

NEONATAL RENAL PHYSIOLOGY

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Question

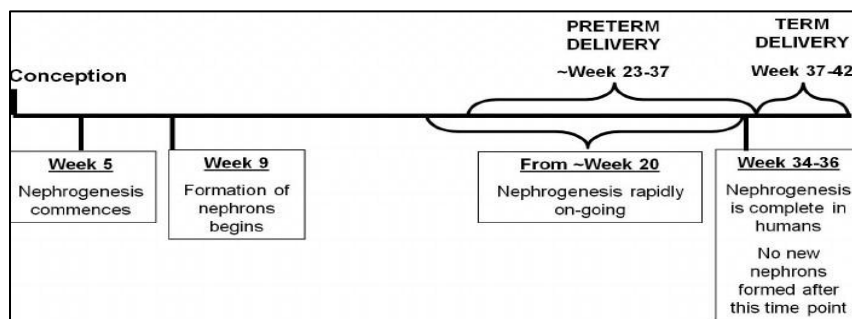
A 2-day-old, 32-week post-conceptual age neonate presents for surgical management of an omphalocele. Which of the following is MOST likely to be present?

- A. Low serum creatinine
- B. Low urine glucose
- C. High serum bicarbonate
- D. Hypotonic urine

Key Points

- Normal renal development begins in the first trimester and continues throughout gestation. The term neonate has a full number of glomeruli, but the glomerular filtration rate (GFR) is about 30% of the normal adult rate, even when corrected to body surface area.¹⁻³
- Neonates, particularly preterm neonates, have immature tubular cells with diminished and blunted response to aldosterone and antidiuretic hormone. There is also decreased ability to reabsorb and excrete electrolytes.⁴⁻⁵

Fetal Renal Development¹



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Neonatal Renal Function and Clinical Implications

GFR: Decreased at birth because:

- The kidneys of the newborn receive only 15 to 20% of the cardiac output in contrast to the 25% observed in the adult.²
- At birth, low systemic blood pressure and high intravascular resistance result in a very reduced driving force of filtration.²
- Very low surface area of the glomerular basement membrane limits the amount of filtered fluid.²

Baseline plasma creatinine levels are higher with increasing prematurity and may remain elevated until 3 weeks of age.³ GFR reaches stable adult levels at approximately 1 year of

age.¹⁻³ Implications may include decreased metabolism and clearance of drugs and anesthetics because of immature renal function.^{5,6}

Renin-angiotensin-aldosterone system: Intact in the neonate, but:

- The neonatal kidney cannot respond to aldosterone due to its immature tubular cells.
- Neonates are obligate sodium losers and require sodium in their intravenous fluids to maintain a normal serum sodium level. Neonates have a higher plasma level of potassium and there is an increased risk of hyperkalemia, especially in ill preterm neonates.²

Acid-base balance:

- In the neonate, the active transport of bicarbonate is decreased and the renal compensatory mechanisms for acid-base balance are slow and limited with a low bicarbonate threshold. Serum bicarbonate is typically low in the neonate and can be very low in the preterm infant.²

Glucose reabsorption:

- The tubular reabsorption of glucose is lower in the neonate compared to the adult. Renal glucosuria is common in infants born before 34 weeks of gestation and does not represent tubular injury.² Supplementation of glucose intake and close monitoring of blood glucose level in neonates is advised perioperatively.

Response to antidiuretic hormone (ADH):

- Fetal and neonatal collecting duct principal cells have a blunted response to ADH. The ability of the neonate to concentrate the urine does not reach the adult level until about 2 years of life. In the event of water depletion, the neonatal kidney will continue to produce an obligatory, dilute urine.² The risk of volume depletion is increased if fluid repletion is inadequate.
- Maintenance fluid requirements are those needed for neutral water and electrolyte balance and are influenced by physiological factors including postnatal age, birth weight and kidney function.

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Answer: D. Hypotonic urine is expected in neonates, due to a blunted response to ADH with a decreased ability to concentrate urine. Answers A, B, and C are the opposite of what would be expected in a neonate.