

A case of severe transient hyperammonemia in a newborn

Min Woo Hwang, M.D., Seung Taek Yu, M.D., and Yeon Kyun Oh, M.D.

Department of Pediatrics, Wonkwang University School of Medicine, Iksan, Korea

= Abstract =

Transient hyperammonemia in a newborn is an overwhelming disease manifested by hyperammonemic coma. The majority of affected newborns are premature and have mild respiratory syndrome. The diagnosis may be difficult to determine. This metabolic disorder is primarily characterized by severe hyperammonemia in the postnatal period, coma, absence of abnormal organic aciduria and normal activity of the enzymes of the urea cycle. Hyperammonemic coma may develop within 2-3 days of life, although its etiology is unknown. Laboratory studies reveal marked hyperammonemia ($>4,000 \mu\text{mol/L}$). The degree of neurologic impairment and developmental delay in this disorder depends on the duration of hyperammonemic coma. Moreover, the infant may succumb to the disease if treatment is not started immediately and continued vigorously. Hyperammonemic coma as a medical emergency requires dialysis therapy. Here, we report a case of severe transient hyperammonemia in a preterm infant (35 week of gestation) presented with respiratory distress, seizure, and deep coma within 48 hours and required ventilatory assistance and marked elevated plasma ammonia levels. He survived with aggressive therapy including peritoneal dialysis, and was followed 2 years later without sequelae. (*Korean J Pediatr* 2010;53:598-602)

Key Words : Transient hyperammonemia, Hyperammonemic coma, Newborn

Introduction

Hyperammonemia is often a sign of an underlying metabolic disorder. Excess dietary and waste nitrogen, remaining after protein synthesis, are normally converted into urea through the urea cycle. Disorders of enzymes of the urea cycle lead to accumulation of ammonia and its precursors. This can cause encephalopathy and death or devastating neurologic sequelae if not treated immediately¹⁾. So, neonatal hyperammonemia is a medical emergency requiring early diagnosis and early treatment.

But the prognosis of transient hyperammonemia in a neonate is usually better than urea cycle disorders. Very low birth weight infants may have a mild hyperammonemia ($40-50 \mu\text{M/L}$), which lasts for about 6-8 week. These infants are usually asymptomatic, and revealed no significant neurologic deficits²⁾.

However severe transient hyperammonemia has been rarely observed in newborn infants. The majority of affected infants are premature and have mild respiratory distress syndrome^{2,3)}. According to available investigations, one case of severe transient hyperammonemia in the newborn infant was reported in Korea⁴⁾. Hyperammonemia may occur in asphyxia and severe hepatic diseases⁵⁾. The cause of the disorder is unknown, but its onset is usually in the first 24 hours after birth when the infant is undergoing mechanical ventilatory support^{2,3)}. The diagnosis may be difficult to determine because many of these same infants are receiving sedatives and muscle relaxants³⁾.

The mortality rate in hyperammonemia is high. However, recent advances in the diagnosis and treatment of it have greatly improved the prognosis for many infants with inborn errors in metabolism. So, early clinical diagnosis of hyperammonemia is essential and treatment of it should be initiated promptly and continued vigorously. Then, recovery without sequelae is common, and hyperammonemia does not recur even with a normal protein diet²⁾.

In this report, we present a case of severe transient hyperammonemia associated with coma in a premature infant with respiratory distress syndrome.

Received : 31 January 2010, Revised : 18 February 2010

Accepted : 2 March 2010

Address for correspondence : Yeon Kyun Oh, M.D.

Department of Pediatrics, Wonkwang University School of Medicine, 344-2 Shinyong-Dong, Iksan, Jeonbuk 570-749, Korea

Tel : +82.63-851-1513, Fax : +82.63-853-3670

E-mail : oyk5412@wonkwang.ac.kr

This study was supported by Wonkwang University in 2008.

Case report

A male neonate was admitted to the neonatal intensive care unit due moaning, cyanosis and premature rupture of membrane. He was born to a 30-year-old gravida 5, para 2 mother at the at the 35 week of gestation. His birth weight was 2,520 g. The neonate was delivered by normal spontaneous vaginal delivery. The Apgar scores were 5 at 1 minute and 6 at 5 minutes.

On physical examination conducted 2 hours after delivery, he developed cyanosis and respiratory distress with moaning and was increased respiratory rate 75/min. So, he was intubated and inhaled oxygen 5 L/min by E-tube. Although oxygen therapy was given, his oxygen saturation level was below 85%, he was plated on a mechanical ventilator. Laboratory analysis of the blood revealed hemoglobin 13.8 g/dL, hematocrit 39.5%, white blood cell count 3,520/ μ L with normal differential count, platelet 329,000/ μ L, ESR 3 mm/hr, CRP 0.28 mg/L. Liver function tests were as follows: AST 68 IU/L, ALT 10 IU/L, ALP 439 IU/L, total bilirubin 3.08 mg/dL. And serum Na^+ 148 mEq/L, K^+ 4.6 mEq/L, total Ca 9.0 mg/dL, BUN 7.8 mg/dL, creatinine 0.69 mg/dL, and glucose screen >80 mg/dL were revealed. A sample of arterial blood showed the following results: pH 7.319, PaCO_2 39.4 mmHg, PaO_2 99.7 mmHg and a base excess of -5.8 mM/L (FiO_2 0.8, RR 40/min, PIP 18 mmHg, PEEP 4 mmHg). A peripheral venous line was placed, and

administration of a 10% dextrose solution was started. His heart rate ranged from 170 to 180 beats/minute and his lung sounded wet. Chest radiograph showed pulmonary opacification, obscuration of cardiac margin, and increased air bronchogram which were characteristic of hyaline membrane disease, grade III. Furthermore, mild abdominal distention was noted. Endotracheal instillation of pulmonary exogenous surfactant was performed for the treatment of hyaline membrane disease. Ampicillin and aminoglycoside antibiotics were also initiated due to maternal premature rupture on membrane and hyaline membrane disease. After then, his respiratory effort was improved and controlled by low level of oxygen (FiO_2 0.4).

On the 2nd hospital day, his respiratory difficulty were continued, and urine output decreased to 0.8 ml/kg/hr. Laboratory exam revealed BUN 11.04 mg/dL, creatinine 1.34 mg/dL, K^+ 5.85 mEq/L. So, he was managed with hydration, lasix and dopamin to relieve the acute renal failure. But hyperkalemia was aggravated (serum K^+ : 9.8 mEq/L), and sine wave and PT prolongation on electrocardiogram (EKG) was revealed.

On the 3rd day of life, seizure was noted and then his mental status changed to coma abruptly. Laboratory studies revealed marked hyperammonemia (plasma ammonia as high as >715 μ M/L –above data was undetectable in our laboratory), hyperkalemia (K^+ : 8.82 to 9.98 mEq/L), elevated lactate (66.1 mg/dL), and increased serum creatinine 1.5 mg/dL (Table 1). In spite of intensive therapy to re-

Table 1. Summary of Clinical Manifestations and Laboratory Results

HD	Hb (g/dL)	WBC (/ μ L)	PLT (/ μ L)	BUN (mg/dL)	Cr (mg/dL)	Na (mEq/L)	K (mEq/L)	Ammonia (μ M/L)	Note
1	13.7	3,520	329K	7.8	0.69	148	4.6		ventilator care
2	14.1	10,640	280K	11.04	1.34	146	5.33 → 9.98		administration of surfactant oliguria (0.8cc/kg/hr), severe hyperkalemia ECG monitoring :
3	8.4	16,170	206K	19.40	1.40	142.1	7.4 → 6.68	>715	PR prolongation, Sine wave seizure, comatose mental status detection of hyperammonemia :
4	13.1	16,800	124K	31.06	1.29	140.6	5.05	>715	start the peritoneal dialysis semicomatose mental status, seizure stop
6	10.0	17,990	86K	14.82	0.70	138.0	3.20	616 → 338	stuporous mental status
7-9	8.1	27,600	184K	7.6	0.35	142.1	3.82	219 → 162 → 83	alert mental status, stop the peritoneal dialysis Brain CT: normal Brain MRI: normal
20									

Abbreviation : HD, hospital day

lieve the hyperammonemia and hyperkalemia, his comatous mental status with abnormal laboratory findings was continued. Additional tests for blood amino acid levels, plasma and urine concentration of organic acids, and plasma long chain fatty acid levels test were performed to rule out the metabolic disorder. The test results showed the absence of abnormal organic aciduria and normal activities of the enzymes of the urea cycle.

On the 4th day of life, peritoneal dialysis was started with lactulose enema, and protein intake restriction. His hyperkalemia improved to normal but comatous mental state with hyperammonemia above 715 $\mu\text{M/L}$ was continued for 5 days. After 5 days of peritoneal dialysis, the patient became mentally alert. And improvement of hyperkalemia was shown on laboratory exam and EKG. On the 9th day of life, his ammonia level returned to normal, and his brain computed tomography (CT) showed no abnormalities. On the 20th days of life, his brain magnetic resonance imaging (MRI) showed also no specific abnormalities. As a result, the diagnosis of severe transient hyperammonemia in a neonate was made. And he was discharged on 21th day of life. At the follow-up examinations for 2 years, his development is in the normal range without any sign of delay.

Discussion

Transient hyperammonemia in a newborn, a condition of unknown etiology, was first described by Ballard and colleagues in 1978⁶⁾. The clinical picture is similar to patients with defects in the activity of the enzymes of the urea cycle that appear in the neonatal period. It may be difficult to determine the diagnosis. Very low birth weight infants may have a mild transient hyperammonemia, which lasts for about 6–8 week. These infants are asymptomatic and have no significant neurologic deficits. But severe transient hyperammonemia has been reported in newborn infants rarely^{6, 7–10)}. The majority of these infants are premature, and this disease usually develops during the course of treatment for respiratory distress syndrome²⁾. Giacoia et al⁸⁾ reported that large premature and infant males most commonly were affected. These infants are born without any prenatal problems and are initially cared for in a regular nursery. These babies become symptomatic and can develop lethargy that rapidly progresses to somnolence and coma with intractable seizures, respiratory distress, and death. The plasma ammonia level may be enormously ele-

vated, as high as urea cycle enzyme disorder^{2, 3)}. Hyperammonemic coma may develop within 2–3 days after birth. Laboratory studies reveal marked hyperammonemia ($>4,000 \mu\text{M/L}$) with moderate increases in plasma levels of glutamine and alanine. In our case, marked hyperammonemia (plasma ammonia as high as $>715 \mu\text{M/L}$ –above data was undetectable in our laboratory) is also checked, but plasma levels of glutamine and alanine are not increased. Several investigators have sought to implicate hypoxia as a prerequisite to the development of hyperammonemia^{11, 12)}. Beddis et al.¹³⁾ reported that a significant number of his nursery admissions with birth asphyxia or hyaline membrane disease also suffered from hyperammonemia. Arterial blood gases revealed significant hypoxia in his cases.

The most important laboratory findings associated with inborn errors of metabolism presenting with an acute encephalopathy is hyperammonemia. Transient hyperammonemia of newborn can be diagnosed only after exclusion of inborn errors of metabolism that also produce symptomatic neonatal hyperammonemia, principally enzymes of the urea cycle and organic acidemias. This differentiation has to be done by measuring plasma and urine aminoacids, urine ketones and organic acids and enzyme activities¹⁴⁾. These laboratory findings in this case revealed normal, which was suggested no urea cycle enzyme disorder.

The diagnosis may be difficult to determine because many of these same infants are receiving sedatives and muscle relaxants to optimize therapy of their life threatening pulmonary disease. Important clues are the absence of deep tendon reflexes, the absence of the normal newborn reflexes, and decrease or absence of response to painful stimuli³⁾.

Hyperammonemia is a medical emergency and can lead to coma. Rapid resolution of hyperammonemia is critical to producing a favorable outcome^{2, 3, 15, 16)}. The prognosis of recovery depends on the duration of coma; the longer duration of coma, the worse is the prognosis. The infant may succumb to the disease if treatment is not started immediately. While severe hyperammonemia ($>800 \mu\text{M/L}$) for greater than 24 hours is usually associated with irreversible neurological damage, the duration of hyperammonemia has proven to be perhaps a more important risk factor than the peak level in determining long term outcome¹⁶⁾.

As with hyperammonemic coma in the urea cycle enzyme disorder, this medical emergency requires dialysis therapy¹⁶⁾. Hemodialysis has been reported to be the only method

to remove ammonia rapidly from the body^{16, 17)}. Rapid detoxification plays a critical role in preventing or minimizing the damage to the brain and other organs¹⁸⁾. This approach not only prevents further damage due to direct effects of a metabolite, such as ammonia, but also stabilizes the metabolic pathways that may be affected subsequently. While preparing for hemodialysis or extracorporeal membrane oxygenation, ammonia scavenging therapy should be initiated, even prior to the diagnosis of a specific metabolic etiology, if it is felt that alteration in the central nervous system status is a result of the high ammonia level¹⁶⁾. Current literature suggests that patients with very high ammonia level should receive hemodialysis prior to extracorporeal membrane oxygenation¹⁶⁾. We think that, even if the ammonia was slowly relieved, peritoneal dialysis in this patient may be served to improve the clinical and laboratory findings, especially hyperammonemia.

The mortality rate in hyperammonemia is high. However, if a patient who can be treated early and aggressively, recovery without sequelae is common^{2, 3, 16)}. If, not be treated early, many survivors may suffer from neurologic sequelae, e.g., mental retardation, seizures, cortical atrophy, and spastic quadriparesis. Neurologic sequelae and survival depend on the duration of hyperammonemic coma. Neurologic deficits usually occur if the coma persists for more than 2 days¹⁹⁾.

In conclusion, although hyperammonemia in neonate has a good prognosis as a prompt diagnosis and aggressive therapy, a plasma ammonia levels should be considered as a routine diagnostic test in cases of newborn infants with signs of changes in the mental status, emesis, seizures and/or poor feeding.

한 글 요약

신생아의 심한 일과성 고암모니아혈증 1례

원광대학교 의과대학 소아과학교실

황민우 · 유승택 · 오연균

신생아 일과성 고암모니아혈증은 고암모니아혈증을 특징으로 하며 대부분 호흡곤란 치료를 받는 미숙아에서 발생한다. 발생 원인은 정확히 알려져 있지 않으나 생후 2-3일에 호흡 곤란, 기면, 경련, 혼수 등의 임상 증상을 보이고, 생화학적 검사 상 혈중 암모니아 농도가 현저히 증가하며 요소회로 효소 치는 정상을 보인다. 치료가 늦으면 사망에 이르는 응급을 요하는 질환이나 즉

각적이고 적절한 치료 시 신경학적 손상을 남기지 않고 호전 가능하다.

저자들은 호흡곤란을 보여 호흡기 치료를 받던 35주 미숙아에서 48시간 내에 경련과 함께 혼수상태에 빠지고 검사상 고암모니아혈증을 보여 신투석 등의 치료 후 회복되었으며 2년 추적관찰에서 정상을 보인 환아를 보고하는 바이다.

References

- Burton B. Pediatric liver: helping adults by treating children. Urea cycle disorders. Clin Liver Dis 2000;4:1-13.
- Iraj R, Urea Clycle and Hyperammonemia. In: Kliegman RM, Behrman RE, Jenson HB, Stanton BF. Nelson textbook of pediatrics. 18th ed. Philadelphia: WB Saunders Co, 2007:561.
- Gerard TB. Inborn Errors of Carbohydrate, Ammonia, Amino Acid, and Organic Acid Metabolism. In: Tausch HW, Ballard RA, Gleason CA. Avery's diseases of the newborn. 8th ed. Philadelphia: Elsevier Sanders Co, 2005:234-5.
- Choi JY, Lee SH, Jun SS, Seo SS. A case of transient hyperammonemia of the newborn infant. J Korean Soc Neonatal 2001;8:156-60.
- Snyderman SE. Clinical aspects of disorders of the urea cycle. Pediatrics 1981;68:284-9.
- Ballard RA, Vinocur B, Reynolds JW, Wennberg RP, Merritt A, Sweetman L, et al. Transient hyperammonemia of the preterm infant. N Engl J Med 1978;299:920-5.
- Ellison PH, Cowger ML. Transient hyperammonemia in the preterm infant: neurologic aspects. Neurology 1981;31:767-70.
- Giacioia GP, Padilla-Lugo A. Severe transient neonatal hyperammonemia. Am J Perinatol 1986;3:249-54.
- Whitelaw A, Bridges S, Leaf A, Evans D. Emergency treatment of neonatal hyperammonemic coma with systemic hypothermia. Lancet 2001;358:36-8.
- Stojanovic VD, Doronjski AR, Barisic N, Kovacevic BB, Paviovic VS. A case of transient hyperammonemia in a newborn. J Matern Fetal Neonatal Med 2009;31:1-4.
- Goldberg RN, Cabal LA, Sinatra FR, Plajstek CE, Hodgman JE. Hyperammonemia associated with perinatal asphyxia. Pediatrics 1979;64:336-41.
- Walser M. Urea cycle disorders and other hereditary hyperammonemia syndromes. In: Stanbury JB, Wyngaarden JB, Frederickson DS, Goldstein JL, Brown MS, editors. The metabolic basis of inherited disease. 5th ed. New York: McGraw-Hill, 1983:402-38.
- Beddis IR, Hughes EA, Rosser E, Fenton JC. Plasma ammonia levels in newborn infants admitted to an intensive care baby unit. Arch Dis Child 1980;55:516-20.
- Krishnan L, Diwakar KK, Patil P, Bhaskaranand N. Transient hyperammonemia of newborn. Indian J Pediatr 1996;63:113-6.
- Yoshino M, Sakaguchi Y, Kuriya N, Ohtani Y, Yamashita F, Hashimoto T, et al. A nationwide survey on transient hyperammonemia in newborn infants in Japan: prognosis of life

- and neurological outcome. *Neuropediatrics* 1991;22:198-202.
- 16) Rajpoot DK, Gargus JJ. Acute hemodialysis for hyperammonemia in small neonates. *Pediatr Nephrol* 2004;19:390-5.
- 17) Summar M, Pietsch J, Deshpande J, Schulman G. Effective hemodialysis and hemofiltration driven by an extracorporeal membrane oxygenation pump in infants with hyperammonemia. *J Pediatr* 1996;128:379-82.
- 18) Batshaw ML. Inborn errors of urea synthesis. *Ann Neurol* 1994;35:133-41.
- 19) Cleary MA, Green A. Developmental delay: when to suspect and how to investigate for an inborn error of metabolism. *Arch Dis Child* 2005;90:1128-32.