The Quantab Strip in the Measurement of Urinary Chloride and Sodium Concentrations

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The “Quantab” strip (Ames) measures chloride in fluids. For sodium chloride solutions and urine we found very good correlations between the Quantab reading and the chloride concentration as measured by chemical assay (r = 0.95 for chloride and r = 0.85 for sodium in urine). The strip gave reproducible results over the temperature range 4 to 37 °C. There was very little inter- and intra-observer variation in reading the strip. Although 10 to 23 min is required to complete the reaction, the strip reading is stable thereafter. We suggest that the strip could be useful in epidemiological studies of urinary sodium concentration and clinically in helping patients adhere to a low-salt diet.

Additional Keyphrases: screening · dipsticks · self-testing · electrolytes

The “Quantab” chloride titrator strip (Ames Division, Miles Laboratories Ltd., Slough, Berks., U.K.) is a 78 x 13 mm plastic strip with an attached capillary column impregnated with silver dichromate, which is brown. When a strip is placed in the solution under test, fluid passes up the column from the bottom by capillary action and chloride ions react with the silver ions to form white silver chloride. When the solution reaches the top of the capillary column, an orange moisture-sensitive band turns black, whereupon a reading can be taken from the strip. The chloride concentration of the solution determines the level of the meniscus between white and brown. The reading is taken from the highest point on the meniscus across to divisions drawn on the sides of the strip. The scale is from 0 to 10, in arbitrary units with 0.2-unit division lines (Figure 1).

The strip has been used for many years for measuring the chloride concentration of water for swimming pools and concrete manufacture, but recently it has been used clinically. In four studies (1–4) the strip was used in an assessment of sodium chloride excretion, with good correlation between strip reading and urinary chloride concentration. In this, the first formal assessment, we have compared the strip reading with previously determined chloride and sodium concentrations in urine and standard sodium chloride solutions. Stability, reproducibility, and speed of reaction were estimated, as was intra- and interobserver variability in reading the strip.

Materials and Methods

Urine correlations. The strip was used to estimate the chloride concentration of 128 urine samples obtained from volunteers while they were taking high-, normal-, and low-salt diets. The strips were read by one observer (P.J.M.S.) and the urinary chloride concentration was evaluated by coulometry, with the Corning 920 chloride meter. Sodium was measured with a Model 543 flame photometer (Instrumentation Laboratory, Lexington, MA 02173).

Chloride solution correlation. The strip was used to estimate the chloride concentration of sodium chloride solutions of known strengths (0, 10, 25, 50, 100, 150, 200, 300, and 400 mmol/L).

Reaction time. The time taken for the orange moisture-sensitive band on the “Quantab” strip to turn black was measured in 58 instances. The strip was then viewed after...
15 and 30 min to see if any change had occurred in this reading.

Effect of temperature. The "Quantab" strip was used to estimate the chloride concentration of 100 mmol/L sodium chloride solutions maintained at 4, 24, and 37 °C.

Intra- and interobserver variation. The results by 10 "Quantab" strips for a wide range of urine chloride concentrations were read by nine observers in a randomized order on two occasions, so that each observer read the same strip twice, in a double-blind study.

Statistics. Mean and standard deviations are given for the data that have an approximately normal distribution; mean and range are given for data with a skewed distribution.

Results

Reaction time. The mean time taken for the orange band to turn black in 58 "Quantab" strips was 14.1 min (range, 10 to 23 min). After a further 30 min this initial reading had remained unchanged. In later tests we noted that one out of about 300 strips failed to show any reading, even after 2 h. This failure occurred in a particularly cloudy urine sample, and we presume that the capillary channels in the strip became blocked. Tests of four urine samples containing 2 to 3 g of protein per liter showed no abnormal prolongation of reaction time or alteration in reading.

Chloride solution correlation. The data of the comparison between strip reading and chemical estimate of chloride concentration are shown in Figure 2. The relationship is approximately linear between 25 and 400 mmol/L, with a high correlation coefficient (r = 0.98, p < 0.001). The urinary chloride concentrations we found fell on this straight portion of the relationship in 96% of cases; therefore, simple linear regression analysis has been applied.

Urine correlations. Using "Quantab," we performed 224 estimations on 128 urine samples that were later analyzed by coulometry. Duplicate readings were performed to obtain a value for variability of strip estimations. Figure 3 shows scatter plots of strip reading vs chloride and sodium concentrations; chloride concentrations ranged from 12 to 276 mmol/L, sodium concentrations from 15 to 261 mmol/L. Readings on the strips ranged from 1.0 to 6.5 units. Correlation of electrolyte concentrations estimated by the strip with those by coulometry for chloride was r = 0.95, p < 0.001, and for sodium r = 0.85, p < 0.001. Duplicate strip estimations on 96 urine samples gave an average CV of 4.0%.

Effect of temperature. There were no significant differences in the Quantab strip readings for the 100 mmol/L sodium chloride solutions tested at 4, 24, and 37 °C.

Inter- and intraobserver variability. There was very good agreement among readings made by different observers and for separate duplicate readings by the same observer, with CVs of 0.7% and 0.3%, respectively.

Discussion

We conclude that the "Quantab" strip provides an accurate, reliable quantitative measure of the urinary chloride concentration. The strip reading also correlates well with urinary sodium concentration, because the concentrations of chloride and sodium in urine are closely related. Observers found the strip easy to read, and there was very little intra- and interobserver variation. The variability of duplicate strip readings on the same sample was small and, once complete, the reaction was stable.

We encountered a few problems in using the strips. The strip took a relatively long time to react as compared with urine dipstick tests for glucose and protein. Occasionally the
meniscus between the white and brown areas was blurred, which impeded an accurate reading. If the urine contained much solid matter, the capillary channels could become blocked, preventing any reaction. We did not investigate the effects of pH changes and pharmacological agents on the strip readings, but the chemical reaction involved would suggest that such effects would be small. For a strip reading the urine was placed in a small container and as little as 1 mL of solution gave a reading; if too much fluid was placed in the container, however, the capillary pores at the top of the column would become blocked, preventing the flow of solution up the column.

We suggest that the strip may be of interest to epidemiologists who wish to estimate the sodium concentrations of a large number of urine samples. Further, clinicians treating hypertensive patients may find the strips helpful in improving patients' adherence to a low-salt diet by providing rapid feedback about salt excretion.

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References