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
Implementation of decision rules (Ottawa Ankle Rules) for the use of radiography in patients with acute ankle injury seen in Emergency Departments (EDs).

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
A hypothetical cohort of ED physicians from a single institution.

Setting
A university hospital adult ED. The economic study was carried out in the USA and Canada.

Dates to which data relate
The effectiveness data were derived from a trial which formally reported in 1994. The main resource use data come from the same source and 1993 prices were used to report the results of the economic study.

Source of effectiveness data
Effectiveness data were derived from a single study.

Link between effectiveness and cost data
In the main, the costing was undertaken retrospectively on the same patient sample as that used in the effectiveness study.

Study sample
The study sample was the trial of the Ottawa Ankle Rules. This trial compared the proportions of patients referred for ankle and foot radiographic series before and after the Rules were taught to all physicians working in the ED of a university hospital. The model considered two hypothetical cohorts of patients: Intervention group and Control group. All patients without fractures were contacted by telephone to determine whether a fracture was missed, satisfaction with ED care, number of days off work, and subsequent physicians' visits and radiography. Power calculations did not determine the sample size.
Study design
This was a non-randomised study with historical controls (taking the physicians as units of analysis; alternatively, one could categorise the study as a before-and-after study, by considering the ED of the university hospital as the appropriate unit of analysis). The study was single-centred. The duration of follow-up was not stated.

Analysis of effectiveness
The intention to treat principle was used. The primary health outcomes were negative predictive values of the Ottawa Ankle Rules, and patient satisfaction.

Effectiveness results
The intervention group had a 25% reduction in ankle radiographic series (95% CI: 22% to 33%) and a 14% reduction in foot radiographic series (95% CI: -3% to 28%) compared to the control group. Those discharged without radiography spent 36 fewer minutes in the ED. Negative predictive value of 1 were detected for both malleolar (95% CI: 0.985 to 1) and mid-foot (95% CI: 0.991 to 1) fractures. The overall prevalence rate of fractures was about 16%. At telephone follow-up, patients were equally satisfied with quality of ED care regardless of whether radiography was ordered.

Modelling
A decision analytic model was used to estimate costs. The model represented the possible chance nodes of a patient with acute ankle pain having and not having radiography plus the subsequent conditional probabilities of fracture after being and not being given radiography.

Measure of benefits used in the economic analysis
Since the effectiveness study showed no difference in clinical benefit between the alternatives, the economic study was based on the difference in costs only.

Direct costs
Main quantities were analysed separately from the costs. The study incorporated all costs borne by relevant third-party payers and by the patient and included radiography and medico-legal costs (suits associated with missing fractures not receiving radiography). Four different cost schedules were used to estimate the costs of ankle and foot radiography series: Medicare (US), Medicaid (US), hospital charge (US), and Ontario Ministry of Health (Canada). Costs from the US were obtained by survey of a sample of 10 hospitals (the mean cost was used). The Ontario costs were calculated with the use of a fully allocated cost model developed at Ottawa Civic Hospital and included physician fees obtained from the Ontario Schedule of Benefits. The 1993 prices were used to report the results. A litigation rate of 5 in 10,000 patients with missed fractures in the US was adopted for the analysis. The rate for successful litigation for lawsuits related to ankle injury was estimated to be 34% for the US and 33% for Canada.

Statistical analysis of costs
95% confidence intervals (CIs) were reported.

Indirect Costs
Main quantities were analysed separately from the costs. Costs from lost productivity due to waiting time at the ED and missing fractures of patients in the ED were calculated. The human capital approach was used to value the latter. It was assumed that workers' wages reflect their productivity and that 1 day off work is 1 lost day of productivity. The value of time off work was calculated only for patients who were younger than 65 years and were expected to be wage earners, and it was assumed to be equal to the value of their lost wages. The average industrial wage rate was used to value time-savings from waiting at the ED for all patients regardless of their employment status (justified by the labour-supply approach to the value of leisure). 1993 prices were used. It was assumed that a missed fracture resulted in 5
additional days off work which lead to increased incremental costs from lost productivity.

**Currency**
Canadian dollars (Can $) and US dollars ($).

**Sensitivity analysis**
One- and two-way sensitivity analyses were carried out which varied the rate of missed fractures, cost of radiography, probability of lawsuits, and cost of lawsuits. These sensitivity analyses included worst case scenarios in terms of assumptions of a "poor" negative predictive value in conjunction with a "high" settlement amount for a lawsuit resulting from misdiagnosis.

**Estimated benefits used in the economic analysis**
Not applicable.

**Cost results**
In the US, total savings varied between $614,226 and $3,145,910 per 100,000 patients whilst in Canada, the savings amounted to Can$730,145 per 100,000. The cost savings per patient in the US were $32.92 for fully insured patients. Patients insured by Medicaid and Medicare were $7.45 and $8.91, respectively. The corresponding figure for Canada was Can$8.89.

**Synthesis of costs and benefits**
Not applicable. Nevertheless, a sensitivity analysis explored the effects of varying the assumptions on the estimate of negative predictive value of the Rules. With a negative predictive value of 0.985, the incremental cost savings were slightly reduced from baseline (no analysis was made of the outcome side consequences of such an assumption and, thus, no combination of costs and benefits was undertaken). It was assumed that the negative predictive value was 0.985 and the litigation rates were 100 times higher (the probabilities of lawsuits were 0.01 and 0.05 in Canada and US, respectively), the joint impact was that the incremental cost numbers changed slightly. Implementation of the Rules continued to be cost-saving as long as the probability of lawsuit did not exceed 0.72, 0.17, or 0.14 for patients paying by the hospital charge rate, Medicare, or Medicaid, respectively. In Canada, as long as the probability of litigation was below 0.50, the Rules were found to be cost-saving.

**Authors' conclusions**
Implementation of the Ottawa Ankle Rules would result in significant savings of health care dollars. Despite the cost of missed fractures including litigation costs, the Rules have been shown to be cost-effective after incorporation of all direct and indirect costs. The study suggests the introduction of the Rules into practice from both a clinical and a health policy point of view.

**CRD Commentary**
The retrospective nature of the study design used may represent a source of bias to the results of the effectiveness study. The authors appear to have used the term 'cost-effective' to mean 'cost-saving'. The variation of assumptions regarding diagnostic accuracy of the rules appears to call for the production of cost-effectiveness ratios as well as net costs, however, no combination of costs and benefits was carried out in this regard.

**Implications of the study**
Further studies are needed in order properly to address the question of cost-effectiveness of the introduction or otherwise of decision rules for using radiography with patients presenting acute ankle injury at the ED.
Source of funding
None stated.

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