Original Investigation

# Imaging Facilities' Adherence to PI-RADS v2 Minimum Technical Standards for the Performance of Prostate MRI

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**Purpose:** This study aimed to assess variability in imaging facilities' adherence to the minimum technical standards for prostate magnetic resonance imaging acquisition established by Prostate Imaging-Reporting and Data System (PI-RADS) version 2 (v2).

**Methods:** A total of 107 prostate magnetic resonance imaging examinations performed at 107 unique imaging facilities after the release of PI-RADS v2 and that were referred to a tertiary care center for secondary interpretation were included. Image sets, DICOM headers, and outside reports were reviewed to assess adherence to 21 selected PI-RADS v2 minimum technical standards.

**Results:** Hardware arrangements were 23.1%, 1.5T without endorectal coil; 7.7%, 1.5T with endorectal coil; 63.5%, 3T without endorectal coil; and 5.8%, 3T with endorectal coil. Adherence to minimum standards was lowest on T2 weighted imaging (T2WI) for frequency resolution ≤0.4 mm (16.8%) and phase resolution ≤0.7 mm (48.6%), lowest on diffusion-weighted imaging (DWI) for field of view (FOV) 120–220 mm (30.0%), and lowest on dynamic contrast-enhanced (DCE) imaging for slice thickness 3 mm (33.3%) and temporal resolution <10 s (31.5%). High b-value (≥1400 s/mm$^2$) images were included in 58.0% (calculated in 25.9%). Adherence to T2WI phase resolution and DWI inter-slice gap were greater ($P < .05$) at 3T than at 1.5T. Adherence did not differ ($P > .05$) for any parameter between examinations performed with and without an endorectal coil. Adherence was greater for examinations performed at teaching facilities for T2WI slice thickness and DCE temporal resolution ($P < .05$). Adherence was not better for examinations performed in 2016 than in 2015 for any parameter ($P > .05$).

**Conclusion:** Facilities' adherence to PI-RADS v2 minimum technical standards was variable, being particularly poor for T2WI frequency resolution and DCE temporal resolution. The standards warrant greater community education. Certain technical standards may be too stringent, and revisions should be considered.

**Key Words:** Prostate cancer; MRI; PI-RADS; diffusion-weighted imaging; dynamic contrast-enhanced imaging.

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## INTRODUCTION

The Prostate Imaging-Reporting and Data System (PI-RADS) version 2 (v2) was developed with the goal of improving the detection and characterization of suspected prostate cancer through multiparametric prostate magnetic resonance imaging (MRI). In support of this goal, its first listed specific aim is to "establish minimum acceptable technical parameters" for prostate MRI. PI-RADS v2 implements this aim by specifying a wide range of explicit acquisition parameters for T2-weighted imaging (T2WI), diffusion-weighted imaging (DWI), and dynamic contrast-enhanced imaging (DCE). The provision of these minimum technical standards is intended to promote robust image quality of prostate MRI across practices.

Much of the attention toward PI-RADS v2 has related to its standards for examination interpretation and reporting. Indeed, increasing peer-reviewed literature supports the diagnostic performance of PI-RADS v2 in the detection of clinically significant prostate cancer (1–3). However, less attention has been directed toward full dissemination and implementation of the minimum technical standards within PI-RADS v2. Therefore, little is known regarding the success in communication and dissemination of the technical standards by leaders in the field, as well as the success in adherence by individual practices. Moreover, given a paucity of data informing many of the individual standards, the determination of the exact standards relied heavily on expert consensus. Therefore, it remains possible that some of the technical standards are in fact suboptimal and could warrant reconsideration.

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Our institution is a tertiary care center with a dedicated prostate cancer clinic. Patients commonly present to this clinic having already undergone prostate MRI at other imaging facilities. These examinations from other facilities are routinely imported to our local picture archiving and data system (PACS) for secondary interpretation. The resulting availability in our local system of prostate MRI examinations performed at numerous distinct locations provides an opportunity to evaluate the imaging community's success in achieving widespread adoption of the acquisition parameters specified in PI-RADS v2. Therefore, our aim in this study was to assess variability in imaging facilities' adherence to the minimum acceptable technical standards established by PI-RADS v2.

## MATERIALS AND METHODS

This retrospective study was Health Insurance Portability and Accountability Act-compliant and approved by our institutional review board with a waiver of the requirement for written informed consent. The study was performed at a large academic medical center located in Manhattan, New York. As described in an earlier report (4), the region's metropolitan area has the highest population and population density among US metropolitan statistical areas (5,6), and contains at least eight integrated academic medical centers (7).

We searched a departmental database to identify secondary interpretations performed for prostate MRI examinations acquired at outside imaging facilities between April 2015 (approximately 3 months after the initial public release of PI-RADS v2) and July 2016, initially yielding 237 examinations. When multiple examinations from a single facility were identified, the most recent such examination was included. This process provided a final cohort of 107 prostate MRI examinations acquired at 107 unique imaging facilities. The mean ± standard deviation (SD) patient age was 64.5 ± 8.5 years (median, 66 years; range, 40–81 years). The mean ± SD serum prostate-specific antigen was 8.8 ± 12.2 ng/mL (median 6.0 ng/mL, range, 0.4–118 ng/mL). Indications for prostate MRI were clinical suspicion for prostate cancer with no prior prostate biopsy ($n = 26$), prior biopsy negative for prostate cancer ($n = 23$), prior biopsy positive for prostate cancer ($n = 44$), prior therapy for prostate cancer ($n = 10$), and history not provided ($n = 4$).

For all examinations, the referring physician had requested a secondary interpretation, after which the outside images were stored to the local PACS and a departmental radiologist then performed a professional interpretation that was made available within the local electronic health record. For purposes of this investigation, the outside examinations were evaluated using the local PACS.

For each examination, the MRI vendor, field strength, and coil arrangement (classified as endorectal vs external) were recorded. Next, the examinations were reviewed to evaluate adherence to minimum technical standards for T2WI, DWI, and DCE in PI-RADS v2. This assessment included evaluation of the image sets themselves, the DICOM headers for the relevant sequences (Fig 1), and, when available, the original radiology reports from the outside facilities. Adherence to individual technical standards was categorized as unable to be determined when remaining unclear based on this process.

Additional characteristics were recorded regarding the facilities where the outside examinations were performed. The minimum travel distance in miles between each outside facility and the local center was determined using online mapping software (8). These distances were classified as <10 mi, 10–49 mi, 50–99 mi, and ≥100 mi. Facilities were also classified as being in a rural or urban location using a zip code classification system derived using data from the US Census Bureau (9). Finally, facilities were classified as teaching or nonteaching if corresponding with the site of a diagnostic radiology residency program recognized by the Accreditation Council for Graduate Medical Education (10).

The adherence to individual minimum technical standards was summarized descriptively using percentages. The distributions of each of the evaluated parameters were also summarized using standard descriptive statistics. The frequency of adherence to individual standards was further compared between groups based on field strength and coil selection using the Fisher exact test (QuickCalcs; GraphPad Software, Inc., 2017; https://graphpad.com/quickcalcs/contingency1.cfm). Given the very small number of examinations performed using an endorectal coil at a given field strength, comparisons regarding field strength were conducted between examinations performed at 1.5T without an endorectal coil vs at 3T without an endorectal coil, while comparisons regarding coil selection were conducted between all examinations performed using an endorectal (1.5T and 3T combined) vs all examinations performed without an endorectal coil (1.5T and 3T combined). Fisher exact tests were also used to compare adherence between examinations performed in 2015 vs in 2016; examinations performed at facilities located within 100 mi of the local center vs facilities located at a greater distance; and examinations performed at teaching vs nonteaching facilities. Comparisons were not carried out between examinations performed at rural vs urban facilities, given the very low number of rural facilities identified.

## RESULTS

Among the 107 prostate MRI examinations performed at 107 unique imaging facilities after the advent of PI-RADS v2, the distribution of vendors was 45.8% Siemens, 37.4% General Electric, 13.1% Phillips, and 1.9% Toshiba. A total of 63.5% were performed at 3T without an endorectal coil, 23.1% at 1.5T without an endorectal coil, 5.8% at 3T with an endorectal coil, and 7.7% at 1.5T with an endorectal coil (Fig 2).

A total of 17.8% of examinations were performed at a facility located within 10 mi, 44.9% at a facility within 10–49 mi, 9.3% at a facility within 50–99 mi, and 28.0% at a facility located ≥100 miles away. A total of 26.2% were performed at a teaching facility. A total of 1.9% were performed at a rural

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