EXAMINING THE SAFETY AND COST OF RISK-REDUCING SALPINGECTOMIES AS PROPHYLACTIC TREATMENT FOR WOMEN SEEKING STERILIZATION WHO ARE AT LOW TO MODERATE RISK FOR OVARIAN CANCER

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Abstract

BACKGROUND: Ovarian cancer is considered the most lethal of all gynecological malignancies and ranks fifth among the most common cause of cancer deaths in women (1). There is evidence that the site of origin for the majority of the most serious form of ovarian cancers, high-grade serous carcinoma (HGSC), is the fallopian tube (4). Further evidence from the Sectioning and Extensively Examining the FIMbria (SEE-FIM) protocol revealed tubal involvement as well as serous intraepithelial carcinomas in 70% and 40-60% of unselected women diagnosed with ovarian or primary peritoneal HGSC respectively (8-14). As a result, there has been growing consensus as to whether risk-reducing salpingectomies (RRS) should be performed for women who are at moderate risk for developing ovarian cancer especially at a time of patient desired sterilization. A retrospective chart review and review of the literature to determine the safety and cost of risk-reducing salpingectomies performed as sterilizations in comparison to tubal ligations was performed using the Healthcare Cost and Utilization Project inpatient database from 2008-2012.

METHODS: Safety was assessed by examining ICD-9 codes associated with unintentional intraoperative injuries and length of hospital stay between bilateral salpingectomy without oophorectomy and tubal ligation. Women older than 50 yrs., with a family history of ovarian cancer, *BRCA* positive, a lack of menstrual activity in the past 12 months, and imaging suggestive of ovarian cyst or tubal pathology at transvaginal ultrasound were excluded. Cost was determined and compared between the two procedures through the total charges listed with each procedure. Data for length of hospital stay, total charges, and unintentional intraoperative injury were analyzed using multiple linear regression models to calculate coefficients (95%CI), p-values, and odds ratios. These were adjusted for age, gender, race, Charlson score, admission type, median income, primary payer, and selected hospital characteristics (size, teaching vs non-teaching, location/region). All estimates were adjusted using the population weights provided by HCUP.

RESULTS: There was no significant difference in the length of hospital stay between each of the procedures with the bilateral salpingectomy procedure having a mean stay of 0.29 days greater than tubal ligation (95%CI -0.19, 0.79 p: 0.24). There was no significant difference between intraoperative injuries when comparing bilateral salpingectomy to tubal ligation with an odds ratio of 4.84 (95%CI 0.38, 60.9 p: 0.22). There was a significant difference between the total charges associated with each procedure with tubal ligation having a mean cost of $2,227.21 (95%CI $403.2, $4051.10) and the bilateral salpingectomy procedure having a mean cost of $11,189.80 (95%CI $6,582.70, $15,796.80 p<0.001).

CONCLUSIONS: According to this study and literature review the safety of both bilateral salpingectomy without oophorectomy and tubal appears to be comparable. The large cost difference between the two procedures should shift the conversation towards the question of whether hospital billing and insurance coverage for bilateral salpingectomy without oophorectomy should be examined more closely in order to provide RRS as a prophylactic treatment for women at moderate risk for developing ovarian cancer seeking sterilization.

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Introduction

Ovarian cancer is considered the most lethal of all gynecological malignancies and ranks fifth among the most common cause of cancer deaths in women. Even with improvements in surgical and adjuvant treatment for ovarian cancer, the prognosis remains poor with a five-year survival rate of only 45% (1).

The histological subtypes of ovarian cancer that present with the morphological classification of being epithelial ovarian carcinomas (EOCs) include: high-grade serious carcinoma (HGSC), clear cell carcinoma (CCC), endometrioid carcinoma (EC), mucinous carcinoma, and low-grade serous carcinoma. Of all these subtypes, seventy percent of EOCs possess HGSC histology (2). These serous tumors are considered quite aggressive with many being detected in the more advanced stages and commonly reoccur despite platinum-based and surgical treatments (3).

There is evidence that the site of origin for the majority of these HGSCs is the fallopian tube (4). This was determined primarily in a study where women who carried *BRCA1/2* mutations that underwent prophylactic salpingo-oophorectomies had most of the serous intraepithelial carcinomas (STICs) arising from the fimbrial ends of the fallopian tube (5-7). This finding led to the development of the Sectioning and Extensively Examining the FIMbria (SEE-FIM) protocol which subsequently revealed tubal involvement as well as STICs in 70% and 40-60% of unselected women diagnosed with ovarian or primary peritoneal HGSC respectively (8-14).

Current State of Prophylactic Treatment for Ovarian Cancer

Prophylactic bilateral salpingo-oophorectomies (BSO) have been indicated for women that are *BRCA1/2* carriers and has even been suggested for women at moderate risk of developing ovarian cancer. However, there are some long-term complications to consider with this form of prophylactic treatment.

Over 600,000 hysterectomies are performed each year in the United States with about 55% accompanied by BSO (15). A large analysis of over 20,000 patients by the Nurses' Health Study revealed that all-cause mortality, as well as cancer mortality, increased with women who

received BSO (16). This increase in mortality was primarily due to increases in heart disease and stroke among those patients; furthermore, it was concluded that with an expected lifespan of 35 years after surgery, there will be one early death for every nine BSOs performed (16).

The risks associated with BSO at the time of hysterectomy has begun shifting the consensus towards leaving the ovaries in place for prolonged hormone exposure and instead focusing on the removal of the fallopian tubes.

Shifting Consensus towards Risk-Reducing Salpingectomy as Prophylactic Treatment of Ovarian Cancer

In 2000, a review of US health care statistics stated that approximately 700,000 bilateral tubal sterilizations (BTS) were performed annually with 11 million US women 15 to 44 years of age relying on tubal sterilization as a form of contraception (17). Instead of performing tubal ligations, consideration should be given to risk-reducing salpingectomies (RRS) for women seeking permanent sterilization.

In addition, RRS should be considered as an optional procedure during other open or laparoscopic surgeries, such as cesarean births, for women who are at average risk of developing ovarian cancer. This would be more feasible in comparison to a laparoscopic RRS being performed for the sole purpose of reducing the risk of pelvic serous carcinoma as only 11.6 per 100,000 women a year with average risk end up with ovarian cancer (18).

Essentially, this retrospective study and review of literature will hope to answer the question of whether risk-reducing salpingectomy compared to laparoscopic tubal ligation is safe as a form of sterilization and prophylactic treatment.

Current Data

The Efficacy of Risk-Reducing Salpingectomy

A population-based cohort study out of Stockholm, Sweden compared data on women with previous surgery on benign indication (sterilization, salpingectomy, hysterectomy, and BSO) to women who were unexposed to any treatment between the years 1973 and 2009. They

discovered a statistically significant lower risk for ovarian cancer among women with previous salpingectomy when compared with the unexposed population. In addition, risk reductions were also found among women with previous hysterectomy, sterilization, and hysterectomy with BSO. In comparison to unilateral salpingectomy, bilateral salpingectomy was associated with a 50% decrease in the risk of ovarian cancer. They concluded that the removal of the fallopian tubes by itself, or concomitantly with other benign surgery, is an effective way to reduce the risk of ovarian cancer in the general population. (19)

The Safety of Risk-Reducing Salpingectomy

There are existing studies discussing the safety and projected costs of risk-reducing salpingectomies. In a particular study conducted in Valencia, Spain by Minig et al., 97 premenopausal women who had undergone hysterectomy plus bilateral salpingectomy were compared with 71 premenopausal women who received simple hysterectomies. The study found that with regards to the average operative time, estimated blood loss, uterine size, and intraoperative complications, results were similar between the two groups. In addition, there were no significant differences reported between the groups in terms of emergency visits after readmission and hospital readmission. (20)

Ovarian Preservation after Risk-Reducing Salpingectomy

Another study conducted by Morelli et al. examined operative time, variation in hemoglobin levels, postoperative hospital stays, postoperative return to normal activity, and complication rates between two groups of 79 women who underwent total laparoscopic hysterectomy (TLH) plus bilateral salpingectomy and standard TLH without salpingectomy, respectively. It was determined that there were no significant differences between these groups. It was also determined that there were no negative effects on ovarian function in the group with TLH plus bilateral salpingectomy as measured by changes in FSH, Antral Follicle Count, AMH, and mean ovarian diameters in comparison to the TLH without salpingectomy group. (21)

The Estimated Cost of Risk-Reducing Salpingectomy

With regards to cost, one study constructed a Markov Monte Carlo simulation model to estimate the costs and benefits of opportunistic salpingectomy in a hypothetical cohort of women. They estimated that salpingectomy for surgical sterilization was more costly ($9,719.52 +- 3.74) than tubal ligation ($9,339.48 + 26.74) but more effective of reducing the risk of ovarian cancer by 29.2% and increasing life expectancy. (22)

Patient Perception of Risk-Reducing Salpingectomy

The perception of RRS from a patient's perspective is vital in addressing their concerns about the procedure as well as encouraging them to have it performed if they seek sterilization. One study performed a questionnaire of 100 healthy female volunteers regarding their medical history, demographics, and thoughts on RRS. Among those respondents, 71% were unaware of the seriousness of ovarian cancer, 79% were unaware the fallopian tube is indicated as the origin of HGSCs and 87% stated they never heard of RRS as a form of prophylactic treatment for ovarian cancer. Of these respondents, 98% agreed that they had the right to be informed about RRS as well as the choice to undergo the procedure. However, 68% reported fears regarding the potential risk of surgical complications while 3% reported fears regarding the surgical cost of the procedure. (23)

Methods

Data Collection

Available data found in the Healthcare Cost and Utilization Project nationwide inpatient database on patients who received ICD-9 procedure codes related to the procedures as listed below will be collected from January 1, 2008 through December 31, 2012.

Population Exclusion Criteria

Exclusion: Women older than 50 yrs., with a family history of ovarian cancer, *BRCA* positive, a lack of menstrual activity in the past 12 months, and imaging suggestive of ovarian cyst or tubal pathology at transvaginal ultrasound will be excluded.

Statistical Analysis

Data for length of hospital stay, total charges, and unintentional intraoperative injury were analyzed using multiple linear regression models to calculate coefficients with 95% confidence intervals, p-values, and odds ratios. These were adjusted for age, gender, race, Charlson score, admission type, median income, primary payer, and selected hospital characteristics (size, teaching vs non-teaching, location/region). All estimates were adjusted using the population weights provided by HCUP.

Table 1. ICD-9 Procedure Codes

Tubal Ligation Procedures - Occlusion	**ICD-9-CM**
Occlusion of Bilateral Fallopian Tubes via Percutaneous Endoscopic Approach	66.21, 66.22, 66.29
Tubal Ligation Procedures – Destruction	**ICD-9-CM**
Destruction of Bilateral Fallopian Tubes via Percutaneous Endoscopic Approach	66.29
Bilateral Salpingectomy Procedures	**ICD-9-CM**
Resection of Bilateral Fallopian Tubes via Percutaneous Endoscopic Approach	66.51
Resection of Bilateral Fallopian Tubes via Natural or Artificial Opening	66.51
Resection of Bilateral Fallopian Tubes via Natural or Artificial Endoscopic	66.51
Resection of Bilateral Fallopian Tubes via Natural or Artificial Opening with Percutaneous Endoscopic Assistance	66.51

Table 2. ICD-9 Intraoperative Injury Codes

Unintentional Intraoperative Injury Descriptor	**ICD-9-CM**
Accidental cut, puncture, perforation, or hemorrhage during surgical operation	E8700
Removal of other organ (partial) (total) causing abnormal patient reaction, or later complication, without mention of misadventure at time of operation	E8786
Other specified surgical operations and procedures causing abnormal patient reaction, or later complication, without mention at time of operation	E8788

Results

Table 3. Demographics and Hospital Characteristics

	Occlusion of Bilateral Fallopian Tubes via Percutaneous Endoscopic Approach *ICD-9: 66.22.* N=4,332	*Destruction of Bilateral Fallopian Tubes via Percutaneous Endoscopic Approach* *ICD-9: 66.29* N=5,503	*Resection of Bilateral Fallopian Tubes via Percutaneous, Natural, or Artificial Opening with Endoscopic Approach or Percutaneous Endoscopic Assistance* *ICD-9: 66.51* N=1,986	P-value
Age, years (mean, 95% CI)	30.6 (32.3, 30.9)	30.9 (30.5, 31.2)	37.4 (36.7, 38.2)	<0.001
Race (%, 95% CI)				
Caucasian	41.9 (38.5, 45.4)	54.4 (51.2, 57.6)	55.2 (49.9, 60.3)	
African American	14.4 (14.1, 17.1)	16.6 (14.4, 19.1)	20.8 (16.9, 25.4)	<0.001
Hispanic	34.8 (31.5, 38.2)	20.8 (18.4, 23.5)	17.6 (13.9, 21.9)	
Others	8.8 (7.0, 11.1)	8.1 (6.5, 10.0)	6.4 (4.2, 9.5)	
Charlson Score for Comorbidities (%, 95% CI)				
0	95.3 (93.6, 96.5)	93.2 (91.4, 94.5)	85.1 (81.3, 88.3)	<0.001
1	4.2 (3.0, 5.8)	5.9 (4.7, 7.5)	13.8 (10.8, 17.6)	
>=2	0.46 (0.17, 1.3)	0.89 (0.47, 1.6)	1.0 (0.37, 2.7)	
Admission Type (%, 95% CI)				
Non-Elective	72.9 (69.8, 75.7)	65.9 (63.2, 68.7)	46.4 (41.5, 51.4)	<0.001
Elective	27.1 (24.3, 30.2)	34.0 (31.3, 36.8)	53.6 (48.6, 58.5)	
Median Income (%, 95% CI)				
1st Quartile	38.2 (34.7, 41.9)	37.8 (34.7, 41.1)	29.4 (24.8, 34.5)	
2nd Quartile	29.9 (26.6, 33.5)	30.7 (27.7, 33.4)	21.1 (17.2, 25.8)	<0.001
3rd Quartile	20.9 (18.0, 24.1)	18.6 (16.1, 21.3)	27.3 (22.3, 32.3)	
4th Quartile	10.9 (8.7, 13.5)	12.8 (10.8, 15.2)	22.1 (17.9, 26.9)	

Primary Payer (%, 95% CI)				
Medicare	1.2 (0.69, 2.4)	1.2 (0.13, 2.3)	3.4 (1.9, 5.9)	<0.001
Medicaid	66.6 (63.2, 69.9)	49.7 (46.6, 52.9)	21.4 (17.5, 26.0)	
Private uninsured	25.0 (22.2, 28.3)	42.7 (39.5, 45.8)	62.9 (57.8, 67.8)	
Self-Pay/Others	7.0 (5.4, 9.1)	6.3 (4.9, 8.0)	12.1 (9.2, 16.0)	
Hospital Bed Size (%, 95% CI)				
Small	14.9 (12.6, 17.4)	22.8 (20.4, 25.3)	8.9 (6.4, 12.0)	<0.001
Medium	27.3 (24.4, 30.3)	24.2 (21.7, 26.8)	20.2 (16.5, 24.5)	
Large	57.8 (54.4, 61.1)	53.1 (50.1, 56.0)	70.9 (66.2, 75.1)	
Hospital location (%, 95% CI)				
Rural	17.9 (15.3, 20.9)	22.3 (19.8, 25.1)	12.3 (9.3, 16.2)	<0.001
Urban	82.0 (79.1, 84.7)	77.7 (74.9, 80.2)	87.6 (83.8, 90.7)	
Hospital Region (%, 95% CI)				
Northwest	8.8 (7.0, 10.9)	11.3 (9.6, 13.4)	24.7 (20.7, 29.2)	<0.001
Midwest	13.2 (11.0, 15.6)	28.3 (25.7, 30.9)	16.2 (12.8, 20.1)	
South	47.7 (44.4, 51.0)	43.3 (40.4, 46.3)	40.5 (35.8, 45.5)	
West	30.3 (27.3, 33.5)	17.1 (14.9, 19.4)	18.5 (14.9, 22.7)	
Hospital Teaching Status (%, 95% CI)				
Non-Teaching	50.4 (46.8, 53.9)	60.1 (56.9, 63.2)	52.8 (47.6, 58.0)	<0.001
Teaching	49.6 (46.0, 53.2)	39.9 (36.8, 43.0)	47.1 (41.9, 52.4)	
Year (%, 95% CI)				
2008	27.1 (24.3, 30.2)	29.0 (26.4, 31.8)	15.0 (11.9, 18.8)	
2009	25.2 (22.4, 28.2)	20.5 (18.2, 23.0)	8.7 (6.3, 11.9)	<0.001
2010	16.9 (14.6, 19.6)	18.1 (15.9, 20.4)	56.8 (51.8, 64.7)	
2011	18.6 (16.1, 21.3)	18.3 (16.1, 20.7)	10.0 (7.5, 13.5)	
2012	12.1 (10.1, 14.5)	14.1 (12.1, 16.3)	9.3 (6.8, 12.6)	

All P-values were calculated using Linear regression for continuous variable and Chi-Squared analysis for categorical variables after implementing population weights. Estimates does not consider missing data. This table highlights the demographics of each population that fell within their respective surgical procedure categories. Major highlights from this set emphasize Caucasians, individuals without comorbidities, and 1st quartile income earners as the typical patients to receive the listed sterilization procedures. Medicaid patients received the most sterilization procedures for tubal ligation while self-pay was done with salpingectomy. Most procedures were done non-electively in the year 2010.

Table 4. *Assessing the Association between Procedure, Length of Stay and Total Charges Respectively*

Predictors	Coefficient (95% CI)	P-Value[1]
Length of Stay		
Procedure		
ICD 9: 66.22	REF	
ICD 9: 66.29	-0.09 (-0.42, 0.24)	0.58
ICD 9: 66.51	0.29 (-0.19, 0.79)	0.24
Total Charges (Cost)		
Procedure		
ICD 9: 66.22	REF	
ICD 9: 66.29	2,227.21 (403.2, 4,051.1)	0.01
ICD 9: 66.51	11,189.8 (6,582.7, 15,796.8)	<0.001

[1]Coefficients (95%CI) and p-values were calculated using multiple linear regression adjusting for age, gender, race, Charlson score, admission type, median income, primary payer, and selected hospital characteristics (size, teaching vs non-teaching, location/region). All Estimates were adjusted using the population weights provided by HCUP. This table highlights that between women who received either tubal ligation or salpingectomy there was no significant difference in length of hospital stay but a significant cost difference between the two with salpingectomies typically costing much more.

Table 5. *Unintentional Intraoperative Complications by Procedure*

Predictors	OR (95% CI)	P-Value[1]
E-Code 8700		
Procedure		
ICD 9: 66.22	REF	
ICD 9: 66.29	9.21 (0.87, 96.9)	0.06
ICD 9: 66.51	4.84 (0.38, 60.9)	0.22
E-CODE 8786		
Procedure		
ICD 9: 66.22	REF	
ICD 9: 66.29	0.89 (0.14, 5.56)	0.90
ICD 9: 66.51	1.41 (0.04, 47.2)	0.84
E-CODE 8788		
Procedure		
ICD 9: 66.22	REF	
ICD 9: 66.29	3.04 (0.57, 16.1)	0.19
ICD 9: 66.51	4.17 (0.55, 31.5)	0.16

[1]Odds Ratios (95%CI) and p-values were calculated using multiple logistic regression adjusting for age, gender, race, Charlson score, admission type, median income, primary payer, and selected hospital characteristics (size, teaching vs non-teaching, location/region). All Estimates were adjusted using the population weights provided by HCUP. This table highlights that there was no significant difference between either tubal ligation or salpingectomy for accidental intraoperative injuries as provided by the different ICD-9 accidental injury codes.

Table 6. Association between Population, Hospital Characteristics, LOS and Total Charges, respectively

Demographics and Hospital Characteristics	Length of Stay		Total Cost	
	Coefficient (95% CI)	P-value	Coefficient (95% CI)	P-value
Age, years (Per 10-year Increase)	0.015 (-0.19, 0.22)	0.88	1903.5 (426.8, 3380.1)	0.01
Race				
Caucasian	REF		REF	
African American	0.57 (0.04, 1.10)	0.03	3157.1 (-37.5, 6351.7)	0.05
Hispanic	0.05 (-0.23, 0.34)	0.74	1369.6 (-725.0, 3464.2)	0.20
Others	-0.01 (-0.28, 0.26)	0.92	1612.7 (-1894.8, 5120.3)	0.36
Charlson Score for Comorbidities				
0	REF		REF	
1	0.25 (-0.33, 0.83)	0.40	1364.2 (-3790.0, 6518.5)	0.60
>=2	3.46 (-1.05, 7.98)	0.13	30625.7 (6878.4, 54372.9)	0.01
Admission Type				
Non-Elective	REF		REF	
Elective	-0.25 (-0.39, -0.11)	0.001	-632.2 (-1556.6, 292.0)	0.18
Median Income				
1st Quartile	REF		REF	
2nd Quartile	-0.07 (-0.36, 0.22)	0.62	-162.5 (-2293.1, 1968.0)	0.88
3rd Quartile	0.06 (-0.41, 0.52)	0.81	1623.3 (-892.6, 4139.4)	0.20
4th Quartile	0.006 (-0.35, 0.36)	0.97	29.5 (-2922.4, 2981.6)	0.98

Primary Payer				
Medicare	REF		REF	
Medicaid	-0.47 (-1.85, 0.91)	0.50	1782.4 (-3523.1, 7087.9)	0.51
Private uninsured	-0.77 (-2.12, 0.57)	0.26	4022.5 (-1161.3, 9206.3)	0.12
Self-Pay/Others	-0.06 (-1.65, 1.52)	0.93	4038.9 (-2783.3, 10861.2)	0.24
Hospital Bed Size				
Small	REF		REF	
Medium	-0.08 (-0.63, 0.46)	0.76	-775.4 (-3594.7, 2043.9)	0.58
Large	-0.22 (-0.75, 0.31)	0.41	-959.3 (-3735.7, 1816.9)	0.49
Hospital location				
Rural	REF		REF	
Urban	-0.006 (-0.23, 0.23)	0.95	4669.8 (2421.9, 6917.7)	<0.001
Hospital Region				
Northwest	REF		REF	
Midwest	0.05 (-0.32, 0.43)	0.77	-2583.3 (-6002.3, 835.5)	0.13
South	0.20 (-0.11, 0.52)	0.21	-1382.6 (-4805.7, 2040.5)	0.42
West	-0.03 (-0.35, 0.29)	0.85	7956.2 (4105.7, 11806.6)	<0.001
Hospital Teaching Status				
Non-Teaching	REF		REF	
Teaching	0.33 (0.07, 0.59)	0.01	-2754.5 (-4521.2, -987.7)	0.002
Year				
2008	REF		REF	
2009	-0.03 (-0.42, 0.36)	0.88	581.5 (-1699.9, 2863.0)	0.61
2010	0.05 (-0.21, 0.31)	0.69	N/A	
2011	N/A		N/A	
2012	N/A		N/A	

Coefficients (95% CI) and p-values calculated using multiple linear regression adjusting for all other predictors in the model. All estimates were adjusted using the population weights provided by HCUP. This table highlights that the length of stay and cost were not significantly different depending on the demographics of the patients who received either tubal ligations or salpingectomies. The statistical differences do show that the length of stay is less for patients who received sterilization through an elective procedure and longer for places that were teaching hospitals. Cost was statistically different for hospitals that were in the West (more expensive), were teaching (less expensive), and had greater than two comorbidities (more expensive).

Data Analysis Summary

There was no significant difference in the length of hospital stay between each of the procedures with the bilateral salpingectomy procedure having a mean stay of 0.29 days greater than tubal ligation (95%CI -0.19, 0.79 p: 0.24). There was no significant difference between intraoperative injuries when comparing bilateral salpingectomy to tubal ligation with an odds ratio of 4.84 (95%CI 0.38, 60.9 p: 0.22). There was a significant difference between the total charges associated with each procedure with tubal ligation having a mean cost of $2,227.21 (95%CI $403.2, $4051.10) and the bilateral salpingectomy procedure having a mean cost of $11,189.80 (95%CI $6,582.70, $15,796.80 p<0.001).

Discussion

As indicated by the above results, the safety of both bilateral salpingectomy without oophorectomy and tubal ligation with regards to the length of hospital stay and unintentional intraoperative injury appears to be comparable. The results of this analysis appear to agree and augment the rising argument that risk-reducing salpingectomies are considered safe procedures and comparable to tubal ligations when examining short-term outcomes such as operation time, intraoperative blood loss, length of stay, and intraoperative complications/injuries (20). With this in mind, physicians can be assured when they encourage their patients, who are considering tubal ligation for desired sterilization, to pursue bilateral salpingectomy as a possibility for not only its safety but for its ability to reduce the risk for ovarian cancer.

Despite the relatively new concept of risk-reducing salpingectomies and need for further prospective cohort studies to concretely determine its efficacy in risk-reduction, the studies discussed below are just a few of the growing number of cases that support the idea that salpingectomies can reduce the risk of ovarian cancer.

As previously mentioned, in a population-based cohort study by Falconer et al., it was determined that the risk for ovarian cancer among women who underwent salpingectomy were considerably lower when compared with the unexposed population (hazard ratio = 0.65, 95%CI 0.52-0.81). They also discovered that bilateral salpingectomy demonstrated better outcomes when comparing the incidence of ovarian cancer than unilateral salpingectomy (bilateral HR = 0.35, 95%CI = 0.17-0.73 and unilateral HR = 0.71, 95%CI = 0.56-0.91). (19)

Another study conducted by Dilly et al., used Monte-Carlo simulations estimating ovarian cancer risk reduction, complication rates, utilities and associated costs obtained from already published literature regarding opportunistic/risk-reducing salpingectomy while assessing incremental cost-effectiveness ratios (ICER) and quality adjusted life years (QALY) gained. It was determined that the incidence of ovarian cancer at age 65 was significantly different for those that underwent prophylactic salpingectomy (2.2% incidence) versus those who did not receive

this operation (4.75% incidence). In addition, it was estimated that the salpingectomy would yield $23.9 million in dollars saved while having an ICER of $31,432/QALY compared to tubal ligation. (24)

Finally, a meta-analysis conducted by Anggraeni et al., compiling five different studies examining the efficacy of salpingectomy conjectured that the risk of ovarian cancer for women of the general population would be reduced by 29.2%-64% (26). This was similar to the results of another meta-analysis by Yoon et al., that found a lower risk of incidence for ovarian cancer for patients who underwent bilateral salpingectomy compared to control (OR; 0.51, 95%CI 0.35-0.75). (25)

While the efficacy of this procedure is being established, the next question a physician should have in mind is whether or not to recommend this procedure to a patient seeking sterilization when contemplating the long-term safety profile. The major concerns that a physician must contend with regarding this procedure typically involve the effects of menopause on a woman's cardiovascular, cerebrovascular, and bone health. There is well-established data that demonstrates the negative effect pre-menopausal oophorectomy has on these health factors as the protective effects of estrogen are removed. It has been demonstrated that there is an increased risk for mortality related to cardiovascular disease, strokes, and osteoporosis/hip fractures with pre-menopausal oophorectomy (15-16, 27-31). For example, current data has demonstrated that women older than sixty years of age with oophorectomy are at a twofold increase in mortality with hip fracture than compared to women with intact ovaries (29-30). The overall hope of leaving the ovaries intact and simply removing the fallopian tubes would be that long-term ovarian function would not be affected by this procedure.

Since bilateral salpingectomies without oophorectomy have been performed only within the last decade, future studies should focus on a prospective cohort to measure the difference between individuals who receive tubal ligation and this procedure for morbidities and mortalities related to cardiovascular, cerebrovascular, and musculoskeletal pathologies. Current data supports the fact that risk-reducing salpingectomies do not affect ovarian function both at three months post-operatively as well as in a three to five-year follow-up (32). This data

is promising as it can be hypothesized that long-term complications will not arise; however, more prospective studies would be required before making an absolute argument in favor of ovarian preservation after bilateral salpingectomy.

Another factor to consider before offering this procedure is understanding the cultural and religious beliefs that a woman may have. Despite the fact that this procedure is designed to prevent a horrible disease, it also may violate the ethical principles of people who practice religions such as Catholicism. This is an issue that should be brought to the spotlight as there is an estimated 51 million registered Catholics as of 2014 in the United States which comprise approximately 21% of the overall population (33).

Although many Catholics are against the idea of contraception, the importance of living a full and healthy life is well-recognized by the Catholic Church. The Doctrine of Double Effect therefore plays a large role in this discussion where *The New Catholic Encyclopedia* states that this doctrine contains four conditions that must be met in order to consider an act, such as the bilateral salpingectomy, of moral high-ground: 1) the act itself must be morally good or at least indifferent, 2) the person may not consciously want the bad effect but may permit it, 3) the good effect must be produced directly from the act and not the bad effect, and 4) the good effect must compensate for allowing the bad effect. If pregnant, full-term Catholic mother and her husband are satisfied with the number of children they have and are hoping to use more effective means of preventing future pregnancies, a physician with the permission of their patient, should consult their religious authority to help patients feel more comfortable in following their faith while protecting themselves from deleterious disease.

The next concern on the patient's mind, as well as the hospital's and insurance company are the cost of this procedure. The analysis revealed a significant difference between bilateral salpingectomy vs tubal ligation in terms of total charges the hospital billed the patient. There appeared to be a significant difference in charges depending on several factors including whether the hospital was urban ($p<0.001$), located in the west region ($p<0.001$), whether it was a teaching hospital ($p<0.002$), whether the patient was older ($p<0.01$), and the patient's Charlson comorbidity score ($p<0.01$). We can conjecture that the older the patient as well as

the patients with higher comorbidity may be charged more based on the level of care billed for either for anesthesia or the surgeon. However, the other criteria are more subject to wide-based interpretation and cannot be further delineated at this time. It is the hope that the total charges could be reduced for patients by initiating negotiation with hospital billing and insurance companies using the current data regarding the benefits of risk-reducing salpingectomy to make the procedure more affordable.

Conclusions

The major focus of this paper, existing data, and future studies regarding the safety, cost, and efficacy of bilateral salpingectomy as prophylaxis against ovarian cancer is to address the concerns of four parties: patients, physicians, hospitals, and insurance companies.

We want to provide patients ease of mind in knowing that this procedure is safe, simple, and cheap. As physicians, we want to ensure that this procedure is not only feasible, but has proven long-term outcomes for ovarian cancer prophylaxis, and one that won't increase morbidity or mortality. For hospitals and insurance companies, this procedure should be able to save them from having to pay for future costly medical expenses that revolve around first preventing unwanted pregnancies and secondly preventing the cost of having future hospitalizations due to complications of ovarian cancer.

As of now, it appears that risk-reducing salpingectomy is relatively safe compared to its tubal ligation counterpart. However, the high cost of this procedure, which is most likely tied to hospital billing, should be closely examined in the hopes that negotiations can be set between hospitals and insurance companies to make the procedure more affordable for patients to pay in the short-term for ultimate long-term gain.

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