



## Introduction

A 10-year-old patient presents with painful isolated hematuria; no trauma history; otherwise normal labs and physical. What diagnostic imaging procedure should you order?

To answer this question using evidence-based guidelines, physicians must currently navigate among multiple information resources, find patient-appropriate imaging recommendations, and then translate these recommendations into one of hundreds or thousands of hospital-specific procedure terms before placing a radiology order. Not surprisingly, evidence suggests few physicians are consistently able to overcome this high barrier to appropriate ordering.

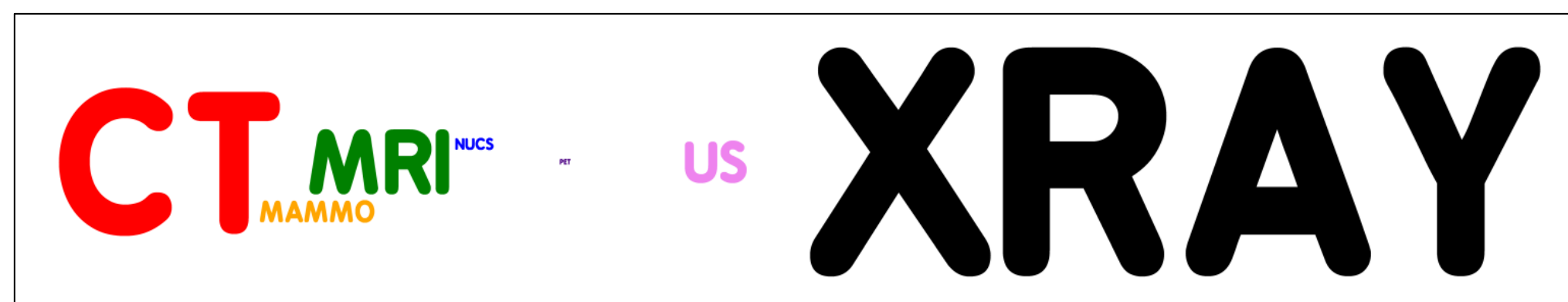
To lower the barrier, we started the RightRad project at Johns Hopkins. RightRad aims to link the complex workflow required for appropriate order entry into a single streamlined interface available online. The project is based on consolidation of the American College of Radiology (ACR) Appropriateness Criteria and designed for rapid incremental searching at the point of care. Adding additional local value, approved recommendations are linked to Hopkins-specific procedure terms.

**Please click to step through four slides detailing project milestones or you can explore RightRad directly on your own device at <http://www.rightrad.com>.**

# Project Milestone 1



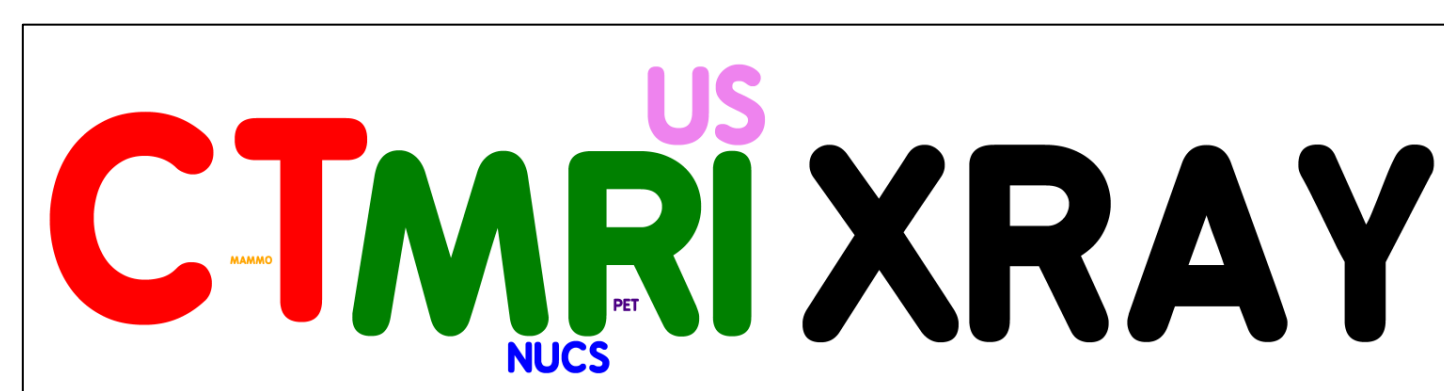
Distribution of diagnostic imaging at Johns Hopkins Hospital, 2008-11  
*N = 1366931, top 50 shown (word height proportional to frequency)*



## Localization Feasibility

We analyzed the lexicon of diagnostic imaging orders placed at the Johns Hopkins Hospital (*top*) and highest recommended by the ACR Appropriateness Criteria (*bottom*), since our project aims to link these. We found that over 90% of orders placed at our institution are also top-ranked by the Appropriateness Criteria.

Distribution of diagnostic imaging top-ranked by the ACR Appropriateness Criteria  
*N = 203, top 50 shown (word height proportional to frequency)*



**Conclusion: The ACR Appropriateness Criteria are a relevant starting point for the development of localized guidelines at our institution.**

# Project Milestone 2




## RightRad Screenshots

**1**

RightRad.com. Right patient, right image, right now.

Search by clinical condition or imaging indication to find appropriate orders (eg, "pancreatitis")

 We're a small group from **Hopkins radiology** developing RightRad to help make ordering images faster and more appropriate, based on the guidelines of the American College of Radiology.


Start Searching above and then please let us know whether we're on the right track by leaving comments.

**2**

RightRad.com. Right patient, right image, right now. FAQ

Search by clinical condition or imaging indication to find appropriate orders (eg, "pancreatitis")

hematu

CLINICAL CONDITION	INDICATION VARIANT	ACR MOST-APPROPRIATE ORDER(S)	COMMENT
HEMATURIA	• Generalized renal parenchymal disease	• US kidneys and bladder retroperitoneal	
	• Renal parenchymal disease unknown or absent, OR young females with hemorrhagic cystitis	• CT abdomen and pelvis without and with contrast (CT urography)	• Contrast contraindication? X-ray retrograde pyelography or US kidney and bladder retroperitoneal. • X-ray retrograde pyelography also for patients with a strong suspicion of urothelial lesion or to clarify abnormality suspected on CT urography
HEMATURIA - CHILD 	• Isolated	• US kidney and bladder	
	• Painful nontraumatic	• CT abdomen and pelvis without contrast	• CT is more sensitive than ultrasound for stones;
	• Traumatic	• CT abdomen and pelvis with contrast	• For traumatic microscopic hematuria, CT yield is highest in the presence of additional clinical signs of injury
RENAL TRAUMA	• Blunt abdominal injury, with or without hematuria	• CT abdomen and pelvis with contrast. • Delayed phase for evaluation ureters and bladder	• Detection of associated injuries

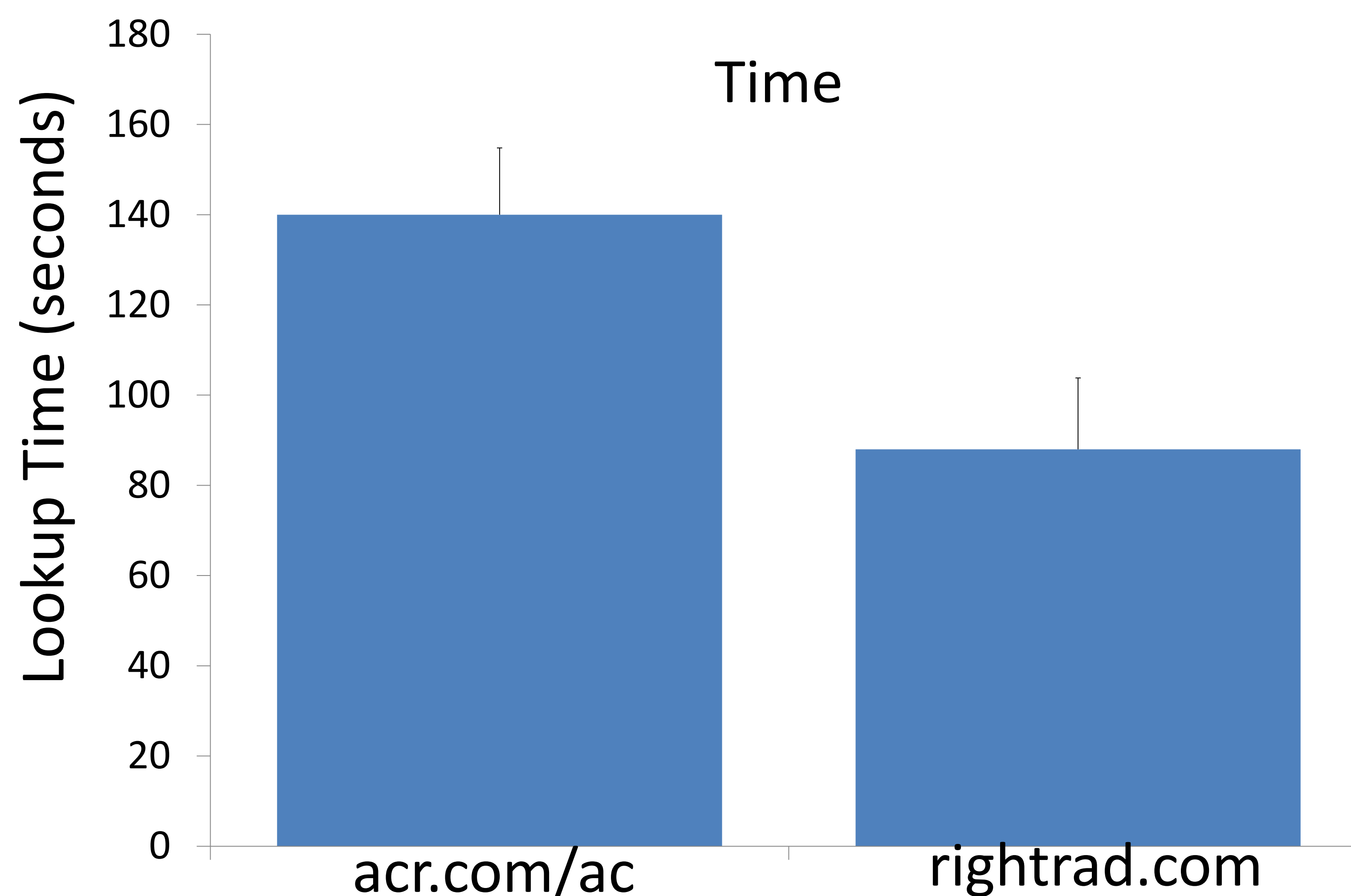
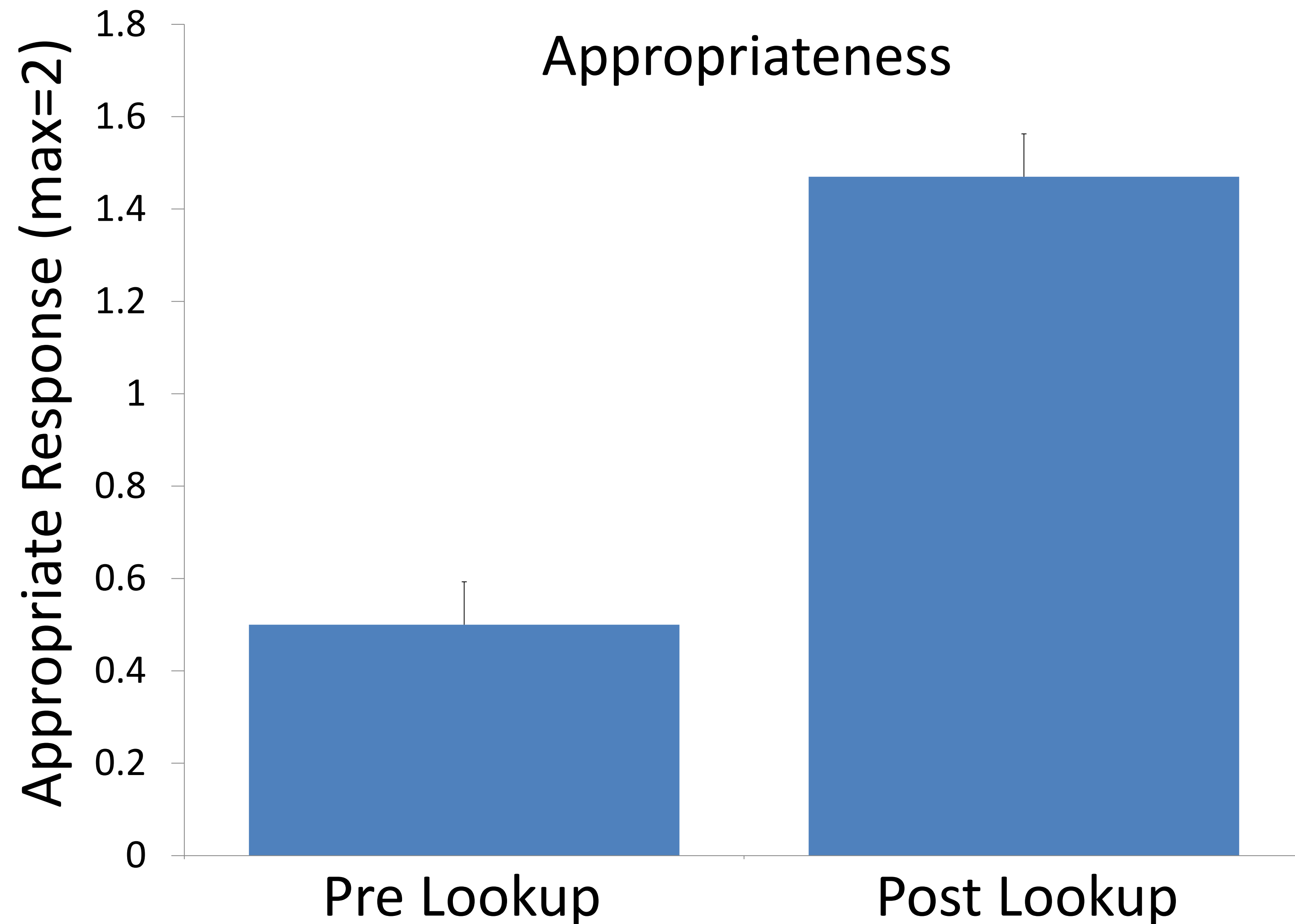
[Suggest Comments or Additions](#)

## Software Feasibility

RightRad was designed using a three-tiered architecture consisting of a standard LAMP backend / middleware configuration (Linux Apache HTTP Server, MySQL, PHP), with HTML / Javascript / JQuery on the front-end. To allow for local adaptation and supplementation, database content was derived from manual review of each diagnostic imaging topic document covered by ACR Appropriateness Criteria (not an API such as ACRSelect). Our iterative search algorithm relies on MySQL's MATCH function. For all possible search terms beginning with A through Z, matched results consisting of paired clinical conditions, indication variants, most-appropriate radiologic procedures, and comments (aggregated database > 8000 words and 68,000 characters) were returned within a mean of 14 ms (range 4 to 26). Subjectively, this corresponds to a rapidly responsive search experience similar to using Google Instant on the web or Spotlight in Apple's OS X.

**Conclusion: Fast incremental web search is feasible against a large dataset based on aggregating the ACR Appropriateness Criteria.**

# Project Milestone 3



## Validation Testing

To test whether use of available interfaces to the ACR Appropriateness Criteria actually improves adherence to these guidelines, we obtained IRB approval for an ongoing clinical vignette study. Resident respondents answered questions such as the one at the start of this storyboard about appropriate imaging for a pediatric patient presenting with painful hematuria. The vignettes were then re-presented with blinded links to two publically available interfaces for looking up the ACR's Appropriateness Criteria: [acr.org/ac](http://acr.org/ac) and [rightrad.com](http://rightrad.com). Preliminary results based on complete responses from 30 radiology and internal medicine residents suggest that use of the ACR Appropriateness Criteria significantly improves selection of appropriate diagnostic imaging ( $t -7.4, p < 0.0001$ ). In addition, use of the RightRad interface is significantly faster ( $t -2.4, p < 0.01$ ). There was no difference in accuracy based on use of either interface.

**Conclusion: Interfacing with the ACR Appropriateness Criteria increases adherence to these evidence-based guidelines. RightRad provides a faster lookup interface than the one currently available at [acr.org/ac](http://acr.org/ac).**



**Acknowledgements:** RightRad represents a large, multidisciplinary collaboration, and we would like to acknowledge the contributions of the following individuals: Karen Bleich, MD; Swati Deshmukh, MD; Tosin Fatusin, MD, MPH; Elliot Fishman, MD; Karen Horton, MD; Thierry Huisman, MD; Olayemi Ikusika, MD; Brenessa Lindeman, MD; Benjamin Northcutt, MD; Susan Peterson, MD; Rod Rahimi, MD, PhD; Gorkem Sevinc, MS; Salina Tsai, MD; and David Yousem, MD.

## Future Directions

We look forward to expanding the RightRad content database to cover popular unaddressed queries at our institution (“epidural abscess,” for instance). Our ultimate goal is to tightly couple RightRad with our institution’s electronic ordering system, so that, for example, just a few keystrokes of “hematur.” or “CT...” or other flexible query terms all accelerate convergent clinical consideration of the most appropriate diagnostic imaging order (“CT Abdomen and Pelvis w/o IV Contrast [Hopkins procedure code CTB5040]” in the case of the introductory vignette ).

## References

1. Bautista, AB, et al. Do clinicians use the American College of Radiology Appropriateness Criteria in the management of their patients? *AJR Am J Roentgenol* 2009;192:1581-85.
2. Chiunda AB;, Mohammed TH. Knowledge of ACR thoracic imaging appropriateness criteria among trainees: One institution’s experience. *Acad Radiol* 2012; 19:635-39.
3. Hirschl DA, et al. Online survey of radiologic ordering practices by pediatric trainees. *JACR* 2010;7:360-3.
4. Taragin BH, et al. Online radiology appropriateness survey results and conclusions from an academic internal medicine residency. *Acad Radiol* 2003; 10:781-85.