



Quality Improvement Standards for the Treatment of Pediatric Empyema

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ABBREVIATIONS

AE = adverse event, CMS = Centers for Medicare and Medicaid Services, CTF = chest tube fibrinolysis, PPE = parapneumonic effusion, PPE/E = parapneumonic effusion/empyema, RPE = reexpansion pulmonary edema, TPA = tissue plasminogen activator, VATS = video-assisted thoracoscopic surgery

PREAMBLE

The mission of the Society of Interventional Radiology (SIR) is to improve patient care through image-guided therapy. The Society was founded in 1973 and is recognized today as the primary specialty society for physicians who provide minimally invasive image-guided therapies. The Standards Division of SIR provides evidence-based clinical practice documents to ensure patient safety and enhance the delivery of patient care. Standards Division members are leaders in the field of interventional radiology from the private and academic sectors of medicine who dedicate the vast majority

of their professional time to performing interventional procedures, and, as such, they represent a broad expert constituency of the subject matter under consideration for standards development. The Standards Division currently produces the following types of documents.

Clinical Practice Guidelines/Practice Parameters

These are statements that include recommendations intended to optimize patient care and assist physicians in clinical decision-making. They are developed by using a rigorous methodology involving a systematic review of the literature and assessment of the evidence.

Competence and Training Statements

These are statements that make recommendations on training and competencies required for a given clinical topic, procedure, or therapy. Recommendations are supported by evidence when available and/or expert consensus.

Quality Improvement Standards

These are statements that combine the recommendations of clinical practice guidelines (where available) and performance measures to provide guidance on clinical quality improvement in interventional radiology practice.

Position Statements

These are statements that reflect the opinion of the SIR concerning areas of evolving clinical practice and/or technologies. Position statements are evidence-based whenever possible, but, because the scope usually involves a developing clinical practice or technology, the body of evidence may not be robust, and an independent panel of experts, usually multidisciplinary, may be convened for document development.

Reporting Standards

These are statements that define a set of standardized data elements to be used in data-collection efforts for describing processes and outcomes of interventional radiologic procedures. The purpose of reporting standards is to facilitate professional agreement on common vocabulary/definitions and to permit comparison of data across studies or combination of data from studies for further analysis.

METHODOLOGY FOR QUALITY IMPROVEMENT STANDARDS

Topics for standards document development are solicited through an annual survey that allows SIR members the opportunity to submit topics for

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consideration. The proposed quality-improvement topics are approved and prioritized by the Executive Council. A recognized expert or group of experts is identified to serve as the principal author or writing group for the document. Additional authors or societies may be sought to increase the scope, depth, and quality of the document depending on the magnitude of the project.

An in-depth literature search is performed by using electronic medical literature databases such as Medline (via PubMed) and the Cochrane Library. A critical review of peer-reviewed articles is performed with regard to the study methodology, results, and conclusions. All documents have adopted an updated methodology for evidence grading and assessment of strength of recommendation (**Appendix A [1–3]**) in order to fulfill Institute of Medicine standards for guidelines development. Accepted definitions of the hierarchic classification of evidence, commonly used by systems such as Oxford and Grading of Recommendations Assessment, Development and Evaluation, are included, and an assessment of the strength of recommendation is defined to assist in clinical decision-making. Similar classification systems are used by other specialty practice societies such as the American College of Cardiology/American Heart Association (1–3). The level-of-evidence assessment will be used to create the evidence tables that inform the standards documents. For documents that incorporate clinical recommendations, the strength of recommendation will be used to denote how well the recommendation is supported by systematic evidence. The qualitative weight of these articles is assembled into an evidence table, which is used to write the document such that it contains evidence-based data with respect to content, rates, and thresholds. Threshold values are determined by calculating the standard deviation of the weighted mean success and adverse events (AEs) reported in all relevant trials with a sample size of approximately 50 patients or greater. Calculated threshold values represent two standard deviations above or below the mean for AE and success rates, respectively.

When the evidence of literature is weak, conflicting, or contradictory, a modified Delphi technique may be used to enhance effective decision-making (4,5), and consensus for the threshold value is reached when 80% of panelists are in agreement. Reported AE-specific rates in some cases reflect the aggregate of AEs of varying severities. Thresholds are derived from the National Benchmarks from the National Quality Registry for interventional radiology when available, a critical evaluation of the literature, and evaluation of empiric data from the members of the Standards Division.

The draft document is critically reviewed by the writing group and members of the Standards Division by telephone conference calling or face-to-face meeting. Comments are discussed by the members of the Standards Division, and appropriate revisions are made to create the final document before peer review, approval by the SIR Operations Committee, and publication.

SIR standards documents are developed to improve quality of care for patients; however, there are other ongoing national quality-improvement efforts such as the Centers for Medicare and Medicaid Services (CMS) Quality Payment Program (<https://qpp.cms.gov>). Reportable measures for the CMS Quality Payment Program will change from year to year. To see if there are reportable measures that pertain to the present quality-improvement standard, please refer to the current CMS measures. CMS measures and access tools to help with reporting of performance measures can be found through the American College of Radiology at <https://www.acr.org/Quality-Safety/National-Radiology-Data-Registry/Qualified-Clinical-Data-Registry> and SIR at <https://www.sirweb.org/practice-resources/quality-improvement2/ir-quality-registry/>. The Interventional Radiology Quality Registry permits the collection of performance measures for image-guided interventional procedures, and participating facilities and physicians will receive reports based on aggregated benchmarks to facilitate patient safety and quality-improvement efforts. The Interventional Radiology Quality Registry also provides participants opportunities to fulfill CMS Physician Quality Reporting System reporting requirements and gain maintenance of certification credit from the American Board of Radiology.

INTRODUCTION

Pediatric empyema is a critical condition frequently encountered by pediatric interventional specialists and occasionally by general interventional

radiologists. Appropriate interventional management is important for recovery.

Important components of care are (i) patient selection, (ii) procedure performance, and (iii) patient monitoring, as measured by indications, success rates, and complication rates, respectively, with assigned threshold levels.

CLINICAL BACKGROUND

Pneumonia is the leading infectious cause of death in children worldwide, causing 15% of deaths of children < 5 years of age (6). In the United States, the incidence of childhood pneumonia is approximately 30–40 per 100,000 (7). Parapneumonic effusions (PPEs) are common in pediatric bacterial pneumonia, with a frequency of 21%–91%, evolving into empyema in 28%–53% of cases (7). The incidence of empyema is increasing, with approximate incidences of 7 per 100,000 in children < 2 years of age and 10 per 100,000 in children 2–4 years of age (7–10).

Management of pediatric PPE/empyema (PPE/E) remains controversial. Modern therapeutic methods and antibiotic agents have decreased the need for traditional surgical intervention. Treatment goals for management remain as follows:

1. Treat the pneumonia with appropriate antibiotic agents;
2. Remove pleural fluid to assist lung reexpansion; and
3. Return the lung to normal function.

The two preferred methods for initial treatment of PPE/E are chest tube insertion with fibrinolysis and video-assisted thoracoscopic surgery (VATS) (7,11,12). Given the similar efficacy of the two procedures, chest tube fibrinolysis (CTF) is a reasonable first option, avoiding operating room costs and possibly general anesthesia. VATS can be reserved for patients whose condition does not respond to CTF (7).

Pathophysiology

PPE is a pleural effusion secondary to pneumonia. Empyema is defined as purulent material within the pleural space. Pleural infection is a continuum, classically divided into three stages (11,13,14):

1. Exudative/simple
2. Fibrinopurulent
3. Organizational

Exudative/simple.—Infections alter the normal pleural fluid, activate an immune response, and cause pleural inflammation. Pleural inflammation increases permeability and migration of inflammatory cells (neutrophils, lymphocytes, eosinophils) into the pleural space (11).

Fibrinopurulent.—The coagulation cascade is activated, leading to procoagulant activity and decreased fibrinolysis. The deposition of fibrin leads to the development of septations and loculations in the pleural space (13).

Organizational.—As the inflammatory process evolves, there is eventual migration of fibroblasts, organizing a solid fibrous pleural peel. The solid fibrous bands may prevent the lung from reexpanding, leading to functional impairment (13).

DIAGNOSTIC AND TREATMENT ALGORITHMS

Diagnosis

PPE/E usually presents with classic symptoms of pneumonia: cough, fever, dyspnea, and poor appetite. Pleuritic chest pain and referred pain to the neck, shoulder, or abdomen may occur. On presentation to the hospital, most patients have already started antibiotic therapy.

Chest radiography is used to confirm the diagnosis, with or without a lateral decubitus film. Pleural fluid volume and hemithorax opacification have been used for risk and outcomes stratification (**Table 1**) (12,14). Ultrasound (US) is the most sensitive and specific imaging modality to confirm the presence and nature of the effusion and the presence and nature

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