Is on-line monitoring of renal function possible?

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**Summary**

Twenty patients who had undergone open heart surgery were studied in order to determine whether measurement of the combined urinary sodium and potassium concentration can be used to monitor renal function.

The clearances of creatinine and the free water demonstrated a significant statistical correlation with the combined urinary sodium and potassium concentration. We conclude that measurement of the combined sodium and potassium concentration in the urine can be used as an indicator of renal function. Thus, measurement of the electrical conductivity in the urine might be suitable as an on-line monitor of renal function during surgery or in the intensive care unit.

On-line monitoring of renal function during anesthesia and on the intensive care unit consists only of measuring the urine production. However, urine production is an unreliable indicator of renal function [4]. More information can be obtained from the measurement of urine components.

Recently, a simple method for the measurement of the combined urinary sodium and potassium concentration has been described, which can also be used on-line [3]. It is possible that measurement of the sodium and potassium ions in the urine could be a valuable test of renal function, which might be applicable as an on-line monitoring system for renal function.

This study was performed to estimate the value of measurement of the combined sodium and potassium ion concentration in the urine and its relation to established tests of renal function.

**Methods**

Twenty patients in the postoperative period following open heart surgery were studied. All patients gave informed consent to a protocol approved by the medical ethics committee of our hospital. Patients with a history of established renal disease were excluded.

Anesthesia was included with diazepam (0.25–0.4 mg/kg i.v.), fentanyl (15–25 μg/kg i.v.) and pancuronium (0.1–0.15 mg/kg i.v.). Cefuroxim was administered as a routine prophylactic antibiotic. For cardiopulmonary bypass a bubble oxygenator (Shiley S-100 A), primed with 1 litre Haemacel and 1 litre Ringers acetate, was used. The flow was 2.4 l/min/m\(^2\) body surface area at 37°C and was adjusted for lower temperatures. Cardioplegia was used for cardioprotection. Nitroprusside was given for blood pressure regulation in the intra- and postoperative period. No diuretics or mannitol were given.
At 5 hours postoperatively a three hour urine collection was commenced. Blood and urine were analysed for creatinine, sodium and potassium and osmolality. Creatinine was determined by routine laboratory methods, sodium and potassium by flame photometry, and osmolality by freezing point depression. The substrate clearance, free water clearance and fractional excretion of sodium and potassium were calculated with standard formulae.

**Statistical methods**

The interrelationship of variables were tested by regression analysis. The correlation coefficient and the regression line were computed. The independence was tested by means of the Pearson product moment [2]. A p-value less than 0.05 was considered significant.

**Results**

Renal function variables obtained in the patients are shown in Table 1. The significance of interrelationships of these variables with the sodium and potassium concentration in the urine is also indicated in this table.

The clearances of creatinine and free water displayed a significant statistical correlation with the combined concentration of sodium and potassium in urine. The relation between the amount of sodium and potassium in urine and the creatinine clearance is shown in Fig. 1.

For each patient the creatinine clearance was predicted using the formula: $0.37 \cdot (\text{combined urinary sodium and potassium concentration}) + 12.8$ (ml/min/m²). The difference between predicted and measured creatinine clearance showed a statistical correlation with the fractional potassium excretion ($r = 0.57$; Significant) (Fig. 2).

**Discussion**

In critical patients during surgery or on the intensive care unit a need for an on-line monitoring system for renal function exists. The development of acute renal failure in these patients is associated with a high mortality [5]. Optimal treatment of renal impairment without delay may prevent renal parenchymal damage. An effective on-line monitoring system of renal function would lead to rapid