Societal Costs of Localized Renal Cancer Surgery

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  1. A title page and an abstract (see below for formatting instructions).

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Scholarly Report submitted in partial fulfillment of the MD Degree at Harvard Medical School

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Student Name: Peter Renehan

Scholarly Report Title: Societal Costs of Localized Renal Cancer Surgery

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(I) ABSTRACT

TITLE: Societal Costs of Localized Renal Cancer Surgery

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Purpose: Hospital-related costs of renal cancer surgery have been described, but the societal costs of surgery-related lost productivity are poorly understood. We sought to estimate the societal cost of renal cancer surgery by assessing surgery-related time off work (TOW) taken by patients and their caretakers.

Methods: 413 subjects who underwent partial or radical nephrectomy enrolled in an IRB-approved prospective quality-of-life study were administered an occupational survey assessing employment status, work physicality, income, surgery-related TOW, and caretaker assistance. We excluded subjects with incomplete occupational information or metastatic disease. We estimated potential wages lost using individual income and TOW, and used logistic regression to evaluate for factors predictive of TOW > 30 days.

Results: Of the 219 subjects who responded to the survey, 138 were employed at time of surgery. 97 subjects returned to work and met the inclusion criteria, and were analyzed. Mean age was 54. 56% of subjects had sedentary jobs. TOW ranged from 7 to 92 days; mean (SD) and median (IQR) TOW was 35 (17) and 33 (24-44) days, respectively. 58% of subjects took > 30 days off. Mean potential wages lost for TOW was $10,152 (SD=$8,153). 83% of subjects had at least one caretaker take TOW (mean/median caretaker TOW: 11/7 days, respectively) to assist in recovery. Subjects with sedentary jobs were less likely to take >30 days off (OR 0.30; 95% CI 0.09 – 0.99).

Conclusions: Most patients take over one month off work after renal cancer surgery; those having sedentary jobs tend to return to work sooner. Recognizing these societal costs may allow better adjustment of patient expectations, and more comprehensive cost-effectiveness analyses in renal cancer care.

(II) STUDENT CONTRIBUTION

My role in design:

a) Conduct independent literature review; formulate hypothesis: The project started with a desire to develop a more comprehensive understanding of the costs associated with renal cancer surgery. My initial responsibility was to compile all the relevant literature on both direct and indirect costs. After finding that most studies focused primarily on the direct, hospital-related costs, we hypothesized that incorporating societal costs, such as time off work, into the analyses might impact the perceived effectiveness of the procedures in material ways. Using an occupational questionnaire, we sought to test our preliminary hypotheses that patients undergoing robotic-assisted surgeries, and/ perform more sedentary jobs are more likely to take fewer days off work.

b) Alongside research team, design societal cost questionnaire: As a team, we drafted a questionnaire that would assess employment status at surgery, work physicality, time off work, level of caretaker assistance required, and income by tax bracket. We also collaborated on the consideration of exclusion criteria, which included patients undergoing cytoreductive nephrectomy, patients with inadequate questionnaire data, or patients who were unemployed at time of surgery.

My role in execution:

a) Called patient participants who requested phone surveys, or who needed help completing the mailed survey.

b) Maintained the REDCap database, updating it with survey results and exporting data to Excel for initial pivot table analyses as needed.

c) Derive the potential wages lost for each subject (multiplied annual income by time off work, and divided by 365).

My role in analysis:

a) Conducted independent pivot table analyses to look for trends among various segments of patients – including employment status, surgery type, work physicality, and income level.

b) Alongside research team, conduct multivariable analyses, which found that sedentary job-holders were significantly less likely to take more than 30 days off of work (OR 0.30, 95% CI 0.09 – 0.99).

My role in writing:

a) Following analyses, I compiled our data and our notes from literature review, and wrote a first draft. I submitted the draft to my advisor (Dr. Chang), who offered feedback, which I incorporated. We bounced drafts back and forth to one another for a handful of months until the paper was finalized. Dr. Chang spent comparatively more time on the multivariable analysis. Most of my writing time was devoted to the Introduction, Methods, Results (except multivariate analysis component), and Discussion sections.

Roles of other contributors:

- Peter Chang – co-lead author, ran the multivariate analysis, helped conceive of the study's rationale and design the study's questionnaire
- Andrew Wagner – helped conceive of the study's rationale and design the study's questionnaire
- Kimberly Taylor, Lauren Dewey, Kyle McAnally, Sara Hyde – helped execute the study, compile survey results, and maintain RedCap database
- Catrina M. Crociani, MPH – helped with study design, statistical analyses

(III) APPENDIX – Submitted, Co-First-Author Paper

Title

Societal Costs of Localized Renal Cancer Surgery

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ABSTRACT

Introduction and Objectives: Hospital-related costs of renal cancer surgery have been described, but the societal costs of surgery-related lost productivity are poorly understood. We sought to estimate the societal cost of renal cancer surgery by assessing surgery-related time off work (TOW) taken by patients and their caretakers.

Methods: 413 subjects who underwent partial or radical nephrectomy enrolled in an IRB-approved prospective quality-of-life study were administered an occupational survey assessing employment status, work physicality, income, surgery-related TOW, and caretaker assistance. We excluded subjects with incomplete occupational information or metastatic disease. We estimated potential wages lost using individual income and TOW, and used logistic regression to evaluate for factors predictive of TOW > 30 days.

Results: Of the 219 subjects who responded to the survey, 138 were employed at time of surgery. 97 subjects returned to work and met the inclusion criteria, and were analyzed. Mean age was 54. 56% of subjects had sedentary jobs. TOW ranged from 7 to 92 days; mean (SD) and median (IQR) TOW was 35 (17) and 33 (24-44) days, respectively. 58% of subjects took > 30 days off. Mean potential wages lost for TOW was $10,152 (SD=$8,153). 83% of subjects had at least one caretaker take TOW (mean/median caretaker TOW: 11/7 days, respectively) to assist in recovery. Subjects with sedentary jobs were less likely to take >30 days off (OR 0.30; 95% CI 0.09 – 0.99).

Conclusions: Most patients take over one month off work after renal cancer surgery; those having sedentary jobs tend to return to work sooner. Recognizing these societal costs may allow better adjustment of patient expectations, and more comprehensive cost-effectiveness analyses in renal cancer care.

Introduction

There are approximately 62,000 new cases and 14,000 deaths from kidney cancer each year.[1] Mortality is declining in part due to curative surgical management, but also due to the increased incidental detection of small, potentially indolent renal masses with cross-sectional imaging.[2] With increased acceptance of non-operative management for incidentally discovered small renal masses[3] and advances in minimally invasive renal cancer surgery, increased emphasis is being placed on the costs of renal cancer treatment.

Most cost analyses for renal cancer surgery focus on direct, hospital-related costs[4,5], which may vary considerably between institutions. Another common approach is to use reimbursement data as a single proxy for cost, which may paint an incomplete picture of the multiple billable events accounting for hospital costs.

Still less attention has been paid to the societal costs of these surgeries, which may be both economically and clinically significant. Under most health economic models, the costs of surgical procedures are assumed up front, while the value (patient satisfaction, function in society) may be accrued over time and thus difficult to measure. However, time off work (TOW) is a societal cost that reflects lost productivity for patients and their caretakers, and is a measurable societal cost that may ultimately prove more generalizable than direct costs, which tend to vary across institutions[6].

Time off work also has clear clinical importance, as it may influence patient satisfaction, treatment preference, and timing of treatment. A clearer understanding of surgery-related TOW after radical and partial nephrectomy could help set realistic expectations for postoperative recovery, potentially leading to improved overall patient satisfaction.

Using an occupational questionnaire, we sought to test our preliminary hypotheses that patients undergoing robotic-assisted surgeries, and/ perform more sedentary jobs are more likely to take fewer days off work. We examined postoperative TOW in patients and their caretakers, and used

this representation of lost productivity to estimate surgery-related societal cost. To our knowledge this study represents the first description of the societal costs of renal cancer surgery.

Methods

Cohort

We administered a societal cost questionnaire to 413 subjects who had undergone radical nephrectomy (RN) or partial nephrectomy (PN) for localized renal cancer from 2008 to 2016 at two academic medical centers. These subjects had already consented to enrolling and participating in an IRB-approved kidney surgery study involving prospective collection of patient-reported quality of life at pre-treatment baseline, and 2, 4, 8, 12, and 52 weeks after surgery, as well as yearly follow-up. Subjects were instructed by their surgeon to avoid heavy lifting for four weeks post-operatively.

We maintained and updated all data in our secure database provided by Research Electronic Data Capture™ web application (REDCap)[7]. We sent subjects the occupational survey 8 weeks after surgery, either through the REDCap system or by traditional mail, per patient preference. Those subjects already enrolled on the quality of life study at the onset of this societal cost study were sent the societal cost survey at their next scheduled follow-up interval. Non-response prompted re-sending of the survey at 4-week intervals, for up to three total requests.

Outcomes

To all subjects, we administered a societal cost questionnaire that assessed employment at the time of surgery, work physicality (sedentary/moderate/heavy lifting), time off work (TOW) in days, level of caretaker assistance (number of caretakers; total number of days they took off work), and income by tax bracket[8] (Supplemental Table 1). We excluded subjects from the analysis if they underwent cytoreductive nephrectomy, had inadequate societal cost questionnaire data, or were not employed at the time of surgery.

We considered the societal cost of lost productivity proportional to the time costs of surgery convalescence. Furthermore, we estimated the potential wages lost for each subject by

multiplying their annual income (the median value of their reported tax bracket) by their time off work in days, and dividing by 365.

We also evaluated the degree of caretaker assistance required by each subject, asking subjects to report the number of caretakers that took time off to help in the subjects' recovery, and the amount of time taken off by caretakers. We then sought to identify predictors of TOW > 30 days, using multivariable logistic regression to evaluate for factors significantly associated with this outcome. SAS version 9.3 was used for all statistical analyses.

Results

Of the 413 subjects sent the societal cost questionnaire, 194 did not complete the survey despite multiple requests. 219 subjects responded to the survey. 138 were employed at the time of surgery. 97 subjects met the inclusion/exclusion criteria, and were included in the analysis (Figure 1). Six subjects did not return to work after surgery, all of whom were over 65 at the time of surgery, and none of whom had a surgical complication. There were no significant differences in age, surgical approach, or complication rate between survey responders and non-responders.

Subject clinical and surgical characteristics are presented in Table 1. The mean subject age was 54 years. We used a minimally invasive surgical approach in 92% of subjects, and almost all subjects were discharged on post-operative one or two. The majority (56%) of subjects had sedentary jobs, while 12% routinely performed heavy lifting at work (Table 2). Most subjects (54%) were of middle class income, as described by an annual income of $48,601 - $125,450, corresponding to the 41^{st} - 60^{th} percentile of average annual income for U.S. Citizens in 2010.

The majority of subjects (57%) took more than four weeks off work (mean TOW for all subjects = 36 days; Table 2). Under the assumption that the societal cost of lost productivity is proportional to potential lost income, the mean societal cost of surgery-related time off work was $10,152 (SD=$8153). Eighty-three percent of subjects reported that at least one caretaker took time off to help with post-operative convalescence. Average caretaker time off was 12 days (Table 2).

On multivariable analysis, subjects with sedentary jobs were significantly less likely to take more than 30 days off work (OR 0.30, 95% CI 0.09 – 0.99). Age, type of surgery (radical or partial nephrectomy, surgical approach (minimally invasive or open), income bracket, post-operative complications, and caretaker assistance were not associated with TOW > 4 weeks on multivariable analysis (Table 3).

Discussion:

Measuring and understanding the costs of health care procedures and processes is now commonplace; however, the perspective and methods by which such analyses are performed vary significantly. Most cost analyses for kidney cancer surgery have focused on estimating direct, hospital-related costs. For example, several investigators have evaluated both variable and fixed costs of surgery for minimally invasive kidney surgery and found hospital costs to range from $7,000-15,000 for laparoscopic radical nephrectomy and robotic partial nephrectomy[4,9,10].

These approaches have their limitations, however. Charges vary significantly by institution and region, and therefore may not be generalizable. Reimbursement data stems from the payor perspective, also varies by region, and thus may not be reflective of the patient experience. Moreover, the hospital costs do not take into account costs incurred in the post-hospitalization period, which could be as significant as the costs of the hospitalization. This and other inherent challenges in measuring cost were the impetus for guideline publications by the Panel of Cost Effectiveness in Medicine[11] and the World Health Organization[12]. Both documents acknowledge the importance and challenges of measuring costs from the societal perspective.

Until now, post-hospitalization costs after kidney surgery were unknown. Other fields have used TOW as a proxy for health outcomes, including rehabilitation medicine, pain management, oncology, and orthopedics[13-16]. In these studies TOW is often modeled dynamically (Markov)[16,17], in step-wise fashion (Kaplan-Meier)[18], or using logistic regression, and the emphasis is often on patients suffering from chronic, debilitating conditions such as severe burns or back pain[13,14,18]. By assessing the impact of time off work (TOW) we measure an outcome that is not only an important contributor to societal cost, but is also critical information for

patients and their families. The period between discharge and the first post-operative visit (often as many as 90 days after surgery) is traditionally a "black box," during which convalescence occurs and employed patients return to work (or do not). To our knowledge, this is the first study to investigate this period from the societal cost perspective in kidney surgery patients.

Reports describing TOW for other abdominal surgical procedures are sparse and importantly, costs have not been incorporated into these analyses. A prospective study of 100 patients undergoing laparoscopic cholecystectomy reported a median TOW of 7 days[20], while a randomized trial comparing single incision laparoscopic cholecystectomy to mini-laparoscopic cholecystectomy showed a mean TOW of 5.3 and 5.9 days, respectively[21].

In contrast, the median TOW in subjects undergoing kidney surgery in our study was 31 days. This is shorter, but on the same scale as the median TOW of 46 days described after laparoscopic donor nephrectomy reported in a matched pair comparison between laparoscopic donor nephrectomy and laparo-endoscopic single site (LESS) donor[22]. Interestingly, the investigators found LESS patients returned to work after only 18 days. These findings allow practitioners to appropriately adjust patient and family expectations before kidney surgery by using another surgery as a frame of reference. Extrapolating from the data above, it would conceivably help patients to know that recovery after minimally invasive renal cancer surgery is significantly more delayed than that after laparoscopic cholecystectomy.

Our study found average estimated societal costs incurred from renal cancer surgery-related TOW to be about $10,000. Moreover, about half of our patients required a caretaker at home whom also took one week off work. These costs at least equal the average hospital-based costs that have been demonstrated after kidney surgery[4,9,10]. Thus our results carry important implications and suggest that the societal costs incurred in the immediate post-hospitalization period may be as impactful as those incurred in the hospital.

We evaluated factors influencing the TOW and found the only significant predictor of taking more than 30 days off work was the physicality of patient employment. Patients with sedentary jobs were significantly less likely to take TOW > 30 days than those who described their jobs as

requiring moderate physical activity or heavy lifting. Although to our knowledge, no other studies describe this finding, at least one study has investigated the influence of physical activity on TOW. Onerup et al reported that preoperative level physical activity was directly correlated with TOW less than 3 weeks following elective cholecystectomy, although they did not assess the level of activity required at work[20,21] .

It is possible that TOW is also influenced by non-clinical factors such as limitations to heavy lifting imposed by the surgeon, availability of short-term disability insurance, whether TOW was paid/unpaid, or amount of TOW allowed/encouraged by the workplace policies[24]. The reasons for TOW were not captured in our occupational questionnaire, and are important areas for future investigation in a larger cohort.

Our study has several limitations. A larger sample size would have increased our power to detect significant predictors of TOW > 30 days. Most of our subjects underwent minimally invasive surgery, which limited our ability to detect the influence of surgical approach on TOW. In our societal cost estimation, we assumed that lost societal productivity from the TOW is proportional to income, which may not be the case; however, this is a common assumption made in such analyses, and on the individual patient basis, is certainly valid if TOW is unpaid. We chose to use individual subjects' income for our calculations of societal costs rather than income by median age group or ZIP code, which may limit the generalizability of our results. However, only through this approach could we assess the potential influence of individual income on TOW. Despite its limitations, our study uses a novel approach to look beyond payor-oriented traditional cost analyses and to examine not only the societal cost of renal cancer surgery, but also its practical burden on their employment and their caretakers.

Conclusion

Even with the growing utilization of minimally invasive surgical approaches, most patients, especially those with non-sedentary jobs, take more than four weeks off work following renal cancer surgery, and many require the assistance of caretakers and loved ones during convalescence. In our cohort, this lost productivity was associated with a substantial average

societal cost of at least $10,000. These findings may help better estimate overall societal costs after kidney surgery, help practitioners to refine patient expectations and improve overall patient satisfaction.

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Table 1: Subject Clinical and Surgical Characteristics

Variable	Radical Nephrectomy (n = 25)	Partial Nephrectomy (n = 72)	Total (n = 97)
Age (SD)	54 (10)	54 (11)	54 (10)
Minimally invasive surgery (%)	23 (92)	66 (92)	89 (92)
EBL in cc (SD)	114 (141)	236 (183)	204 (181)
Hospital stay (median IQR)	2 (1)	2 (2)	2(1)
Post-operative complications – any Clavien Grade (%)	6 (24)	9 (13)	15 (17)

Table 2: Subject occupational characteristics, time off work, caretaker assistance, and estimated lost productivity after localized renal cancer surgery

Variable	Radical Nephrectomy (n = 25)	Partial Nephrectomy (n = 72)	Total (n = 97)
Job Physicality (col %)			
Sedentary	19 (76)	35 (49)	54 (56)
Moderate Activity	4 (16)	27 (37)	31 (32)
Heavy Lifting	2 (8)	10 (14)	12 (12)
Income by tax bracket			
$0 to $12,750 (%)	0 (0)	3 (4)	3 (3)
$12,751 - $48,600 (%)	7 (28)	10 (14)	17 (18)
$48,601 - $125,450 (%)	12 (48)	39 (54)	51 (54)
$125,451 - $203,150 (%)	2 (8)	14 (19)	16 (16)
$203,151 - $398,350 (%)	3 (12)	5 (7)	8 (8)
$398,351 - $425,000 (%)	1 (4)	1 (1)	2 (2)
Time off work (in days)	*See Figure 2*		
Mean (SD)	34 (17)	37 (17)	36 (16)
Median (IQR)	29 (16-42)	32 (21-43)	31 (28-42)
Potential wages lost due to TOW after surgery, in USD* (SD)	$8990 (5935)	$10556 (8794)	$10152 (8153)
Caretaker assistance			
Required the assistance of one or more persons (%)	21 (84)	60 (83)	81 (83)
Mean days off for all assistants per subject (SD)	14 (14)	10 (10)	11 (12)

*(median value of subject's reported tax bracket * TOW in days) / 365

Table 3: Predictors of taking greater than 30 days off work after localized renal cancer surgery

Variable	**Odds Ratio (OR)**	**95% CI**
Sedentary job	*0.30	0.09-0.99
Age	0.67	0.21-2.2
Post-operative complications	1.3	0.28-6.2
Income bracket	0.33	0.09-1.2
Surgical approach (minimally invasive; open)	1.1	0.29-3.9
Caretaker assistance	0.71	0.22-2.3

*denotes statistical significance, $p<0.05$

FIGURE LEGENDS

Figure 1: Analytic cohort

Figure 2: Time off work, in weeks, after localized renal cancer surgery