When Your Clinical Examination Is as Good as an X-Ray Film

SECTION EDITOR
Brian R. Budenholzer, MD

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Stiell IG, Wells GA, Hoag RH, et al. Implementation of the Ottawa Knee Rule for the use of radiography in acute knee injuries. JAMA. 1997;278: 2075-79.

OBJECTIVE. The Ottawa Knee Rule (*see* Need for Knee X-Ray Films) was derived and validated as a prediction rule that would clinically detect 100% of fractures sustained in acute knee injury. This study was done to determine how implementing the rule in clinical practice affects use of radiography. Other objectives were to further validate the accuracy and reliability of the rule and to assess the impact of its use on waiting times and medical charges.

DESIGN. Nonrandomized, controlled clinical trial that included before-and-after comparisons of patients seen in the emergency departments of two intervention hospitals (one community hospital and one teaching hospital) and two control hospitals in Ontario, Canada.

PATIENTS. Patients were adults who had sustained acute knee injury from any cause and were seen at one of the intervention hospitals. Controls were adults who sustained acute knee injury and were seen at one of the two control hospitals. Patients who were younger than 18 years of age, were pregnant, had sustained injury more than 7 days before evaluation, had returned for reassessment of an injury, had altered consciousness, were paraplegic, or had multiple trauma were excluded.

INTERVENTION. The rule was introduced into the emergency departments of the intervention hospitals: Brief lectures were given, pocket cards were distributed, and several posters were mounted. All physicians were encouraged to use the rule when considering radiography for patients with knee injury. The decision to obtain knee x-ray films was left to the discretion of the treating physician.

RESULTS. 3907 eligible patients with knee injury were seen during the study periods. After the rule was introduced, a 26% reduction (95% CI, 22% to 31%) was seen in the proportion of patients sent for knee radiography in the intervention hospitals and a nonsignificant reduction of 1.3% (CI, –4% to 6%) was seen at the control hospitals. In 35 cases (3.5%), x-ray films were obtained despite the rule. There were no fractures in those 35 cases.

After implementation of the rule, patients without fracture spent less time in the emergency department (86 minutes compared with 119 minutes). After discharge from the emergency department, patients were contacted. Of those who were reached, 96% of those who did not receive radiography and 99% of those without fracture who did receive radiography stated that they were satisfied with the physician care they had received in the emergency department. The estimated mean charge for emergency department and subsequent physician visits and radiography was substantially lower for the group that did not receive radiography ($80 compared with $183). Of patients who did not receive radiography in the emergency department, 7% subsequently received knee radiography. None had a fracture identified.

The rule correctly identified all 58 clinically important fractures. Its sensitivity was 100% (CI, 94% to 100%), and its negative predictive value was 100% (CI, 99% to 100%).

COMMENTS. When radiography is withheld because of the rule, fracture is highly unlikely. However, patients should receive a thorough explanation of diagnosis and treatment along with the recommendation that they seek follow-up care if the pain

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Need for Knee X-Ray Films

A series of knee x-ray films is required *only* for patients with knee injury and any of the following findings:

- Age 55 years or older
- Isolated tenderness of the patella (no bone tenderness elsewhere in the knee)
- Tenderness at the head of the fibula
- Inability to flex the knee 90 degrees
- Inability to bear weight both immediately and in examination room or emergency department—that is, the patient is unable to take four steps or to transfer weight twice onto each limb

has not diminished or the ability to walk has not improved after 5 to 7 days. The authors advise using both written and oral explanations.

The authors state that the rule is intended to be applied in the following manner. Because of their increased risk for fracture, all patients older than 55 years of age require radiography. Radiography is also indicated for patients with bone tenderness at common fracture sites, namely, tenderness at the head of the fibula and isolated tenderness of the patella. Patella tenderness that is not isolated but is associated with other areas of bone tenderness is a common, nonspecific finding that should not require radiography. Finally, radiography is indicated for patients with reduced knee function, as manifested by the inability to flex the injured knee to 90 degrees or the inability to bear weight both immediately after the injury and in the emergency department. If other high-risk findings are present, there is no need to assess the ability to bear weight. The ability to bear weight is assessed by asking the patient to walk four paces: If the patient clearly transfers weight twice onto each leg, he or she can bear weight, even if limping. Clinical judgment should always take precedence over the rule, particularly in situations where examination may be unreliable, such as cases of intoxication, multiple trauma with distracting injuries, language barrier, or diminished sensation in the legs.

CONCLUSIONS. Using the five key elements of clinical information that make up the Ottawa Knee Rule, clinicians can reliably determine when a patient either does not or might have knee fracture after acute knee injury. When carefully applied, this rule identifies all patients who might have a clinically significant fracture. The rule reliably rules out fracture in more than 40% of patients with knee injury. Using the rule to avoid knee radiography in patients identified as not having a fracture provides more efficient care and equal or better quality at lower cost.

Wells PS, Anderson DR, Bormanis J, et al. Value of assessment of pretest probability of deep-vein thrombosis in clinical management. Lancet. 1997;350:1795-8.

OBJECTIVE. To determine whether using clinical assessment to guide imaging and treatment decisions in patients with suspected deep venous thrombosis (DVT) is accurate and effective.

DESIGN. Prospective cohort study.

PATIENTS. 593 outpatients with suspected DVT (patients with pain or swelling of the lower extremities in whom the diagnosis of DVT could not be excluded on clinical grounds) were included. Patients were excluded if they had at least one of the following conditions: previous episode of DVT or pulmonary embolism (PE), signs or symptoms of current PE, imminent probability or certainty of death, a reason other than DVT for requiring long-term anticoagulation, a geographic location that precluded follow-up, or age younger than 18 years.

Patients with suspected DVT were judged to be at low risk for DVT if their clinical score predicting the likelihood of DVT was 0 or less, at moderate risk if their

TABLE 1
Clinical Scoring Method To Estimate Risk for Deep Venous Thrombosis

CLINICAL FEATURE	SCORE*
Active cancer (treatment ongoing or within previous 6 months or palliative treatment)	1
Paralysis, paresis, or recent plaster immobilization of the lower extremities	1
Recently bedridden for more than 3 days or major surgery within 4 weeks	1
Localized tenderness along the distribution of the deep venous system	1
Swelling of entire leg	1
Calf swelling of more than 3 cm compared with the asymptomatic leg (measured 10 cm below tibial tuberosity)	1
Pitting edema (greater in the symptomatic leg)	1
Collateral superficial veins (nonvaricose)	1
Alternative diagnosis as or more likely than a diagnosis of deep venous thrombosis	–2

**Total score of 0 or less = low risk for deep venous thrombosis; total score of 1 to 2 = moderate risk for deep venous thrombosis; total score of 3 or more = high risk for deep venous thrombosis.*

score was 1 to 2, and at high risk if their score was 3 or more (Table 1).

INTERVENTION. All patients had venous ultrasonography. Lack of compressibility was the sole criterion for a diagnosis of DVT. Low-risk patients had no further testing and were not treated for DVT if the initial ultrasonogram was negative. If the ultrasonogram was positive, venography was done. Patients received anticoagulation only if the venogram confirmed DVT.

Moderate-risk patients had anticoagulation if the ultrasonogram was positive. If the initial ultrasonogram was negative, ultrasonography was repeated 1 week later. If the second ultrasonogram was positive, anticoagulation was given. Venography was not done in the moderate-risk group. High-risk patients received anticoagulation if the ultrasonogram was positive. If the initial ultrasonogram was negative, venography was performed. Patients with positive venograms confirming DVT received anticoagulation; those with negative venograms did not receive anticoagulation. All patients were followed for at least 3 months. Patients were instructed to report signs or symptoms of DVT or PE during follow-up.

RESULTS. Of the 593 patients, 329 (55%) were judged to be at low risk. Ten low-risk patients (3%) had DVT. Nine patients with DVT had a positive ultrasonogram confirmed by venography. One patient with DVT initially had a negative ultrasonogram; this patient had DVT confirmed 21 days after initial presentation. Two patients had positive ultrasonograms and negative venograms. In the low-risk group, ultrasonography had a sensitivity of 90%, a specificity of 99.4%, a positive predictive value of 82%, and a negative predictive value of 99.7% (95% CI, 98.3% to 100%).

A total of 193 patients (33%) were judged to be at moderate risk. In 32 patients (17%), DVT was diagnosed. Thirty patients with DVT had a positive ultrasonogram, and all patients received anticoagulation. Three of these patients had DVT confirmed on their second ultrasonogram 1 week after an initial negative examination. Two moderate-risk patients initially had negative ultrasonograms and then had DVT confirmed 41 and 90 days after two negative ultrasonograms obtained 1 week apart. In the moderate-risk group, ultrasonography had a sensitivity of 94% and a negative predictive value of 98.8%. Because all moderate-risk patients whose ultrasonograms indicated DVT received anticoagulation, the specificity and positive predictive value of ultrasonography cannot be determined.

Seventy-one patients (12%) were judged to be at high risk. Fifty-three patients (75%) had DVT. Forty-nine patients with DVT had a positive ultrasonogram, and all received anticoagulation. Four had a negative ultrasonogram followed by a positive venogram. Eighteen patients had negative ultrasonograms and a negative venogram (11 patients), had an inconclusive venogram (2 patients), or refused venography (5 patients). None of the 5 patients who refused venography were later shown to have DVT or PE. The sensitivity of ultrasonography plus venography in high-risk patients was 100% (94% for ultrasonography alone). The negative predictive value of a negative initial ultrasonogram was 82%. Because all high-risk patients whose ultrasonograms indicated DVT were treated with anticoagulation, the specificity and the positive predictive value of ultrasonography cannot be determined. (The study protocol, in a sense, assigned a specificity of 100% and thus a positive predictive value of 100% to a positive ultrasonogram in high-risk patients.)

This strategy resulted in diagnosis of all but 3 cases of DVT in patients initially suspected of having DVT. None of the 3 patients who did not receive a diagnosis had PE. Only 5.6% of patients required venography, and only 28% required serial testing.

CONCLUSIONS. Clinical information can be used to accurately triage patients with possible DVT into low-, moderate-, and high-risk groups. A single negative ultrasonogram accurately rules out DVT in low-risk patients. A series of two negative ultrasonograms obtained 1 week apart accurately rules out DVT in moderate-risk patients. High-risk patients with negative ultrasonograms still have an almost 20% chance of having DVT, and venography is warranted in high-risk patients with negative ultrasonograms. Basing imaging and treatment strategies on risk for DVT as determined by simple clinical methods results in accurate, efficient diagnosis or exclusion of DVT.

Key Evidence

- **By using key information obtained from history and physical examination, one can reliably determine whether x-ray films are needed to confirm or rule out a fracture when a patient has knee injury. X-ray films are often unnecessary.**
- **If DVT is suspected, clinicians can use key information obtained from history and physical examination, along with a single ultrasonogram, to reliably rule out DVT, to decide whether to obtain a venogram, or to give anticoagulation. Serial testing is not required, and venograms are rarely needed.**
- **In the assessment of acute knee injury or suspected DVT, careful, precise clinical examination improves the efficiency of care, reduces costs, and maintains or improves quality.**

Section Editor's Comments **Avoiding Unnecessary Diagnostic Tests**

The clinical examination of patients (obtaining a history and performing a physical examination) is usually considered part of "the art of medicine." Consequently, the reliability of clinical assessment is often suspect. This can lead to the use of diagnostic tests to be sure that we do not overlook significant disease despite our clinical impression that such disease is unlikely.

These two very well-conducted clinical studies document that careful clinical examination can safely eliminate the need for unnecessary diagnostic tests in at least two conditions: acute knee injury and DVT. Of note, both studies came from Ottawa, Ontario, Canada, the "birthplace" of the Ottawa Ankle Rules. These elegant studies demonstrate the power of applying evidence-based principles to the clinical examination of patients. Most important, the researchers evaluated their prediction rules during actual use in clinical practice. They found that the rules worked as well in the real world as they did in logistic regression equations.

Both sets of investigators had previously derived "clinical prediction rules" designed to detect *all* cases of the disease in question (1–4). That is, they tried to identify clinical findings that, if present, would identify all cases of the disease. They sought 100% sensitivity in their rules. A "test" that is 100% sensitive identifies all cases of the disease in question. Such a test produces no false-negative results but will produce false-positive results. Because it has near-perfect sensitivity, the clinical prediction rule is both useful and usable in actual practice. A useful evidence-based medicine mnemonic is SnOUT: a negative result on a sensitive test (Sn) rules out (OUT) the disease.

For the two prediction rules presented in these two studies, clinical examination pointed the way to an efficient process of evaluation that clarified the diagnosis. In almost half of the patients with knee injuries, diagnosis was based on clinical examination alone. For those who were not given a diagnosis, the single next step (radiography) confirmed the diagnosis. For possible DVT, clinical examination plus a single, simple, safe ultrasonographic examination provided the diagnosis for 66% of patients. For the remaining 34%, the clinical examination findings identified the single next step needed to finalize the diagnosis. For most patients, this was ultrasonography 1 week later; for a few, it was venography. Using these prediction rules leads to rapid, efficient, *accurate* diagnosis. Costs are lowered without sacrificing quality.

Both of the decision rules discussed in these studies have passed the test of real-world, rigorous research and can be highly recommended for use. Put them in whatever form of "peripheral brain" you carry; put a copy in your examination rooms or your emergency department; and, to paraphrase the ad, "just use them."

Brian Budenholzer, MD, is the director of Clinical Enhancement and Development at Group Health Northwest, P. O. Box 204, Spokane, WA 99210; email: brbudenh@ghnw.ghc.org.

References

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This section is designed to help readers practice evidence-based medicine. Abstracts of articles from the medical literature are provided when solid evidence exists that an intervention is beneficial (and should be used) or is useless or harmful (and should be abandoned or avoided). Articles are selected on the basis of their quality of evidence and value to practicing clinicians.