Financial impact of elimination of routine chest radiographs in a pediatric intensive care unit

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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
A change in the ordering practice in chest radiograph use involving elimination of standing orders for routine daily morning chest radiographs and requiring each radiograph to have a separate written order and a clinical indication (no restrictions were placed on clinical indications) in patients hospitalised in a pediatric intensive care unit (PICU).

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
The study population consisted of heterogenic patients hospitalised in a pediatric intensive care unit (PICU). The cardiothoracic surgery patients were excluded from the study because of the proven value of a chest radiograph for this specific group of patients.

Setting
Tertiary care. The economic study was carried out in Utah, USA.

Dates to which data relate

Source of effectiveness data
The evidence for the final clinical outcomes was derived from a single study.

Link between effectiveness and cost data
Costing was retrospectively undertaken on the same patient sample as that used in the effectiveness analysis.

Study sample
Power calculations were not used to determine the sample size. The study sample consisted of 3,727 PICU patients. A total of 10,585 chest radiographs were obtained from 1,839 noncardiothoracic surgery patients (retrospective historical controls) in the control phase; a 29-month period before the study, representing the actual practice in action. 975 of these patients were intubated at some time, totalling 5,802 ventilator days. In the 5-month evaluative phase 143 routine
chest radiographs were performed on 83 intubated and nonintubated patients. In total there were 1,588 noncardiac patients and 9,098 noncardiac patient days in the post-intervention phase.

**Study design**
This was a prospective non-randomised trial with historical controls, carried out in a single centre. The duration of the follow-up appears to have been until discharge from hospital. Loss to follow-up was not reported. The heterogeneity of the PICU patients was given as the reason for the use of historical controls in the study design.

**Analysis of effectiveness**
The principle (intention to treat or treatment completers only) used in the analysis of effectiveness was not explicitly specified. The main health outcomes were as follows:

1. the intervention's impact on chest radiograph volume as measured by the ratio of chest radiographs per patient day and the ratio of chest radiographs per ventilator day;
2. efficacy of daily morning chest radiographs expressed in terms of changes to clinical management arising from viewing the radiograph as opposed to predictions using all patient information other than the chest radiograph;
3. lengths of PICU and hospital stay;
4. lengths of mechanical ventilation; and
5. quality assurance measures including "untoward events" such as unsuspected pneumothorax or pleural effusion.

In addition, interviews were carried out with all pediatric critical care attending physicians to determine whether they were aware of the occurrence of any untoward events relating to the study. Statistical process control charts with control limits set at +/-2 SD were used to display visually a stable process and the effect of changing the process. Severity of illness (SOI) distribution between the groups was assessed using a diagnosis-dependent severity indexing system, All-Patient Refined Diagnosis-Related Groups; indicating that severity of illness was significantly more in the post-intervention period.

**Effectiveness results**
The effectiveness results were as follows:

Despite the intervention not being introduced in the evaluation phase, chest radiographs per patient day decreased, compared with the control phase, from 1.03 (SD: 0.13) to 0.93 (SD: 0.05; p<0.02). After adjustment for patient value, the corresponding value for the post-intervention phase was 0.65 (SD: 0.14; p<0.01), compared to the control phase.

A 37.6% reduction in the distance between the control limits from 5.05 during the control period to 3.13 after the intervention indicated less month-to-month variability in chest radiograph ordering patterns.

The ratio of chest radiographs per ventilator day showed a 46.6% decrease from 1.81 (SD: 0.31) to 0.97 (SD: 0.20; p<0.01).

A change in patient management due to chest radiographs was observed in only 5% of patients in the evaluative phase.

Average lengths of PICU and hospital stay, and lengths of mechanical ventilation were not significantly different across the three study phases (p>0.05).

The change in the routine practice of ordering chest radiographs was not associated with any untoward events.

The pediatric critical care attending physicians who were interviewed were unaware of any adverse events related to the study or to the change in ordering behaviour.
Clinical conclusions
The evaluative phase of the study confirmed the authors’ suspicion that many routine chest radiographs did not add new information and patients would be successfully managed without them. Reducing the variation in chest radiograph ordering patterns was the secondary goal of the study.

Measure of benefits used in the economic analysis
No summary benefit measure was identified in the economic analysis, and only separate clinical outcomes were reported.

Direct costs
Costs were not discounted due to the short time frame of the cost analysis. Some quantities were reported separately from the costs. Cost items were reported separately. Cost analysis covered the variable costs of chest radiographs including film and supplies and radiology technician time. The perspective adopted in the cost analysis was that of a hospital, a patient, and a payer. Patient charge records were reviewed to determine the number of chest radiographs performed. Cost data were obtained from the study institution, the cost analysis being performed in terms of both actual costs and charges. Charge analysis covered the charges associated with each chest radiograph plus an additional portable charge, and radiologist interpretation. The date of the price data was 1994. No adjustments were made for inflation. The cost analysis did not cover the fixed costs of equipment and administrative overheads.

Indirect Costs
Not included.

Currency
US dollars ($).

Sensitivity analysis
Not conducted.

Estimated benefits used in the economic analysis
Not applicable.

Cost results
The change in the routine daily chest radiographs was associated with an estimated cost saving of $45,475.92. This corresponded to a decrease of 3,528 chest radiographs during the 2.5-yrs of the evaluative and post-intervention phases based on a ratio of 1.026 chest radiographs per patient day before the study. The cost savings for the evaluative phase were $1,701.48 versus $43,774.44 for the post-intervention phase. The conservative charge savings to the patients or payers were estimated to be about $352,800 ($100 per chest radiograph times 3,528 fewer chest radiographs performed).

Synthesis of costs and benefits
Costs and benefits were not combined since the intervention appears to have been treated as the dominant strategy.

Authors’ conclusions
These results demonstrate the impact of an evaluation and subsequent change in radiology ordering practice in the authors’ PICU. The change resulted in decreased variability in ordering practice, fewer chest radiographs per patient,
and accompanying cost savings to the patients and payers.

CRD COMMENTARY - Selection of comparators
A justification was given for the choice of the comparator (the strategy of obtaining routine daily chest radiographs) which was the standard practice in the context in question. You, as a database user, should consider whether this is a widely used health technology in your own setting.

Validity of estimate of measure of effectiveness
The internal validity of the effectiveness results can not be guaranteed due to the non-randomised design of the study; the authors acknowledged that potential biases in the study included the lack of a method for tracking complications, the assumption that the patient mix in the study ICU has stayed relatively stable during the 5-yr period despite the severity of illness analysis indicating otherwise, and the possibility of Hawthorne Effect (the change in clinician behaviour secondary to taking part in a study) in the evaluative phase. The post-intervention group was found to be poorer in terms of severity of illness. The patient sample was heterogenous, except for the cardiothoracic surgery patients who were excluded from the study because of proven efficacy of chest radiographs for this group of patients, and can not be treated as representative of a particular patient population.

Validity of estimate of measure of benefit
The authors did not derive a measure of health benefit and the economic analysis may therefore be regarded as a cost-consequences analysis.

Validity of estimate of costs
Some quantities were reported separately from the costs and adequate details of methods of cost estimation were given. No justification was provided for the exclusion of the fixed costs from the cost analysis. The cost analysis was based on both actual costs and charges. Statistical analysis was performed on some components of the resource use data. The price year was specified but no adjustment was made for inflation.

Other issues
Given the non-randomised nature of the study design and the lack of sensitivity analysis, some degree of caution may need to be exercised in the interpretation of the study results. The issue of generalisability to other settings or countries was not addressed. Appropriate comparisons were made with other studies. The study sample (with the exception of the cardiothoracic surgery patients who were excluded from the study) consisted of heterogenous patients who received services in a PICU and the authors' general comments appear to reflect this.

Implications of the study
The authors support continued use of chest radiographs to evaluate changes in patient clinical status and appliance position. The authors recommend continued evaluation of routine ordering patterns to evaluate the clinical usefulness of a diagnostic test and its impact on decision-making and diagnostic efficacy.

Source of funding
None stated.

Bibliographic details
10470769

Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
Cost Savings; Diagnostic Tests, Routine /economics /methods /standards; Evidence-Based Medicine; Forms and Records Control; Hospitals, Pediatric /economics; Humans; Intensive Care Units, Pediatric /economics; Length of Stay /statistics & numerical data; Medical Records; Patient Selection; Practice Patterns, Physicians' /economics; Prospective Studies; Radiography, Thoracic /economics /utilization; Respiration, Artificial /statistics & numerical data; Total Quality Management; Utah

AccessionNumber
21999001643

Date bibliographic record published
31/10/2000

Date abstract record published
31/10/2000