Hypernatremia (pediatrics)

Hypernatremia is denifed as S-Na > 150 mmol/l. If all feedback mechanisms are preserved and the child is conscious, thirst is a typical manifestation of hypernatremia. Another defense mechanism is an increase in ADH secretion and the production of highly concentrated urine. In most cases, this change of sodium concentration in serum occurs when the patient is weakened by some underlying acute or chronic illness, exacerbated by insufficient water intake. *Extracelular osmolality* is compensated by the formation of idiogenic intracellular osmols in the CNS. A significant amount is already present after 24 hours . **Correction of natremia** must therefore be really slow, as it follows that the body is more at risk of rapidly induced sodium loss with the risk of developing cerebral edema than existing hypernatremia.

The clinical picture is modeled by water redistribution and its transfer from ICT to ECT. This is why patients have a long-preserved skin turgor, which is sometimes dough. The brain is the most sensitive to moving water from ICT to ECT. Cerebral dehydration and cell volume shrinkage of varying degrees may occur here. The brain can adapt to a 10-15% reduction in this volume, but> 20% accelerated loss of ICT leads to severe structural changes in the CNS, most of which are irreversible.

Clinical manifestations

Most often we find non-specific symptoms: lethargy, confusion, "squeaky" crying, increased neuromuscular irritability, stiff neck, convulsions, unconsciousness, markedly depressed large fontanel. The symptoms can be very dramatic, as some patients may experience separation of the meningeal sheaths from the brain accompanied by intracranial / intracerebral haemorrhage, and also development of demyelination. There is a big difference between body temperature measured in the rectum and at the foot (> 8 ° C), there may be hypotension or hypertension, manifestations of vasculitis, intravascular coagulation. Rhabdomyolysis may occur in association with hypernatraemia.

Diagnostic algorithm

By combining the values of S-Na, S-osmo, U-Na, U-osmo and assessing the condition of ECT, we can, as with hyponatremia, differentially diagnose the following types of hypernatremia:

Hyperatremia due to water and sodium deficiency (water deficit is> Na deficit) + decreased ECT volume

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U-Na < 20 mmol/L + U-osmo < 300 mmol/kg → renal loss
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- diabetes insipidus centralis,
- diabetes insipidus renalis.

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U-Na < 20 mmol/L + U-osmo > 600 mmol/kg → extrarenal loss
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- hyperventilation,
- hyperpyrexia.

Hypernatremia due to free water deficit (represents a deficit of "only" water, ie hypernatremia is relative = Na content in the organism is normal) + reduced ECT volume

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U-Na < 20 mmol/L + U-osmo < 300 mmol/kg → renal loss
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- diabetes insipidus centralis,
- diabetes insipidus renalis.

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U-Na < 20 mmol/L + U-osmo > 600 mmol/kg → extrarenal loss
```

- hyperventilation,
- hyperpyrexia.

Hyperatremia from sodium overdose + normal or elevated ECT

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U-Na > 20 mmol/L + U-osmo is > S-osmo
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- excessive supply of NaCl or $NaHCO_3$,
- incorrect preparation of infant formulas.

Increased natriuresis and urine osmolality are a manifestation of the body's compensation in intact kidney function.

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U-Na < 20 mmol/l  -> renal retention of natrium
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- primary hyperaldosteronism,
- morbus/syndrome Cushing.

In most cases, when U-osmo increases, U-Na decreases and vice versa. Exceptions are hyponatremic conditions of SIADH and CSWS and hypernatremic conditions of diabetes insipidus renalis and centralis.

Additional comment

The cause of hypernatremia is often multifactorial and requires a comprehensive consideration. In addition to the clinical findings, anamnestic data are extremely important, especially the method of preparation of the infant formula in newborns and infants. Hypernatremia in infants and toddlers is also easy with fever and inadequate fluid intake. The body surface area of newborns, infants and toddlers is relatively large in relation to ECT volume and sweating losses (sweat is a prototype of hypotonic fluid except patients with cystic fibrosis) are therefore significant.

Hypernatremia therapy

Hypernatremia associated with > 10% weight loss requires correction by infusion.

$$\mathbf{calculation\ of\ water\ deficit\ in\ liters} = 0,6 \cdot \mathbf{weight(kg)} \cdot \left(1 - \frac{\mathbf{normal\ S\text{-}Na}}{\mathbf{current\ S\text{-}Na}}\right)$$

Accurate determination of free water deficit is difficult, especially in hypernatremic dehydration, where most water losses are intracellular, there are no signs of loss of circulating volume, and on the contrary, ECT volume is ensured. In practice, we proceed as follows: for the first 1-2 hours we serve 1/1 FR or 1/1 Ringer sol. We also serve solutions where Na is about 60 mmol/L lower than the current sodium (usually 2/3 - 1/1 solutions). With a good clinical condition of the child and a tendency to normalize laboratory parameters, it is possible to terminate the therapy p.o. rehydration solution. A safe decrease S-Na by max. 0.5 mmol/L/h, resp. S-osmo decrease by max. 1 mmol/L/h. On the contrary, a daily decrease of more than 12 mmol/L carries the risk of cerebral edema. We prolong the adjustment of ECT and ICT to approximately twice the correction time compared to normonatremic dehydration. We usually plan a total correction of 72 hours.

In hypernatremia > 170 mmol/L, the S-Na should not fall below 150 mmol/L during the first 48-72 hours after starting treatment. At Na> 175 mmol/L we consider furosemide 1-5 mg/kg i.v. Dialysis is a last resort in refractory cases. If convulsions occur during hypernatremia therapy, they are probably related to the development of cerebral edema. In this case, it is advisable to slow down the infusion correction, or to apply a smaller dose of hypertonic NaCl solution.

Recommended monitoring

- á 1 hour control of HR, RR, BP, state of consciousness, fluid balance,
- á 4 hours control of Na, K, glycemia a ABB,
- at sodium level below 150 mmol/L we continue the correction as in isotonic dehydration.

Links

Sources

- HAVRÁNEK, Jiří: *Dysbalance natria*. (upraveno)

Related Articles

- Sodium imbalance (pediatrics)
- Vnitřní prostředí (pediatrics)
- Hyponatremia (pediatrics)
- Serum osmolality
- Sodium imbalance
- Hyponatremia
- Hypernatremia