Urine Drainage Tubing Configuration Affects Urinary System Outflow Pressure in an In Vitro Model

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BACKGROUND

A dependent loop (*Figure 1*) is a commonly observed configuration in urine drainage tubing that connects a urinary (Foley) catheter to a urine collection bag. It was suspected that a dependent loop observed in urine drainage tubing contributed to poor urine outflow in a patient who had recently received a kidney transplant. Rearrangement of the drainage tube appeared to result in faster urine outflow rate. An in-vitro investigation of the pressures required to move urine through a Foley catheter and urine drainage tubing, and into a vented collection bag was undertaken. It was also observed that the respective heights of the menisci on either side of the dependent loop were unequal. We hypothesized that dependent loops in urine drainage systems can generate back-pressure on the bladder that interferes with bladder emptying.

METHODS

An in-vitro model consisting of an infusion pump to mimic urine production, a modified 500 mL IV bag to model the bladder, and a Foley catheter and urine drainage system (drainage tubing and vented collection bag) were assembled. We measured and recorded pressures in the “bladder,” at the urine culture port, and in the collection bag via electronic pressure sensors. We varied the difference in meniscus elevation in the dependent loop based on dimensions observed in our operating rooms.

RESULTS

Bladder pressures in excess of 30 mm Hg that need to be overcome to move urine through a urine drainage system can result from drainage tubing loops. Peak bladder pressures are directly related (R^2=0.998, *Figure 2*) to the difference in meniscus elevation in a dependent loop in urine drainage tubing.

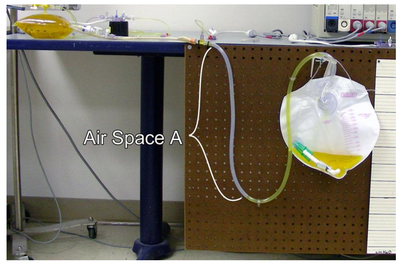


Figure 1: In vitro model of uninary system, Foley catheter, drainage tube and collection bag

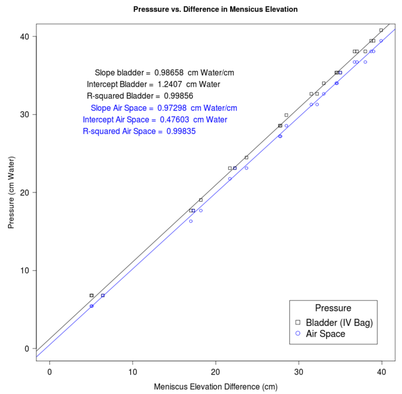
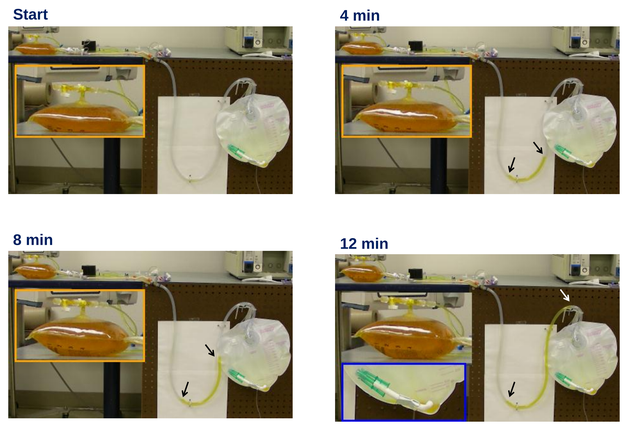
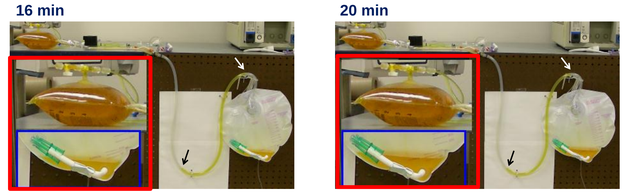


Figure 2: Bladder and air space pressures vs. meniscus height difference



Bladder pressure increases as fluid climbs the distal leg of the loop.



After cresting, fluid can enter the drainage bag, but, bladder pressure remains at its maximum value.

CONCLUSION

Dependent loops are associated with CAUTI [1] and can generate pressures large enough to obstruct flow in urine drainage systems [2]. Bladder pressure is widely used to measure intra-abdominal pressure [3], and intra-abdominal hypertension has been linked with poor renal function after OLT [4] and with acute renal failure [5]. Collection of urine in a dependent loop can lead to back-pressure which is directly revealed (in cm H_20) by the difference in elevation between proximal and distal urine menisci, and is transferred by the Foley catheter to our model bladder.

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