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Importance of cost-effectiveness and value in cancer care and healthcare policy

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Abstract

The cost of cancer care in the U.S. has increased by fivefold over the last three decades. Rising cancer prevalence, costly pharmaceuticals, physician and facility fees have all contributed to the expenditure. As our healthcare system shifts from volume to value, greater scrutiny of interventions with clinical equipoise is required. Traditionally, quality adjusted life years (QALYs) and incremental cost-effectiveness ratios (ICERs) have served as surrogate markers for value. However, these calculations fail to incorporate population or patient preferences. The diagnosis and treatment of prostate cancer, breast cancer and thyroid cancer are used as a framework to discuss value and cost-effectiveness.

Keywords

Value; QALY; ICER; Ductal carcinoma in-situ; Prostate cancer; Thyroid cancer

Introduction

It is difficult to discuss healthcare in the United States without also delving into its cost. Peruse through any major newspaper or healthcare publication and you are bound to come across headlines regarding access to healthcare, the rising cost of its delivery or expensive new advancements in treatment options. The cost conversation is particularly pertinent in the current political climate and with the Affordable Care Act. The Centers for Disease Control and Prevention (CDC) estimates a near \$3 trillion dollar expenditure on healthcare in the U.S., representing more than 17% of the Gross Domestic Product (GDP) [1]. Cancer care comprises a significant proportion of the expenses, upwards of \$120 billion dollars annually [2, 3]. A near 5-fold increase in spending on cancer care has been seen over the last three decades [4].

Analysis of the Surveillance, Epidemiology and End Results (SEER) database indicates that the priciest cancers in terms of total healthcare cost in descending order are breast, colorectal, lymphoma, lung, and prostate [2]. Breast cancer alone constitutes \$16.5 billion dollars of the national expenditure. The overlap between this list and that of the most prevalent cancers is not at all surprising. From the broad perspective of healthcare policy, the

relevant question becomes what can be done to mitigate the cost? However, before we can discuss cost reduction and cost-effectiveness in oncology, the conversation needs to be reframed to include the concept of value.

Value as a construct for evaluating oncological interventions

Value is broadly defined as healthcare outcomes obtained per dollar spent[5]. That is to say, that if two different interventions for a particular oncological process have the same end result, then the intervention with the lower cost represents greater value. While this seems like a fairly straightforward concept, attempting to measure value elucidates some of the challenges. For example, at what juncture do we measure an intervention's value? Is it immediately after an operative intervention, at the 1-yr survival or at the 5-yr survival mark? Do we measure overall survival or disease-free survival? Is survival the most relevant endpoint from the patient perspective; should we instead consider symptoms, functional status or quality of life (QOL)?

The answer to these questions is contingent on multiple variables, including the natural history of the cancer type and patient factors. For instance, the value of an intervention in an aggressive cancer with a high mortality rate is perhaps best measured by short-term outcomes, whereas the value of an intervention in an indolent cancer with high survivability should be assessed based on long-term endpoints. To further complicate this discussion, consider an indolent cancer in patients with multiple co-morbidities; should shorter-term outcomes be used to gauge true value in this patient population? The American Society of Clinical Oncology (ASCO) and the NCI Cancer Outcomes Measurement Working Group (COMWG) have emphasized measuring clinical and patient-centered endpoints to assess the quality of cancer care[6].

A framework for measuring value in cancer surgery

In 2010, Porter, an economist, published a framework to measure value in healthcare, in the New England Journal of Medicine. He described a multi-tier system with the most important outcomes at the top. Further along the intervention is assessed over time for secondary outcomes. Survival and the degree to which one recovers represents top tier outcomes. The middle tier evaluates the process of recovery; which takes into account the functional status of the patient, the time to recover, as well as complications or adverse effects of treatment [5]. Lower tier outcomes include the sustainability of the recovery, as well as long-term consequences of the therapy. This patient-centered approach allows for the value of an intervention to be assessed in conjunction with evolving patient goals.

Currently however, quality-adjusted life years (QALYs) are often used as the outcome by which value is assessed. QALYs is a function of life expectancy with a particular intervention and the quality of those years; measured on a scale from 0 to 1, where one represents perfect health. For example, if a new chemotherapeutic agent extends an individual's life by 4 years, and the quality of those years is rated at 0.5, then the QALYs is 2. The National Institute for Health and Clinical Excellence (NICE) in the United Kingdom utilizes QALYs to evaluate interventions. In 1999, NICE was established by the National Health Service (NHS) to appraise new medical treatments and assess their clinical and cost-

effectiveness, i.e. their value. Financial considerations are accounted for with the incremental cost effectiveness ratio (ICER), which is defined as the cost differential between the new intervention and an established intervention per QALY gained. Monetary thresholds are often set per QALY. Interventions below the threshold represent value within the constructs of NICE. The threshold in the UK is £ 20,000–30,000 per QALY, equivalent to \$33,000–55,000 U.S. dollars [7]. While there is no official cut off used in the U.S., \$100,000 per QALY is often quoted as a reasonable benchmark for cost-effectiveness [8]. This draws attention to yet another complexity of measuring value in healthcare. How much of a society's resources should be allocated to a QALY? The societal and political task of setting an upper monetary limit per-QALY is beyond the scope of this article, but an ethical dilemma, which requires further consideration.

Forty percent of the technologies assessed by NICE are indicated for cancer care, the majority being new pharmaceuticals [9]. The limitation of using ICER, particularly in evaluating novel interventions, is that often there is insufficient data to assess quality-adjusted life years.

For instance, Imatinib, a selective tyrosine kinase inhibitor, utilized in the treatment of gastrointestinal stromal tumors (GIST) underwent multiple reviews before NICE approved it as a cost-effective therapy. GIST is the most common mesenchymal tumors of the gastrointestinal tract. Research out of Kitamura's laboratory established the link between GI stromal tumors and mutations in the *KIT* protooncogene, resulting in activation of tyrosine kinase receptors [10]. Imatinib revolutionized the treatment of advanced GIST. Well-localized GIST tumors can be managed surgically. However, prior to Imatinib, options were limited in advanced disease as these tumors are resistant to systemic therapy. In phase II trials of Imatinib a partial response was demonstrated in the majority of patients with metastatic GIST and the 1-year survival rate was noted to be 88% [11]. Given this early clinical success, the FDA granted Imatinib an accelerated approval in 2002 for the treatment of metastatic GIST. Subsequently, the Z9001 study, a placebo-controlled randomized trial noted improved recurrence-free survival with adjuvant Imatinib use which lead the FDA to endorse adjuvant use in 2008. In comparison, NICE approved the use of Imatinib for metastatic disease in 2004 and after multiple rejections finally granted approval as adjuvant therapy in 2014. Ultimately, Imatinib has been shown to improve overall survival in patients with high-risk GIST [12]. Imatinib has become such an integral part of GIST treatment that the historical treatment of GIST is often referred to as the pre-Imatinib era. NICE's early rejections point to the challenge of establishing cost-effective intervention protocols without hindering implementation of new innovations.

Personal costs of cancer treatments

The impact of cost extends beyond healthcare systems to personal cost. Pharmaceuticals, for example, represent a substantial cost in cancer care. In 2012, the average new cancer medication was priced above \$100,000 per year of therapy [13]. Even with medical insurance, the typical cancer patient's out-of-pocket expenditure is 20–30% of the total cost of treatment [13, 14]. The financial burden of treatment often results in patients needing to decrease the prescribed treatment course. In Zafar's body of work on the financial toxicity of

cancer treatment, he notes that 20% of patients take less than the prescribed amount of a medication in an effort to save money, while another 24% don't even fill their prescriptions [15], and others spend themselves into bankruptcy[16]. In fact, a cancer diagnosis carries a 2.65-times greater likelihood of declaring personal bankruptcy[16].

Patients, value, and risk

Patients subject themselves to the financial burdens of treatment based-on the concept that the intervention in which they are investing in is of value. Patients believe that the investment they are making in their treatment will bear a return commensurate with the financial risks they incur, however this assumption has come into question in various clinical settings. Value, as discussed in this paper, is based on the outcomes achieved. The value of working up and treating prostate, breast, and thyroid cancer, in specific clinical scenarios is discussed. Clinical equipoise may exist between two or more therapeutic options for each of these cancers. Prostate and breast cancer were chosen for this discussion as they represent two of the three most common cancers, whereas thyroid cancer was chosen as it represents one of the fastest growing cancer diagnoses. Thus, changes can be made in the testing and treatment protocols for these cancers to reflect value.

Value-driven oncological care has become a priority. The Institute of Medicine held a workshop in 2012 to discuss affordable cancer care. Millions of healthcare dollars are wasted in the form of unnecessary services and ineffectively delivered services [17]. Consolidated disease specific cancer care would limit some of the waste. In the clinical scenarios provided below, there are multiple examples of clinical practice patterns, which do not reflect recommended guidelines from specialty societies.

Scenario 1: Prostate Cancer

The clinical setting

Seventeen to twenty percent of all men will be diagnosed with prostate cancer during their lifetime [18, 19]. The vast majority, greater than 70% with low-risk disease, defined as a prostate specific antigen (PSA) level <10 µg/L and a Gleason score < 6. Overall survival at 10 years is greater than 90% and disease-specific mortality is 3–6% [19, 20]. The indolent nature of low-risk prostate cancer lends itself to the possibility of surveillance as a treatment option. In fact, a large randomized control trial, with 12-year follow-up, compared radical prostatectomy versus observation in localized prostate cancer (PIVOT trial). This study found that surgical intervention did not decrease all-cause mortality or disease-specific mortality when compared to observation alone [21]. Yet, approximately 90% of men diagnosed with low-risk disease undergo radical prostatectomy, external beam radiation or brachytherapy [22]. These curative interventions are not without side effects. The morbidity associated with prostatectomy and radiation therapy includes erectile dysfunction and urinary incontinence [23]. Erectile dysfunction is noted in >50% of post-prostatectomy patients vs. 43% of patients who undergo radiation therapy. Urinary incontinence is seen in 35% of prostatectomy patients and 12% of radiation patients[23]. Furthermore, up to 11% of patients who undergo radiation therapy develop urethral strictures [24].

The value question

Does a surveillance strategy for prostate cancer represent greater value compared to curative treatments?

Multiple studies have addressed the feasibility of active surveillance (AS) or watchful waiting (WW) as appropriate management strategies, for low-risk prostate cancer. AS entails regular digital rectal exams, PSA testing and biopsies. WW on the other hand involves monitoring for symptoms. With either AS or WW strategies, if there is increased patient anxiety, clinical progression, increasing PSA levels or upstaging of Gleason score, the treatment plan is then reevaluated. These reassessments allow for transition from surveillance to definitive therapy without reducing the chance for cure [25].

The up-front cost of a curative intervention is higher than that of surveillance. Eldefrawy et al. utilized Medicare reimbursement data and institutional expenses to provide the following cost estimates: the cumulative cost for a robotic-assisted radical prostatectomy at 1 year and 10 years was \$17,824 and \$22,762 respectively, external beam radiotherapy \$20,730 and \$23,953, brachytherapy \$14,061 and \$17,284. Lastly, AS costs \$1,154 and \$13,116 at the 1 year and 10 year mark respectively. [19]. While this study demonstrates higher follow-up care cost with AS, AS is still the most cost-effective of the treatment options. Furthermore, AS avoids the potential complication of surgery and thus represents greater value. Yet, despite this, the surveillance strategy remains under-utilized by our current healthcare systems.

Next steps in moving ahead

AS represents a valuable alternative to curative treatment for prostate cancer in the appropriate clinical setting. Age and life expectancy should be taken into consideration when discussing management options. For a younger individual, with an average life expectancy, operative intervention may ultimately be of greater value. As active surveillance over a 20–30 year time-period will likely represent greater cost than upfront curative treatment. Additionally, the psychological and emotional burden of regular testing may not be well tolerated by a particular individual. Conversely, for an older individual, AS likely represents greater value. As mentioned previously, the mortality rate would be comparable to upfront curative management. These individuals would also avoid potential urinary and sexual dysfunction. For the intermediate age group, there is still potential value in AS, however likely at a lower rate. Risk stratification of patient subgroups and patient specific consideration, such as ability to comply with repeat biopsies, need to be taken into consideration before considering surveillance as a management strategy.

Scenario 2: Breast Cancer

The clinical setting

Ductal carcinoma in-situ (DCIS), a premalignant proliferation of epithelial cells, was once a fairly rare diagnosis. In 1975, the incidence was 5.8 per 100,000. Currently, DCIS represents 20–25% of breast cancers[26–28]. The rise in incidence has largely been attributed to breast cancer screening programs [29]. While DCIS does not have the potential to metastasize; its

surgical and medical management is similar to that of invasive disease. Treatment consists of mastectomy or breast conserving surgery (BCS), adjuvant radiotherapy and hormone therapies.

The complexity of DCIS lies in the heterogeneity of its natural history. Mitotic indices, nuclear morphology and other histological features such as necrosis are used to delineate low, intermediate and high grade DCIS. The likelihood that DCIS will progress to invasive disease varies from 14–50% [26, 30]. Furthermore, the time interval over which DCIS potentially progresses varies from 5 years for high-grade DCIS to upwards of 20 years for low grade DCIS [30]. The underpinning of surgical intervention in DCIS is to prevent the development of invasive disease.

The value question

Given the uncertain natural history of DCIS, is AS a potentially valuable alternative treatment option?

DCIS is usually detected on a routine screening mammogram, in which microcalcifications prompt a biopsy. Surveillance of these lesions would entail repeat biopsies, as well as routine screening mammography to identify any new ipsilateral or contralateral lesions. AS represents approximately \$900 in annual costs, with the median cost of a mammogram being \$100 [31] and an annual core needle biopsy being \$800 [32]. In comparison, BCS or a mastectomy, is associated with a mean cost of \$15,000–\$19,000 [33]. Adjuvant therapy in conjunction with BCS represents an additional \$8,000 in spending [34]. Radiological costs related to surveillance imaging, also applies to patients who elect to undergo a surgical intervention. ASCO recommends that patients have a post-operative mammogram at 1 year from the initial mammogram and at least 6 months post-radiation therapy and then annually going forward [35]. At 10 years the cost of surgical intervention and subsequent surveillance represents \$24,000–\$28,000 in spending, vs. surveillance alone, at \$9,000. In addition to cost savings, surveillance would limit the surgical morbidity and psychological stress of undergoing a breast resection. While this crude calculation is an oversimplification of the cost analyses, it draws attention to the potential value of AS in women with low grade DCIS.

Next steps in moving ahead

Implementation of AS requires identifying the appropriate risk-stratified group of women with DCIS. Hwang's group created a computational risk model in which they estimate at 10 years the disease-specific cumulative mortality (DSCM) of active surveillance at age 40 years, 55 years and 70 years to be 3.5%, 2.8% and 2.8%, respectively; this is in comparison to 0.9%, 1.3% and 2.7% for the same age groups with surgical intervention [36]. While there is a projected difference the benefit of surgical and medical intervention diminishes with age. In this model the DSCM also merge when there is low under-staging of DCIS. Hwang's model takes into account that 20% of core needle biopsies diagnosing DCIS contain undetected invasive components. These are ultimately detected on final pathology of resected tissue [36, 37].

AS may be a viable alternative to surgery in older women, whose biopsies specimens are deemed to be of good quality as assessed by the pathologist. A small retrospective study

looked at women with DCIS who withdrew from an investigation of neoadjuvant hormone therapy and instead opted for observation. In this study 43% of the women remained on surveillance without any evidence of progression at 2 years [38]. While this study was limited in size and only included women with estrogen receptor positive DCIS, it demonstrates that surveillance may be a feasible option for long-term management. However, further work is needed to identify the appropriate patient population for this treatment alternative.

Scenario 3: Thyroid Cancer

The clinical setting

Over the last 30 years, the rate at which thyroid cancer is diagnosed has increased substantially. In fact, the incidence has risen by 5.5% annually over the last decade alone [39]. Interestingly, the increase in incidence has not been associated with a rise in mortality from thyroid cancer [40]. Indicating that at least in part, there is greater detection of indolent disease. Of the four types of thyroid cancer: papillary, follicular, medullary and anaplastic; papillary has the highest survival rate, at greater than 95% at 10 years and it is the largest contributor to the rising incidence rate [41]. Extensive work-up of incidental-detected thyroid nodules is likely contributing to this phenomenon. While the 2013 National Comprehensive Cancer Network (NCCN) guidelines do not recommend fine-needle aspiration (FNA) for any thyroid nodule <1cm; lesions measuring <1cm account for 39% of new thyroid cancers [41].

The radiographic discovery of an incidental thyroid mass, typically initiates a work-up that includes FNA, which costs \$1,300[42]. If cytology results are equivocal, additional investigations with repeat biopsies or diagnostic surgery are carried out. The malignancy rate for incidental nodules detected on CT and MRI is 0–11% and for ultrasound is 1.6%[43]. When comparing clinically diagnosed thyroid cancer, incidentally discovered cancerous lesions are more like to be papillary carcinomas and smaller in size [43]. Davies analysis of the SEER data from 1973 to 2005 suggests an excellent prognosis for small-localized papillary carcinomas even without immediate definitive treatment [44]. Current guidelines outlined by the American Thyroid Association and the NCI for stage I and II papillary thyroid cancer include total thyroidectomy for tumors ≥1cm and lobectomy for tumors <1cm.

The value question

Does the cost incurred from the intensity of working up and treating incidental thyroid nodules alter outcomes?

The decision to work-up an incidental nodule should not be reflexive. Given the low disease-specific mortality of thyroid cancer, pursuing a diagnosis for incidental thyroid nodules should be a conscious decision that take into account the patient's age and co-morbidities. The use of radioactive iodine ablation (RAI) outside current recommendations is another area where value is jeopardized. Adjuvant RAI is frequently used with total thyroidectomy to eradicate residual disease and facilitate post-operative monitoring for recurrence. It is

currently recommended for known metastatic disease, extrathyroidal extension, large tumor size (>4cm) or other high-risk histological features such as vascular invasion. However, in actually clinical practice 23.3% of patients with localized papillary thyroid cancer <1cm in size receive RAI [45]. This inappropriate use of RAI adds an additional \$5,430 to \$9,106 to patient costs, without adding value [45]. A large retrospective study with 1,298 patients with low risk differentiated thyroid cancer found no disease-specific or overall survival benefit of radioactive iodine therapy [46].

Next steps in moving ahead

The work-up and treatment of incidentally found thyroid masses is of limited value. The decision to pursue a tissue diagnosis for an incidental mass should be based on patient risk factors. If following the work-up surgery is indicated, the intensity of treatment should reflect the intensity of the disease. As discussed previously, lobectomy is recommended for small <1cm well differentiated lesions. However, a large retrospective study of 889 patients at Memorial Sloan Kettering noted neither a difference in overall survival nor a difference in regional recurrence in patients with intraglandular cancer under 4 cm in size treated with lobectomy vs. total thyroidectomy. While the cost of a partial vs. total thyroidectomy is comparable at \$5,617, the added cost and impact of lifelong post-operative hormone replacement therapy on QOL can be avoided by limiting resection to a lobectomy [47].

Again, there is no single strategy that would be best for all patients with a given disease. There is a need for treatment protocols that better delineate interventions based on more precise risk group stratification.

Discussion

In 1971, the “War on Cancer” was initiated with the National Cancer Act, which pledged a record sum of \$1.59 billion dollars for cancer research [48]. The goal was lofty to say the least, to cure cancer. At the time, cancer represented the second leading cause of death in the US. It still ranks second today. However, over the last 45 years, our understanding of cancer has evolved. It is no longer viewed as a singular entity, but rather a complex group of diseases with varying natural histories and treatment options. Our expenditure on cancer care must reflect this understanding. We have continued to spend an exorbitant amount on treating indolent and low-risk cancers, merely because there still exist an association between the word cancer and lethal in the American psyche. As the number of individuals living with cancer has increased over time [49] so has the cost of continued cancer care. When taking into account the growing aging population of the U.S. it is inevitable that the cost will keep on rising. The concept of value must be incorporated into cancer care.

Realigning terms to better reflect value

In order to shift testing and treatment protocols to better reflect healthcare value, it is important to recognize the key players involved; namely, the patient, the provider, the public and the policy-makers. Frank discussions between the stakeholders are essential. Ensuring that the risks of cancer treatments merit invasive testing, evaluation and treatment is an important first step in aligning the goals of treatment and ultimately the value of treatment.

This is especially pertinent in cancers where the long-term disease-specific risk may be minimal, and yet the up-front treatment costs and harms may be potentially burdensome. For the benefit of physicians, payers, and patients, it is imperative that surgeons- who are faced with weighing the potential benefits and risks of invasive treatment for cancer care every- have a clear voice in these discussions.

References

1. Hyattsville, M. National Center for Health Statistics. Health, United States, 2014: With Special Feature on Adults Aged 55–64. 2015.
2. Mariotto AB, et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2):117–28. [PubMed: 21228314]
3. Radice D, Redaelli A. Breast cancer management: quality-of-life and cost considerations. *PharmacoEconomics*. 2003; 21(6):383–96. [PubMed: 12678566]
4. Tangka FK, et al. Cancer treatment cost in the United States: has the burden shifted over time? *Cancer*. 2010; 116(14):3477–84. [PubMed: 20564103]
5. Porter ME. What is value in health care? *The New England journal of medicine*. 2010; 363(26):2477–81. [PubMed: 21142528]
6. Ellis LM, et al. American Society of Clinical Oncology perspective: Raising the bar for clinical trials by defining clinically meaningful outcomes. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*. 2014; 32(12):1277–80. [PubMed: 24638016]
7. Neumann PJ, Greenberg D. Is the United States ready for QALYs? *Health affairs*. 2009; 28(5):1366–71. [PubMed: 19738253]
8. Malin JL. Wrestling with the high price of cancer care: should we control costs by individuals' ability to pay or society's willingness to pay? *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*. 2010; 28(20):3212–4. [PubMed: 20498400]
9. Trowman R, et al. The National Institute for Health and Clinical Excellence and its role in assessing the value of new cancer treatments in England and Wales. *Clinical cancer research : an official journal of the American Association for Cancer Research*. 2011; 17(15):4930–5. [PubMed: 21791636]
10. Cioffi A, Maki RG. GI Stromal Tumors: 15 Years of Lessons From a Rare Cancer. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*. 2015; 33(16):1849–54. [PubMed: 25918303]
11. Croom KF, Perry CM. Imatinib mesylate: in the treatment of gastrointestinal stromal tumours. *Drugs*. 2003; 63(5):513–22. discussion 523–4. [PubMed: 12600228]
12. Bischof DA, et al. Adherence to Guidelines for Adjuvant Imatinib Therapy for GIST: A Multi-institutional Analysis. *Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract*. 2015; 19(6):1022–8. [PubMed: 25731828]
13. Kantarjian H, et al. High cancer drug prices in the United States: reasons and proposed solutions. *Journal of oncology practice /American Society of Clinical Oncology*. 2014; 10(4):e208–11.
14. Malik NN. Controlling the cost of innovative cancer therapeutics. *Nature reviews Clinical oncology*. 2009; 6(9):550–2.
15. Zafar SY, et al. The financial toxicity of cancer treatment: a pilot study assessing out-of-pocket expenses and the insured cancer patient's experience. *The oncologist*. 2013; 18(4):381–90. [PubMed: 23442307]
16. Zafar SY. Financial Toxicity of Cancer Care: It's Time to Intervene. *JNCI J Natl Cancer Inst*. 2016; 108(5)
17. Roman BR, Awad MI, Patel SG. Defining value-driven care in head and neck oncology. *Current oncology reports*. 2015; 17(1):424. [PubMed: 25416318]
18. Skolarus TA, et al. American Cancer Society prostate cancer survivorship care guidelines. *CA: a cancer journal for clinicians*. 2014; 64(4):225–49. [PubMed: 24916760]

19. Eldefrawy A, et al. Active surveillance vs. treatment for low-risk prostate cancer: a cost comparison. *Urologic oncology*. 2013; 31(5):576–80. [PubMed: 21616691]
20. Hayes JH, et al. Observation versus initial treatment for men with localized, low-risk prostate cancer: a cost-effectiveness analysis. *Annals of internal medicine*. 2013; 158(12):853–60. [PubMed: 23778902]
21. Wilt TJ, et al. Radical prostatectomy versus observation for localized prostate cancer. *The New England journal of medicine*. 2012; 367(3):203–13. [PubMed: 22808955]
22. Cooperberg MR, et al. Contemporary trends in low risk prostate cancer: risk assessment and treatment. *The Journal of urology*. 2007; 178(3 Pt 2):S14–9. [PubMed: 17644125]
23. Wilt TJ, et al. Systematic review: comparative effectiveness and harms of treatments for clinically localized prostate cancer. *Annals of internal medicine*. 2008; 148(6):435–48. [PubMed: 18252677]
24. Hofer MD, Gonzalez CM. Management of radiation-induced urethral strictures. *Translational andrology and urology*. 2015; 4(1):66–71. [PubMed: 26816812]
25. Petrelli F, et al. Predictive Factors for Reclassification and Relapse in Prostate Cancer Eligible for Active Surveillance: a Systematic Review and Meta-Analysis. *Urology*. 2016
26. Pang JM, Gorringer KL, Fox SB. Ductal carcinoma in situ - update on risk assessment and management. *Histopathology*. 2016; 68(1):96–109. [PubMed: 26768032]
27. Virnig BA, et al. Ductal carcinoma in situ of the breast: a systematic review of incidence, treatment, and outcomes. *Journal of the National Cancer Institute*. 2010; 102(3):170–8. [PubMed: 20071685]
28. Virnig, BA.; Shamliyan, T.; Tuttle, TM., et al. Diagnosis and Management of Ductal Carcinoma in Situ (DCIS). Agency for Healthcare Research and Quality; 2009.
29. Masson S, Bahl A. The management of ductal carcinoma in situ: current controversies and future directions. *Clinical oncology*. 2013; 25(5):275–82. [PubMed: 23453783]
30. Wells CJ, et al. Evolving paradigm for imaging, diagnosis, and management of DCIS. *Journal of the American College of Radiology : JACR*. 2013; 10(12):918–23. [PubMed: 24295941]
31. Feig S. Cost-effectiveness of mammography, MRI, and ultrasonography for breast cancer screening. *Radiologic clinics of North America*. 2010; 48(5):879–91. [PubMed: 20868891]
32. Burkhardt JH, Sunshine JH. Core-needle and surgical breast biopsy: comparison of three methods of assessing cost. *Radiology*. 1999; 212(1):181–8. [PubMed: 10405740]
33. Barlow WE, et al. Cost comparison of mastectomy versus breast-conserving therapy for early-stage breast cancer. *Journal of the National Cancer Institute*. 2001; 93(6):447–55. [PubMed: 11259470]
34. Boero IJ, et al. The impact of radiotherapy costs on clinical outcomes in breast cancer. *Radiotherapy and oncology : journal of the European Society for Therapeutic Radiology and Oncology*. 2015; 117(2):393–9. [PubMed: 26472317]
35. Shah M, Denlinger CS. Optimal post-treatment surveillance in cancer survivors: is more really better? *Oncology*. 2015; 29(4):230–40. [PubMed: 25952485]
36. Ryser MD, et al. Outcomes of Active Surveillance for Ductal Carcinoma in Situ: A Computational Risk Analysis. *Journal of the National Cancer Institute*. 2016; 108(5)
37. Willems SM, van Deurzen CH, van Diest PJ. Diagnosis of breast lesions: fine-needle aspiration cytology or core needle biopsy? A review. *Journal of clinical pathology*. 2012; 65(4):287–92. [PubMed: 22039282]
38. Meyerson AF, et al. Outcome of long term active surveillance for estrogen receptor-positive ductal carcinoma in situ. *Breast*. 2011; 20(6):529–33. [PubMed: 21843942]
39. Nguyen QT, et al. Diagnosis and treatment of patients with thyroid cancer. *American health & drug benefits*. 2015; 8(1):30–40. [PubMed: 25964831]
40. Davies L, et al. American Association of Clinical Endocrinologists and American College of Endocrinology Disease State Clinical Review: The Increasing Incidence of Thyroid Cancer. *Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists*. 2015; 21(6):686–96.
41. Hoang JK, Nguyen XV, Davies L. Overdiagnosis of thyroid cancer: answers to five key questions. *Academic radiology*. 2015; 22(8):1024–9. [PubMed: 26100186]

42. Khalid AN, et al. Fine-needle aspiration biopsy versus ultrasound-guided fine-needle aspiration biopsy: cost-effectiveness as a frontline diagnostic modality for solitary thyroid nodules. *Head & neck*. 2008; 30(8):1035–9. [PubMed: 18442056]
43. Hoang JK, et al. Managing incidental thyroid nodules detected on imaging: white paper of the ACR Incidental Thyroid Findings Committee. *Journal of the American College of Radiology : JACR*. 2015; 12(2):143–50. [PubMed: 25456025]
44. Davies L, Welch HG. Thyroid cancer survival in the United States: observational data from 1973 to 2005. *Archives of otolaryngology--head & neck surgery*. 2010; 136(5):440–4. [PubMed: 20479371]
45. Goffredo P, et al. Patterns of use and cost for inappropriate radioactive iodine treatment for thyroid cancer in the United States: use and misuse. *JAMA internal medicine*. 2015; 175(4):638–40. [PubMed: 25686394]
46. Schwartz C, et al. Impact on overall survival of radioactive iodine in low-risk differentiated thyroid cancer patients. *The Journal of clinical endocrinology and metabolism*. 2012; 97(5):1526–35. [PubMed: 22344193]
47. Marino M, et al. Costs of outpatient thyroid surgery from the University HealthSystem Consortium (UHC) database. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*. 2014; 150(5):762–9. [PubMed: 24496743]
48. science, P.i. Cancer wars (the Mary Lasker papers). [cited 2016; Available from: <http://profiles.nlm.nih.gov/ps/retrieve/Narrative/TL/p-nid/201>]
49. Lee, JA.; Roehrig, CS.; Butto, ED. Cancer. 2016. Cancer care cost trends in the United States: 1998 to 2012.

Synopsis

There are medical and surgical interventions in oncology, which represent a mismatch between cost and outcomes. Value, as understood by the patient and the public, needs to be clearly defined and an effort to restructure healthcare policies and protocols to maximize value should be emphasized.

Table 1

Cost comparison of surveillance strategies in prostate, breast and thyroid cancer vs. curative/operative interventions.

Cancer site	Cost of Surgical/Medical Treatment	Cost of Surveillance
Prostate Cancer ¹	Radical Prostatectomy- \$17,824	\$1,154/year
	External Beam Radiotherapy- \$20,730	
	Brachytherapy- \$14,061	
Breast Cancer (DCIS)	Mastectomy- \$15,000–\$19,000 ⁴	\$900/year ^{2,3}
	BCS & radiotherapy- \$23,000– \$27,000 ⁵	
Thyroid Cancer	Thyroidectomy - \$5,617 ⁶	\$1,300/year ⁷

¹Eldefrawy, A., et al., Active surveillance vs. treatment for low-risk prostate cancer: a cost comparison. *Urologic oncology*, 2013. 31(5): p. 576–80.

²Feig, S., Cost-effectiveness of mammography, MRI, and ultrasonography for breast cancer screening. *Radiologic clinics of North America*, 2010. 48(5): p. 879–91.

³Burkhardt, J.H. and J.H. Sunshine, Core-needle and surgical breast biopsy: comparison of three methods of assessing cost. *Radiology*, 1999. 212(1): p. 181–8.

⁴Barlow, W.E., et al., Cost comparison of mastectomy versus breast-conserving therapy for early-stage breast cancer. *Journal of the National Cancer Institute*, 2001. 93(6): p. 447–55.

⁵Boero, I.J., et al., *The impact of radiotherapy costs on clinical outcomes in breast cancer*. *Radiotherapy and oncology : journal of the European Society for Therapeutic Radiology and Oncology*, 2015. 117(2): p. 393–9.

⁶Marino, M., et al., *Costs of outpatient thyroid surgery from the University HealthSystem Consortium (UHC) database*. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*, 2014. 150(5): p. 762–9.

⁷Khalid, A.N., et al., Fine-needle aspiration biopsy versus ultrasound-guided fine-needle aspiration biopsy: cost-effectiveness as a frontline diagnostic modality for solitary thyroid nodules. *Head & neck*, 2008. 30(8): p. 1035–9.

Table 2

Definitions of terms used in health care policy.

Term	Definition
Value	Health care outcomes/dollar spent
Incremental cost- effectiveness ratio (ICER)	(Total cost of intervention-total cost of comparator)/(QALYs with intervention- QALYS with comparator)
Quality of Life	Years of life x quality of life. Where
Adjusted Years (QALY)	quality of life is given a value between 1 and 0. One representing perfect health and zero representing death.
Quality of Life (QOL)	Multidimensional questionnaire based assessment of the impact of a disease or treatment on an individual's physical, emotional, cognitive, social, spiritual and/or financial well-being.