Fluid Intake and urinary output affect plasma sodium concentration in extremely preterm infants early after birth

Toshihiko Ikuta^{1, 2*}, Kazumichi Fujioka², Takami Yamauchi¹, Emiko Takeoka¹, Sachiko Matsui¹, Saki Okubo^{1, 2}, Shoko Tamaki¹, Hitomi Mimura¹, Seiji Yoshimoto¹, Hideto Nakao¹, Kazumoto Iijima²
1, Department of Neonatology, Kobe Children's Hospital, Kobe, Japan
2, Department of Pediatrics, Kobe University Graduate School of Medicine, Kobe, Japan

Background: Hyponatremia are highly prevalent in Extremely preterm infants (EPI, < 28 weeks of gestation) during the 1st week of life, due to high body water content and large insensible water losses. The purpose of this study was to investigate the factors affecting plasma sodium concentration (P_{Na}) in EPI.

Methods: This retrospective observational study included 40 appropriate for gestational age (AGA) infants born at 22-27 weeks of gestation in Kobe Children's Hospital from 2015 to 2016. AGA was defined as a birth weight that is between the 10th and 90th percentiles. Three cases were excluded because one died, and two received exchange transfusion for the first 72 hours, and 37 infants (gestational age 25.9 (22.3-27.7) weeks, birthweight 814 (414-1180) g) was analyzed. The neonatal data including P_{Na} change (mEq/l), sodium supply (mEq/kg), fluid intake (ml/kg), and urinary output (ml/kg) was extracted 8-hourly for the first 72 hours by medical chart review (**Figure 1**). Data were expressed as median (minimum - maximum) and $p < 0.01$ was deemed as statistically significant.

Figure 1. Data Collection

The first available P_{Na} each 8 hour was obtained.

Table 1. Neonatal characteristics

	GA 22-24 weeks n=15	GA 25-27 weeks n=22
Gestational age, weeks (range)	24.1 (22.3-24.9)	26.5 (25.4-27.7)
Birth weight, g (range)	618 (414-796)	935 (776-1180)
Male births (%)	6 (40.0)	15 (68.2)
Multiple birth (%)	6 (40.0)	5 (22.7)
Maternal complications		
PIH (%)	0 (0)	0 (0)
GDM (%)	0 (0)	0 (0)
Antenatal steroids (%)	11 (73.3)	13 (59.1)
Use of		
Ritodrine hydrochloride (%)	13 (86.7)	18 (81.8)
tocolytic agent		
Magnesium sulfate (%)	13 (86.7)	20 (90.9)
Apgar score		
at 1 min (range)	2 (1-7)	3 (1-7)
at 5 min (range)	7 (3-9)	7 (3-9)
Chorioamnionitis (%)	15 (100)	17 (77.3)
Medication		
Indomethacin (%)	14 (93.3)	6 (27.3)
for the first 72 hours		
Furosemide (%)	8 (53.3)	9 (40.9)
Hydrocortisone (%)	4 (26.7)	9 (40.9)

GDM; gestational diabetes mellitus, PIH; pregnancy induced hypertension

Results: The clinical characteristics are described in **Table 1**.

The sodium supply and fluid intake for the first 72 hours are described in **Figure 2**. Total fluid intake was 330.2 (229.6-529.5) ml/kg, and total sodium supply was 15.0 (7.0-31.6) mEq/kg for the first 72 hours. 15 cases (40.5%) developed hyponatremia ($P_{Na} < 135$ mEq/l), and 29 cases (78.4%) developed hypernatremia ($P_{Na} > 145$ mEq/l) (**Figure 3**). P_{Na} change was positively correlated with urinary output at 8-16, 24-32, 32-40 and 48-56 hours after birth ($r=0.668$, $r=0.570$, $r=0.519$, $r=0.500$, respectively), and was negatively correlated with fluid intake at 64-72 hours after birth ($r=0.541$) with significance. Sodium supply did not affect P_{Na} change (**Table 2**).

Figure 2. Sodium supply and fluid intake during the first 72 hours

Figure 3. P_{Na} (mEq/l) during the first 72 hours

Table 2. Factors correlated with P_{Na} change

Postnatal age (hours)	Fluid intake (ml/kg)	Sodium supply (mEq/kg)	Urinary output (ml/kg)
0-8	N.S.	N.S.	N.S.
8-16	N.S.	N.S.	0.67 *
16-24	N.S.	N.S.	N.S.
24-32	N.S.	N.S.	0.57 *
32-40	N.S.	N.S.	0.52 *
40-48	N.S.	N.S.	N.S.
48-56	N.S.	N.S.	0.50 *
56-64	N.S.	N.S.	N.S.
64-72	-0.54 *	N.S.	N.S.

Data were expressed as Pearson's correlation coefficient (r). * $p < 0.01$

Conclusion: P_{Na} change in EPI early after birth was more influenced by urinary output and fluid intake than by sodium supply.