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Defining the value of magnetic resonance imaging in prostate brachytherapy using time-driven activity-based costing

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ABSTRACT Magnetic resonance imaging (MRI) simulation and planning for prostate brachytherapy (PBT) may deliver potential clinical benefits but at an unknown cost to the provider and healthcare system. Time-driven activity-based costing (TDABC) is an innovative bottom-up costing tool in healthcare that can be used to measure the actual consumption of resources required over the full cycle of care. TDABC analysis was conducted to compare patient-level costs for an MRI-based versus traditional PBT workflow. TDABC cost was only 1% higher for the MRI-based workflow, and utilization of MRI allowed for cost shifting from other imaging modalities, such as CT and ultrasound, to MRI during the PBT process. Future initiatives will be required to follow the costs of care over longer periods of time to determine if improvements in outcomes and toxicities with an MRI-based approach lead to lower resource utilization and spending over the long-term. Understanding provider costs will become important as healthcare reform transitions to value-based purchasing and other alternative payment models.

Keywords: Value; Value-based healthcare delivery; Brachytherapy; Magnetic resonance imaging; Time-driven activity-based costing

Introduction

Although advanced medical technology in the United States is in part responsible for increasing the cost of cancer care delivery, it has also been associated with concomitant improvements in cancer care outcomes (1−3). In the U.S. health care system, the delivery of high-value care, which is defined as the quality of health outcomes divided by the cost of achieving those outcomes (4), has been questioned. At its core, the current fee-for-service health care system reimburses care based on the volume of services (i.e., procedures, consultations, medications, etc.) rendered, rather than the value that these services deliver (5). However, the Department of Health and Human Services has recently unveiled goals of transforming 30% of traditional Medicare FFS payments to quality or value through alternative payment models by the end of 2016 and 50% by 2018 (6). Thus, to improve outcomes and decrease cost, physicians and hospital systems will require fundamental restructuring to shift its goal from volume to value (4, 7). The rising cost of technological innovations will therefore need to be appraised in the context of the value they deliver during the cycle of patient care.

Advanced technology in radiation oncology

Radiation therapy (RT), in particular, has relied on innovations in technology to improve cancer care outcomes but has also faced significant controversy regarding rising costs (8). Each successive generation of new technology, from two-dimensional to three-dimensional and, more recently, to intensity-modulated radiation therapy (IMRT), has potentially improved outcomes and toxicity by more effectively delivering dose to tumor cells and sparing normal healthy tissues (9). However, the progressively complex machinery and skilled personnel required to deliver RT has become increasingly expensive with each generation of technology. For instance, despite a limited number of published clinical

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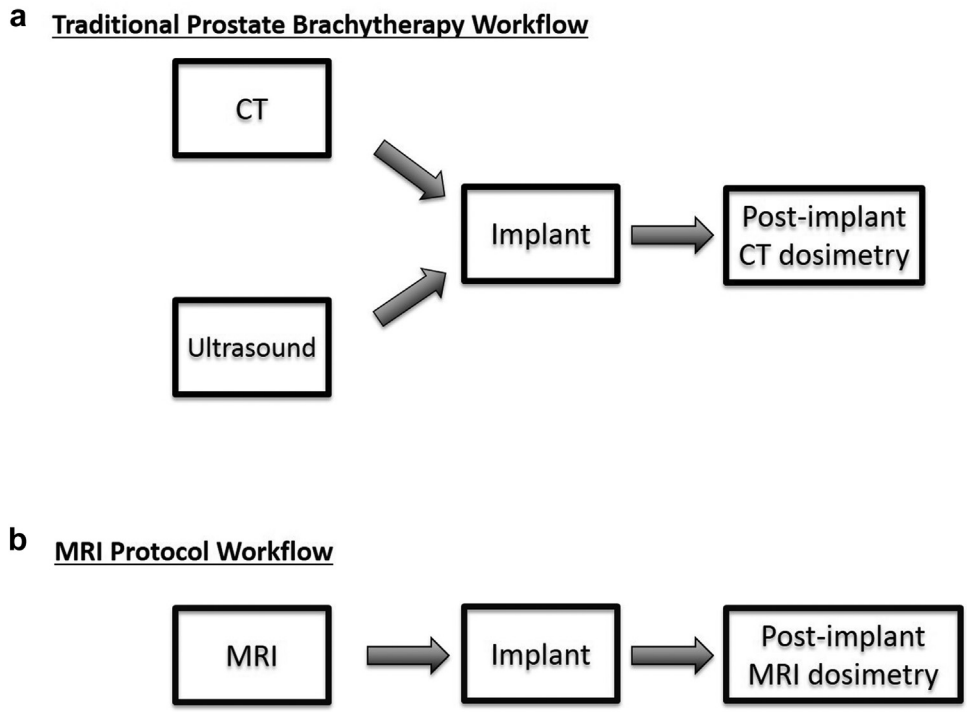

Fig. 1. Comparison of the traditional prostate brachytherapy workflow and the MRI protocol workflow.

studies in the late 1990s regarding IMRT, federal policymakers set reimbursement that encouraged its adoption (10, 11), which ultimately allowed for the rapid expansion and wider dissemination of IMRT technology. However, such innovations in health care technology need to be evaluated in the context of the value they contribute to the patient specifically and to the health care system generally.

The role of magnetic resonance imaging in prostate brachytherapy

Incorporation of magnetic resonance imaging (MRI) simulation in the prostate brachytherapy (PBT) holds promise of enhancing the current PBT workflow in several ways. First, MRI simulation may be able to replace the traditional ultrasound volume study and the CT scan for pubic arch interference (Fig. 1). Such resource substitutions may lessen the technical demand and operator dependency of the traditional workflow and allow for a more streamlined process for physicians. The greater soft tissue contrast of MRI could also lead to better reproducibility, lower rates of toxicities, and improved outcomes. However, MRI simulation could also contribute to the process in several negative ways. For instance, planning a brachytherapy implant on MRI is associated with a steep learning curve and delivering the MRI-planned implant under ultrasound guidance is dependent on the skill of the radiation oncologist. The need for an MRI simulation scan can also decrease efficiency of most traditional workflows and add complexity due to the potentially limited availability of MRI and relative lack of radiology expertise in prostate MRI interpretation. MRI may also add costs to the traditional workflow during a time of downward cost pressures at the health care system level. As the field of radiation oncology looks to define the value of MRI in PBT, clinical and cost end points will need to be carefully evaluated (12).

The shifting role of advanced technology in prostate cancer treatment and implications on cost

The cost of cancer care has been projected to reach at least $158 billion by 2020—the cost for the treatment of localized prostate cancer in particular has risen dramatically and is projected to reach $12 billion by the same time (13). As these costs have risen, utilization of certain treatment modalities has also changed over time and has mirrored economic changes in reimbursement. In a recent Surveillance, Epidemiology, and End Results database study by Mahmood *et al.* (14) in localized prostate cancer patients who were treated with RT as a local therapy, the authors highlighted the decrease in PBT between 2004 and 2009 from 44% to 38%, whereas the rate of external beam radiation therapy (EBRT) increased from 56% to 62%. Similarly, Martin *et al.* (15) examined the National Cancer Data Base and found that PBT use declines from 45.5% to 34% over the same time period among all patients treated with RT. In this latter study, patients treated after the mid-2000s were more likely to be treated with surgery, such