Cost-effectiveness of MR imaging-guided strategies for detection of prostate cancer in biopsy-naïve men

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The overdiagnosis and overtreatment of clinically indolent prostate cancer has been repeatedly criticized due to significant adverse effects on the quality of life for patients, and contribution to escalating health care costs [1, 2]. However, aggressive prostate cancer continues to cause significant morbidity and death. Hence, there is urgent need to develop better diagnostic pathways for detection of clinically significant cancer [3]. Magnetic resonance (MR) imaging and MR imaging-guided biopsy strategies are important technologies for the detection of clinically significant prostate cancer [4–7] but there is a reluctance to incorporate MR imaging into practice guidelines for prostate cancer detection because MR Imaging is perceived to be an expensive technology.

Escalating costs in the management of prostate cancer are related to inefficient diagnostic pathways that frequently place patients in incorrect treatment groups. Current estimates place prostate cancer care costs in the United States at over $10 billion annually [8]. Rather than looking at imaging costs in isolation, the cost effectiveness of using imaging in outcome based paradigms for detection of clinically significant prostate cancer needs to be evaluated. If we can maximize the accuracy of identifying clinically significant lesions, the costs of overtreatment can be reduced while improving quality of life for the patients.

To test the assumption whether MRI is truly too expensive for routine insertion into prostate cancer diagnostic pathways prior to biopsy, we created a decision analysis model to compare the cost-effectiveness of different diagnostic strategies without and with the use of multi-parametric MRI in the detection of clinically significant prostate cancer [9]. The base case in the model was a biopsy-naïve man for whom prostate biopsy has been recommended on the basis of abnormal digital rectal examination results or elevated prostate-specific antigen levels. The model was further tested in three age groups which are most affected by morbidity and mortality due to prostate cancer based on life expectancy: 41–50 years, 51–60 years, and 61–70 years. Strategies with and without contrast administration for diagnostic MRI exam were evaluated, each further evaluated for a diagnostic pathway using:

a) cognitively guided biopsy;
b) MRI-ultrasound fusion biopsy;
c) in-gantry MRI guided biopsy.

These were compared with the standard clinical paradigm of a 12-quadrant transrectal ultrasound guided biopsy. An abbreviated model is depicted in Figure 1.

Model parameters as disease prevalence, sensitivity and specificity of each technique, were derived from literature. Costs of the techniques were derived from from the physician fee schedule at www.CMS.gov; costs of patients losing a day of work were derived from the Bureau of Labor Statistics.

The primary outcome measure was net health benefit, which was measured as quality-adjusted life years gained or lost by investing resources in a new strategy compared with a standard strategy at a willingness-to-pay threshold of $50,000 per quality adjusted life year gained. In other words, society is assumed to be willing to pay $50,000 for each quality adjusted life year, and strategies meeting this threshold are considered cost effective. One way sensitivity

analysis was performed on the parameters input into the model. Probabilistic sensitivity analysis was performed by using Monte Carlo simulations, and the proportion of samples for each strategy that were cost-effective was then calculated.

We found that diagnostic MR imaging examinations followed by targeted MR-guided biopsy methods are cost-effective compared with the standard transrectal US-guided biopsy strategy for detection of clinically significant prostate cancer, in over 94% of the simulations. All strategies that employ diagnostic MR imaging followed by MR-guided biopsy of only suspicious lesions yielded additional net health benefits for all age groups, higher than the standard biopsy strategy. The analysis also revealed that, non-contrast diagnostic MR examinations followed by cognitively guided biopsy and foregoing standard biopsy in the case of a negative MR examination was the most cost-effective strategy. Maximal net health benefits were provided through in-Gantry biopsy, and the additional QALY gained by this strategy over the cognitive biopsy strategy was also cost-effective.

MRI disproportionately misses low grade tumors, and microscopic tumors (also less likely to be aggressive), both of which are often detected on an ultrasound guided biopsy, while yielding better performance for higher risk disease. These characteristics may result in avoiding unnecessary associated complications and overtreatment that may occur after diagnosis. MR imaging-guided pathways have been shown to reduce the detection of low risk cancers by 89.4% and reduced the overall need for biopsy by 51% [8]. A meta-analysis [10] revealed that the sensitivity of transrectal US biopsy in the detection of clinically insignificant cancers was approximately 83%, whereas that for MR imaging-guided methods was approximately 44% [10]. Furthermore, for intermediate/high-risk cancers, the negative predictive value of a negative MR imaging examination was 96.9% whereas that of a standard biopsy was 71.9% [8]. These are some

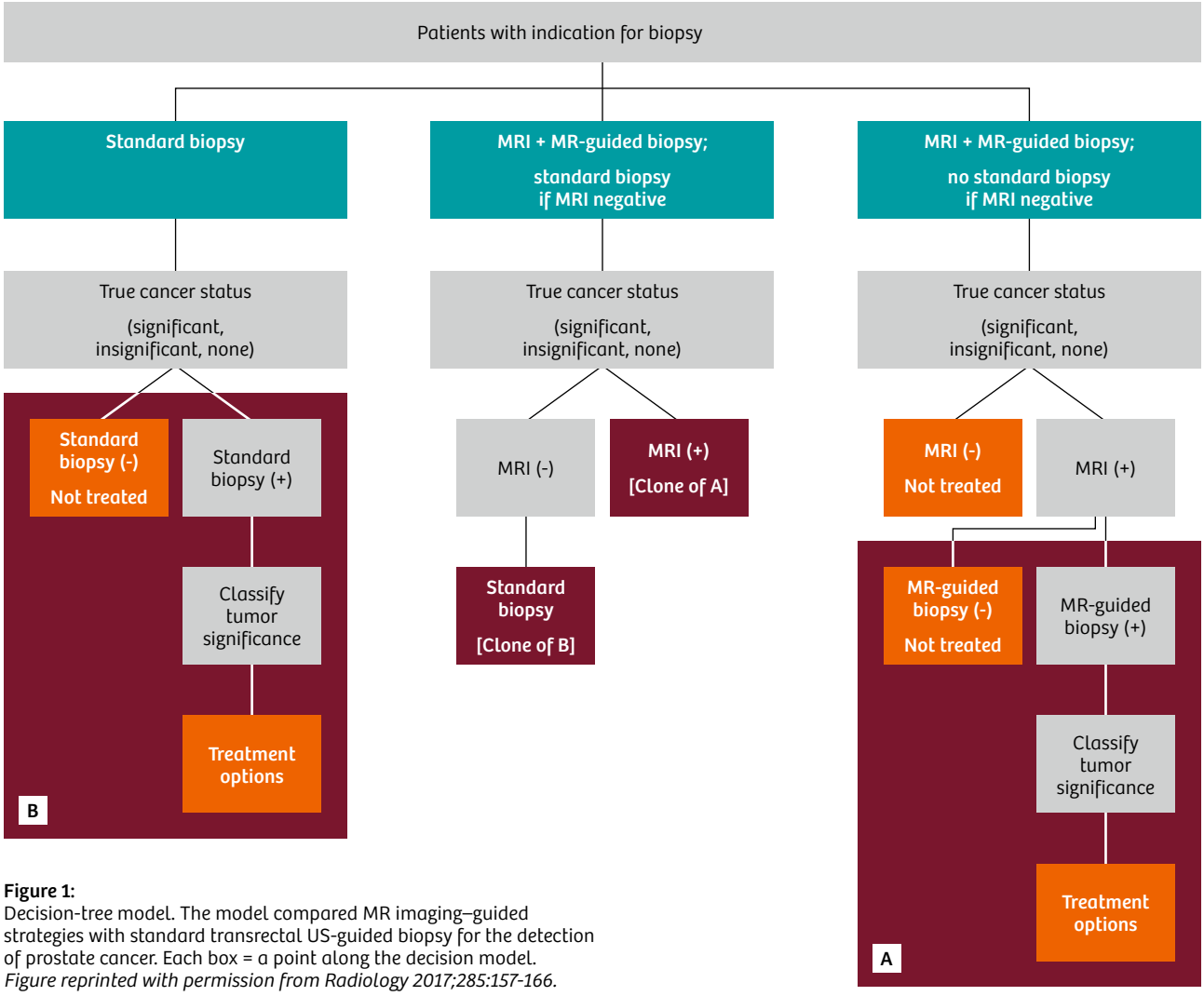

Figure 1:
Decision-tree model. The model compared MR imaging–guided strategies with standard transrectal US-guided biopsy for the detection of prostate cancer. Each box = a point along the decision model.
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factors that likely accounted for the improved cost-effectiveness of MRI-guided strategies seen in the present study.

Thus we found in this study that contrary to the common assumptions (indeed contrary to our own assumptions prior to initiating the study), MRI guided strategies are cost effective for detection of clinically significant prostate cancer. This work may provide cost-effectiveness based impetus for exploring the incorporation of MRI guided strategies for the diagnosis of prostate cancer.

Please Note: The above is summarized from work presented in greater detail in our previous publication [9].

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