Gynecologic Oncology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Gynecologic Oncology

journal homepage: www.elsevier.com/locate/ygyno

Cost-effectiveness of opportunistic salpingectomy for ovarian cancer prevention

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HIGHLIGHTS

- Opportunistic salpingectomy may be a cost-effective strategy for decreasing ovarian cancer risk.
- Cost-effectiveness is greater with hysterectomy than for permanent contraception.
- Our results depend on the risk-reducing impact of salpingectomy, which is not yet well-defined.

ARTICLE INFO

Article history:
Received 5 May 2017
Received in revised form 24 May 2017
Accepted 26 May 2017
Available online xxxx

Keywords:
Salpingectomy
Ovarian cancer
Cost-effectiveness

ABSTRACT

Objectives. Data suggesting a link between the fallopian tube and ovarian cancer have led to an increase in rates of salpingectomy at the time of pelvic surgery, a practice known as opportunistic salpingectomy (OS). However, the potential benefits, risks and costs for this new practice are not well established. Our objective was to assess the cost-effectiveness of opportunistic salpingectomy at the time of laparoscopic permanent contraception or hysterectomy for benign indications.

Methods. We created two models to compare the cost-effectiveness of salpingectomy versus usual care. The hypothetical study population is 50,000 women aged 45 undergoing laparoscopic hysterectomy with ovarian preservation for benign indications, and 300,000 women aged 35 undergoing laparoscopic permanent contraception. SEER data were used for probabilities of ovarian cancer cases and deaths. The ovarian cancer risk reduction, complication rates, utilities and associated costs were obtained from published literature. Sensitivity analyses and Monte Carlo simulation were performed, and incremental cost-effectiveness ratios (ICERs) were calculated to determine the cost per quality adjusted life year (QALY) gained.

Results. In the laparoscopic hysterectomy cohort, OS is cost saving and would yield $23.9 million in health care dollars saved. In the laparoscopic permanent contraception cohort, OS is cost-effective with an ICER of $31,432/QALY compared to tubal ligation, and remains cost-effective as long as it reduces ovarian cancer risk by 54%. Monte Carlo simulation demonstrated cost-effectiveness with hysterectomy and permanent contraception in 62.3% and 55% of trials, respectively.

Conclusions. Opportunistic salpingectomy for low-risk women undergoing pelvic surgery may be a cost-effective strategy for decreasing ovarian cancer risk at time of hysterectomy or permanent contraception. In our model, salpingectomy was cost-effective with both procedures, but the advantage greater at time of hysterectomy.

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http://dx.doi.org/10.1016/j.ygyno.2017.05.034
0090-8258/

1. Introduction

Despite advances in cancer treatment over the last several decades, ovarian cancer remains the deadliest gynecologic malignancy in the United States with over 14,000 deaths per year [1]. While significant resources have been utilized to develop screening tools to detect ovarian cancer, we still do not have a highly sensitive test that can reliably detect ovarian cancer in its early stages [2]. Therefore, many researchers are focusing on strategies to prevent ovarian cancer [3]. One such strategy involves prophylactically removing the fallopian tubes at the time of pelvic surgery for benign indications, a practice known as opportunistic salpingectomy.

Histopathologic data from the last 20 years has shown that epithelial ovarian cancer may actually originate from the fallopian tube [4–6]. Population-based data showing a decreased incidence of ovarian cancer in patients who have undergone salpingectomy for benign indications support this theory. The risk-reducing benefit likely extends beyond the already known risk reduction from tubal ligation [7–11]. This evidence has led gynecologists to perform opportunistic salpingectomies at the time of hysterectomy or tubal surgery for permanent contraception, and many major gynecologic societies in the United States and Canada support this practice change [12,13]. A recent study evaluating hysterectomy practices in a large health system revealed a significant increase in rates of hysterectomies being performed with salpingectomy (14.7% in 2011 to 72.7% in 2014, $p < 0.001$) [14].

As this practice becomes more pervasive, additional evidence addressing a range of potential risks and benefits is needed before implementing widespread practice change. While there have been concerns that opportunistic salpingectomy would increase surgical complication rates [15,16], data have not supported this [14,17,18]. The effect on ovarian function is still unknown with conflicting results in the few studies that have been conducted [18,19]. Although the histopathologic and retrospective data is compelling, prospective data is still needed to confirm the ovarian cancer risk reduction benefits. Patient quality of life and health care costs are also important considerations. Although ovarian cancer is relatively rare, it has an extraordinary impact on healthcare costs, mortality, and quality of life [20,21]. Hysterectomy and tubal ligation are common procedures that could substantially decrease ovarian cancer rates, with approximately 415,000 women undergoing hysterectomy (for benign indications) and another 300,000 undergoing laparoscopic tubal sterilization per year in the United States [22,23]. Without prospective data, theoretical modeling of cost-effectiveness plays an important role in establishing the benefit of a policy change.

We performed a cost-effectiveness analysis (CEA) to examine the potential effects of routine opportunistic salpingectomy at the time of laparoscopic hysterectomy for benign indications and laparoscopic permanent contraception. We hypothesized that despite potential increased initial costs of salpingectomy, the long-term impact would render these procedures cost-effective.

2. Methods

We created two decision models to evaluate the cost-effectiveness of salpingectomy at the time of laparoscopic permanent contraception and hysterectomy, respectively. Our primary outcome was the incremental cost-effectiveness ratio (ICER) of opportunistic salpingectomy compared to standard procedures in each setting. The ICER is the cost per one additional quality-adjusted life year (QALY) gained, and a lower ICER corresponds to a more cost-effective strategy. We calculated total costs and QALYs to determine ICERs for each strategy in the models. QALYs were calculated using utilities, which are predefined values attributed to a year of life in a certain health state. A standard willingness-to-pay (WTP) threshold of $100,000 per QALY was applied [24]. The WTP threshold is the amount that a society is willing to pay for one additional year of life in perfect health.

Our secondary outcomes included cancer deaths, cancer cases, unintended pregnancies, QALYs and cost. Both models were built and analyzed using TreeAge software (TreeAge Pro 2016, Williamstown, MA). Probabilities, costs, utilities of the respective procedures, complications, and outcomes were calculated using published data and are shown in Tables 1 and 2. This study was exempt from Institutional Review Board approval.

2.1. Hysterectomy model

For the hysterectomy model, a theoretical cohort of 50,000 women who underwent laparoscopic hysterectomy was used. This number is an estimate of the number of women who undergo standard laparoscopic hysterectomy for benign indications with adnexal sparing in the United States annually [25]. For simplicity, vaginal, robotic and abdominal hysterectomies were excluded from the model. Women were assumed to have their hysterectomy at age 45 and be at risk of developing ovarian cancer at age 63, to account for the approximate average age of hysterectomy and median age of ovarian cancer diagnosis, respectively. Due to the protective effects of tubal ligation, a probability of prior tubal ligation was applied to women who underwent hysterectomy without salpingectomy [26]. Probabilities of surgical complication, ovarian cancer diagnosis, and ovarian cancer death after hysterectomy either with or without bilateral salpingectomy were included in the model (Table 1). Fig. 1 shows a schematic of the hysterectomy decision tree model.

2.2. Permanent contraception model

An estimated 300,000 women undergo interval laparoscopic tubal ligation for permanent contraception, typically through occlusive procedures (e.g. titanium clip, silastic ring) or cautery [22]. The study population applied to this model is a theoretical cohort of 300,000 women aged 35 who request laparoscopic sterilization. In addition to the outcomes of ovarian cancer cases and deaths as in the hysterectomy model, this model also accounts for the differences in unintended and ectopic pregnancy rates associated with either laparoscopic tubal occlusion or total bilateral salpingectomy. Fig. 2 shows a schematic of the permanent contraception model.

2.3. Probabilities

Ovarian cancer rates were calculated based on a baseline lifetime population risk of ovarian cancer of 1.3%, and risk reduction data from a 2015 study by Falconer et al. (Table 1). This study is the largest population-based retrospective study evaluating the impact of bilateral

Table 1
Baseline probabilities.

Variable	Probability	Reference
Surgical complication		
Hysterectomy (with and without salpingectomy)	0.15	[27]
Tubal ligation	0.016	[28]
Laparoscopic salpingectomy	0.016	[a]
Tubal ligation	0.31	[26]
Unintended pregnancy		
After tubal ligation	0.0045	[32]
After salpingectomy	0.0038	[32]
Ectopic pregnancy		
After tubal ligation	0.0069	[33]
After salpingectomy	0.0018	[33]
Lifetime ovarian cancer risk		
Baseline	0.013	[1]
After tubal ligation	0.009	[7]
After bilateral salpingectomy	0.005	[7]
After hysterectomy	0.01	[7]
Death from ovarian cancer	0.54	[1]

[a] No increased baseline complication rate for opportunistic salpingectomy.

Please cite this article as: S.E. Dilley, et al., Cost-effectiveness of opportunistic salpingectomy for ovarian cancer prevention, Gynecol Oncol (2017), http://dx.doi.org/10.1016/j.ygyno.2017.05.034