The implementation of bedside bladder ultrasound technology: effects on patient and cost postoperative outcomes in tertiary care

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The use of a portable ultrasound device to measure bladder volume, in order to assess the need for catheterisation. This was compared with the use of standard timed intermittent catheterisation for patients requiring postoperative catheterisation.

Type of intervention
Post-operative recovery.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients in general surgical and orthopaedic postoperative units. Patients were excluded if they had "dermal ulcers, nephrotomy, obesity, confirmed pregnancy, an incision in a location that precludes an ultrasound scan, or a known pelvic mass greater than 2 cm".

Setting
The setting was a large tertiary care hospital (Abbott Northwestern Hospital, Minneapolis, Minnesota, USA).

Dates to which data relate
The year during which the effectiveness data were collected was not stated. However, the study was published in 2000. The years to which the resource use related were not stated. The price year was not reported. Some of the costs were derived from a study published in 1997.

Source of effectiveness data
The effectiveness data were derived from a single study

Link between effectiveness and cost data
The costing was carried out retrospectively.

Study sample
No prospective power calculations were performed to determine the sample size. The sample was taken from patients in general surgical and orthopaedic units. The patient sample would appear to have been appropriate for the study question. All the patients in the general surgery unit who consented to participate in the study were allocated to the ultrasound arm of the study (n=50). The patients on two of the three orthopaedic units were allocated to the standard
timed catheterisation protocol (n=53). The patients in the third orthopaedic unit were allocated to the ultrasound protocol (n=50).

There were 100 patients in the ultrasound arm and 53 patients in the standard protocol arm of the study. The number of patients who were excluded, or who declined to participate in the study, was not reported.

**Study design**

The study was a non-randomised controlled trial conducted at a single centre. The duration of follow-up was the length of stay in hospital, although this was not explicitly reported. The patients were followed for an additional 30 days post-discharge to assess the frequency of urinary tract infections (UTIs). The loss to follow-up was 18.3% during hospitalisation, and 17.6% from discharge to 30 days post-discharge. In total, the loss to follow-up was 20.9%. Those patients who were lost to follow-up were excluded from the analysis.

**Analysis of effectiveness**

It was not stated whether the analysis was conducted on an intention to treat basis or on treatment completers. The primary outcomes were the number of catheterisations avoided due to the ultrasound scan results, the total number of catheterisations performed, and the proportion of patients who contracted UTIs during hospitalisation or during the 30 days following discharge.

The patients in the ultrasound group were shown to be significantly older than the standard group. Further, they had more hip and knee replacement procedures. The impact of this on the results was assessed. There was found to be a positive correlation between age, having hip or knee repair, and the numbers of catheterisations.

**Effectiveness results**

When comparing the ultrasound readings with the subsequent catheterised bladder volume, a correlation coefficient of 0.76 to 0.97 was observed, (p<0.01).

In the general surgical group (all patients allocated to the ultrasound arm), the total number of catheterisations avoided was 70. Thirty-eight per cent of the patients in the "due to void" option, and 81% of the patients in the "void with residual" option, avoided at least 1 catheterisation. Eight of the 46 patients for whom there were data developed UTIs, either during hospitalisation or in the 30 days post-discharge.

In the orthopaedic group following the ultrasound protocol, there were 84 catheterisations carried out in the 50 patients. This compared with 104 catheterisations carried out in the 53 patients following the standard protocol. There was a 14% difference in the number of catheterisations required per patient, 1.68 in the ultrasound group and 1.96 in the standard group. This difference, however, was not statistically significant, (p=0.21).

Two of the 45 patients (4%) for whom there were data in the ultrasound group developed UTIs at some point, compared with 4 of the 30 patients (13%) in the standard protocol group. This difference was not statistically significant, (p=0.17).

**Clinical conclusions**

Although there was no statistically significant difference in the numbers of catheterisations and UTIs between the protocols, there was a trend towards fewer of each in the ultrasound group. The ultrasound device may be most useful in measuring the residual urine volume ("void with residual" option in the ultrasound arm).

**Measure of benefits used in the economic analysis**

The authors did not derive a measure of health benefit. The analysis was therefore categorised as a cost-consequences study.
Direct costs
The resource quantities and the costs were reported separately. The costs included were those relevant to a hospital. These included the purchase price of an ultrasound machine and catheter trays. The authors also included the cost of treating a UTI, which was taken from the literature. The source of the other cost data was not stated, but the costs were most likely to have been local. Discounting was not applicable due to the short timeframe of the study. The marginal costs were reported. The price year was not stated.

Statistical analysis of costs
No statistical analysis of costs was reported.

Indirect Costs
The indirect costs were not included in this study.

Currency
US dollars ($).

Sensitivity analysis
No sensitivity analysis was performed.

Estimated benefits used in the economic analysis
See the 'Effectiveness Results' section.

Cost results
The cost of the ultrasound machine was $8,300 and that for a catheter tray was $13.

The mean catheter tray cost per patient was $25.48 for the standard protocol and $21.84 for the ultrasound protocol. At this cost, it would take 639 avoided catheterisations to pay for the ultrasound machine. The authors estimated that 1,585 trays were used per year by the surgical and orthopaedic units. Using the 14% reduction in the number of catheterisations per patient in the orthopaedic sample, the authors estimated that 222 trays would be saved per year. Thus the cost of the machine would be paid off in 2.9 years. The authors stated that a UTI costs $680 to treat. Thus, the investment would also be paid back if just over 12 UTIs were avoided.

Synthesis of costs and benefits
Not applicable.

Authors' conclusions
In the authors' own setting, it would take 2.9 years to pay back the cost of the ultrasound machine by savings in catheter trays or UTI treatment costs. The ultrasound device was shown to be accurate and effective, especially amongst older patients having knee or hip repair, or requiring residual urine estimation. The cost data made a strong argument for the purchasing of multiple machines throughout the hospital. Finally, the use of ultrasound assessment promotes "databased practice" to guide practitioners in decisions to order invasive urinary catheterisations.

CRD COMMENTARY - Selection of comparators
The comparator used represented current practice in the authors' setting. You should decide if the comparator represents current practice in your setting.
Validity of estimate of measure of effectiveness
The analysis was based on a prospective non-randomised trial. This was largely appropriate for the study question, although a randomised study would have been preferable. The study sample was representative of the study population.

The characteristics of the patient groups were shown to be significantly different at analysis. For example, the ultrasound group was significantly older, and were more likely to have had hip and knee replacements. A statistical test of the impact of these variables showed that they were linked to the number of catheterisations, and so "may have clouded the ability to assess the effectiveness of the ultrasound technology".

The analysis of effectiveness was based only on those patients whom the authors were able to follow-up. No attempt was made to account for the effects of missing data, for example, through a sensitivity analysis. Thus, the possibility of non-random loss-to-follow-up was not explored, which weakens the robustness of the results.

The results were presented in terms of the number of catheterisations avoided in the ultrasound patients on the general surgical ward, and the total number of catheterisations performed in the ultrasound and standard groups in the orthopaedics wards. The reason for using these two different outcome measures was unclear. In addition, the number of catheterisations was of limited use as an outcome measure without some comparison with length of stay, as patients who are in hospital longer will require more catheterisations. Further, older patients are likely to have longer lengths of stay.

Validity of estimate of measure of benefit
The authors did not derive a measure of health benefit. The analysis was therefore categorised as a cost-consequences study.

Validity of estimate of costs
The study was conducted from the perspective of a hospital. All the categories of cost relevant to this perspective were included. However, there were significant individual omissions from the study. For example, the cost of the medical staff, in terms of the time required to administer the ultrasound test, was not included. The authors suggested that using the ultrasound machine saves nursing time due to the reduced number of catheterisations given. However, this must be balanced against the time required to find and use the ultrasound machine. No data relating to staff time were presented.

The costs and the quantities were reported separately. No statistical or sensitivity analyses of the costs and prices or quantities were performed, which limits the robustness of the results.

The cost analysis assumed that there was a significant difference between the ultrasound and standard protocols in terms of the numbers of catheterisations. However, this study was unable to detect such a difference, and therefore, the results must be treated with caution. The lack of statistical significance was likely to have been due to the small sample size.

Other issues
The authors did not make any comparisons of their results with other studies. The issue of generalisability to other settings was briefly addressed, although the effectiveness and cost-effectiveness of the ultrasound device in other patient groups was not discussed.

The authors acknowledged the limiting effect of the difference between the groups in terms of the patients’ ages and procedure type. They recommended that a randomised trial on age-matched patients be performed.

In summary, this was an interesting examination on the use of a portable ultrasound device for assessing bladder volume, which may reduce unnecessary catheterisations. However, due to the large number of limitations in the study, and the lack of any sensitivity analysis, this should only be used to generate a hypothesis of the effectiveness and cost-effectiveness of the device. This study should not be used to guide decision-making.
**Implications of the study**
As a result of this study, the authors' institution purchased seven bladder ultrasound machines. A circulating nurse with specific skills in using the machine provided access to units without their own device.

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Supported in part by Diagnostic Ultrasound Corporation.

**Bibliographic details**

**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Adult; Aged; Aged, 80 and over; Female; Hospital Costs; Humans; Male; Middle Aged; Orthopedic Nursing /methods; Outcome Assessment (Health Care) /statistics & numerical data /economics; Point-of-Care Systems /economics; Postoperative Care /economics /methods; Prospective Studies; Research Support, Non-U.S. Gov't; Urinary Bladder /ultrasonography; Urinary Catheterization /utilization /economics; Urination Disorders /ultrasonography /nursing /therapy; Urine

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