An Electronic Form for Reporting Results of Targeted Prostate Biopsy: Urology Integrated Diagnostic Report (Uro-IDR)

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OBJECTIVE To detail the development of an electronic report that graphically conveys all relevant information from targeted prostate biopsy.

METHODS The Urology Integrated Diagnostic Report (Uro-IDR) is based on a published framework (*RadPath)* which enables the compilation of diagnostic data from urology, radiology, and pathology. Each component of the Uro-IDR is generated by the contributing clinician, is assembled in one document, and provides correlation of the 3 inputs at a glance. Upon completion, the Uro-IDR is automatically linked to the electronic medical record as an interactive file and can also be downloaded for offline sharing as a PDF.

RESULTS At our institution, 1638 individual Uro-IDRs were generated between June 2016 and April 2019. There were 5715 views of these documents via the EMR. The average turnaround time for the creation of an individual report decreased from nearly 8 days at the time of its launch to 2 days after 6 months of use. The average time for report generation was 22 seconds for the pathologist and 69 seconds for the radiologist. An instructive video is linked to this article.

CONCLUSION The Uro-IDR has proven to be a feasible, efficient, clinically useful form to concisely transmit key information about targeted prostate biopsy to both clinicians and patients. UROLOGY 138: 188–193, 2020. © 2020 Elsevier Inc.

MRI-guided prostate biopsy has provided a fulcrum upon which contemporary management of prostate cancer may now turn.[1] Decisions about active surveillance, focal therapy, and surgery or radiation are currently made via output from this multidisciplinary collaboration between radiology (MRI), urology (guided biopsy), and pathology (histologic interpretation). In the past, clinicians needed only to have a pathology report to make treatment decisions. Today, however, knowledge of all 3 contributions frequently help to direct management. Remarkably, after some 10 years of MRI-guided prostate biopsy, a concise standardized report, conveying the key findings from all 3 disciplines, still is lacking.

A platform for such a multidisciplinary report, focused on lung biopsy, was described in 2016.[2] The need for developing that report is similar to the current need for integrated diagnostics in prostate biopsy: to provide clinicians one concise, user-friendly, readily-available document with key information from the sources that produce it.[3-6] In the case of lung biopsy, inputs came from thoracic surgeons, radiologists, and pathologists. The structure which evolved after a year of development is known as a "RadPath."[2] User surveys showed that when clinicians accessed RadPath reports via the EMR, search time was reduced, workflow was improved, and patient education was facilitated.[2] Further, when viewing RadPath, apparent discordances between radiologic and pathologic findings could be resolved more easily than when various reports were accessed individually.

The objective of our project was to create a web-based, EMR-integrated document, based on the RadPath platform that would streamline the reporting of contemporary prostate biopsy. All key elements from radiology, urology, and pathology were to be included. The result of the project is the "Uro-RadPath" report or Urology Integrated Diagnostic Report ("Uro-IDR"). During development of the Uro-IDR, a practical workflow evolved from initial MRI, through the

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targeted biopsy process, to the pathology readout; and the clinical utility of the final document became apparent.

MATERIALS AND METHODS

The Uro-IDR employs the *RadPath* platform, a web-based application using the Java-based Grails framework that is used to locate clinical data and automatically structure the report. The application has data feeds from several of the UCLA information systems, including (1) a radiology picture archiving and communication system feed for retrieving images and reports, (2) a structured query language for retrieving reports, test results, and images from the laboratory information system, and (3) a connection to the authentication and authorization sign-on server. Details of the *RadPath* platform, as it was originally developed for lung biopsy, were described by Arnold et al.[2]

The Uro-IDR is optimized for the workflow described below, but is adaptable to other workflows. In the current workflow for MR-targeted prostate biopsy, the following steps are employed (1) diagnostic imaging (prostate multiparametric MRI; mpMRI), (2) targeted biopsy, and (3) pathology interpretation (Fig. 1). The Uro-IDR is initiated and created by the next 3 steps: (4) pathologist review, (5) radiologist review, and (6) radiologist correlation (Fig. 2).

1. *Diagnostic imaging:* Once the patient undergoes mpMRI of the prostate the radiologist interprets the imaging based on PI-RADS v2 score and contours the regions of interest using fusion software.[7]
2. *Targeted biopsy:* MRI/ultrasound fusion prostate biopsy is performed. The biopsy core coordinates (targeted and systematic) are registered by the fusion software and permanently stored.
3. *Pathology interpretation:* The pathologist then reviews each biopsy core and provides for each core individually, Gleason grading (and in our institution, cancer core length and % pattern 4). A traditional pathology report is then generated, detailing the final diagnosis.
4. *Pathologist review:* After steps 1-3 are completed, the pathologist initiates the creation of the Uro-IDR. *RadPath* connects to the laboratory information system and retrieves the completed pathologic report and accompanying representative digital images which are selected by the pathologist during interpretation. *RadPath* then formats this information into a tabular view, highlighting the final diagnosis and representative images as shown in Figure 2. The pathologist then reviews the automatically-generated structuring of the report, and if necessary, edits any errors of automated data transfer and adds other relevant diagnostic information before finalizing the pathology component of the report. Upon report finalization, a message is sent to the radiology service through the *RadPath* system.
5. *Radiologist review:* The radiologist who performed the initial read receives a request via email. After logging into the system, the radiologist is presented with the completed pathology panel and the original diagnostic radiology study retrieved from the radiology information system. Further studies may be suggested at this point. *RadPath* then automatically restructures the original report to highlight the Conclusion and Findings sections in a tabular presentation and to display representative image slices.

   The selection of key images from the original report by the radiologist will trigger the system to obtain the relevant image. For example, a note referencing "5-12" will cue the system to retrieve series 5, slice 12 of the current study. The radiologist may at any time choose to add additional images via the *Add Images button*, which can query an integrated picture archiving and communication system viewer and allow for image selection.
6. *Radiologist correlation:* After finalizing the radiology panel, the radiologist correlates the mpMRI findings with the pathologic diagnosis. This is achieved in 2 ways: (1) *Correlation* and *Action* drop-down lists and (2) a free-text comment box. The *Correlation* drop-down includes the following options: *combined findings suggest sampling error, defer to pathology diagnosis, radiology and pathology correlates, incomplete representation*, and *correlation not available*; while the *Action* drop-down provides the options of: *no further action needed from radiology and pathology, consider repeat biopsy if clinically indicated; Other: see comments*. These allow referring physicians to receive succinct, consistent feedback (eg, *combined findings suggest sampling error, consider repeat biopsy if clinically indicated* could be a potential correlation, action pair). The free-text box allows for further discussion to contextualize the correlation and action. The text box is especially useful in cases of discordance to provide a rationale for the selected action.

Once the report is complete, the *RadPath* system, employing international standards for the exchange of clinical data (Health Level 7), communicates the report to the EMR in the form of a hyperlink. The referring physician also receives a notification that the Uro-IDR is available for his or her patient. The Uro-IDR *Assessment* tab (Fig. 1), functionally the "home" page of the report, provides the key findings. It reveals the radiology correlation prominently, just beneath the final pathologic summary, along with photos from the original mpMRI and fusion biopsy. More specific data from the original radiology and pathology reports are available under their respective tabs. The *Ancillary Studies* tab allows for the inclusion of other relevant imaging, while the *Image Analysis* tab allows for 3-dimensional (3D) rotation of the prostate with the region of interest and core locations mapped. A timeline of the patient's clinical history (including previous imaging and biopsies) is also provided, along with all images associated with the original radiology and pathology reports. Both the *Image Analysis* and *Timeline* tabs are shown in Figure 3.

RESULTS

A video detailing the features and usage of the Uro-IDR is available in Supplementary Video 1. Since the platform's launch in May of 2016, 1638 Uro-IDRs have been generated, which have received 5715 separate views on the EMR. This equates to an average of 3 or 4 views per Uro-IDR after its completion. Figure 4A shows a breakdown of the number of Uro-IDRs created per month per calendar year, as well as the average report turnaround time, calculated in days per calendar year. Turnaround time was calculated from when the pathologist started the report to the time the radiologist completed the correlation. The number of Uro-IDRs created per month has remained similar over the 3 years, with an average of 46 reports generated per month, reflecting biopsy capacity. Report turnaround time decreased dramatically within 6 months of the platform's launch, from nearly 8 days to under 2 days, and has remained consistent since. The average time spent by pathologists in the creation of a single Uro-IDR was 22 seconds compared to 69 seconds by radiologists.

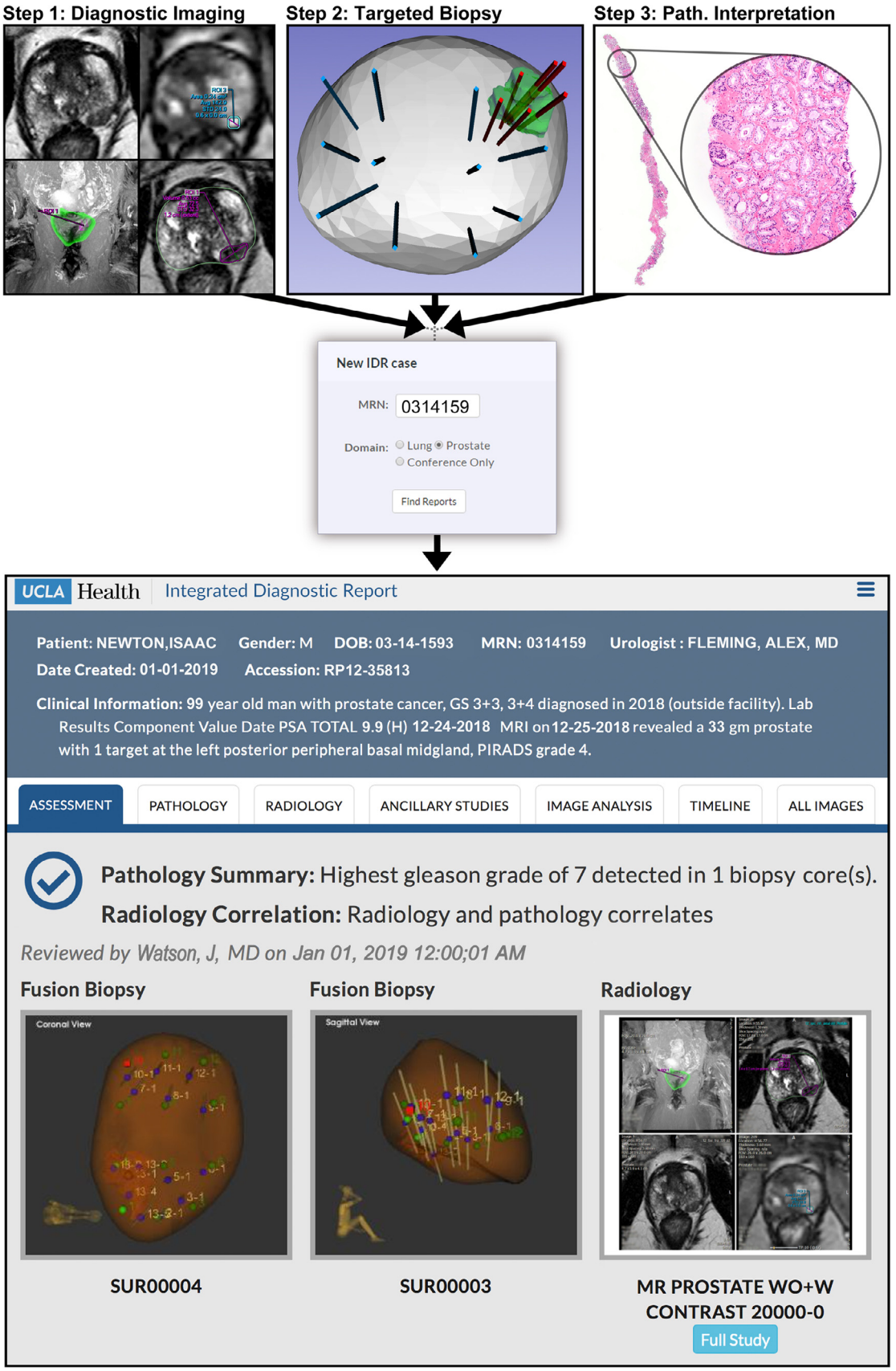

Figure 1. Schematic representation of the workflow involved in generating the Uro-IDR. Shown are the steps of diagnostic imaging, followed by targeted biopsy and pathology interpretation. Steps 1-3 allow for initiation of the report by pathology, which begins by entering the patient MRN. Finally, the Uro-IDR is generated following input from radiology. Shown is a representative image of the report's *Assessment* tab, highlighting the key demographic, clinical, radiological, and pathologic findings. (Color version available online.)

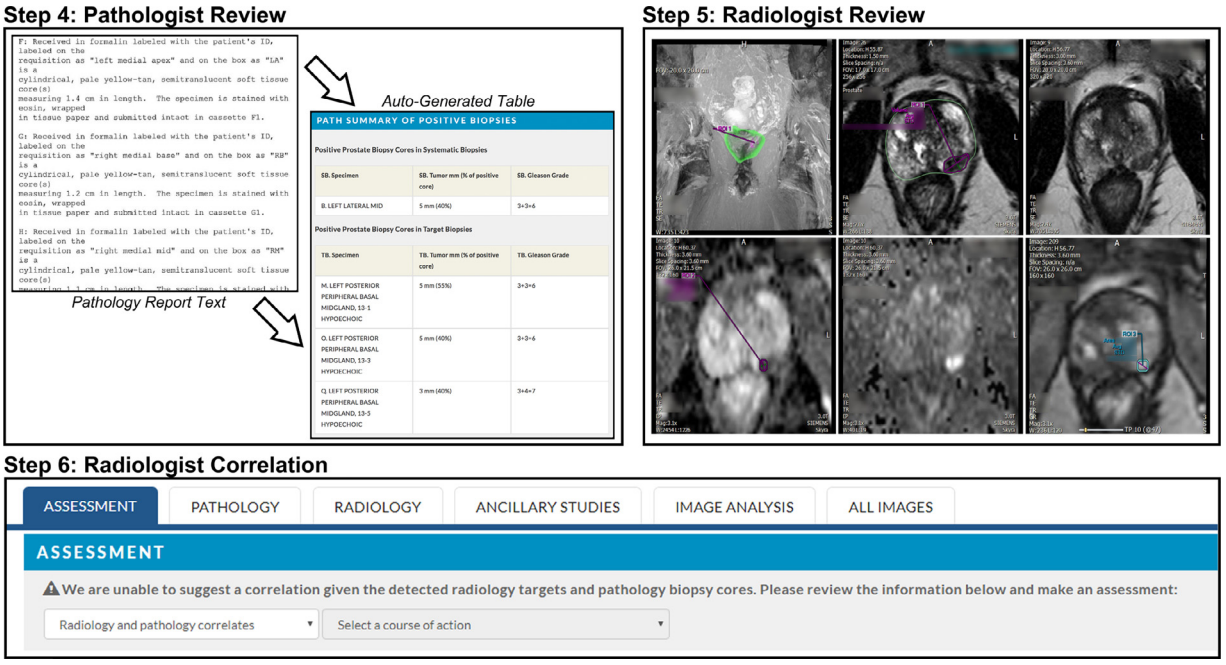

Figure 2. Step 4 shows the automatic tabular restructuring of the pathology report that takes place during pathologist review. Step 5 demonstrates radiologist review in which key images from the original report are added to the Uro-IDR to be made available under the *All Images* tab. Step 6 shows the *Correlation and Action* drop-down lists. (Color version available online.)

Furthermore, *Correlation* and *Action* drop-down lists allowed us to classify the final correlation associated with each Uro-IDR generated. In 11 cases (1%) correlation between radiology and pathology suggested sampling error.

DISCUSSION

The Uro-IDR has been implemented at UCLA for 3 years and has streamlined the process of correlating radiologic and pathologic findings. Currently, every prostate biopsy case performed at our institution has an accompanying Uro-IDR report. Each report is viewed nearly 4 times, suggesting that end users (urologists and others) actively utilize the Uro-IDR. This may be done to avoid searching the EMR for each component separately, although data on original report views through the EMR in comparison is unknown. Tools such as image retrieval, and *Correlation* and *Action* drop-downs, make the system time-efficient for the radiologists and pathologists who interact with it. Pathologists spend just over 20 seconds in generating the pathology panel, largely due to built-in automation within the Uro-IDR. We are currently in the process of fully automating this step to further streamline the creation of the report. While this would remove a built-in quality control step, errors of data transfer in automated generation of the report appear to be rare and can still be addressed by the radiologist. Radiologists spend more time (69 seconds) interacting with the report as they are tasked with providing a final correlation. Moreover, efficiency and report quality appear to improve as users begin adapting their reporting practices knowing that a Uro-IDR will be generated. Radiologists, for example, ensure that key slices are denoted in text fields so that they are retrievable by *RadPath* without the added effort of manual image selection. This is evidenced by the significant decrease in report turnaround times from nearly 8 days to the current time of less than 2 days within 6 months of the system's launch.

Several workflows were attempted before arriving at the one detailed here. Alternative workflow designs differed in terms of which departments would initiate the report and which would provide correlation of findings. The agreed upon solution of initiation by pathologists and correlation by radiologists is advantageous because it allows radiology to (1) interact with the system only once and (2) reassess radiographic findings in light of additional evidence. The quantitative image features and histology correlations available within the Uro-IDR also provide real-time feedback to the radiologists reviewing the case post hoc, effectively functioning as a validated research diagnostics tool that can help improve mpMRI interpretation skills over time. Anecdotally, radiologists and pathologists are appreciative of this utility, as confirmed by their desire to continue and expand it. Moreover, to ensure that the process of correlation was both efficient and conclusive, we implemented the *Correlation* and *Action* drop-downs to help facilitate a common language for updating the original radiology conclusion. These tools have primarily served as a convenient communication method to facilitate dialogue between the radiologist and urologist when necessary. We have not observed the drop-downs to directly influence clinical decision-making, however, as supported by the fact that only 1% of cases had a correlation suggesting sampling error.

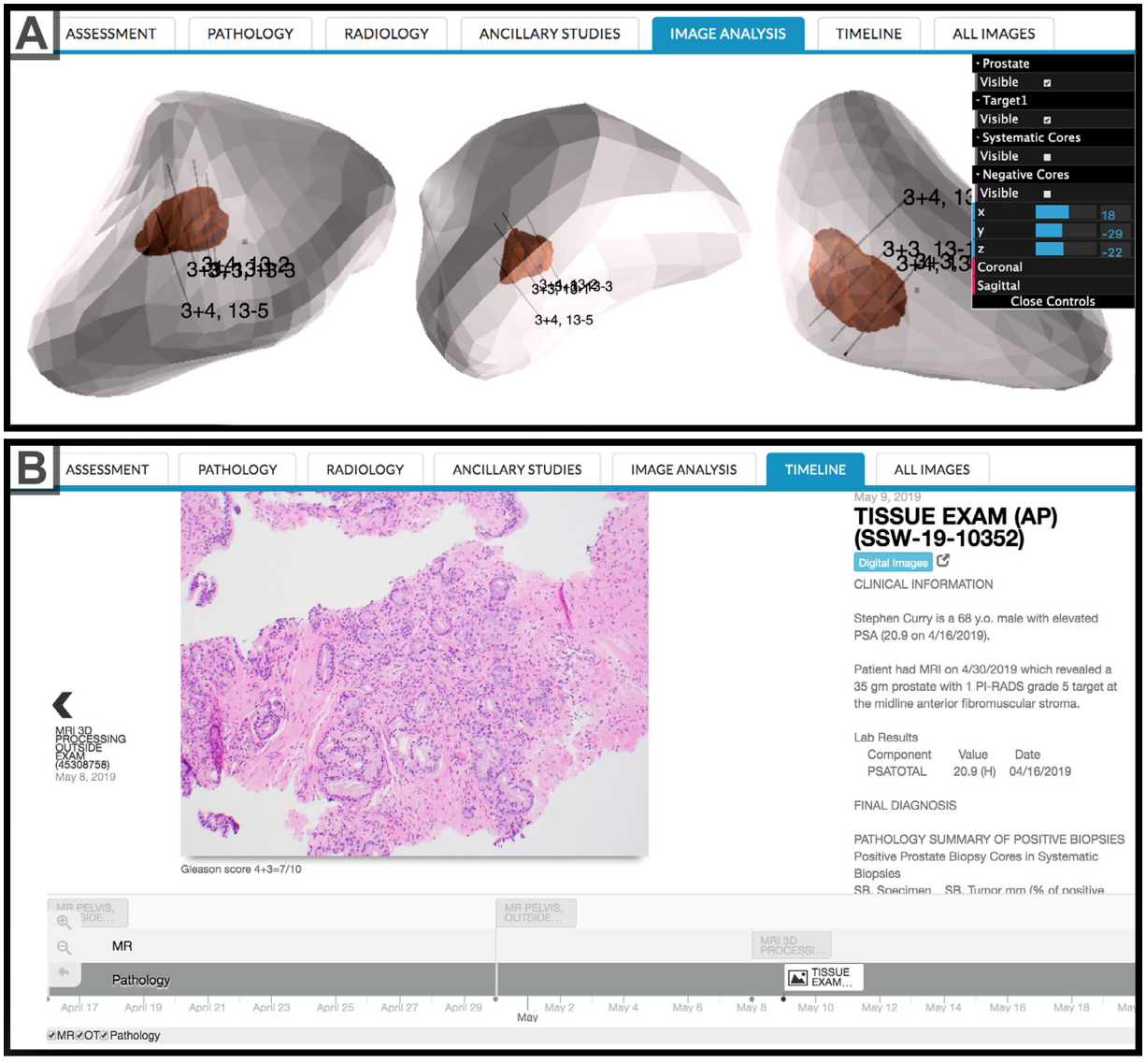

Figure 3. Panel A demonstrates the 3D visualization features available under the *Image Analysis* tab of the Uro-IDR. Users are able to rotate a single 3D figure of the prostate with the lesion of interest and biopsy cores mapped to obtain multiple views, such as the ones shown. Panel B shows a representative image of the *Timeline* tab, detailing a patient's diagnostic history. (Color version available online.)

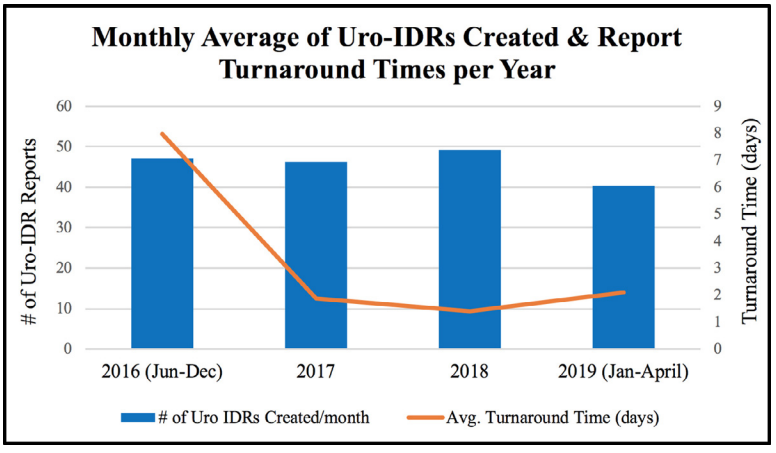

Figure 4. Panel A shows the number of Uro-IDRs generated per month per calendar year, along with the average turnaround time (days) for a single Uro-IDR per calendar year. (Color version available online.)

Of the 1638 Uro-IDRs created at our institution, 11 cases (1%) had radiology-pathology discordance that suggested sampling error. This correlation may help avoid false-negative conclusions in which cases of high radiographic suspicion of malignancy are misdiagnosed as benign. In such cases, the radiologist also provides a written addendum to the correlation further explaining their conclusion.

The Uro-IDR's consolidation of clinical data has proven useful to patient counseling and treatment planning. Urologists at our institution use the Uro-IDR to facilitate patient education, anecdotally noting improved patient-understanding when they do so. This may be attributed to the intuitive tabular presentation of findings within the report, and the unique image visualization modalities it provides. Furthermore, 3-dimensional visualization of the prostate allows urologists to spatially conceptualize the disease, providing a visual tool to aid in treatment decisions. For example, the Image Analysis tab is utilized in the operating room to assist during focal therapy planning and treatment.

The Uro-IDR also provides a transferable summary of a patient's diagnostic work-up. Many patients request a printed version of their report for a consolidated reference of their results or ask for it to be e-mailed to their referring physician. The latter is done directly between physicians through the *RadPath* system, ensuring efficient and complete information transfer. Despite positive subjective clinician and patient experiences with the Uro-IDR, the utility of the system has not been formally quantified at this time.

This web-based, vendor agnostic platform is based on our institution's source code, and can be made available to outside institutions on a case-by-case basis and tailored to other EMR systems*. However, the work of IT groups is essential to establish, configure, and maintain the data feeds from the clinical reporting systems that make the Uro-IDR possible. Thus, a healthcare provider's current IT infrastructure and commitment to IT resources should be the primary considerations when considering implementation of the Uro-IDR. Additionally, resources should be devoted to familiarizing clinicians with the report, highlighting its utility to their clinical practice. This was done at our institution via emails to faculty, which we retrospectively recognize provided a suboptimal showcase of this interactive system and likely delayed its widespread usership. This may also have further contributed to the 6-month delay in decreasing report turnaround time. Ensuring buy-in from clinicians prior to implementation and properly educating potential end-users on the intricacies of the system would be helpful steps to ensure the system is utilized to its full potential upon launch.

CONCLUSION

The Uro-IDR, an electronic form combining key aspects of targeted prostate biopsy, facilitates the management of prostate cancer. Integrated into a single EMR-linked report, the Uro-IDR allows radiologic, pathologic, and urologic elements to become available to clinicians and patients in a clear, convenient, concise form. Implementation of the Uro-IDR at other institutions (via open-access source-code sharing) is an anticipated outgrowth of the project.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.urology.2020.01.015.

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