# Critical Review Form

## Economic Evaluation

Cervical Spine Evaluation in Urban Trauma Centers: Lowering Institutional Costs and Complications Through Helical CT Scan, *J Am Coll Surg* 2005; 200: 160-165

**Objective:** "To examine and compare the institutional costs associated with the two alternative imaging strategies and determine whether helical CT might also be a less costly overall strategy" when applied to moderate- and high-risk cervical-spine patients (p 161).

**Methods:** Using a previously published decision-analysis model (fig 1 pg 162, see definitions of decision-analysis and cost-analysis below), the investigators evaluated 2 initial imaging strategies to evaluate cervical spine injury in moderate and high risk trauma patients: plain x-rays versus CT. They defined moderate or high risk patients as: focal neurological deficits; head injury; high energy mechanism; or age greater than 50 with moderate mechanism. Based on their institutional experience and MEDLINE literature review they built their model on the following estimates:

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| 1. Probability of cervical spine fracture | 7.75% (0-15%) |
| 2. Probability of paralysis if missed c-spine injury | 14.5% (0-29%) |
| 3. X-ray sensitivity | 64% (0-100%) |
| 4. X-ray specificity | 80.5% (0-100%) |
| 5. CT sensitivity | 96% (0-100%) |
| 6. CT specificity | 96.5% (0-100%) |
| 7. Cost of x-rays (3 view series) | $120 (0-3000) |
| 8. Cost of CT | $ 330 (0-3000) |
| 9. Cost of legal settlement for missed fracture | $500,000 (0-1,000,000) |

The investigators used a sensitivity analysis based on the ranges in parenthesis above to account for institutional and regional variability

| Guide | | Comments |
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| **I.** | **Are the Recommendations Valid?** | |
| **A.** | **Did the investigators adopt a sufficiently broad viewpoint?** | Yes. Their sensitivity analysis varies by figures to account for different quality CT's, variable reader proficiency, and institutional costs. The authors acknowledge that helical CT with reconstructive views have been shown to be faster, with superior sensitivity and specificity for detecting fractures with cost-effectiveness in the moderate–high risk trauma patient from a societal perspective (page 160). However, CT has also been viewed as more expensive from an institutional perspective and therefore has not been universally adopted as an initial screening study. |

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| **B.** | **Are the results reported separately for patients whose baseline risk differs?** | • No. Results are reported together for both moderate and high risk patients.<br>• The authors used a previously described risk-stratification scheme (Blackmore C; Cervical Spine Screening with CT in Trauma Patients: A cost-effectiveness Analysis, *Radiology* 1999; 212: 117)<br>*1.* High Risk<br>▪ Focal neuro deficit 31% (20-76)<br>▪ Severe head injury 11% (9.4-15)<br>▪ Hi energy mech 15% (6-100)<br>*2.* Mod Risk<br>▪ Hi energy + Age< 50 4.2 %(3-7)<br>▪ Mod-energy mech (MVC < 30, fall, bike) + Age > 50 5.5%(3.6- 10)<br>*3.* Low Risk<br>▪ Mod energy + age < 50 2% (1.6-3)<br>▪ Low –energy mech (blunt trauma or unknown) 0.6% (0.4-0.9)<br><br>Blackmore's low risk patient tier was not included in this analysis. However, the "clumping together" of patients was probably offset by the broad ranges included in the various cost analyses |
| **C.** | **Were costs measured accurately?** | Costs appear to reflect average US radiological and legal institution expenses. If anything, it appears that the settlement figure is on the low end which would only support the use of CT's |
| **D.** | **Did investigators consider the timing of costs and outcomes?** | No, the investigators did not address time in the cost analysis. This was originally set out to be a study evaluating whether institutional costs (financial only) could be reduced using CT as the screen. |
| **II.** | **What Are the Results?** | |

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| **A.** | **What are the incremental costs and effects of each strategy?** | • Helical CT results in an incidence of 0.45 cases of paralysis from missed cervical spine per 1000 moderate to high risk patients compared with a rate of 4.05 cases for x-ray. This equates to an absolute risk reduction of 3.6/1000 patients.<br><br>• CT was the preferred study unless the<br>o average payment was less than $58,180 /case paralysis resulting from missed cervical fracture(p 163)<br>o probability of fracture was less than 0.9% (hi risk incidence 10-15%, overall incidence 2-5%)<br>o probability of paralysis from a missed cervical spine fracture was < 1.7%<br>o cost of CT exceeded $1918<br><br>• CT was always the preferred study even if x-rays were free as long as CT cost less than $1799 or the cost of litigation exceeded $91,430 per case of paralysis from missed fracture.<br><br>• X-rays would be the preferred study if the sensitivity of CT for fracture identification dropped below 70% or if plain x-ray sensitivity exceeded 90%.<br><br>• CT was favored over x-ray with per patient costs of $2,142 for x-ray versus $554 for CT with settlement costs representing 94% of the total x-ray expense. |
| **B.** | **Do incremental costs and effects differ between subgroups?** | Subgroup costs were not analyzed. |
| **C.** | **How much does allowance for uncertainty change the results?** | The model was robust in the authors' sensitivity analysis with CT remaining the preferred imaging choice at all levels of their analysis. |
| **III.** | **How Can I Apply the Results to Patient Care?** | |
| **A.** | **Are the treatment benefits worth the harms and costs?** | Yes, if missed cervical spine injury morbidity and litigation can be avoided in a cost-effective manner which the study implies. |

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| **B.** | **Could my patients expect similar health outcomes?** | Yes assuming the cost of radiographic studies and litigation are similar or at least proportional to the costs of the cost-benefit analysis in the article. However, there is no reason to assume our mod-hi risk trauma patients are any different nor that the ramifications of missed c-spine injuries are any different. If anything, if litigation costs are higher, this would only enhance the support for CT over x-rays. |
| **C.** | **Can I expect similar costs at my setting?** | Yes. |
| **III.** | **How Can I Apply the Criteria to Patient Care?** | |
| **A.** | **Are the criteria relevant to your practice setting?**<br><br>*Medical practice is shaped by an amalgam of evidence, values, and circumstances; clinicians should consider their local medical culture and practice circumstances before importing a particular set of audit criteria.* | Yes. These are the same questions, same studies, same radiologic questions, and same medical-legal implications. |
| **B.** | **Have the criteria been field-tested for feasibility of use in diverse settings, include settings similar to yours?** | No. |

## Limitations

1) Several biases *against* CT including the lack of cost –analysis of *ongoing* paralysis or cost of usual post- x-ray confirmatory CT. When is the last time you noted a cervical fracture or dislocation on x-ray for which Neurosurgery or Ortho-spine did not request a CT for further evaluation?

2) Poor definition of low, moderate, or high-risk with expected significant inter-rater variability. The authors could have avoided this by using validated assessment tools like NEXUS or CCSR to define non–low risk patients.

## Bottom Line

An earlier paper that this paper drew heavily on showed a societal benefit from a cost-effectiveness standpoint in favor of CT for c-spine imaging in moderate-high risk neck injury patients. These authors show that using the same decision analysis, CT is a more diagnostically sensitive yet least costly first line imaging strategy over a wide range of radiographic costs, sensitivity variation and litigating amounts. This paper makes a compelling argument in favor of using CT as the initial choice for imaging. An interesting application of this strategy would be to focus on low-moderate patients (fracture probability 0.6-5.5%) who fail already validated low risk clinical criteria like NEXUS or CCSR and see whether CT holds out for these patients as well.

## Definitions

Economic analysis – is a set of formal, quantitative methods used to compare 2 or more treatments, programs, or strategies with respect to their 1) resource use (cost) and 2) their expected outcomes. Comparing 2 or more costs only is a *cost analysis.* In health strategies there are usually 3 types of economic analysis:

1. Cost benefit – these report patient important outcomes (life –years gained or diseases prevented) and essentially looks for best outcome for the least amount of money
2. Cost utility Analysis– this approach different types of outcome are weighed to produce a composite index of outcome such as quality-adjusted life year (QALY). Quality adjustment involves placing a lower value on time spent with impaired physical and emotional function than time spent in full health. (death = 0 and 1 represents full health). This generally looks at cost from a societal standpoint.
3. Cost Effectiveness– investigators put a dollar value on additional life gained, migraine headaches prevented or MI's prevented. In these situations, health care consumers consider what they would be willing to pay for programs or products that achieve particular outcomes such as prolonging life or preventing adverse event. This puts benefit to patients and society in some form of balance.

This article is a hybrid between cost effectiveness and decision analysis.

Decision analysis - analytic technique that can be used to examine relative costs, effectiveness and cost-effectiveness alternative therapeutic and diagnostic strategies Components include

1. defining the problem, objectives and perspective of the analysis
2. delineating all relevant alternative strategies to be examined
3. delineating the consequences (clinical outcomes) of each pathway that could be faced by the patient in each strategy
4. estimating the probabilities of those pathways and associated consequences
5. calculating the expected outcomes of each alternative strategy
6. ranking the alternatives in order or preference
7. examining the impact of the baseline assumption and changes in the estimated probabilities on expected value and preferred order of the alternative strategies