, lesion detection, beam profile)
	Preventative maintenance
	Quality assurance
	Sophisticated testing devices
	Test objects vs. tissue equivalent phantoms
Bioeffects and safety	
	ALARA principle
	Bioeffects statements
	Bioeffects studies
	Bioeffects: definition, clinical significance
	Mechanisms: thermal, cavitation, mechanical
	Output display standard
	Ultrasound output intensities