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# VOIDED VOLUMES AND URINARY OUTPUT OF WATER AND SOLUTES, OVER A 72-HOUR PERIOD, IN 62 NORMAL SCHOOL-AGE CHILDREN

**Aims of Study**

In pediatrics, the maximum volume voided ('maximum functional bladder capacity') is used ubiquitously, usually related to age, for important clinical decisions. Values are obtained with the well-standardized tool of 3-day frequency/volume charts, but the factor(s) determining the volume of a given voiding have not been identified yet. This study was set up to compare the impact of biometric parameters, urine composition, and the time of voiding, on the voided volume in school-age children.

**Methods**

With informed consent of parents and teachers, 62 non-enuretic children from one primary school recorded the volume and the time of every voiding, and sampled every voiding, over a period of 72 hours. Ages of the 62 children (23 girls and 39 boys) ranged from 5.9 to 11.9 years. Informed consent, protocols and standardisation were based on a pilot study in 7 children. All collections were performed at home, with free intake of food and drinks, within the time span of one week. The volume voided first thing in the morning, after at least 6 hours of uninterrupted sleep, was labeled early morning volume (EMV). In all samples, osmolality was measured, as well as creatinine, calcium, and phosphate. The output of urine and osmoles was also expressed as ml and mOsm per kg bodyweight per hour, and the average hourly values were plotted on a 72-hour time scale [1].

A multivariate stepwise logistic regression analysis was used to calculate the significance of the variables age, sex, height, bodyweight, time of day, urine osmolality, urine creatinine, urine calcium, and urine phosphate, with respect to the volume voided.

**Results**

Over a total of 183 twentyfour-hour periods, 1062 voided volumes were recorded, covering a very wide range, from 30 to 575 ml. The distribution of these volumes, expressed as ml per $m^2$ body surface area, is skewed to the larger values. However, the EMV's show a nearly normal distribution, suggesting they form a separate class. Univariate analysis shows that there are statistically significant coorrelations between the magnitude of the voided volume and urine osmolality, urine creatinine, and the biometric parameters height, weight, and body surface area. However, the magnitude of the voided volume is completely dependent of the time of the voiding: the largest volumes are by far obtained as EMV's, right after 6 hours of uninterrupted sleep.

The average hourly output of water and osmoles varies widely in rate at daytime, but the output of water drops consistently, every 24-hour period, at 21:00 hrs, to 0.8±0.2 ml/kg/hr. This rate is constant, until 07:30 hrs the next morning. Within these periods of constancy, the average hourly output of osmoles approaches and parallels the constant rate for the output of water, implying a continuously high osmolality.

## Conclusions

The range of voided volumes obtained with accurately kept frequency/volume records is very wide. Although the magnitude of the volume correlates in a statistically significant way with urine osmolality and urine creatinine, as well as with the subject's height and weight, the clinically relevant correlation for the magnitude of the volumes clearly is circadian time. This implies that night-time modulation of bladder control is different from daytime facilitation or inhibition. In the management of children with nocturnal enuresis, frequency/volume charts are less suited to find the maximum voided volume for a given child, as these children lack normal early morning voidings.

The consistency of the circadian rhythm in the output of water and solutes warrants further research of this rhythm in children with monosymptomatic nocturnal enuresis.

## References

1. Van Mastrigt R, Eijskoot R. (1996). Analysis of voided urine volumes measured using a small electronic pocket balance. *Scand J Urol Nephrol* **28**:257-263