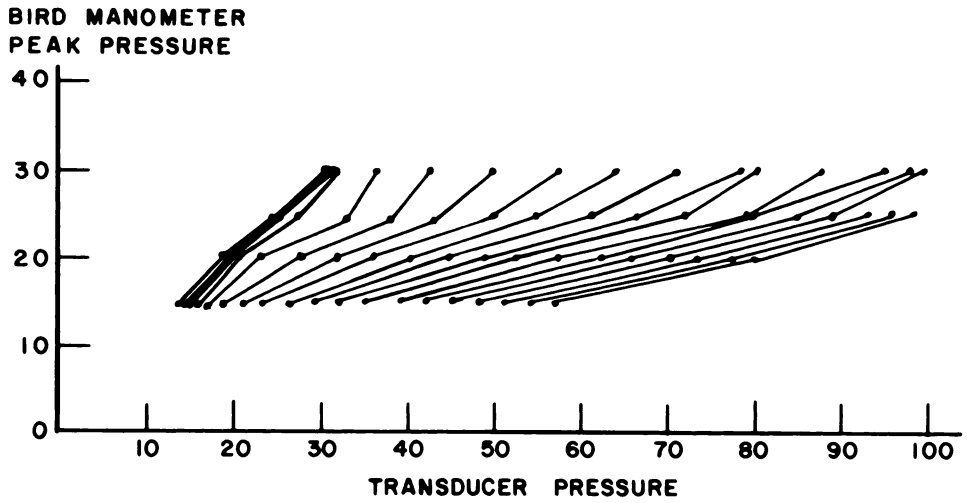

Fig 6. Relationship between dynamic Bird manometer peak pressure and transducer pressure readings at rates of 20 to 200/min. Each point represents mean of six separate transducer pressure determinations at specific rate and manometer peak pressure reading of 15, 20, 25, and 30 cm H_2O. Line overlays represent specific rates in ten-minute increments, with effect of increasing rate displayed from left to right with this type of manometer. Pressures exceeding peak transducer calibration value (100 cm H_2O) are not displayed.

equipment that display the same accuracy and frequency response as modern ventilator manometers and that can be positioned near the infant to allow simultaneous observation of the infant and inflation pressure.

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Acute Hyponatremia and Seizures in an Infant After a Swimming Lesson

There have been a number of recent reports describing water intoxication in infants.[1-4] In each case, hyponatremia followed an excessive intake of free water, either as the result of feeding mismanagement[1-3] or vigorous hydration with water during a febrile illness.[4] This report describes an infant who developed hyponatremia and seizures after swallowing an unknown volume of water during a swimming lesson. We will discuss the case and comment on present recommendations for preschool swimming instruction.

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CASE REPORT

An 11-month-old girl was in excellent health until the day of admission. During a 60-minute swimming lesson, she was noted to swallow more water than usual, but exhibited no unusual symptomatology while in the pool. Thirty minutes after the lesson, she became irritable, lethargic, and disoriented. She vomited forcefully en route to the hospital and developed generalized seizures shortly after arriving in the emergency room. Her rectal temperature was 35.3°C, heart rate 124 beats per minute, respirations 26/min, and systolic blood pressure was 98 mm Hg. Measurements included weight 11.2 kg (97th

percentile), length 77 cm (90th percentile), and head circumference 47.5 cm (95th percentile). Except for her neurologic status, findings from the physical examination were within normal limits.

Findings from laboratory tests on admission included: blood glucose 97 mg/dL, calcium 8.8 mg/dL, creatinine 0.5 mg/dL, hemoglobin 11.2 gm/dL, and WBC count 20,600/μL with a normal differential. The serum electrolytes were sodium 122 mEq/L, chloride 92 mEq/L, potassium 3.2 mEq/L, and CO_2 22 mEq/L. The patient's seizures were treated with diazepam, phenobarbital, and diphenylhydantoin followed by fluid restriction limited to 0.9% NaCl at 50 mL/kg/day.

The patient had voided en route to the hospital, but the first specimen analyzed was that which occurred three hours after admission. Urine osmolality was 500 mosm/kg and urine sodium was 170 mEq/L. Simultaneous serum values were sodium 134 mEq/L and osmolality 273 mosm/kg. Over the next 16 hours, the urine output was 910 mL and body weight decreased by 450 g. Findings from an EEG performed on the fourth hospital day were normal, and the infant was discharged without anticonvulsant medications. Follow-up 12 months later revealed a healthy infant without neurologic sequelae.

DISCUSSION

Acute hyponatremia may result from excessive sodium loss, excessive intake of free water, or inappropriate secretion of antidiuretic hormone (SIADH). Most previously reported cases of "water intoxication" involved healthy infants fed formulas improperly prepared at home. Partridge et al[1] and Schulman[2] argued that SIADH was unlikely in their infants and felt that the hyponatremia encountered was solely the result of excessive free water intake. David and co-workers,[3] however, were the first to study prospectively a number of infants with water intoxication. Their documentation of increased arginine vasopressin levels in some of their patients supports their contention that SIADH plays a role in at least some patients with water intoxication. Our patient differs from most reported cases in that she ingested an unknown volume of swimming pool water over a short period of time. She did not have a high salt intake in the 24 hours prior to admission, and the transient nature of this illness in an otherwise healthy infant militates against a salt wasting nephropathy or adrenal dysfunction.

The presence of a high urine osmolality and a high urine sodium at a time when her serum electrolytes were normalizing suggests the possibility of SIADH as the cause of the hyponatremia. This diagnosis is not conclusive, however, because we did not measure the plasma arginine vasopressin concentration and the urine studies were not concurrent with the period of hyponatremia. It is presumed, however, that this urine was formed at the time of presentation. At present, there is still disagreement about the criteria necessary to diagnose SIADH in patients presenting with hyponatremia and excessive water intake.[5] Our patient was reported to swallow more water than usual during her swimming lession. The stress associated with this ingestion and repeated submersion during her lesson might explain the inappropriate release of antidiuretic hormone[6,7]

It is not known how many infants engaged in swimming instruction or swimming are subject to water intoxication. In our review of the literature, we found no published case reports and there has been only brief mention of this complication.[8–10] Additional history revealed that four weeks prior to admission our patient had an episode of disorientation and lethargy that followed a 45-minute swimming lession and resolved within a half hour. She may have experienced symptomatic hyponatremia at that time which resolved spontaneously. Because the pathogenesis of this disorder is incompletely understood, the exact volume of water required to cause water intoxication is unknown and, in fact, may vary depending on the role of SIADH in its development. We speculate that a greater number of infants develop mild hyponatremia while swimming, but never reach medical attention because of the nonspecific nature of their symptoms.

The debate over the optimal age to begin swimming instruction is not new. Advocates of preschool swimming instruction stress that it may prevent later fear of water, it allows the parent and child to share a pleasurable activity, and it may decrease the number of drownings in this age group.[10–12] Opponents argue that even though infants and toddlers may learn to float or swim a few strokes, they cannot be expected to react properly in an emergency and, therefore, should never be considered water safe.[13,14] In 1980, the American Academy of Pediatrics published its statement on swimming instructions for infants.[15] Recognizing the increased popularity of these programs, the Academy recommended that controlled studies be conducted to investigate the potential risks of swimming programs to infants. They emphasized that swimming lessons should be on a one-to-one basis with a parent and stressed that childhood water safety has only been proven in three areas: adequate fencing, constant adult supervision, and the use of flotation jackets for nonswimmers.

It is important for health professionals to recognize that there is variation in infant swim programs throughout the country and there is a lack of standardized guidelines for instructors. According to M. Murphy, the director of the YMCA National Aquat-

ics Program, classes differ primarily on their emphasis in "waterproofing" the infant through repeated submersion (personal communication, 1982). Because infant swimming is defensible as a social activity and not a means of water safety, the National YMCA discourages programs that emphasize water submersion.[16] Despite this recommendation, many local groups continue to offer such programs. Swimming experts agree that children less than 2 years of age will automatically hold their breath when submerged, but they do swallow water. Although controlled studied are lacking, experience indicates that infants swallow more water when repeatedly submerged than when engaged in "water adjustment" programs that do not involve submersion (M. Murphy, personal communication, 1982). Our patient had been enrolled in a waterproofing program, and her case suggests that swimming instruction that involves repeated submersion of infants may be more dangerous than previously assumed.

As a result of this case, we have begun to incorporate the discussion of swimming instruction into anticipatory guidance given at 6 months of age. We advise parents to avoid programs that encourage water submersion, and they are cautioned to stop the lesson if their child should swallow unusual amounts of water or exhibit any symptoms of possible hyponatremia. We recommend that practitioners measure arginine vasopressin levels in addition to serum and urine electrolytes in any patient who is seen with water intoxication.

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