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The American College of Radiology will periodically define new practice parameters and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice parameter and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice parameters and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice parameter and technical standard by those entities not providing these services is not authorized.

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ACR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE AND INTERPRETATION OF SKELETAL SURVEYS IN CHILDREN

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care¹. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the practice parameters, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the practice parameters when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the practice parameters. However, a practitioner who employs an approach substantially different from these practice parameters is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these practice parameters will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these practice parameters is to assist practitioners in achieving this objective.

¹ *Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing*, ___ N.W.2d ___ (Iowa 2013) Iowa Supreme Court refuses to find that the *ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, *Stanley v. McCarver*, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

I. INTRODUCTION

This practice parameter was revised collaboratively by the American College of Radiology (ACR) and the Society for Pediatric Radiology (SPR).

A skeletal survey is a systematically performed series of radiographic images that encompasses the entire skeleton or those anatomic regions appropriate for the clinical indications. Radiographic skeletal surveys are used for a variety of clinical problems in children. Common clinical indications include suspected child abuse, skeletal dysplasia, metabolic disorder or bony metastases [1-10]. The goal of the skeletal survey is to accurately identify focal and diffuse abnormalities of the skeleton, including acute or healing fractures, bone lesions, evidence of metabolic bone disease or characteristics of skeletal dysplasia, and to differentiate them from developmental changes and other anatomic variants that may occur in infants and children

II. INDICATIONS

Indications for skeletal surveys include, but are not limited to:

- A. Known or suspected physical abuse in infants and young children
- B. Known or suspected skeletal dysplasias, syndromes, and metabolic disorders
- C. Known or suspected neoplasia and related disorders

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR–SPR Practice Parameter for General Radiography](#) [11].

In addition:

- The radiologist should understand the utility of alternate imaging techniques such as ultrasonography, computed tomography, nuclear medicine, and magnetic resonance imaging in order to fulfill a consultative role and to interpret pediatric skeletal surveys in the context of other available imaging results.
- The technologist should have training and experience in performing radiographic examinations in infants and children. In particular, the technologist should be familiar with positioning and patient restraint, as well as customary measures to minimize radiation exposure. The technologist should be aware of the unique circumstances created when children with suspected abuse are brought to the radiology department by caretakers, guardians, and child protective service representatives.

IV. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for radiographic skeletal surveys should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35, adopted in 2006)

The skeletal survey examination should be performed in accordance with traditional principles of high-quality diagnostic radiography. These include proper technique factors, positioning, collimation, image identification, restraining methods, and patient shielding.

The imaging protocol for the skeletal survey will depend on the particular clinical indication. Additionally, the radiologist should consider modifying a complete protocol based on imaging already performed on the infant or child so as to minimize unnecessary radiation exposure.

A. Known or Suspected Child Abuse

Each anatomic region should be imaged with a separate radiographic exposure to ensure uniform image density and maximize image sharpness. A single radiograph (babygram) of the entire infant should not be performed. Each extremity should be radiographed in at least the frontal projection. Radiographs of the axial skeleton should be obtained in 2 projections, anteroposterior (AP)/frontal and lateral. Additionally, right and left posterior oblique views of the entire rib cage should be acquired [12-17]. Additional views as needed should be obtained to fully document suspected abnormalities and may include lateral views of the long bones [18], a Towne view of the skull, AP and lateral views of selected joints, or additional obliquities of the ribs or other areas of concern [19]. The examination should be reviewed by a qualified radiologist as defined in section III.

A follow-up skeletal survey may be indicated in the setting of nonaccidental injury. Many times a complete repeat exam is appropriate, though a limited exam could also be considered [20-25]. Postmortem skeletal surveys may also be helpful [26,27].

B. Skeletal Dysplasias, Syndromes, and Metabolic Disorders

1. Skeletal dysplasias and syndromes

Imaging of skeletal dysplasias, including those in children with disproportionate stature and a wide variety of syndromes, should conform to the standard skeletal survey protocol (see the Skeletal Survey Table below), with the following exceptions:

- a. Entire arms and legs can be exposed on a single film when the size of the child permits.
- b. In newborns and young infants, whole-body AP and lateral radiographs may be appropriate, but separate views of the skull (frontal and lateral), hands (posteroanterior (PA)), and feet (AP) are advisable. Lateral views of the feet and ankles may be useful in selected cases.
- c. As previously noted, review by a qualified physician is essential, with additional views obtained as required (eg, flexion and extension lateral views of the cervical spine for certain skeletal dysplasias).
- d. In some patients, selected images of specific regions or additional views may be appropriate, depending on the differential diagnoses being considered [28-31].

2. Metabolic disorders (rickets and rickets-like disorders)

In general it is not necessary to survey the entire bony skeleton for metabolic disorders. A targeted examination focusing on the appropriate anatomic regions of interest to include PA views of the wrists and AP views of the knees is recommended. Occasionally, a complete skeletal survey may be warranted [32].

C. Neoplasia and Related Conditions

Langerhans Cell Histiocytosis can present with a solitary bone lesion or widely disseminated disease. A complete skeletal survey should be performed as part of the initial imaging evaluation. Additional orthogonal projections of areas suspected to be abnormal on clinical or other imaging grounds should be obtained. A complete skeletal survey may also be obtained as part of the evaluation for metastatic disease to the bone [33-35].

COMPLETE SKELETAL SURVEY TABLE

APPENDICULAR SKELETON
Humeri (AP)
Forearms (AP)
Hands (PA)
Femurs (AP)
Lower legs (AP)
Feet (AP)

AXIAL SKELETON
Thorax (AP, lateral, right and left obliques), to include sternum, ribs, thoracic and upper lumbar spine
Abdomen, to include the pelvis (AP)
Lumbosacral spine (lateral)
Skull (frontal and lateral), to include cervical spine (if not completely visualized on lateral skull)

V. DOCUMENTATION

An official interpretation (final report) of the examination should be included in the patient's medical record. The report should provide a concise description of all sites of definite and suspected abnormality. A standardized summary with descriptive text may be helpful [36]. When a constellation of radiographic findings is sufficient to raise strong suspicion of abuse, this should be so stated in the radiology report and communicated to the referring physician, and this communication should be documented in the final report. A physician diagnosing suspected child abuse is often legally required to notify local child protection authorities. Thus, if the attending physician does not report the case, the radiologist may still be required to do so.

Reporting should be in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings](#) [37].

VI. EQUIPMENT SPECIFICATIONS, RADIOGRAPHIC TECHNIQUE, AND RADIATION DOSE

The quality of a skeletal system survey is a function of the resolution of the imaging system. Attention to contrast and resolution should be addressed when selecting the film/screen combination or digital imaging equipment.

Radiology departments should carefully select their digital radiographic systems with particular attention to high diagnostic efficiency and optimize technical factors and processing parameters suitable for the demanding application of skeletal survey for suspected child abuse [4,10,38,39]. The lowest possible radiation dose consistent with acceptable diagnostic image quality should be used, particularly in pediatric examinations.

In infants, the entire examination should be performed with a suitable high-detail imaging system that may use either digital or conventional screen-film radiographic technique. In the toddler and older child, dose considerations may require that a general medium-speed system, usually employing a moving grid, may be used for imaging the larger body regions. Peak kilovoltage should be set at a sufficiently low level to provide adequate subject contrast.

When a digital radiographic system is used, it should have high spatial resolution and exhibit optimal dose efficiency characteristics. If these systems have a multiple resolution mode capability, the high-resolution mode should be used. The higher resolution mode may require an increase in mAs to maintain the signal-to-noise ratio and to optimize visualization of skeletal structures. Digital processing menus and image display parameters should be selected to enhance bone detail [10,38,40-47]. Optimal use of high-resolution imaging systems will

result in an increase in radiation dose compared to typical low-dose systems widely used for general pediatric imaging. When judiciously applied for appropriate indications, this increased dose is justifiable in order to obtain superior skeletal detail. When modern high-detail imaging systems are coupled with meticulous radiographic technique, the patient dose remains well within accepted levels, and the associated risks are extremely small. Appropriate collimation and patient shielding should be used to limit radiation exposure to the anatomic area of interest.

The kVp range employed in skeletal survey imaging is 55 to 70, which is generally used for all images of the appendicular skeleton, skull, and spine of infants. In the toddler, the kVp is increased as necessary when imaging the skull and spine. The mAs is adjusted according to the kVp, image recording system, and x-ray equipment design (eg, filtration, generator, etc.). The focus-to-film distance is 101.6 cm (40 in). Skeletal survey images in infants are usually performed on the tabletop. In toddlers and older children, dose considerations may require a change of imaging system from a slow, high-resolution screen/film combination to a medium-speed, general-purpose, lower-resolution system. The use of the under-table cassette slot in conjunction with a moving antiscatter grid is likely to produce optimal results in larger patients. Meticulous positioning and collimation over each anatomic region are essential. Both joints are included in all long-bone images. Chest imaging uses bone detail technique.

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, registered radiologist assistants, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, “as low as reasonably achievable” (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel that work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection and application of dose limits) and the principles of proper management of radiation dose to patients (justification, optimization and the use of dose reference levels)

http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.pdf

Nationally developed guidelines, such as the ACR [Appropriateness Criteria®](#), should be used to help choose the most appropriate imaging procedures to prevent unwarranted radiation exposure.

Facilities should have and adhere to policies and procedures that require varying ionizing radiation examination protocols (plain radiography, fluoroscopy, interventional radiology, CT) to take into account patient body habitus (such as patient dimensions, weight, or body mass index) to optimize the relationship between minimal radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used whenever appropriate. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available at the Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org) websites. These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be measured and patient radiation dose estimated for representative examinations and types of patients by a Qualified Medical Physicist in accordance with the applicable ACR technical standards. Regular auditing of patient dose indices should be performed by comparing the facility’s dose information with national benchmarks, such as the ACR Dose Index Registry, the NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director’s National Evaluation of X-ray Trends. (ACR Resolution 17 adopted in 2006 – revised in 2009, 2013, Resolution 52).

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (<http://www.acr.org/guidelines>).

Equipment performance monitoring should be in accordance with the [ACR-AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Radiographic Equipment](#).

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