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Seminar article

The economic effect of using magnetic resonance imaging and magnetic resonance ultrasound fusion biopsy for prostate cancer diagnosis

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Abstract

Prostate magnetic resonance imaging (MRI) is a maturing imaging modality that has been used to improve detection and staging of prostate cancer. The goal of this review is to evaluate the economic effect of the use of MRI and MRI fusion in the diagnosis of prostate cancer. A literature review was used to identify articles regarding efficacy and cost of MRI and MRI-guided biopsies. There are currently a limited number of studies evaluating cost of incorporating MRI into clinical practice. These studies are primarily models projecting cost estimates based on meta-analyses of the literature. There is considerable variance in the effectiveness of MRI-guided biopsies, both cognitive and fusion, based on user experience, type of MRI (3T vs. 1.5T), use of endorectal coil and type of scoring system for abnormalities such that there is still potential for improvement in accuracy. There is also variability in assumed costs of incorporating MRI into clinical practice. The addition of MRI to the diagnostic algorithm for prostate cancer has caused a shift in how we understand the disease and in what tumors are found on initial and repeat biopsies. Further risk stratification may allow more men to pursue noncurative therapy, which in and of itself is cost-effective in properly selected men. As prostate cancer care comes under increasing scrutiny on a national level, there is pressure on providers to be more accurate in their diagnoses. This in turn can lead to additional testing including Multiparametric MRI, which adds upfront cost. Whether the additional cost of prostate MRI is warranted in detection of prostate cancer is an area of intense research.

Keywords: Prostate cancer; MRI fusion; Prostate biopsy; Health care cost

1. Introduction

The diagnosis and management of prostate cancer is currently shifting with new recommendations for screening proposed by the US Preventative Task Force and increasing use of active surveillance [1–3]. Standard management of patients with the disease has come under intense scrutiny from government [1,3], payers, and the press [4] owing to concerns of overtreatment and improper stewardship of health care resources. At the same time, the algorithm for prostate cancer management is undergoing rapid evolution with multiple new adjunct tests [5,6] coming to market and more men opting for surveillance instead of curative intent therapy [7]. Adding to the complexity, prostate magnetic resonance imaging (MRI) has matured into an imaging modality central to many urologic practices. In contrast with serum, urine, or histologic tests, it provides information about both tumor presence and localization. Concerns about cost and technologic availability have not slowed the dissemination and ever-expanding indications for MRI. Whether the additional cost of prostate MRI is warranted is an area of intense research [2,8–20].

On a slower scale, prostate biopsy itself has also undergone sequential evolution and improvement [21]. It remains the gold standard for diagnosis and pretherapy grading in prostate cancer. Since its inception over 100 years ago, needle biopsy of the prostate has become increasingly more accurate and commonplace. Although there have been advances that have improved the technical safety of the procedure, the increase of resistant bacteria has led to increased risk of sepsis [22]. There is continued pressure for less costly methods of diagnosing and triaging prostate cancers. Strategies to improve the utility of biopsy have

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run the gamut from additional genetic marker assays [23] to urine-based tests [24] to various forms of prebiopsy imaging [25].

When reviewing autopsy and postcystectomy prostate specimens, it becomes apparent that some prostate-specific antigen (PSA)−detected prostate cancers found on transrectal ultrasound (TRUS) prostate biopsy may not have the clinical implications of a traditional cancer [26]. The term "clinically relevant prostate cancer" [27] is increasingly used but not stringently defined. As longer follow-up accrues in large active surveillance series [28], it becomes apparent that a portion of tumors previously managed with curative intent have little to no metastatic potential. The critical question for these cancers is therapy disposition, itself a complex question requiring the integration of not only tumor characteristics, but also an overall assessment of expected patient lifespan [29].

PSA is a test with imperfect performance attributes and without a clear-cut level necessitating biopsy [30]. PSA screening is nevertheless a large step forward in evaluating prostate cancer. Large randomized trials [31,32] have shown a disease-specific survival advantage to prostate cancer screening with PSA. The best designed and least contaminated of these trials demonstrates a protective effect commensurate with breast cancer screening [31]. A common theme of these studies is concern of overdetection and overtreatment of prostate cancers that may not have clinical relevance, incurring significant morbidity on patients and significant cost to health care systems [33]. A major shift in the focus of biopsy has occurred with imaging-linked biopsy modalities [34], seeking a higher accuracy in diagnosing high-grade lesions while avoiding detection of "insignificant" low-risk cancers [10]. A difficult question to answer is whether more imaging adds or saves overall cost, especially with imaging performance itself improving at a rapid pace.

Cost of care is a major focus from a health policy perspective. Domestically, US population demographics coupled with recent legislative decisions are expected to drive a rapid expansion in Medicare spending in the next decade [35]. Cancer care cost is expected to increase 27% between 2010 and 2020 with the single largest driver being ongoing care for prostate cancer [36]. Controversy was generated in May 2012 when the United States Preventative Services Task Force issued a recommendation against PSA-based screening for prostate cancer in all men regardless of age, racial status, or family history of prostate cancer [3]. The American Urologic Association subsequently released guidelines for PSA screening, recommending shared decision making for PSA screening in men aged 55 to 69 years [1]. This stance was echoed by other major cancer care organizations, including the American Cancer Society [37] and National Comprehensive Cancer Network [38]. Age range recommendations have also been called into question in light of epidemiologic evidence in high-grade disease and the previously demonstrated prognostic value of early PSA testing in men outside the age range for clinically apparent prostate cancer [30,39,40].

The goal of this review is to evaluate the economic effect of use of MRI and MRI fusion in diagnosis of prostate cancer. To provide context to the pros and cons of MRI in prostate cancer detection, we start by reviewing the current standard of ultrasound-guided biopsy and then discuss the effect of adding MRI to standard of care.

2. Ultrasound-guided biopsy

TRUS prostate biopsy is a commonly performed urologic procedure with known infectious complications but low overall morbidity [22]. From a health care perspective, costs of TRUS biopsy are a result not only of the procedure itself but also of management of postbiopsy complications, which added approximately $6,800 per incident to cost of care in a 2015 study [41]. Incidence of positive biopsy for elevated PSA depends on PSA cutoff but is typically between 20% and 45% [42]. This would imply that between 55% and 80% of currently performed biopsies might be avoidable with more accurate prebiopsy risk stratification.

A frequently encountered clinical problem in prostate cancer screening is the issue of patients with prior negative-result biopsy and clinical features concerning for prostate cancer. Patient features such as absolute PSA level and presence of nondiagnostic abnormal glands have been shown to predict cancer detection on repeat TRUS biopsy, but they do not provide localizing information to aid repeat biopsy [43–45]. Using additional parameters available via ultrasonography (multiparametric ultrasound) such as intravenous contrast, elastography, and Doppler, the diagnostic accuracy of TRUS biopsy might be improved [46]. Although this technique may have long-term merit, it is currently used only in a few academic centers and suffers from the significant intraobserver variability inherent in ultrasonography.

TRUS biopsy constitutes a significant outlay of health care resources; more than 1.3 million prostate biopsies are performed annually [47] at a price ranging from $500 to $4,000 with "fair" cost set at $2,312 [11] for a total of more than 3 billion dollars annually. If greater than half of these biopsies are negative, there is the opportunity to save health care costs in the billions by avoiding these procedures. Complications from prostate biopsy are similarly expensive and methods to decrease incidence may be cost-effective [48]. Incidence has been reported to vary as widely as 0% to 9% and appears to be rising with time [49]. Cost efficacy studies of biopsy prophylaxis are sensitive to changes in rate of postbiopsy infection. Common approaches include extended spectrum intravenous or intramuscular antibiotics, additional needle sterilization techniques, and prebiopsy rectal swab for targeted prophylaxis [50].