Based on our observation, it can be concluded that adenocarcinoma in a Barrett's esophagus can occur in children as young as 8 years old. Thus, frequent endoscopic visualization of the esophagus is important in cases of congenital gastroesophageal reflux with persistent reflux following surgical repair. Further, it is mandatory not only to visualise the esophagus endoscopically but to take biopsy specimens from the distal esophagus to diagnose changes of Barrett's esophagitis or any early in situ malignant changes. In this manner, timely surgical excision can be achieved, with a better chance of survival.

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DAILY CRANIAL ULTRASOUNDS DURING ECMO: A QUALITY REVIEW/COST ANALYSIS PROJECT

To the Editor:

Since extracorporeal membrane oxygenation (ECMO) was introduced in the early 1970s, more than 10,000 neonates with cardiac and respiratory failure have been treated successfully.[1] Over time, neonatal ECMO has become a more precise treatment modality within defined patient groups and, with experience in patient management, clinical practice continues to evolve. As in other areas of medicine, ECMO centers are reviewing their individual practices to determine whether alterations in management can be instituted without compromising patient care. Many of these changes are driven by cost factors. Because of the high cost associated with ECMO, an annual review of laboratory tests, diagnostic studies, and personnel use is being undertaken in our institution. We regularly discontinue or reduce the frequency of the tests deemed nonessential based on these reviews. We speculated that identification of a patient population that does not require daily examinations while on ECMO would reduce the overall cost of care for these patients.

The medical records of 53 neonatal patients who required ECMO at Egleston Children's Hospital between January 1991 and October 1993 were reviewed retrospectively. Data collected included patient weight, gestational age, gender, diagnosis, type of ECMO (venoarterial or venovenous), length of ECMO support, and whether or not cardiopulmonary arrest (defined as receiving chest compressions and/or epinephrine boluses) had occurred. Pre-ECMO blood gas data within 24 hours of initiating ECMO also was collected, and included the lowest Pa_{O_2}, the lowest and highest Pa_{CO_2}, and the lowest pH. We perform neonatal ECMO using a double-lumen venovenous cannula and a jugular venous drain. We do not routinely use Amicar (aminocaproic acid), and we maintain our activated clothing times between 200 to 220 seconds.

All cranial ultrasound reports, including pre-ECMO ultrasonography and every daily ultrasound examination performed throughout the ECMO run, were reviewed by a pediatric radiologist. To assess cost effectiveness and clinical importance, the two ultrasound examinations performed immediately before ECMO and within 24 hours of initiating ECMO were evaluated for information that would contribute to patient management decisions. Ultrasound results were defined as abnormal if hemorrhage, cerebral edema, or extraaxial fluid was present. All variables were compared using a t test or Fisher's Exact test, as appropriate. A level of significance of $P < .05$ was used for all tests.

Four patient records were removed from consideration because of incomplete data. None of these patients had ultrasound evidence of intracranial hemorrhage. The 49 remaining patients were classified into two groups. The patients were classified prospectively as being at risk if their gestational age was less than 38 weeks, if they weighed less than 3 kg at birth, and/or if they required cardiopulmonary resuscitation before being treated with ECMO. This classification was based on previous data showing that immaturity, low birth weight, and the need for cardiopulmonary resuscitation increase the risk of intracranial hemorrhage.[2-6] All other patients were classified as low risk. The diagnosis used to refer the patient for ECMO was not considered in defining these

Table 1. Demographic Data

	No. of Patients	Mean Gestational Age: wk (range)	Mean Birth Weight: kg (range)	Male Gender: n (%)	Venoarterial ECMO: n (%)	Mean ECMO Hours (range)	Survival Rate
Total	49	39 (32-44)	3.24 (2.14-4.63)	32 (65%)	9 (18%)	124 (40-328)	39/49 (80%)
Low risk	33	40 (38-44)	3.63 (3-4.63)	22 (66%)	3 (9%)	126 (59-328)	33/33 (100%)
High risk	16	37 (32-43)	2.84 (2.14-3.77)	10 (63%)	6 (38%)	122 (40-223)	10/16 (62%)

Table 2. Diagnoses

	Total No. of Patients	Meconium Aspiration Syndrome	Persistent Pulmonary Hypertension	Respiratory Distress Syndrome	Congenital Diaphragmatic Hernia	Group Beta Strep
Low risk	33	12	8	3	7	3
High risk	16	0	3	3	5	5

groups. Patient outcomes were reviewed for occurrence of intracranial hemorrhage on each daily cranial ultrasound examination.

Demographic and clinical data for the study population are shown in Table 1. There was no difference in outcome with respect to type of ECMO, blood gas results, length of ECMO run, or gender. Although referral diagnosis was not taken into consideration for categorization of risk, it noteworthy that 100% of all meconium aspiration patients were classified as low risk. Diagnoses are shown in Table 2.

Only 2 of 41 neonates (4.9%) with two normal ultrasound results had hemorrhage develop after day 1; 4 of 8 neonates (62%) with one abnormal cranial ultrasound result had hemorrhages after day 1 ($P = .004$).

The risk categorization was applied to a total of 49 patients. Thirty-three infants (67%) were classified as low risk, and 16 (33%) as high risk. Twenty-nine low-risk infants had two normal early ultrasound results, one (3.4%) of whom had subsequent hemorrhage (grade II intraventricular) on day 5 of ECMO. This patient remained on ECMO and was decannulated successfully. The remaining four low-risk infants had one abnormal early ultrasound result; of these, two had hemorrhage later in their ECMO runs (one with intracerebral hemorrhage diagnosed on day 1, and the other with intraventricular hemorrhage on day 5).

Sixteen infants were considered high risk, 12 of whom had two normal early ultrasound results. One of these 12 had subsequent intracerebral hemorrhage on day 3 of ECMO. This patient underwent deceleration of care, was removed from ECMO support, and died subsequently. Four high-risk infants had one abnormal early ultrasound result, two of whom had intracerebral hemorrhages during the ECMO run. Both of these patients were removed from ECMO support and were long-term survivors.

All patients in the low-risk group survived. Six (37%) deaths occurred in the high-risk group, caused by intracerebral hemorrhagic infarct (1), pulmonary arterial hypertension (2), lethal congenital heart defect (1), and pulmonary hypoplasia (2).

Our data suggest that the combination of the results of a pre-ECMO cranial ultrasound examination and a second ultrasound scan obtained within 24 hours of initiation of ECMO can be used to determine whether subsequent daily cranial ultrasound examinations are needed. In the present series, only one (3%) of the low-risk neonates with normal pre- and early-ECMO cranial ultrasound findings had subsequent hemorrhage. In contrast, 50% of both high-risk and low-risk patients with one abnormal examination result had intracranial abnormalities identified subsequently. These findings have prompted an alteration in patient management in our ECMO center. Low-risk neonates with normal cranial ultrasound results before, and within 24 hours of initiating ECMO, do not have additional routine daily ultrasound examinations. Additional ultrasound examinations are obtained when clinical signs and symptoms warrant further evaluation of the patient. High-risk patients or low-risk patients who have a single abnormal cranial ultrasound result continue to have daily ultrasound examinations to screen for hemorrhagic complications.

Reviews of clinical management protocols in our institution have resulted in fewer "routine" laboratory tests, fewer "routine" chest radiographs, and have changed our physician coverage patterns without effect on outcome. Decreasing the frequency of cranial ultrasound examinations as a change in practice patterns is relevant to our institution; however, at this time it would be difficult to apply our findings universally because of the relatively small number of patients in this study. Nonetheless, reducing the number of cranial ultrasound examinations in a low-risk population such as ours should be considered. Additionally, each ECMO center should undertake similar reviews of their patient care practices in an attempt to provide safe, quality care while decreasing the overall cost of that care. Because each extra ultrasound examination resulted in a charge of $245.00, we calculated that the application of the study's findings to the reported patient population would have resulted in a $42,000.00 reduction in hospital charges.

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