Comparison of Hospital Length of Stay and Readmissions by Surgical Approach in the Treatment of Endometrial Cancer in Washington State, 2008-2011: Robotic Assisted Surgery Compared with Laparoscopy and Laparotomy

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Abstract

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Objectives: Our aims were to determine the trends in surgical approach (laparotomy (XLAP) versus laparoscopy (LS) versus robotic assisted (RAS)) over time for surgically managed endometrial cancer (EC) from 2008-2011, and to determine if length of stay (LOS) and hospital readmissions differed by surgical approach.

Methods: We performed a population-based retrospective cohort study of EC patients treated with RAS, LS, or XLAP in Washington State from 2008-2011. We identified patients treated at hospitals that provided all three surgical approaches using the Comprehensive Hospital Abstract Reporting System (CHARS. We compared the proportion of each approach from 2008 to 2011. We assessed the association between surgical approach and LOS using linear regression to estimate change in mean number of days and 95% confidence intervals (CI), and the association between approach and any readmission within 90 days, as well as stratified by early (0-30 days), intermediate (31-60 days), and late readmission (61-90 days) using logistic regression to estimate odds ratios (OR) and 95% CI, adjusting for the year of surgery.

Results: We identified 2,258 patients who underwent surgical treatment of EC, with 1,003 RAS, 284 LS, and 971 XLAP. Patients undergoing XLAP had more comorbidities than those who had RA or LS (CCI ≥2 12.4%, 8.6% and 7.4% respectively. p<0.01). Obesity rates were similar for all groups at 31%. Comparing 2008 to 2011, cases performed by LS and XLAP significantly declined (32.3% to 6.5% and 55.6% to 26.5% respectively) as use of the RA approach increased (12.0% to 66.9%). Mean LOS was shorter for both RA (-2.7days; 95% CI: -2.9, -2.5 days) and LS (-2.5 days; 95% CI: -2.8, -2.2 days) compared to XLAP. Risk of any readmission 0- 90 days from discharge for patients undergoing RAS was half as likely compared to XLAP (OR : 0.5 95% CI: 0.3, 0.6) but not different for LS vs XLAP (OR=0.7; 95% CI: 0.5, 1.1). Early and intermediate-timed readmission for RAS vs XLAP were 60% less likely (OR=0.4; 95% CI: 0.3, and OR=0.4; 95% CI: 0.2, 0.8 respectively) with no difference in late readmissions (OR=1.0; 95% CI: 0.5, 2.1).

Conclusions: Patients who underwent either RA or LS surgery for the treatment of EC had shorter LOS, however only those undergoing RAS had a lower risk of readmission compared to XLAP. Robotic surgery should be viewed as an alternative to laparoscopy in the treatment of EC, and preferable to XLAP.

Introduction

Endometrial cancer (EC) is the most common cancer of the female reproductive tract in the U.S. The most common type of EC is often found in association with obesity; with the overall increase in obesity in the U.S. there has been a parallel increase in the incidence of EC in recent years (1) (2). In 2014, an estimated 52,630 new cases and 8,590 deaths resulted from EC nationally (3). In the state of Washington alone, there were an average of 864 cases per year and a 1.5% increased incidence in EC from 2005-2009 as reported by the Surveillance, Epidemiology and End Results (SEER) program, which encompasses 27 of Washington's 39 counties. The treatment for patients with EC incorporates surgery 90% of the time. Historically this was done via open laparotomy (XLAP); however the introduction of laparoscopy (LS) in the 1990s and robotic assisted surgery (RAS) in 2000 has allowed many of these women to have a minimally invasive cancer surgery. A minimally invasive approach to surgery with LS or RAS allows for an equivalent evaluation and treatment of the cancer (4). The LAP2 trial was a large randomized control trial comparing LS to XLAP and reported benefits to LS including smaller incisions, fewer infections, lower complication rates, shorter hospital stays, and a more rapid recovery and return to normal daily activities (5) (6). However, the practical application of LS surgery may be limited in gynecologic oncology, particularly in the morbidly obese patient with conversion to laparotomy correlated with increasing body mass index (BMI) (7) (8) and an increasingly obese US population (9).

RAS has been proposed as an alternative to LS because it offers the benefits of minimally invasive surgery with a lower conversion rate to XLAP. This is thought to be due to the dexterity and ergonomic improvements of RAS compared to LS, and can therefore increase patient access to minimally invasive surgery (9) (10). The most commonly used robotic surgery device was approved by the US Food and Drug Administration (FDA) in 2000 for use in gynecologic surgery. Multiple studies have shown that patients undergoing RAS may have fewer complications and lower rates of conversion to open surgery compared to laparoscopy (5) (7) (8) (11) (12). However, these findings have been inconsistent, and population based cohort studies which compare RAS to LS showed limited patient benefits, at the cost of longer operating times, and greater expense for RAS (6) (13). The shift to RAS has primarily been away from XLAP, not LS, and so we question the relevance of studies comparing RAS to LS. RAS may make a minimally invasive approach available to those who were not candidates for traditional laparoscopy increasing access to minimally invasive surgery for women with endometrial cancer. The population-based studies that have been done did not make the important comparison of RAS to XLAP and so may have missed the potential benefits to the robotic approach.

Given that minimally invasive surgery is commonly used in the diagnosis and treatment of EC, we assessed the trends over time in use of robotic, laparoscopic, and open surgical approaches and evaluated the length of hospital stay and risk of readmission by surgical approach. We hypothesized that that the proportion of cases performed robotically would increase over the study period while the proportion of both XLAP and LS procedures would decline. We also hypothesized that both the LS and RAS groups would have a reduction in readmissions, and a shorter length of stay compared to those having a traditional XLAP.

Materials and Methods

We performed a retrospective cohort study of all female patients 18 years old and older with EC that underwent surgical treatment in Washington State from 2008-2011. We utilized the Comprehensive Hospital Abstract Reporting System (CHARS), which includes all non-federal hospital discharge data in Washington State, to identify women admitted with EC. The International Statistical Classification of Diseases and Related Health Problems version 9 (ICD-9) codes are captured in CHARS with up to 25 diagnostic and 9 procedure codes per admission. These codes were searched to identify women admitted to a Washington hospital with a diagnosis of EC (ICD-9 code 182.0), and to classify surgical group into XLAP (ICD-9 codes 68.49, 68.69), LS (ICD-9 codes68.41, 68.51, 68.61), and RAS (ICD-9 codes 17.42, 17.44, 17.49) We excluded patients treated at hospitals that did not provide all three surgical approaches and patients with a record of admission for EC that did not include a hysterectomy procedure. We also excluded women undergoing total vaginal hysterectomy or pelvic exenteration because these are not standard of care approaches to initial surgical treatment of EC, Given that RAS was assigned an ICD-9 procedural code separate from laparoscopic surgery in 2008, we restricted our analysis to CHARS data from 2008 to 2011. We took the approach of comparing RAS and LS to XLAP given that national trends show more women are having a minimally invasive procedure in the treatment of EC since the introduction of the robotic system (20). Therefore, comparing RAS and LS to XLAP appears to be the more appropriate comparison when discussing the utility of RAS and should consequently be considered the correct comparison when discussing patient outcomes.

We ascertained demographic information, medical comorbidities, and surgical complexity. Patient demographic data included age, type of insurance (government (Medicare/ Medicaid/Tricare), private/health maintenance organization, or other (self-pay/charity care/liability and industry), and obesity status. Patients were classified as obese if they were assigned an ICD-9 code for obesity not otherwise specified, morbid obesity, or an obese body mass index (BMI) ≥30 kg/m^2 (ICD9 codes 278.x, V85.3x, V85.4x). Obesity ICD-9 coding was modified during the time period of this study; for all years codes for "Obese NOS" and "morbid obesity" were available, however codes indicating patient's BMI group were modified in 2010 with a change from the initial highest category of BMI ≥40kg/m^2 to increased specificity with codes for morbid and super obese BMIs of 40-44.99, 45-59.99, and ≥60mg/m^2. Because this level of detail was not available for all study years we used the pre-2010 categorization of BMI. Number and type of medical comorbidities were obtained from the index surgical hospitalization to calculate a baseline Charlson Comorbidity Index (CCI) score (14). Subjects received one point for each of severe medical condition (Appendix) and points were summed to determine the overall CCI score. We modified the CCI score to exclude gynecologic cancer. Other important comorbid conditions that impact risk of surgical complications but are not captured by the CCI score, such as hypertension, tobacco use, obstructive sleep apnea, asthma, and hyperlipidemia were ascertained from the index surgical hospitalization. Medical comorbidities used in calculating the CCI score and additional comorbid conditions with accompanying ICD-9 codes are listed in the appendix. Surgical complexity was determined by whether or not a lymph node sampling or dissection (LND) was performed with hysterectomy.

The outcome variables assessed were surgical trends over time, length of hospital stay (LOS) measured in days and hospital readmission measured as a binary (no/yes) outcome and also as stratified by timing of readmission into early (0-30 day), intermediate (31-60 days), and late postoperative readmissions (61-90 days). Readmissions were assessed by linking up to 3 additional records of hospitalization using patients' social security number in CHARS within 90 days after discharge from the initial surgical hospitalization.

Data Analysis

We compared patient demographic and comorbidity characteristics by surgical approach using Chi square testing. Trends for surgical approach over time were assessed using linear regression to compare the mean number of each surgical approach per year.

We assessed the association between surgical approach and LOS using multivariable linear regression to estimate change in mean number of days and 95% confidence intervals (CI). The association between surgical approach and the outcomes of any readmission, as well as the stratified outcomes of early (0- 30 days), intermediate (31-60 days), and late (61-90 days) readmissions were assessed using multivariable logistic regression to estimate odds ratios (OR) and 95% CIs with XLAP used as the referent group. All analyses were adjusted for the *a priori* confounders of surgical complexity and the patient's preoperative medical comorbidity as measured by continuous CCI score (0-5). We evaluated additional potential confounders using a data driven, stepwise approach. Covariates assessed as potential confounders included the binary variables of obesity, asthma, obstructive sleep apnea, and tobacco use and the continuous variable of year of surgery. Confounding was defined as a 10% change in the estimated effect with addition of a variable to the linear or logistic regression model. Only year of surgery was determined to be a confounder and so our final multivariable model was adjusted for surgical complexity, CCI score, and year of surgery.

Results

We identified 2,258 women who underwent surgical treatment of EC from 2008-2011, with 1,003 (44.4%) RAS, 284 (12.6%) LS, and 971 (43.0%) XLAP. Obesity rates were similar across surgical approach at 31%, however, among the limited patients for whom BMI category was recorded (n=413), a significantly higher proportion of subjects who were morbidly obese with a BMI ≥40mg/m^2 underwent either XLAP (85.3%) or RAS (72.2%) compared to LS (66.7%) (p<0.01). While individual medical comorbidities did not vary significantly by surgical approach, a higher proportion of those undergoing XLAP had a CCI score ≥2 (12.4%) compared to RAS or LS (8.6% and 7.4%, respectively p<0.001). Patients undergoing XLAP (60.8%) were most likely to have the more surgically complex procedure of LND with hysterectomy, followed by RAS (53.3%) and then LS (47.9%) (p<0.001).

Analysis of surgical trends from 2008 to 2011 showed that cases performed by LS and XLAP both significantly declined (32.3% to 6.5% and 55.6% to 26.5% respectively; p<0.001) as use of the RAS approach increased from 12.0% in 2008 to 66.9% in 2011 (p<0.001) (Fig 1).

Mean LOS was shorter for RA by 2.7 days (95% CI: -2.9, -2.5 days) and for LS by 2.5 days (95% CI: -2.8, -2.2 days) compared to XLAP. The overall readmission rate within 90 days of discharge from surgery for this cohort was 11.2% and the frequency of early readmissions (0-30 days) was 6.4%. The majority of subjects who experienced a readmission had an early readmission (59.3%), followed by 23.3% with intermediate-timed readmissions (31-60 days) and 17.4% with late readmissions (61-90 days) after discharge from the surgical hospitalization. There were 55 patients (2.4%) who were readmitted multiple times (2-6) within 90 days of discharge from the surgical hospitalization and this did not vary by surgical approach. Risk of any readmission 0- 90 days from discharge for patients undergoing RAS was half as likely compared to those undergoing open XLAP (OR: 0.5 95% CI: 0.3, 0.6) but not different for LS vs XLAP (OR=0.7; 95% CI: 0.5, 1.1)(Table 2). These findings were primarily driven by fewer early (OR=0.4; 95% CI: 0.3, 0.6) and intermediate-timed (OR=0.4; 95% CI: 0.2, 0.8) readmissions in the RAS group with no differences seen in late readmission between RAS and XLAP (OR=1.0; 95% CI: 0.5, 2.1). We found no differences in timing of readmission when comparing LS to XLAP (Table 2).

Discussion

In Washington State, we found a significant trend over a four year period with more women undergoing minimally invasive surgery for the treatment of EC and a corresponding decrease in the proportion of cases performed by traditional XLAP. We found a rapid increase in use of RAS with more than 2/3 of cases performed by RAS in 2011. In addition, patients who underwent either RA or LS surgery for the treatment of EC from 2008-2011 had a significantly shorter LOS, however only those undergoing RAS had a lower risk of readmission compared to XLAP. We also noted lower rates of early and intermediate-timed readmissions with RAS compared to XLAP. Readmission rates were similar from 61-90 days, with very few late readmissions in any group, suggesting the impact of surgical approach on postoperative readmissions is predominantly in the early and intermediate time range.

Our data are consistent with previously published literature comparing XLAP to LS with respect to hospital LOS (8) (10) (5). Minimally invasive surgery by LS or RAS resulted in a LOS 2.5-2.7 days shorter than for XLAP. Given the shift from XLAP to RAS in recent years, the comparison of RAS to XLAP is an important one that prior papers assessing outcomes such as LOS by surgical approach have failed to make (6). National trends and our findings highlight the increased availability of a minimally invasive procedure, even in the morbidly obese, with the introduction of RAS that was not provided by standard LS. In the LAP2 randomized control trial comparing LS to XLAP, outcomes such as shorter LOS were significantly better for women undergoing LS compared to XLAP (5) (19). Our finding of shorter hospital LOS among patients undergoing LS and RA is an important patient outcome because prolonged LOS has been correlated with increased risk of contracting nosocomial infections and surgical site infections, as well as reduced short term quality of life (QOL), and higher readmission rates, a patient safety indicator (PSI) listed by the Agency for Healthcare Research and Quality (AHRQ) (7) (15) (16) (17). The Centers for Medicare and Medicaid Services (CMS) in 2014 began to link reimbursement to benchmarks of appropriate inpatient admission LOS (18).

In this cohort, we found the overall frequency of readmissions from 0-90 days of surgical hospitalization was 11.2%, and frequency of 0-30 day readmissions was 6.6%. Women undergoing RAS had a 60% decreased risk of readmission at 0-30 days and at 31-60 days. A number of other studies have characterized the costs and complication rate associated with surgical approach to the management of endometrial cancer, but few have included readmissions as part of that assessment (8) (11) (12). Furthermore, time from discharge to readmission is not uniformly assessed in the literature, with authors describing 30, 60, or 90 day readmission rates ranging from as low 2.5% to 13.2% (12) (21) (22) while the AHRQ and CMS identifies 30 day readmission rates as a quality metric (16) (23). This heterogeneity in outcome reporting makes it difficult to compare findings or define a readmission quality indicator that is evidenced based. Additionally, most studies are limited to single-institution reviews and do not capture readmissions to other hospitals, likely resulting in an under-ascertainment of readmissions. The strength of using a state-wide database in our study was the ability to have near complete capture of readmissions, even if they did not occur at the hospital where the initial surgery was performed. Common indications for unplanned readmissions after gynecologic surgery include poor pain control, slow return of bowel function with narcotic use, surgical site infections or incisional breakdown, and venous thromboembolism (26). We hypothesize the reduced frequency of early and intermediate timed readmissions among the RAS group may be due to a shorter LOS, lower pain medication requirements and a faster return to baseline function as seen in other studies (24) (25). We also assessed timing of readmissions and found that readmission rates were highest within the first 30 days from surgical hospitalization and did not differ by surgical approach after 60 days. Based on this evidence and comparisons to the wide range of readmission rates and timing reported in the literature, we conclude that 30-day readmission rates best capture any potential differences due to surgical approach and the effect of surgical choice wanes rapidly after this early time interval.

There are several limitations to this study that are primarily inherent to the use of an administrative (CHARS) database that may be limited by the accuracy and completeness of coding. We were not able to completely adjust for obesity, an important confounder in any study of EC that is also associated with higher operative morbidity and higher conversion rates (5) (26) (27). Obesity was likely not completely captured in CHARS ICD-9 diagnostic codes. Additional confounding factors including history of tobacco use, obstructive sleep apnea, and diabetes may influence choice of surgical approach as well as patient outcomes and are likely under-ascertained in CHARS. Under-ascertainment of potential confounders may lead to residual confounding, resulting in an attenuation of our odds ratios. Another important change to ICD-9 coding was the introduction of a specific code for RAS in 2008. Prior to 2008 all RAS was coded as LS. In the year 2008, some providers may not yet have been accustomed to using the new RAS code and continued to use the LS code, resulting in misclassification of surgical approach. We were also not able to determine if patients underwent an attempt at LS or RAS and were converted to XLAP because they were only given one ICD-9 code for the surgery completed. No patients were assigned the ICD-9 procedure code for surgical conversion from a minimally-invasive to an open procedure. Prior studies report a frequency of conversion from LS or RAS to XLAP ranging from 2.9-25.8% (5) (10). This could lead to misclassification of surgical approach and an attenuation of risks associated with an attempted RAS or LS approach. Finally, with the increase in RAS utilization during our study period, the size of our LS group decreased which may have limited our power to detect differences between LS and XLAP in outcomes such as readmission.

In conclusion, we identified short LOS as a benefit to LS and RAS, but only RAS was found to result in fewer readmissions. These findings impact health care expenditures, patient QOL, and societal costs associated with delivery of quality cancer care. Future studies assessing LOS and readmission rates related to surgical approach should evaluate reasons for readmission and separately assess planned, unplanned, and unavoidable readmissions. An attempt should also be made to improve the ascertainment of conversion rates in administrative databases in order to differentiate between women undergoing a planned versus an unplanned, and likely more complicated, procedure. In the era of quality metrics RAS may be a means of offering women with EC increased access to minimally invasive surgical treatment and improved short-term outcomes.

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Figure 1: Surgical trends in the management of EC in Washington State 2008-2011.

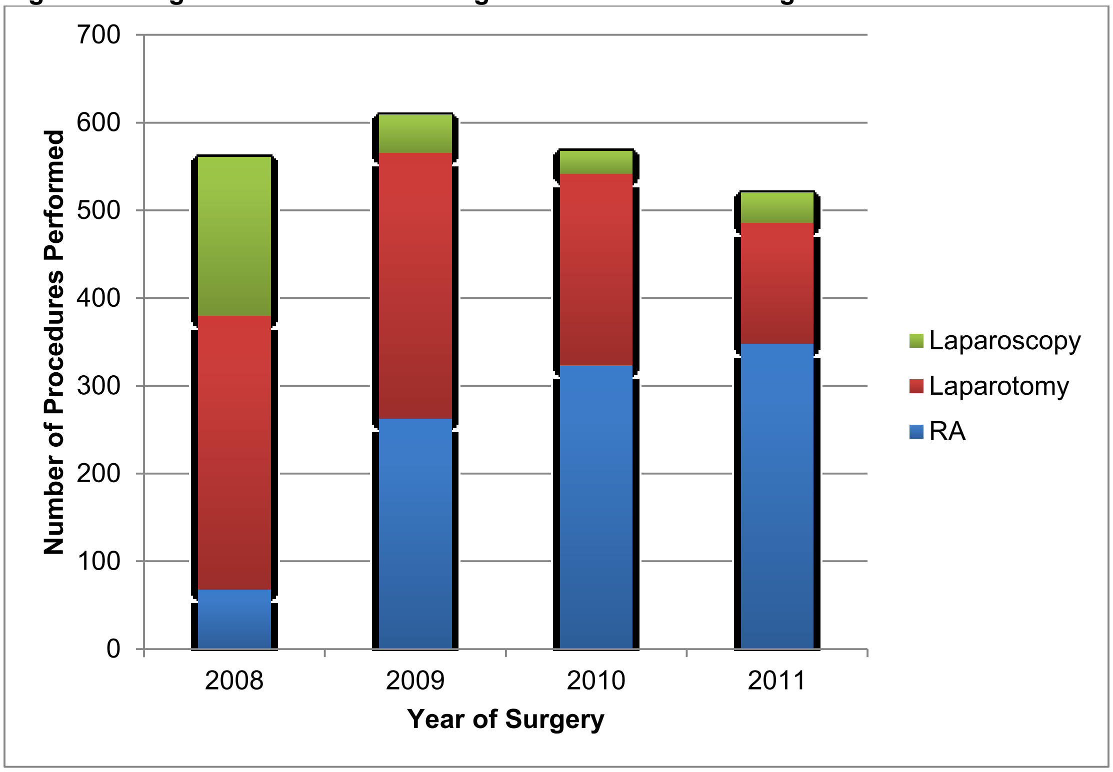

Table 1: Patient characteristics according to surgical approach for women undergoing surgery for the management of EC in Washington State, 2008-2011.

	Robotic *(N=1,003)* *Number (%)*	Laparoscopic *(N=284)* *Number (%)*	Laparotomy *(N=971)* *Number (%)*
Age (years)			
<45	61 (6.1)	17 (6.0)	49 (5.0)
45-55	202 (20.1)	71 (25.0)	217 (22.3)
56-65	365 (36.4)	96 (33.8)	351 (36.2)
>65	375 (37.4)	100 (35.2)	354 (36.5)
Type of Insurance[a]			
Government	442 (44.1)	111 (39.1)	448 (46.1)
Private	532 (53.0)	169 (59.5)	500 (51.5)
Other	29 (3.0)	4 (1.4)	23 (2.4)
Obese	322 (32.1)	100 (35.2)	280 (28.8)
BMI†			
30-34.9	19 (8.8)	4 (9.5)	7 (4.3)
35 – 39.9	37 (17.1)	8 (19.0)	15 (9.2)
≥40‡	156 (72.2)	28 (66.7)	139 (85.3)
Diabetes	217 (21.6)	57 (20.1)	194 (20.0)
History of Tobacco	79 (7.9)	20 (7.0)	53 (5.5)
Charlson Comorbidity Index†	917 (91.4)	263 (92.6)	851 (87.6)
0-1	86 (8.6)	21 (7.4)	120 (12.4)
≥2			
Lymph Node Dissection†	535 (53.3)	136 (47.9)	590 (60.8)

†Chi2 $p<0.01$
*specific BMI data available for 413 patients, some of whom were recorded as having normal range or overweight BMI (data not shown).
‡ ICD9 versions 2010 & earlier, the highest BMI category code was for a BMI >40.
[a]Government insurers included primarily Medicare/Medicaid with a small proportion of TRI-CARE/Indian Health Services/Department of Corrections. Other insurance statuses included self-pay & charity care.

Table 2: Overall readmissions and timing of readmissions by Surgical Approach

	Robotic			Laparoscopic			Laparotomy	
	(N=1003) number(%)	Odds Ratio	(95% Confidence Interval)	*(N=284) number(%)*	Odds Ratio	(95% Confidence Interval)	*(N=971) number(%)*	Odds Ratio (95% Confidence Interval)
None	922 (91.9)			256 (90.1)			827 (85.2)	
Any	81 (8.1)	0.5	(0.3, 0.6)	28 (9.9)	0.7	(0.5, 1.1)	144 (14.8)	-ref-
Timing								
0-30	45 (4.5)	0.4	(0.3, 0.6)	17 (6.0)	0.7	(0.4, 1.2)	88 (9.1)	-ref-
31-60	17 (1.7)	0.4	(0.2, 0.8)	5 (1.8)	0.5	(0.2, 1.4)	37 (3.8)	-ref-
61-90	19 (1.9)	1.0	(0.5, 2.1)	6 (2.1)	1.3	(0.5, 3.4)	19 (2.0)	-ref-

Odds ratios adjusted for year of surgery, lymph node dissection (no/yes), and Charlson comorbidity index score.

Appendix: ICD-9 diagnostic and procedure codes

Case Diagnostic Code for Endometrial Cancer	182.0
Exposure Procedure Codes (hysterectomy & staging)	
Robotic assisted laparoscopy	17.42, 17.44, 17.49
Laparoscopy	68.41, 68.51, 68.61
Laparotomy	68.49, 68.69
Lymph node sampling or dissection	40.50, 40.52, 40.24, 40.1
Charlson Comorbidity diagnostic codes†	
Myocardial Infarction	401.0x-401.1x, 401.9
Congestive Heart Failure	427.9-429.0
Peripheral Vascular Disease	443.x
Dementia	290.x
Chronic Pulmonary Disease	490.x-496.x, 506.4, 500.x-505.x
Debilitating Rheumatologic Disease	710.x, 714.x, 725.x
Peptic Ulcer	531.x-534.x
Mild Liver Disease	571.x
Moderate to Severe Liver Disease	572.x, 456.x
Diabetes Mellitus	250.0-250.3
Diabetes with renal/neurologic/ophthalmologic complications	250.4-250.6
Hemiplegia or Paraplegia	342.x, 344.1
Chronic Kidney Disease	582.x, 583.x, 585.x, 586.x, 588.x
Autoimmune Deficiency Syndrome	042-044, 795.x, V08
History of Malignancy*	140.x-172.x, 174.x-179.x, 188.x-189.x, 200.x-208.x, 196.x-197.x, 198.0-198.5
Other medical diagnostic codes	
Diabetes Mellitus	250.x
Hypertensive disorders	400.9, 401.2, 401.9
Tobacco use	V158
Obstructive sleep apnea	327.2
Asthma	493.0, V175
Hyperlipidemia	272.x
Obese‡	278.x, V85.3x, V85.4x

†Using diagnostic codes from the index admission, patients received a point towards their total CCI score for any of these categories for a possible of 14 points total.
*excludes gynecologic cancers
‡A subject was considered obese if their record contained diagnostic codes for obese not otherwise specified, morbid obesity and/or any BMI code for a BMI ≥30mg/m^2.

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