AIUM Practice Parameter for the Performance of Neurosonography in Neonates and Infants

Parameter developed in conjunction with the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU).
The American Institute of Ultrasound in Medicine (AIUM) is a multidisciplinary association dedicated to advancing the safe and effective use of ultrasound in medicine through professional and public education, research, development of parameters, and accreditation. To promote this mission, the AIUM is pleased to publish, in conjunction with the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU), this AIUM Practice Parameter for the Performance of Neurosonography in Neonates and Infants. We are indebted to the many volunteers who contributed their time, knowledge, and energy to bringing this document to completion.

The AIUM represents the entire range of clinical and basic science interests in medical diagnostic ultrasound, and, with hundreds of volunteers, the AIUM has promoted the safe and effective use of ultrasound in clinical medicine for more than 50 years. This document and others like it will continue to advance this mission.

Practice parameters of the AIUM are intended to provide the medical ultrasound community with parameters for the performance and recording of high-quality ultrasound examinations. The parameters reflect what the AIUM considers the minimum criteria for a complete examination in each area but are not intended to establish a legal standard of care. AIUM-accredited practices are expected to generally follow the parameters with recognition that deviations from these parameters will be needed in some cases, depending on patient needs and available equipment. Practices are encouraged to go beyond the parameters to provide additional service and information as needed.
I. Introduction

The clinical aspects contained in specific sections of this parameter (Introduction, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American Institute of Ultrasound in Medicine (AIUM), the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU). Recommendations for physician requirements, written requests for the examination, documentation, and quality control vary among the organizations and are addressed by each separately.

This parameter has been developed to assist physicians performing sonographic studies of the brain in neonates and infants. For the purpose of this parameter, infants are defined primarily as those in whom the anterior fontanelle remains open. Neurosonography should be performed only when there is a valid medical reason, and the lowest possible ultrasonic exposure settings should be used to gain the necessary diagnostic information. In some cases, additional or specialized examinations may be necessary. Although it is not possible to detect every abnormality, adherence to the following parameter will maximize the detection of most abnormalities of the brain in neonates and infants that can be imaged with ultrasound.

II. Indications/Contraindications

Indications for neurosonography in preterm or term neonates and infants include but are not limited to:

- Evaluation for hemorrhage or parenchymal abnormalities in preterm and term infants.1–5
- Evaluation for hydrocephalus.1–5
- Evaluation for the presence of vascular abnormalities.2–8
- Evaluation for possible or suspected hypoxic ischemic encephalopathy.2–5,9–12
- Evaluation and follow-up of patients on hypothermia, extracorporeal membrane oxygenation, and other support machines.
- Evaluation for the presence of congenital malformations.2–5
- Evaluation of signs and/or symptoms of central nervous system disorders (eg, seizures, facial malformations, macrocephaly, microcephaly, and intrauterine growth restriction).2–5,13
- Evaluation of congenital or acquired brain infections.2–5
- Evaluation of trauma (eg, complications of falls, cephalohematoma, and subgaleal hematoma, including fractures, subdural hematoma, and/or subarachnoid hemorrhage).2–5,14,15
- Evaluation for craniosynostosis.16
- Follow-up or surveillance of previously documented abnormalities, including prenatal abnormalities.2–5
- Screening before surgical procedures.

There are no contraindications to neurosonography.
III. Qualifications of Personnel


IV. Written Request for the Examination

The written or electronic request for an ultrasound examination should provide sufficient information to allow for the appropriate performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider or under the provider’s direction. The accompanying clinical information should be provided by a physician or other appropriate health care provider familiar with the patient’s clinical situation and should be consistent with relevant legal and local health care facility requirements.

V. Specifications of the Examination

(Also see section VII, Equipment Specifications.)

Standard Imaging Examination of the Neonate and Infant\textsuperscript{2–5}

The coronal view, by convention, should have the patient’s right side on the left side of the image. Representative coronal views should be obtained by sweeping through the entire brain from anterior to posterior using the anterior fontanelle as a sonic window and should include, sequentially:

- Frontal lobes anterior to the frontal horns of the lateral ventricles with orbits visualized deep to the skull base.
- Frontal horns or bodies of the lateral ventricles and interhemispheric fissure.
- Lateral ventricles at the level of the lateral and third ventricles.
- Include interhemispheric fissure, cingulate sulcus (if developed), corpus callosum, septum pellucidum or cavum septi pellucidi, caudate nuclei, putamina, globi pallidi, and sylvian fissures. The foramina of Monro should also be depicted, outlining the course of the choroid plexus from the lateral into the third ventricle.
- Lateral ventricles slightly posterior to the foramina of Monro where the lateral and third ventricles communicate. Include the pons and medulla, thalami, and choroid plexus in the roof of the third ventricle and in the caudothalamic grooves.
- Level of the quadrigeminal plate cistern and cerebellum. Include the cerebellar vermis, cisterna magna posteriorly and inferiorly, bodies of the lateral ventricles bordered by caudate nuclei and thalami, and temporal horns.
- Echogenic glomi of choroid plexuses at the posterior aspect of the lateral ventricles at the level of trigones. Include the splenium of the corpus callosum at divergence of the lateral ventricle, periventricular white matter lateral to posterior horns of the lateral ventricles.
- Area posterior to the occipital horns. Include parietal and occipital lobes and the pos-
terior interhemispheric fissure.

- Extra-axial fluid spaces as needed. Use linear high-frequency (≥9 MHz) transducers to obtain a coronal magnification view of the extra-axial fluid space, including only peripheral brain structures (superior sagittal sinus at the level of the frontal horns; measure the sinocortical distance, craniocortical distance, and width of the interhemispheric fissure).¹⁷

The transducer may be tilted from side to side to image as much of the superficial peripheral surfaces of the cerebral hemispheres as possible. The appropriate frequency of the transducer should be selected to ensure that the superficial and deep structures are well depicted. In some later-term or older infants, more than one transducer frequency may be needed for optimal evaluation of the supratentorial and infratentorial structures.

The sagittal view, by convention, should place the anterior aspect of the brain on the left side of the image. The right or left side should be clearly annotated. Sequential representative sagittal views are obtained with appropriate degrees of left and right transducer angulation because the frontal horns are somewhat more medial than the bodies of the lateral ventricles. These views should include:

- Right and left parasagittal to demonstrate the insula.
- Right and left parasagittal to demonstrate the sylvian fissure.
- Right parasagittal to image the deep white matter (periventricular regions).
- Right and left parasagittal views of the lateral ventricles, including the caudothalamic groove.
- Right and left parasagittal views of the lateral ventricles showing the choroid plexus.
- Additional parasagittal views to include all parts of the lateral ventricles.
- Midline sagittal views to include the corpus callosum, cavum septi pellucidi and cavum vergae if present, third and fourth ventricles, aqueduct of Sylvius, brain stem, cerebellar vermis, cisterna magna, and sulci (if present). The branches of the anterior cerebral artery (pericallosal artery and callosomarginal artery) may be visualized.
- Pulsed Doppler assessment of the midline anterior cerebral artery resistive index, as needed.

The **mastoid view** is primarily used to visualize the cerebellum. On an anterior axial image at the level of the brain stem, the third ventricle, cerebral peduncles, thalamus, and basilar cisterns can also be demonstrated. A more posterior axial image shows the fourth ventricle, posterior vermis, and folia of the cerebellar hemispheres, tentorium, and cisterna magna.¹⁸,¹⁹

Additional views, if necessary, may be taken through the posterior or mastoid fontanelle, the foramen magnum, any open suture, the Burr hole, a craniotomy defect, or thin areas of the temporal and parietal bones.²⁰ The transtemporal approach may also be used to visualize the circle of Willis and its major branches.

**Posterior fontanelle, axial, and sagittal views** may be used, as necessary, to clarify abnormalities suspected in the occipital areas, posterior horns of the lateral ventricles, and cerebellum.²⁰

For patients with ventricular shunt tubes, additional oblique views via the anterior fontanelle and/or axial views may be obtained when a shunt tube and its tip are not visualized on routine scans.

When clinically indicated, spectral, color, and/or power Doppler imaging may be useful to evaluate vascular structures through a fontanelle or a transcranial approach.
VI. Documentation

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the ultrasound examination and its interpretation. Images of all appropriate areas, both normal and abnormal, should be recorded. Variations from normal size should be accompanied by measurements. Images should be labeled with the patient identification, facility identification, examination date, and side (right or left) of the anatomic site imaged. An official interpretation (final report) of the ultrasound findings should be included in the patient’s medical record. Retention of the ultrasound examination should be consistent with both clinical needs and relevant legal and local health care facility requirements.

Reporting should be in accordance with the AIUM Practice Parameter for Documentation of an Ultrasound Examination.

VII. Equipment Specifications

Neurosonographic examinations should be conducted with sector or curved linear transducers that can fit within and image through the anterior fontanelle.\(^2\)\(^-\)\(^5\) Linear transducers are useful in evaluating superficial structures such as the superior sagittal sinus. If the anterior fontanelle is not available, imaging may be performed through available sutural openings or by using a transcranial approach via the thinner squamosal portion of the temporal bone. This approach may require a lower-frequency transducer to penetrate through the bone. The transducer should be adjusted to operate at the highest clinically appropriate frequency, realizing that there is a trade-off between resolution and beam penetration. Higher frequencies are used in neonates and young infants and lower frequencies in older infants.

The Doppler power output should be as low as reasonably achievable (ALARA) to answer the diagnostic question.

VIII. Quality Control and Improvement, Safety, Infection Control, and Patient Education

Policies and procedures related to quality control, patient education, infection control, and safety should be developed and implemented in accordance with the AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices.

Equipment performance monitoring should be in accordance with the AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices.
IX. ALARA Principle

The potential benefits and risks of each examination should be considered. The ALARA principle should be observed when adjusting controls that affect the acoustic output and by considering transducer dwell times. Further details on ALARA may be found in the AIUM publication *Medical Ultrasound Safety, Third Edition*.

Acknowledgments

This parameter was revised by the AIUM in collaboration with the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU) according to the process described in the AIUM Clinical Standards Committee Manual.

Collaborative Committees

Members represent their societies in the initial and final revision of this parameter.

**ACR**
Henrietta Kotlus Rosenberg, MD, *Chair*
Beverly E. Hashimoto, MD

**AIUM**
Teresita Angtuaco, MD
Lynn Fordham, MD
Rob Goodman, MD

**SPR**
Carol E. Barnewolt, MD
Judy A. Estroff, MD
Harriet J. Paltiel, MD

**SRU**
Dorothy I. Bulas, MD
Harris L. Cohen, MD
Brian D. Coley, MD

**AIUM Clinical Standards Committee**
Joseph Wax, MD, *Chair*
John Pellerito, MD, *Vice Chair*
Bryann Bromley, MD
Pat Fulgham, MD
Charlotte Henning sen, MS, RT, RDMS, RVT
Alexander Levitov, MD
Vicki Noble, MD, RDMS
Anthony Odibo, MD, MSCE
David Paushter, MD
Dolores Pretorius, MD
Khaled Sakhel, MD
Shia Salem, MD
Jay Smith, MD
Paula Woodward, MD

Renamed 2015
References


