



OSMOLALITY AND CATHETERIZATION

Discomfort at catheter withdrawal is occasionally reported by some patients practicing intermittent catheterization with hydrophilic coated catheters.¹ This phenomenon has been linked to prolonged catheterizations and high osmolality of urine, but seems to be solved by a hydrophilic surface, isotonic to urine, which reduces both removal friction and urethral trauma.

Osmotic activity is the process when water in one solution, with lower concentration of e.g. salt ions or sugar molecules, moves through a semipermeable barrier in the direction of a higher concentration to equalize concentrations. The osmotic activity could both be *measured* in milliosmoles/kilogram (mOsm/kg) solvent, i.e. osmolality, and *calculated* as milliosmoles/liter (mOsm/L) solution, i.e. osmolarity.^{2,3} In human serum osmolarity is approximately equivalent to osmolality given the density of ≈ 1 kg/L of the fluid.^{2,3}

Normal human plasma osmolality is reported to approximately 290 mOsm/kg,^{4,5} and corresponding osmolarity of plasma and other body fluid is about the same, between 270-300 mOsm/L.⁵ Human urine osmolality may however vary between ≈ 50 -1200 mOsm/kg, depending on water intake,⁴ but the expected normal fasting urine osmolality should be at least three times the serum osmolality,⁵ i.e. ≈ 800 -1200 mOsm/kg. For example, the majority of fifty years old males morning urine osmolality were reported to lie between 780-1360 mOsm/kg⁶ and corresponding normal values in children after 7 hours water deprivation were 827-1136 mOsm/kg.⁷ Variations associated with different conditions could also be seen, and patients with spinal cord injury have been reported to have an increased urine production during nighttime resulting in a lack of normal urine osmolality variations.^{8,9} For example, Kiliç et al. observed unchanged level of urine osmolality between day and night among both tetra- and paraplegic patients, while values in a normal control group were significantly different between night and day.⁸ Also, Szollar et al. discovered low levels of urine osmolality among tetraplegic patients with reported similar day and night values.⁹

The cause of this lack of daily variation is proposed to be absence of *antidiuretic hormone* increase during nighttime among spinal cord injured patients.⁸⁻¹⁰ This in turn is caused by long periods of sitting down during daytime, with pooling of blood in the lower extremities followed by increased vessel fluid volume and urine production when lying down.^{8,9} The phenomena could be addressed by compression stockings, regulated fluid intake and additions of antidiuretic hormone mimicking drugs⁸⁻¹⁰ to reach less urine production during nighttime, and as a result, higher urine osmolality.¹⁰ In summary, urine osmolality levels could be expected around ≈ 300 -800 mOsm/kg during limited daytime in a well hydrated normal individual and between ≈ 800 -1200 mOsm/kg in normal morning urine and in the general patient practicing intermittent catheterization and controlled fluid intake.

A hydrophilic surface with high osmolality, and thereby isotonic to urine (i.e. same osmolality as expected in normal urine), has been concluded to be associated with less removal friction and urethral trauma.¹¹ The osmolality of the LoFric catheter has been reported to be between 900-950 mOsm/kg¹² and falls well within the expected range of urine osmolality in patients practicing intermittent catheterization of ≈ 800 -1200 mOsm/kg. The high osmolality ensures the hydrophilic coating to be kept, also after longer catheterization (> 5 min),¹¹ and prevents incidences of catheter sticking to the urethra upon withdrawal.^{12,13} This may also be the reason why LoFric catheters measured the lowest withdrawal friction when compared to other hydrophilic catheters used among spinal cord injured patients practicing intermittent catheterization,¹² or when tested in an experimental model.¹⁴

REFERENCES

- Vahr S, Cobussen-Boekhorst H, Eikenboom J, et al. Evidence-based guideline for best practice in urological health care. Catheterisation. Urethral intermittent in adults. Dilatation, urethral intermittent in adults. . *EAUN guideline 2013* [Full text EAUN guideline](#)
- Erstad BL. Osmolality and osmolarity: narrowing the terminology gap. *Pharmacotherapy*. Sep 2003;23(9):1085-1086. [Abstract in PubMed](#)
- Hoffman RS, Smilkstein MJ, Howland MA, Goldfrank LR. Osmol gaps revisited: normal values and limitations. *Journal of toxicology. Clinical toxicology*. 1993;31(1):81-93. [Abstract in PubMed](#)
- Sands JM, Layton HE. Advances in understanding the urine-concentrating mechanism. *Annual review of physiology*. 2014;76:387-409. [Abstract in PubMed](#)
- infusionnurse. Is there a difference? Osmolarity vs. Osmolality.. 2010; [Full text available at infusionnurse.org](#)
- Tibblin G, Vikgren P. Urine Osmolality in a Population Study of Hypertension. *Bulletin of the World Health Organization*. 1964;31:345-348. [Abstract in PubMed](#)
- Dunger DB, Seckl JR, Grant DB, Yeoman L, Lightman SL. A short water deprivation test incorporating urinary arginine vasopressin estimations for the investigation of posterior pituitary function in children. *Acta endocrinologica*. Jan 1988;117(1):13-18. [Abstract in PubMed](#)
- Kilinc S, Akman MN, Levendoglu F, Ozker R. Diurnal variation of antidiuretic hormone and urinary output in spinal cord injury. *Spinal cord*. May 1999;37(5):332-335. [Abstract in PubMed](#)
- Szollar S, North J, Chung J. Antidiuretic hormone levels and polyuria in spinal cord injury. A preliminary report. *Paraplegia*. Feb 1995;33(2):94-97. [Abstract in PubMed](#)
- Zahariou A, Karagiannis G, Papaioannou P, Stathi K, Michail X. The use of desmopressin in the management of nocturnal enuresis in patients with spinal cord injury. *Europa medicophysica*. Sep 2007;43(3):333-338. [Abstract in PubMed](#)
- Lundgren J, Bengtsson O, Israelsson A, Jonsson AC, Lindh AS, Utas J. The importance of osmolality for intermittent catheterization of the urethra. *Spinal cord*. Jan 2000;38(1):45-50. [Abstract in PubMed](#)
- Waller L, Telander M, Sullivan L. The importance of osmolality in hydrophilic urethral catheters: a crossover study. *Spinal cord*. Apr 1997;35(4):229-233. [Abstract in PubMed](#)
- Fader M, Moore KN, Cottenden AM, Pettersson L, Brooks R, Malone-Lee J. Coated catheters for intermittent catheterization: smooth or sticky? *BJU international*. Sep 2001;88(4):373-377. [Abstract in PubMed](#)
- Jones DS, Garvin CP, Gorman SP. Design of a simulated urethra model for the quantitative assessment of urinary catheter lubricity. *Journal of materials science. Materials in medicine*. Jan 2001;12(1):15-21. [Abstract in PubMed](#)

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