Implementation of the Ottawa Knee Rule for the use of radiography in acute knee injuries


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 Ottawa knee rule for the use of radiography in acute knee injuries.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
Adults seen with acute knee injuries.

Setting
Hospital and the community. The study was carried out in 2 teaching hospitals and 2 community hospitals in Ontario, Canada.

Dates to which data relate
The effectiveness data were based on patients who participated in the trial between July 1994 and September 1996. Cost data were from the years 1996/1997. The price year was not stated.

Source of effectiveness data
The evidence for effectiveness was based on a single controlled clinical trial.

Link between effectiveness and cost data
The costing conducted for the study was undertaken on the same patient sample as that used in the effectiveness study, and was conducted prospectively alongside the effectiveness study.

Study sample
3,907 consecutive eligible adults seen with acute knee injuries in the emergency departments of 2 intervention and 2 control hospitals in Canada participated in the trial. Patients included were all those seen during the 12-month periods before intervention (July 1994 - July 1995) and after intervention (September 1995 - September 1996). Adult patients were eligible if they had sustained an acute injury of the knee from any mechanism. Excluded were patients who were younger than 18 years, were pregnant, had isolated injuries of the skin without underlying soft tissue or bone involvement, were referred from outside the hospital with radiographs, had knee injuries that occurred more than 7 days previously, had returned for reassessment of the same injury, had altered level of consciousness, were paraplegic, or had multiple trauma. Potentially eligible patients were identified by study nurses who reviewed patient logs and a
central co-ordinator who assessed whether patients satisfied the inclusion or exclusion criteria.

For the intervention hospitals, the mean age was 38 years before (range: 18 - 93) and 39 years after (range: 18 - 101) compared with 40 years before (range: 18 - 96) and 41 years after (range: 18 - 97) for the control hospitals. In terms of gender, 550 males out of a total of 982 patients before and 563 male patients out of a total of 1,063 patients after participated in the intervention group. For the control group, 524 male patients out of 962 patients before and 477 male patients out of 900 patients after were included. For the before-intervention, after-intervention, before-control and after-control groups respectively, 122, 122, 182 and 132 patients were working, 356, 395, 256 and 215 patients were doing sports and 504, 546, 524 and 553 patients were engaged in other activities. Power calculations were not used to determine the sample size.

**Study design**
This was a non-randomized controlled trial with before-after and concurrent controls. The study took place at 2 teaching hospitals and 2 community hospitals. The intervention and control groups each consisted of patients at 1 teaching and 1 community hospital. All non-fracture patients in the after-intervention period were followed up by a structured telephone interview at 10 days. No patient was excluded during the after-intervention period because a data collection form was not completed or because of physician non-compliance with the decision rule. During the follow-up, 446 of 456 patients discharged without radiography (97.8%) and 521 of 537 patients discharged after radiography (97%) were reached by telephone. To assess inter-observer agreement, a second data collection form was completed by another physician who was blinded to the results of the first assessment.

**Analysis of effectiveness**
The analysis was based on the intention-to-treat principle. The authors stated that any losses to follow-up did not affect the primary outcome measure. The primary outcome measures included referral for knee radiography, time in emergency department, patient satisfaction, number of fractures diagnosed after discharge, time spent off work, percentage of subsequent physician visits and knee radiographs, and accuracy and reliability of the rule. Patient characteristics were compared in terms of age, gender, mechanism of injury, activity at time of injury, number of isolated knee injuries, number of clinically important and unimportant fractures, type of hospital attended and type of management. Comparing the before period to the after period, patient characteristics were very similar for both the intervention and the control groups. Comparing the intervention group to the control group, patient characteristics were similar, except for slightly higher proportions of clinically important fractures and admissions in the control group.

**Effectiveness results**
From the before to the after period, there was a relative reduction of 26.4% in the proportion of patients referred for knee radiography in the intervention group (77.6% versus 57.1%, p<0.001), but a relative reduction of only 1.3% in the control group (76.9% versus 75.9%, p=0.6). These changes over time were significant when the intervention and control groups were compared (p<0.001). Each intervention hospital separately demonstrated a significant reduction in referral for radiography while changes were not significant at either control hospital. Physicians accurately interpreted the rule for 97.7% of cases and physician interobserver agreement for interpretation of the rule in 69 cases had a K value of 0.91 (95%CI: 0.82 - 1).

During the after-intervention period, non-fracture patients discharged without radiography spent less time in the emergency department than did those who underwent radiography (85.7 minutes versus 118.8 minutes). Of those patients reached during the follow-up period, 95.7% of the no-radiography group and 98.7% of the radiography group stated that they were satisfied with physician care at the emergency department. For both groups no fracture was diagnosed after discharge.

Compared to the radiography group, those in the no-radiography group spent less time off work (3.0 days (SD, 8.5) versus 5.8 days (SD, 14.2)), had a lower percentage of subsequent physician visits (38.3% versus 52.4%) and exhibited a higher percentage of subsequent knee radiographs (6.9% versus 1.7%). The Ottawa knee rule correctly identified all 58 clinically important fractures thereby achieving a sensitivity of 1.0 (95%CI: 0.94 - 1.0) and a negative predictive value of 1.0 (95%CI: 0.99 - 1.0).
Clinical conclusions
The trial demonstrated a significant reduction in emergency department use of radiography for patients with acute knee injuries. This effect applies equally to a teaching university hospital as to a non-teaching community hospital.

Modelling
No modelling was undertaken.

Measure of benefits used in the economic analysis
The primary measure of benefit was the proportion of eligible patients referred for a standard knee radiographic series.

Direct costs
The direct cost measures included emergency department physician fees, emergency department knee radiographic series technical and professional fees, follow-up office physician visit fees, and follow-up radiographic series fees. Costs were not discounted. Quantities and costs were not reported separately. The quantity/cost boundary adopted was that of the hospital. The estimation of quantities and costs was based on actual data. The medical charges used were representative of figures provided by several US hospitals. The price year was not stated.

Statistical analysis of costs
Patient characteristics, outcome measures and charges were compared using the chi squared test and the Student t test, as appropriate. Interobserver agreement was analysed using the K coefficient. 95% confidence intervals were calculated. All p-values were two-tailed.

Indirect Costs
No attempt was made to estimate indirect medical costs.

Currency
US dollars ($).

Sensitivity analysis
No sensitivity analysis was carried out.

Estimated benefits used in the economic analysis
From the before to the after period, there was a relative reduction of 26.4% in the proportion of patients referred for knee radiography in the intervention group (77.6% versus 57.1%, p<0.001), but a relative reduction of only 1.3% in the control group (76.9% versus 75.9%, p=0.6). These changes over time were significant when the intervention and control groups were compared (p<0.001). Each intervention hospital separately demonstrated a significant reduction in referral for radiography while changes were not significant at either control hospital.

Cost results
The estimated mean charge for emergency department and subsequent physician visits and radiography was substantially lower for the non-radiography group ($80 versus $183).

Synthesis of costs and benefits
Costs and benefits were not combined. Widespread implementation of the Ottawa knee rule led to a decrease in the use
of knee radiography without patient dissatisfaction or missed fractures and was associated with reduced waiting times and costs. The rule has proven to be highly sensitive, reliable, and very acceptable to clinicians.

Authors’ conclusions
Widespread use of the Ottawa knee rule could lead to important societal health care savings without jeopardising the care of acute knee injury patients.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparator was clear. However, more detail on the control procedure could have been provided.

Validity of estimate of measure of benefit
The measure of benefit would appear to be valid. However, the adoption of the number of referrals for knee radiography as the primary benefit measure is only justified when the clinical decision rule is accurate and reliable, which was the case. Eventually, a future study could also consider outcome measures after treatment for acute knee injury.

Validity of estimate of costs
The reporting of the cost results in terms of means, 95% confidence intervals and p-values could have been more extensive. Obviously, not all direct and indirect costs have been included in the protocol. The application of US cost figures to a study set in Canada raises questions. A major limitation of this study is the substitution of charges for true opportunity costs. It is unfortunate that no sensitivity analysis was conducted, which makes it impossible to assess the robustness of the results. In summary, it is difficult to make recommendations or predictions on the basis of the current cost analysis.

Other issues
Results were not reported separately for the teaching and community hospitals. As the authors stated, several manoeuvres used in the trial may have boosted compliance by physicians. This illustrates the need for local measures to implement published guidelines.

Implications of the study
A more extensive cost-effectiveness analysis based on a randomised controlled trial and which incorporates all relevant costs and outcome measures is called for.

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Other publications of related interest


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