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Endocarditis in Neonatal Intensive Care Unit

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SUMMARY. **The clinical spectrum of infective endocarditis (IE) in infants is examined in four infants between 3 and 9 months of age. None of the patients had signs of IE; all four had an anatomically normal heart. Echocardiograms showed echodense vegetations in the left side of heart in three cases and in the right side in one. Three of the four patients recovered after the episode of endocarditis. Three of the four patients had necrotizing enterocolitis in the neonatal period. The important predisposing factor was the presence of indwelling central catheter for intravenous nutrition. Unlike previously reported cases, coagulase-negative *Staphylococci* and *Enterococci* were important causative organisms in this high-risk nursery population.**

KEY WORDS: **Endocarditis — Infants**

Infective endocarditis (IE) in infants has been well recognized pathologically for the last 40 years. Most of these cases were in infants with congenital heart disease [3, 8, 17, 18] and the diagnosis was made only on postmortem examination [9–11, 17, 19]. During the last decade, there has been an increasing survival of sick and small newborns as neonatal intensive care has become more and more sophisticated. Many invasive procedures used to sustain life are, however, not without serious consequences. We diagnosed IE in four infants over a period of 2 years in a neonatal intensive care unit, which admits 800 infants per year. All these infants had indwelling central catheters serving as indispensable life lines to provide intravenous nutrition.

The purpose of this report is to (1) describe the clinical presentation in these four infants, (2) discuss the possible pathogenesis of left heart endocarditis associated with the central venous catheters, and (3) review the changing spectrum of the disease in the first year of life.

Case Reports

Case 1

This 1261-g female infant was born at 31 weeks of gestation in a community hospital. Apgars were 5 and 7 at 1 and 5 min, respectively. She was transferred to Cook County Hospital for management of respiratory distress and prematurity. She required assisted ventilation for the first 48 h of life and an exchange transfusion for hyperbilirubinemia at 56 h of age. Neonatal course was further complicated by necrotizing enterocolitis on day 8 which rapidly progressed to perforation within the next 24 h. A laparotomy revealed extensive necrosis of the gut requiring resection and removal of the large portion of gut (small as well as large) and ileocecal valve. The infant was totally dependent on intravenous nutrition; hence, a central line was placed on the 25th day of life. The hospital course was marked by bacteremia at age 4, 6, and 8 months. Blood cultures (all cultures reported in this study were drawn from a peripheral vessel) grew *Enterobacter cloacae*, *Klebsiella* and coagulase-negative staphylococcus, respectively, during these episodes.

At 9 months, she once again became febrile and lethargic. There was no evidence of petechiae, splenomegaly, or heart murmur throughout this illness. The white cell count was 16,600 with 76% neutrophils, 16% lymphocytes, and 8% monocytes. Blood cultures grew enterococcus and coagulase-negative staphylococcus. She was treated with vancomycin and gentamicin, but both organisms persisted for the next 7 days. An echocardiogram on the 6th day of illness showed echodense masses on the papillary muscle apparatus of the anterior mitral valve leaflet (Fig. 1) and on the aortic valve leaflets (Fig. 2). These findings were consistent with vegetations of infective endocarditis (IE). The infant was still totally dependent on intravenous nutrition, and there were no sites left for another central line. The central line, therefore, could not be removed, and treatment was continued for 4 weeks with vancomycin and gentamicin. Serial echocardiograms revealed that the vegetation on the aortic valve was no longer detectable at the age of 15 months. However, the vegetation on the papillary muscle apparatus on the mitral valve was still present at the age of 23 months (i.e., 14 months after the initial illness). Echocardiogram at 29 months showed complete resolution of the vegetation at the mitral valve area.

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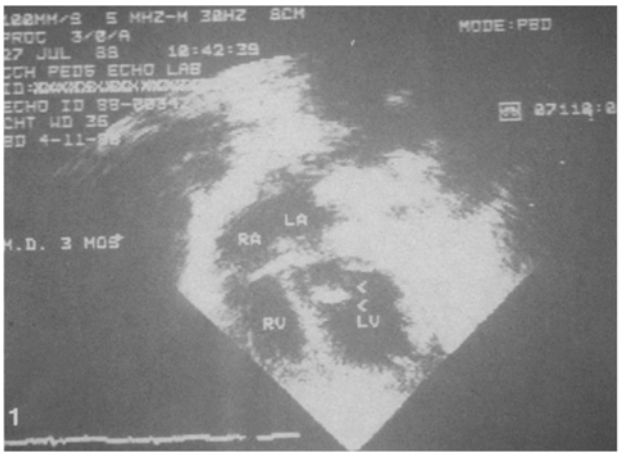

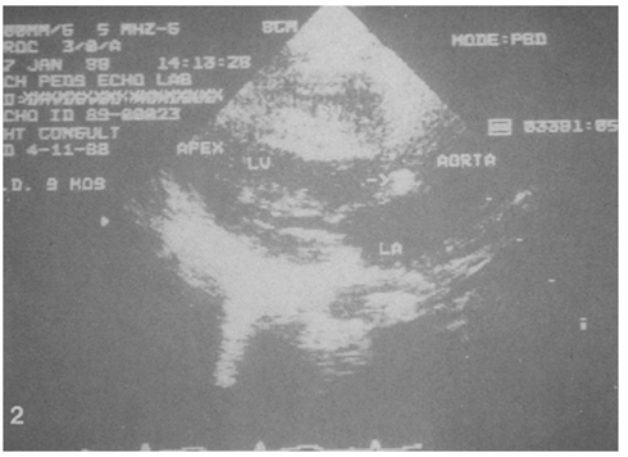

Fig. 1. *Case 1.* Apical four-chamber view showing vegetation on papillary muscle apparatus of anterior mitral valve leaflet.

Fig. 2. *Case 1.* Long-axis showing vegetation on aortic valve leaflet.

Case 2

This 1400-g female infant was born at 31 weeks gestation. Apgars were 8 and 8 at 1 and 5 min, respectively. She was ventilated for the first 24 h of life; 2 days later she developed necrotizing enterocolitis. The disease rapidly progressed to perforation over the next few hours. A laparotomy done the same day revealed extensive necrosis of the gut; the demarcation between viable and nonviable bowel was unclear. The abdomen was closed and two mucus fistulae were created. She was considered to have disease incompatible with long-term survival but upon parental insistence a central line was inserted for intravenous nutrition and the infant was transferred to us for a second-look laparotomy. This was done at the age of 3 weeks, at which time the majority of the small bowel was in the form of a matted mass. Aggressive management and life-support measures were continued at the urging of the parents in hope of finding enough salvageable bowel at a later date. A third laparotomy was done at the age of 3 months; only 15 cm of bowel without the ileocecal valve could be salvaged. She was treated for enterococcal septicemia at 4 months and *Staphylococcus aureus* pneumonia at 5 months.

At 6.5 months, she became febrile and deteriorated rapidly over the next 24 h. There was no splenomegaly, heart murmur, or microscopic hematuria. Laboratory workup revealed a white cell count of 7880 with 56% neutrophils, 39% lymphocytes, and 5% monocytes. The platelet count was 55,000 and there was markedly prolonged PT and PTT. Blood cultures grew coagulase-negative staphylococcus. The bacteremia persisted for the next 4 days, despite treatment with vancomycin and gentamicin in adequate doses. On day 5 of illness, an echocardiogram showed a vegetation on the papillary muscle apparatus on the mitral valve. On this day, the repeat blood culture (from the peripheral vein) was also positive for *Klebsiella* and *Pseudomonas* besides coagulase-negative staphylococcus. The initial antibiotic coverage included vancomycin and gentamicin; this was later changed to piperacillin and tobramycin. She was treated for a total of 6 weeks.

Repeat echocardiogram done 3 months later still showed vegetation on papillary muscle apparatus of the mitral valve. She was ultimately discharged home but was readmitted several times for unrelated reasons. She died at 24 months of age. Autopsy was refused.

Case 3

This 670-g male infant was born at 25 weeks gestation with Apgars of 1 and 5 at 1 and 5 min, respectively. He had severe hyaline membrane disease and subsequently developed bronchopulmonary dysplasia. He remained ventilator-dependent until the time of his death. Complications during the first few months of life included hyperglycemia, hyperkalemia, and hyponatremia. Grade II intraventricular hemorrhage was noted on head ultrasound. An umbilical venous line was used for the first 3 days of life and a central line in the form of a percutaneous venous catheter was placed on the 50th day as the infant still required parenteral nutrition.

The neonatal course was marked by two episodes of septicemia. The first one occurred on day 1 of postnatal life; blood culture was positive for alpha streptococcus. The second episode occurred on the 14th day of life and was associated with *Candida*. The infant was initially treated with ampicillin and gentamicin followed by a 4-week course of amphotericin for *Candida*. The infant's respiratory status worsened again on the 85th day. There were no clinical signs suggestive of IE at this time and the white cell count was 11,000 with 41% neutrophils, 19% band forms, 35% lymphocytes, and 5% monocytes; the platelet count was 39,000. The blood culture was positive for enterococcus and bacillus species. Antibiotics included ampicillin and gentamicin. Repeat blood cultures done on days 4 and 8 of this illness persistently showed the same organisms. The central line was removed on the 5th day of illness. An echocardiogram done on the 8th day of illness revealed vegetations in the area of the foramen ovale and on the septal leaflet of the tricuspid valve (Fig. 3). A repeat echocardiogram done 12 days later still showed the same findings as on the previous echocardiogram. The infant had a cardiac arrest on the 102nd day of life and could not be revived. Autopsy was refused.

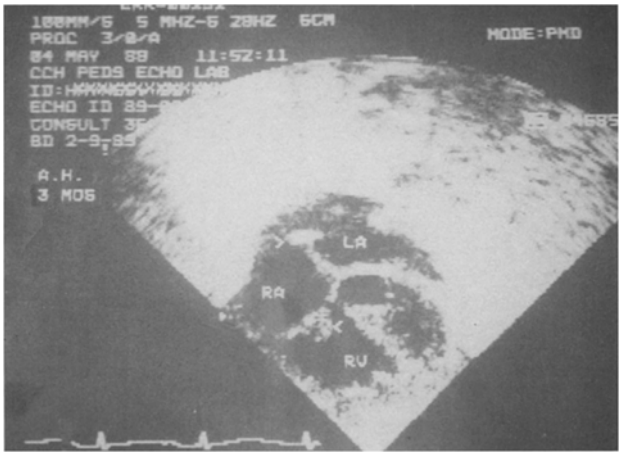

Fig. 3. *Case 3.* Subcostal four-chamber view showing vegetations on the intraatrial septum, a level of patent foramen ovale, and on the septal leaflet of the tricuspid valve.

Case 4

A 1489-g male infant was born at 32 weeks gestation with Apgars of 7 and 8 at 1 and 5 min, respectively. He had severe hyaline membrane disease requiring very high peak inspiratory pressures in the first few days of life. The neonatal course was further complicated by necrotizing enterolitis on the 7th day of life and the baby required surgery for a perforation. A mid-ileal resection was done along with an ileostomy and mucus fistula. The infant was supported with parenteral nutrition. Nasogastric feeding was started 14 days after laparotomy; however, the feeding could only be advanced very slowly because of repeated abdominal distension. A central line in the form of a Broviac catheter was inserted on the 73rd day of life.

On the 86th day, the baby became febrile. There were no other symptoms or signs at this time. White cell count was 8300 with 50% neutrophils, 26% lymphocytes, 20% monocytes, and 4% eosinophils. The platelet count was 68,000. The blood cultures revealed growth of enterococcus. The central line was removed on the 3rd day of illness. An echocardiogram done that day revealed vegetations on the papillary muscle apparatus of the mitral valve. The infant was treated with ampicillin and gentamicin for 28 days.

A repeat echocardiogram done 21 days later again demonstrated a vegetation on the mitral valve apparatus. Subsequent hospital course was uneventful. Reanastomosis of the bowel was done at the age of 3.5 months. The infant was discharged home a month later. He was subsequently lost to follow-up.

Discussion

The four cases of IE reported from our NICU raise our awareness of this possibility occurring in babies who require central venous nutrition. These cases had several similarities despite the disparate etiologies of their illnesses. All four patients had (1) persistent bacteremia, (2) right-sided heart catheters in the form of indwelling central venous lines, and (3) absence of underlying heart disease. The finding of anatomically normal heart is interesting in view of the conflicting reports regarding the role of prior heart disease in etiology of IE in infants [7–9, 11]. Prior to the introduction of central venous nutrition, IE was seen in 10% of infants with bacterial sepsis who had a preexisting congenital heart disease in comparison to 0.8% of those without underlying heart disease [8].

Bacterial endocarditis may develop in one of two ways: (1) The tip of the central catheter may initiate local injury to the endocardium providing intravascular exposure to subendothelial collagen. Subendothelial collagen in itself is a potent initiator of platelet aggregation and subsequent thrombus formation [12]. Bacteria may then colonize these platelet thrombi during episodes of transient bacteremia. This mechanism may be responsible for cases with right-sided endocarditis. However, we try to place the central lines with their distal tips into the superior vena cava rather than in the right atrium. This might explain the uncommon occurrence of the right heart lesions in our cases. (2) The septic emboli or the microorganisms themselves may attach to the normal cardiac endothelium and valves in an unexplained manner [12].

Mitral valve involvement was present in three of the four cases. The marked predominance of mitral valve lesions [8, 10, 21] may be due to the greater stress forces on the mitral valve than on the other cardiac valves, as reflected by the resting pressure at the time of valve closure. None of our cases had patent ductus to account for increased flow along the mitral valve. There was also no suggestion of the presence of patent foramen ovale to account for shunting of thrombi from the right to left side. Alternatively, a patent foramen ovale present during the first few days of life could have been responsible for passage of nonbacterial thrombotic emboli caused by endocardial trauma.

Streptococcus viridans has been held responsible for as many as 50–60% of cases of IE in the pediatric age group [13]. Enterococci account for another 10–20% [1] of cases of IE in the pediatric age group. Enterococcus is a normal commensal in the gut, the recent increase in enterococcal infections among high-risk neonates may be due to the increased survival of very premature, sick infants with complicated medical and surgical courses [6]. Since three of the cases had necrotizing enterocolitis (NEC), it is not surprising that they had enterococcal bacteremia. Coagulase-negative staphylococci have emerged as an important cause of bacteremia in high-risk nurseries [14, 16]. Coagulase-negative staphylococci were the causative

Table 1. Echocardiographic findings

Case	Vegetation			
	Patient age (mo)	Site	Size (mm)	Resolved
1	9	Papillary muscle of ant. MV	2	Yes (×20 mo)
		Aortic valve	3	Yes (×6 mo)
2	6	Papillary muscle of ant. MV	3	No (×3 mo)
3	3	Foramen ovale	4	No (×12 days)
		Tri. valve	3	No (×12 days)
4	3	Papillary muscle of ant. MV	4	No (×21 days)

ant. MV, anterior mitral valve; Tri. valve, tricuspid valve.

agents in 22% of episodes of endocarditis in one study of pediatric patients with otherwise normal hearts [7]. Gram-negative bacilli, on the other hand, are considered to be unusual in causation of IE. However, in high-risk infants, this finding is not surprising. We do not believe that the presence of NEC plays any role in the pathogenesis of endocarditis other than causing an episode of bacteremia.

The absence of signs and complications of endocarditis in our cases may be related to early diagnosis by echocardiogram and higher index of suspicion. Vegetations were 2–4 mm in size (Table 1) and were probably not large enough to be friable or to cause significant hemodynamic changes.

Little information on the course and prognosis of IE in infancy is available. Few cases have been reported in the last few years describing successful treatment of endocarditis in infants [2, 15, 20]. Three of our infants survived the episodes of endocarditis, whereas the fourth infant died of severe bronchopulmonary dysplasia. One of the survivors eventually died 15 months after her episode of endocarditis from unrelated causes. None of our cases required surgical therapy to remove vegetations. Using M-mode echocardiography, Dillon et al. [5] demonstrated large mitral valve vegetations which subsequently resolved during a 6-week course of antibiotic therapy. However, children with large floppy vegetations, or those with congestive heart failure secondary to vegetation, may require early surgical intervention [4]. Long-term follow-up was available in only one of our four cases in whom the vegetation persisted for as long as 14 months.

Early recognition and aggressive management of endocarditis should lead to improved mortality and morbidity. We suggest that cardiac ultrasound be considered in infants with central lines who have repeated and/or persistent bacteremia, even in the absence of specific symptomatology. We believe that infants with IE should be treated with appropriate bactericidal antibiotics for at least 4 weeks after the resolution of bacteremia.

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