Electronic urine output monitoring: a novel approach for patient care improvement

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SUMMARY

- Measuring urine output volume is essential for calculation of the patient's fluid balance. The parameter, when integrated with others, can aid in hemodynamic assessment.
- Currently, in most intensive care units, urine output is monitored manually. This human based monitoring system is error prone, is not continuous, and does not produce real time information (like other hemodynamic parameters such as arterial blood pressure).
- A novel electronic urine output monitoring system, which was installed in the general intensive care unit at the Rambam Health Care Campus, Haifa, Israel, offers a solution for this problem.
- By continuous measurement of the patient's urine output, the system turns this highly significant parameter into one that is equivalent to all other, real-time monitored variables.
- Another important aspect is that due to the automated measuring system, body fluid related infections are avoided. Also, valuable nursing working time is freed, which can be directed towards other aspects of patient care.

INTRODUCTION

Rambam Medical Center is one of the six major hospitals in Israel. It is located in the northern part of the country and serves a population of about 1.25 million people. It is also a level I trauma centre. The Medical Center, being a university hospital, is affiliated to the Technion Institute medical school. Our unit contains eighteen general intensive care beds and the nursing staff comprises of 50 critical care nurses. Our nurse to patient ratio is basically 1:2, but under special conditions (intermediate care patients) the ratio may be reduced to 1:4.

For the last four years, our general ICU patients' data have been managed by a patient data management system (PDMS) using a computerised information system (CIS).

Modern intensive care units (ICUs) contain a technologically enriched environment. The most frequently monitored parameters include arterial blood pressure, central venous pressure (CVP), heart rate, oxygen saturation and urine output. The latter measurement is one of the most informative parameters, being the only one that describes true end organ perfusion. Integration of these parameters is used for assessment of the ICU patient's hemodynamic state. However, even with the wealth of information available from observed parameters, the ICU staff commonly deal with difficult questions such as, should an oliguric patient be treated with fluids or with diuretics, and are they suffering from hypovolaemia or fluid overload? An essential element that is required to address these questions is the accurate assessment of the patient's fluid balance.

Urine output, being the physiologic product of the normal functioning renal system, reflects the kidney blood flow or organ perfusion. Currently, urine output measurement is human based and therefore it is subject to sampling errors. This was demonstrated in a study undertaken by our group, which measured deviations of up to 100% between actual urine produced, compared to the amount measured and reported by the nurse in charge (Menachem, 2007). Errors were attributed mainly to time delay in recording and inaccurate assessment of the urine volume collected.

Strict urine output monitoring is time consuming. We observed that proper performance of this task consumed up to 12.5% of an eight hour nursing shift (32 minutes and 64 minutes in case of 1:2 nurse to patient ratio and 1:4 nurse to patient ratio respectively).

Another important consideration with regard to the traditional urine monitoring system is the infection risk to staff who come into close contact with patients' body fluids.

ELECTRONIC URINE OUTPUT MONITORING SYSTEM

Two years ago an electronic urine output monitoring system was installed in our ICU. This system solves all the aforementioned disadvantages of the human based measuring system: the conventional urinometer. When connected to the PDMS/CIS, the system provides a real-time, continuous recording of the patient's urine output. Using this system, the urine volume is measured and recorded on a minute-to-minute basis and therefore can be used as one of the patient's vital signs. The data is presented graphically, and can be correlated to other hemodynamic parameters (see figures 1 and 2).

Early recognition of changes in the patient's status, such as a decrease in arterial blood pressure or urinary catheter blockage, is easily performed. Using this system, assessment of urine output is no longer inaccurate, and it is now very delicate and precise. Rather than basing our assessment of renal function on hourly urine volume, as is done traditionally, we now use a new parameter: urine production rate, which is measured in millilitres per minute.

Figure 1. The electronic measuring unit attached to the urine collection bag

According to the RIFLE criteria (Bellomo et al., 2004), we believe that early identification of urine production rate changes, reflecting changes in renal function, can lead to earlier diagnosis of kidney Risk and Injury. Early intervention can prevent deterioration in Renal Failure, Loss, End-stage (RIFLE) and reduce the high morbidity and mortality involved with this pathology.

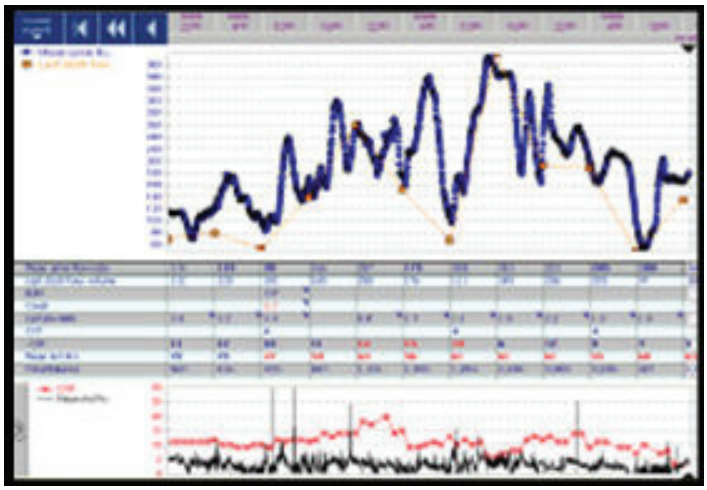

Figure 2. Graphical display of urine production

the electronic urine output monitoring system, integrated with the PDMS/CIS has enabled us to implement an alarm system that can recognise early clinical situations of oliguria, anuria or polyuria. The system is also capable of providing information that assists with the differential diagnosis of the cause.

SUMMARY

In summary, the urine output monitoring system used in conjunction with the PDMS/CIS has created a vital tool that has changed the way we monitor urine output. The system is reliable, easy to use, saves time and improves patient care. Further studies are needed for building a more advanced, expert system that will incorporate this data, and analyse it together with other haemodynamic parameters that will enable the identification of a variety of clinical situations, provide differential diagnoses, and suggest treatment options.

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