Chest and Abdominal CT During Extracorporeal Membrane Oxygenation:

Clinical Benefits in Diagnosis and Treatment[1]

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Rationale and Objective. This study aims to evaluate the clinical usefulness of thoracic and abdominal computed tomography (CT) as an adjunct to bedside diagnostic imaging in patients on extracorporeal membrane oxygenation (ECMO) therapy because of severe acute respiratory failure.

Materials and Methods. Imaging records for 118 consecutive thoracic and abdominal CT examinations performed in 63 patients (22 neonates, 15 children, and 26 adults) on ECMO therapy during an 8-year period were retrospectively reviewed. Reported CT findings were compared with concurrent bedside radiographs and ultrasounds. The clinical importance and effect on treatment of each CT finding was determined by reviewing the medical records.

Results. CT showed 30 clinically important complications in 20 different patients that directly impacted on the treatment, but were not diagnosed with bedside imaging. Of the 30 complications, 15 (50%) were surgically treated, 11 (37%) required percutaneous invasive procedures, and 4 (13%) were managed conservatively. Despite the serious complications, 13 of 20 patients (65%) survived.

Conclusion. Both chest and abdominal CT have an important clinical role in patients on ECMO therapy because of acute respiratory failure, as a complement to bedside imaging, to exclude or show complications and expedite early invasive treatment, when needed.

Key Words. Extracorporeal membrane oxygenation (ECMO); computed tomography (CT); thorax; adult respiratory distress syndrome (ARDS); abdomen.

Extracorporeal membrane oxygenation (ECMO) has been used for nearly 30 years to treat patients with acute extremely severe respiratory failure unresponsive to maximal ventilatory support and medical treatment. ECMO is a form of heart-lung bypass technique for pulmonary support for days or several weeks (1,2). In randomized studies, ECMO has proved to be a life-saving technique in neonates with a number of pulmonary disorders (3,4), and several nonrandomized investigations have shown promising results in children (5,6) and adults (7–9). To date, more than 28 000 patients have been reported to the Extracorporeal Life Support Organization (ELSO) at the approximately 100 ECMO centers in the United States and Europe. Reported overall survival rates among respiratory ECMO patients are 86%, 64%, and 59% in neonates, pediatric patients, and adults, respectively (10).

Plain film radiography and ultrasound imaging (US) frequently are used to evaluate the position of ECMO cannulae, monitor the severity of pulmonary disease, and

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detect complications (11–14). Although thoracic computed tomography (CT) has proved extremely helpful as an adjunct to portable plain film radiography in other critically ill patients in the intensive care unit (ICU) (15–17), the evaluation of patients on ECMO therapy at most ECMO centers still relies almost exclusively on bedside radiographs and US. This might be unfortunate because the evaluation of complications on chest radiographs is particularly difficult because of the pronounced opacification of the lungs often seen in patients on ECMO therapy (Figure 1). The quality of bedside US often is limited by overlying bandages, obscuring air in the lungs and gas-filled bowel loops in the abdomen (12,14). Furthermore, patients on ECMO therapy are at high risk for complications. In large multicenter series, the reported frequency of serious patient complications ranges from 1.8 to 2.1 complications/case, most often hemorrhage related to systemic anticoagulation (18–20). In addition, these patients are difficult to evaluate clinically not only because of sedation and respiratory support, as with other ICU patients, but also because of the assisted circulation. However, transportation of patients on ECMO therapy to the CT department can be technically challenging. We therefore consider it important to separately evaluate the clinical benefit of CT for this group of patients.

At the ECMO department located in the pediatric ICU in our institution, neonate, pediatric, and adult patients have been treated with ECMO for 17 years, with survival rates of 81%, 73%, and 72%, respectively. The ability to transport patients with a mobile ECMO system has contributed to the use of CT as a complement to bedside studies when needed since 1994. In a previous article, we showed that CT can be performed safely during ECMO and, in certain situations, it can add important clinical information (21).

The purpose of this study is to retrospectively evaluate the clinical utility of thoracic and abdominal CT examinations as a routine complement when portable plain film radiography and US are insufficient and also assess the impact of CT imaging findings on the treatment of patients on ECMO therapy because of acute respiratory failure.

MATERIALS AND METHODS

Patients and Study Design

The records of 131 patients with acute respiratory failure treated consecutively with ECMO from May 1994 until February 2002 were searched for a history of thoracic and abdominal CT. Sixty-three of 131 patients (48%) had been examined using chest CT or combined chest and abdominal CT on one or more occasions while on ECMO therapy. Among them were 26 adults (aged 17–59 years), 15 children (aged 1 month–16 years), and 22 neonates (aged 0–1 month). A total of 118 chest scans, of which 76 also included the abdomen, had been performed (Table 1). No abdominal CT examination was performed without a concurrent CT examination of the chest.

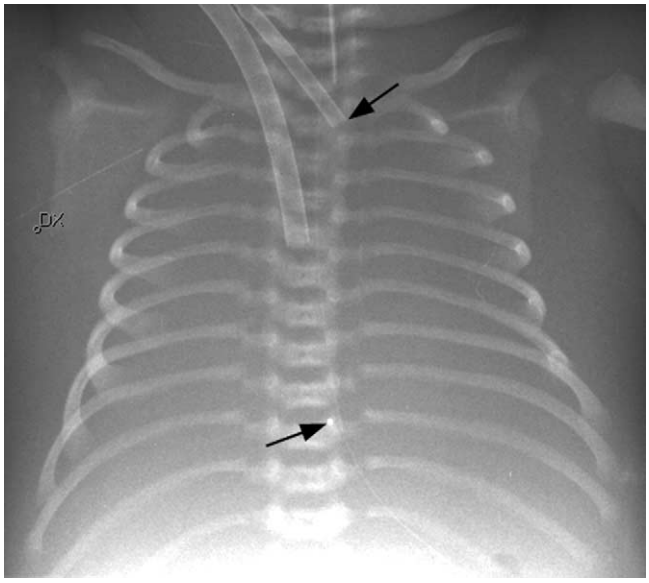

Figure 1. Chest radiograph 24 hours after uncomplicated ECMO therapy start in neonate because of meconium aspiration. The examination shows complete opacification of the lung fields, "white-out" that gradually was clearing during treatment. Venous ECMO cannula with marker in right atrium and arterial cannula in aortic arch (arrows).

Clinical and imaging records for these 63 patients were reviewed by the first author (specialist in general and pediatric radiology) for demographic data, clinical history, stated indication for CT, reported CT findings, findings on most recent prior chest radiograph, findings on any concurrent chest and abdominal US or echocardiography, alteration in clinical management as direct results of the CT findings, and patient outcome.

Reported CT findings were compared with findings on the most recent bedside radiograph and any concurrent US or echocardiogram for additional new information of clinical importance provided by the CT examination. If a substantial alteration in clinical treatment as a direct result of the CT finding was recorded in the medical reports or the finding potentially affected the immediate prognosis for survival, it was documented as clinically important. These alterations in