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IMMEDIATE POSTPARTUM VERSUS INTERVAL INTRAUTERINE DEVICES AND IMPLANT: A COST UTILITY ANALYSIS

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by

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DOCTOR OF MEDICINE
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THESIS

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ABSTRACT

Objectives: To compare the *cost per quality of life (QALY)* between immediate postpartum and interval initiation of intrauterine devices (IUDs) and contraceptive implants from the societal perspective. *Cost per unintended pregnancy prevented* between timing strategies was also compared.

Methods: Two decision analytic models were created using TreeAge Pro 2015 software for TCu380A IUD and levonorgestrel IUD and for the contraceptive implant. Each model compared immediate postpartum versus interval contraceptive provision to determine the occurrence of pregnancy events over time and their impact on costs and QALYs, using a time horizon of 1 to 5 years. The probabilities of insertion, expulsion/removal, pregnancy and the utility values with having an unintended pregnancy were estimated from a literature review. Costs were adjusted to 2014 and included all direct medical and non-medical expenses such as transportation and infant care for the first year of life. Indirect costs were estimated using the human capital method. Sub-analysis using different payer perspectives and adjustments due to mistimed pregnancies were also done. Univariate and probabilistic sensitivity analyses (PSAs) were performed to determine robustness of the model.

Results: The strategy of immediate insertion for all three contraceptive devices dominated interval initiation. For each delivery, interval (versus immediate) insertion results in an additional average cost of $1,549, loss of 0.015 QALY, and an additional incremental cost of $2,249 for each unintended pregnancy prevented. Regardless of perspective used and after adjustments for mistimed pregnancy, immediate insertion remains the strategy of choice. Extending the time horizon to 5 years increases the additional average cost with interval insertion to $2,600, loss of 0.024 QALY, and an additional incremental cost of $4,923 for each unintended pregnancy prevented. The models were most sensitive to the probabilities of actual insertion or postpartum loss to follow up, pregnancy rates from use of IUDs and implants, and cost of immediate insertion. PSA, using Monte Carlo simulation, show that immediate insertion is less costly and more effective 95% of the time.

Conclusion: Immediate postpartum IUD and implant initiation is the dominant strategy compared to interval insertion, which support expansion of long acting reversible contraception (LARC) coverage.

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Chapter 1

Introduction

Long acting reversible contraception (LARC) includes the intrauterine device (IUD) and contraceptive implant. The IUD comes in two forms- the copper-containing Paragard® and the levonorgestrel-containing Mirena® and are prescribed for up to 5-10 years. The implant is marketed as Nexplanon® and is inserted sub-dermally in the upper arm under local anesthesia. It releases a small continuous amount of the synthetic progestin etonogestrel and can be left in place for up to 3 years. Both forms of LARC are highly effective, with failure rates ranging from only 0.05 to 0.8% in the first year of use (Trussell 2011). Typically, they are inserted at 6 weeks postpartum or at any other time that a woman is not pregnant. This is called *interval insertion.* An emerging practice in the US is to initiate LARC immediately postpartum—at 10 minutes after placental delivery for the IUD and up to 72 hours after giving birth for the implant. This is called *immediate postpartum insertion.*

Despite high efficacy, LARC remains underutilized, with only 8.5% of American women who are on contraception reporting its use (Finer, Jerman 2012). The relationship between low LARC utilization rates and unintended pregnancy is well-documented (Blumenthal, Voedisch 2011, Blumenthal, Shah 2013, Secura 2013). In the United States, more than half of all pregnancies are unintended, with an estimated annual direct cost of $4.6 billion (Trussell, Henry 2013).

The immediate postpartum provision of LARC methods has the potential to reduce the burden of unintended pregnancy. Although postpartum LARC initiation has been is commonly used in other parts of the world for the last three decades (Grimes, Lopez 2010) only a few centers in the US follow this practice.

There are several advantages to the immediate postpartum provision of LARC – 1.) Inadvertent insertion of LARC in pregnant women is avoided, 2.) Women are highly motivated to initiate birth control use immediately postpartum, and 3.) Provides convenience for the patient and her provider. However, there are disadvantages as well. The risk of expulsion for the IUD may be higher for immediate placement and early follow up is recommended in order to detect this (Grimes, Lopez 2010). IUD expulsion rates are also dependent on the route of delivery, with cesarean births consistently having lower expulsion rates than vaginal deliveries (Kapp and Curtis 2009, Mwalwanda and Black 2013). In practice, although an increase in expulsion rate may occur with immediate IUD insertion, the benefits outweigh this risk given the high rate of no show for the 6-week postpartum visit.

Systematic reviews have shown that immediate postpartum LARC initiation is safe and effective (Grimes, Lopez 2010, Kapp and Curtis 2009, Mwalwanda and Black 2013) and provides an opportunity to provide birth control at a convenient time to women who are highly motivated to prevent subsequent pregnancies. In the classic study by Echeverri in 1973, of those postpartum women who desired an IUD and had an interval insertion scheduled, only 45% received their IUD, as compared to 95% of women who had an IUD placed in the immediate postpartum period (Echeverry 1973). Tocce in 2012 also showed that the uptake and continuation rate of immediate postpartum implants among adolescents is higher compared to any other form of birth control, including getting the implant at 6 weeks postpartum (Tocce, Sheeder 2012). Of the identified barriers to immediate postpartum LARC use, high upfront cost and insurance coverage relating to access may be the most prominent. If the financial aspect of procuring contraception was removed, up to two-thirds of reproductive-aged women would choose LARC (Secura, Allsworth 2010). Currently, New Mexico is one of only nine states that provide Medicaid reimbursement for immediate postpartum LARC (ACOG 2014). Among private insurance companies, only Kaiser Permanente in California recognizes the procedure and provides coverage.

The American College of Obstetricians and Gynecologists (ACOG) supports the use of LARC in the immediate postpartum period to aid in reducing unintended pregnancy rates and rapid repeat pregnancies (ACOG 2009, ACOG 2011). In the state of New Mexico, about 56% of pregnancies were unintended, with 58% ending in live births (NM PRAMS 2008). Data from the University of New Mexico Hospital (UNMH) in 2002 show that about 12% of postpartum women chose interval LARC as their method of birth control. However, at best, only 60% of these women actually had a LARC placed (Ogburn, Espey 2005). More recent data from 2006-2011 at UNMH indicate an increasing number of women who plan to use birth control after delivery, with preference for the implant and the IUD (Singh, Rogers 2014).

In New Mexico, immediate postpartum LARC insertion is gaining in popularity and practice, largely because of efforts of providers that resulted in a revision of Medicaid reimbursement to remove the cost of LARC insertion from the global fee. It is important to note, however, that even though there is Medicaid coverage that allows and incentivizes providers to train and perform immediate postpartum LARC, a substantial proportion of women who deliver in New Mexico are undocumented. These women typically utilize the

Emergency Medical Services for Aliens (EMSA) program, which is paid for by NM Medicaid (NM Medical Assistance Program Manual Supplement). EMSA does not provide coverage for any family planning services, including the immediate postpartum provision of LARC. In essence, the state pays for the labor and delivery procedures of undocumented women, with no coverage for birth control.

A cost utility study is a subtype of cost-effectiveness analysis that looks at the cost per quality of life (QALY) gained. Two previous cost utility analyses of contraceptive methods show that LARC use leads to cost savings and increased QALYs compared to methods which require patient adherence such as oral contraceptive pills (Secura 2013, Sonnenberg, Burkman 2004). A 2015 study of immediate versus interval IUD insertion by Washington and colleagues demonstrated cost savings of $282,000, 10 additional QALYS and prevention of 88 unwanted pregnancies for every 1000 women who get immediate postpartum LARC (Washington, Jamshidi 2015). This study, however, was done based on a single perspective and did not analyze indirect costs. A study analyzing the cost effectiveness/cost utility of immediate postpartum IUDs and implants compared to interval insertion is relevant given the environment and factors discussed above.

Chapter 2

Specific Aims

Our *long-term goal* is to increase the practice and uptake of highly effective contraceptive methods in the US. The *overall objective* is to perform a cost-utility analysis of immediate postpartum insertion of LARC methods, specifically the IUD and sub-dermal implant, compared to interval insertion. The *central hypothesis* is that immediate postpartum LARC initiation is more cost-effective. Previous cost effectiveness studies have shown that LARC use leads to more cost savings (based on societal and public/private insurer perspectives) and QALYs compared to no contraceptive use or use of less effective birth control methods such as oral contraceptive pills. If our hypothesis is proven correct, our results may help to facilitate the national adoption of immediate postpartum LARC insertion and reduce barriers to coverage and reimbursement.

To test our central hypothesis, we pursued the following objectives using the *societal perspective:*

1. Perform an incremental cost utility analysis (cost per QALY) of immediate postpartum LARC initiation compared with interval insertion through the creation of a decision analytic model using a time horizon of 1 year.

2. Using the same decision analytic model and time horizon of 1 year, perform secondary analyses on the following:

   a. Intermediate outcome - determine the incremental cost per unintended pregnancy that is prevented when LARC is initiated in the immediate postpartum period versus interval insertion

   b. Perspective – use of hospital and third party payer perspectives

c. Subgroup analysis based on the characteristics of the postpartum population of women in the model:

- route of delivery (vaginal versus cesarean)
- age (< 18 y/o and > 18y/o); and
- health insurance status

3. Extension of the time horizon for each decision model to 2, 3, 4 and 5 years.

Chapter 3

Research Design and Methods

A cost utility analysis is a sub-type of cost effectiveness study which looks at the costs of two or more strategies (in this case, the timing strategy of immediate postpartum versus interval LARC) based on a measure of utility. In pharmacoeconomics, utility is a value between 0 and 1 (zero meaning death and one meaning perfect health) that is associated with a particular health state and used in the estimation of quality adjusted life years (QALYs). For example, how do women perceive their quality of life if they have an unintended pregnancy? What numerical utility value would they equate this to, given that a value of 1.0 means a "not pregnant" state?

We created two decision analytic models (IUDs and implant) using TreeAge Pro Computer software that considers women who give birth in New Mexico. We compared the two strategies of LARC provision (immediate versus interval insertion) in the postpartum period and determined the occurrences of pregnancy events over time and their impact on quality of life expressed as QALYs, which is the recommended metric of health outcomes for cost-effectiveness analysis in health care (Siegel, Torrance 1997).

Figure 1 is the study flowchart depicting how we created, refined and tested our models, while Figures 2 and 3 show the decision analytic models for postpartum IUD use and the sub-dermal implant, respectively. Instead of expulsion, removal rates were incorporated with the model using the implant. The inputs used were derived using three processes: literature review, database review and inputs from experts within the research team to generate model parameters based on categories of probabilities, costs and utility measures for having an unintended pregnancy.

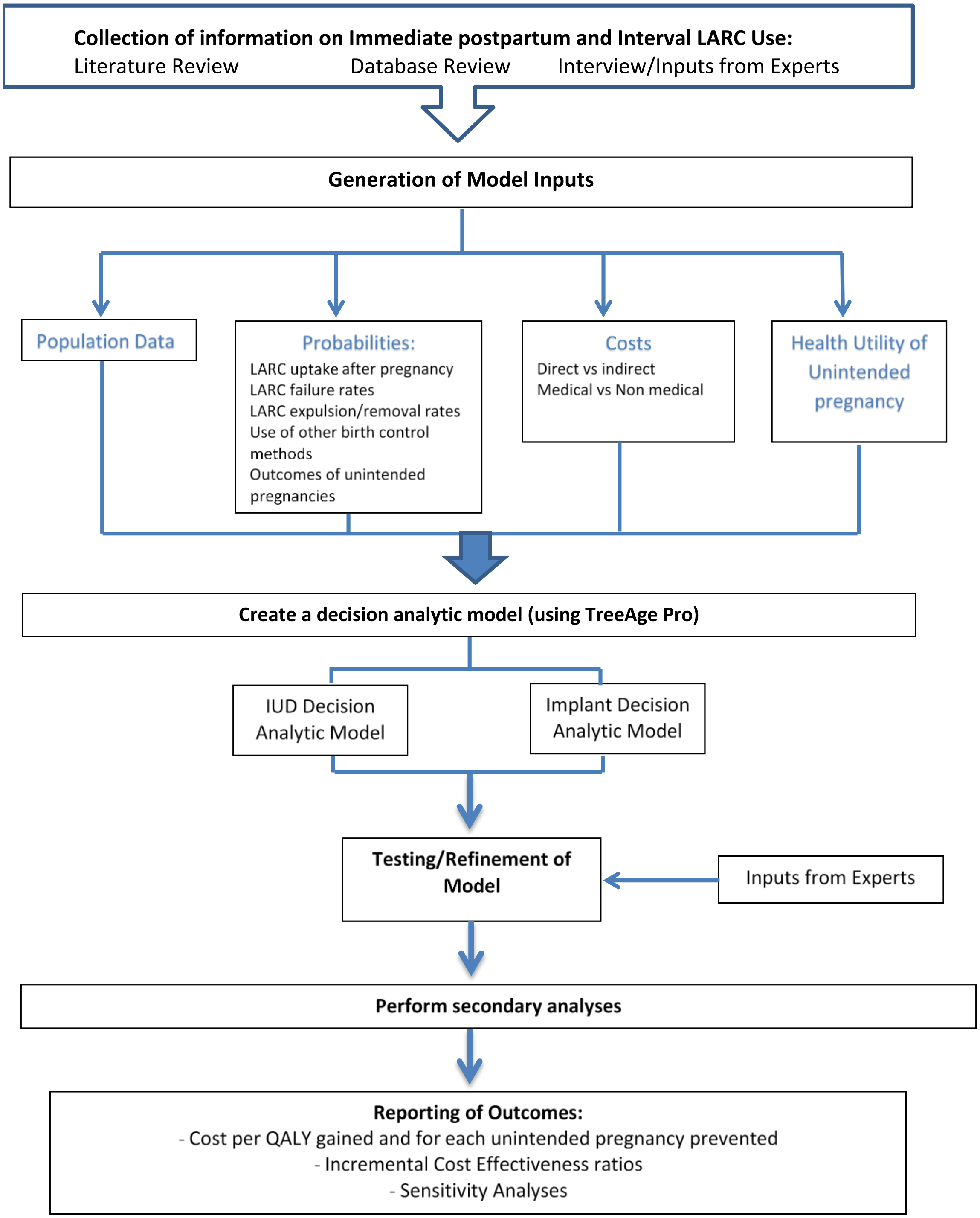

Figure 1. Study Flowchart. LARC – long acting reversible contraception; QALY – quality adjusted life year; IUD – intrauterine device.

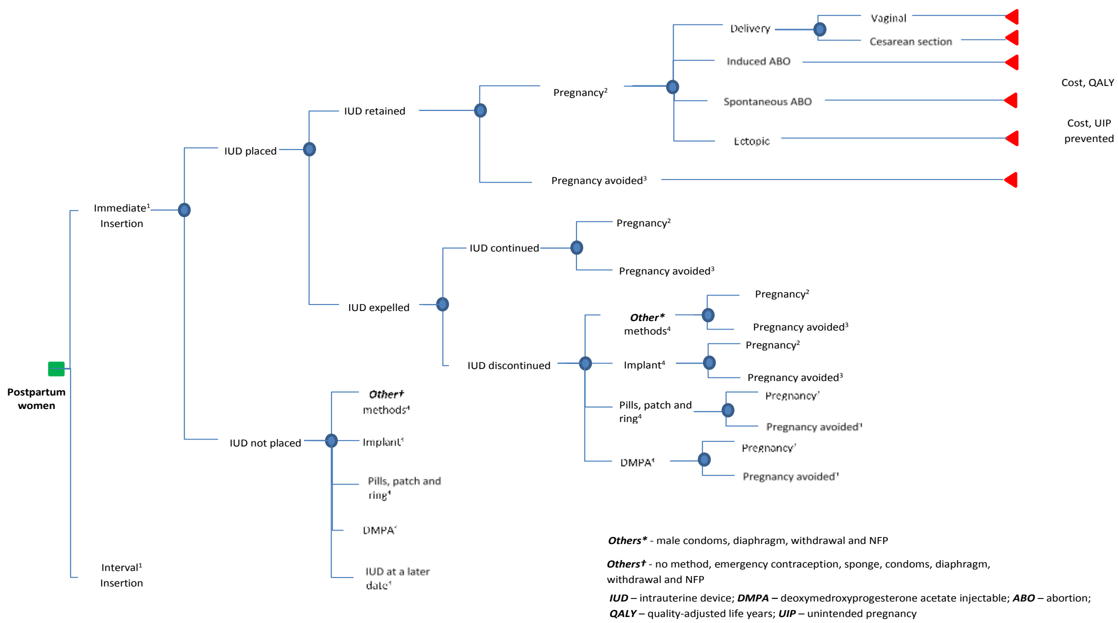

Figure 2: Decision Analytic Model for the IUD. Time horizon = 1 year. The model starts with IUD use by postpartum women which then branches out to the two insertion timing strategies. Each strategy were analyzed using probabilities of uptake, expulsion and pregnancy (failure) rates. The primary endpoint is the comparison of cost per quality of life (QALY) between immediate and interval insertion. Secondarily, the cost per unintended pregnancy that is prevented were also computed. Branches with the same numbers lead to the same pathways, truncated for clarity. For example, pregnancy outcomes follow branching distribution as seen in #2. (IUD – intrauterine device; Mx – management; UIP – unintended pregnancy).

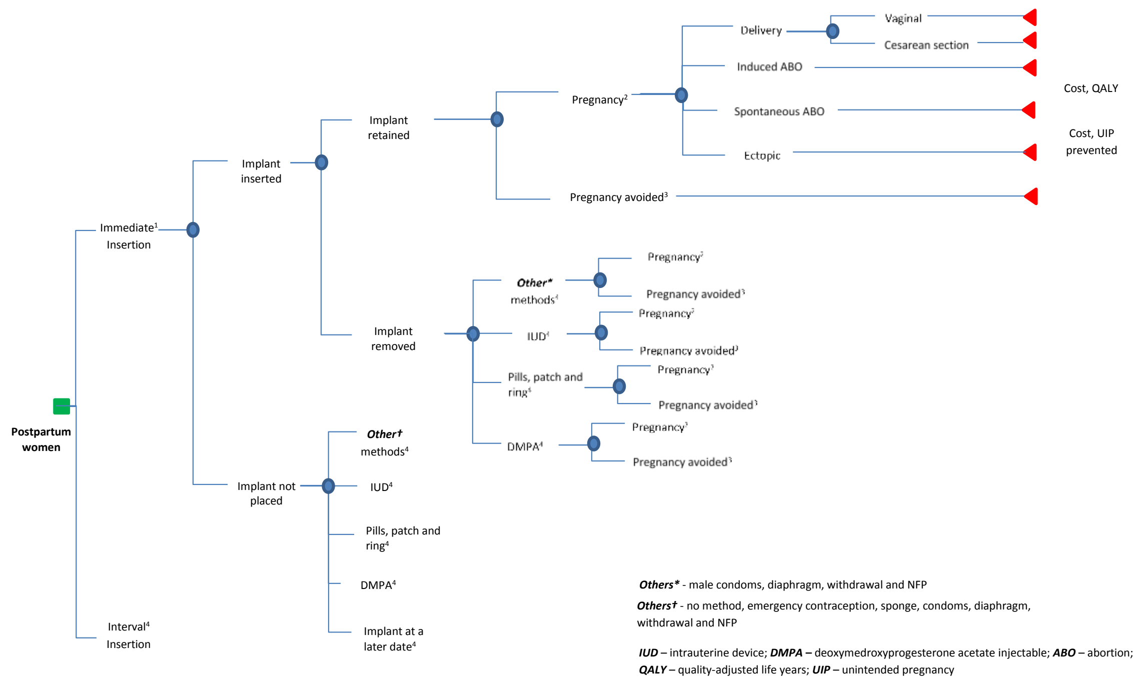

Figure 3: Decision Analytic Model for the implant. Time horizon = 1 year. The model starts with Implant use by postpartum women which then branches out to the two insertion timing strategies. Each strategy were analyzed using the same parameters and output as the IUD, with removal instead of expulsion rates. Branches with the same numbers lead to the same pathways, truncated for clarity. For example, pregnancy outcomes follow branching distribution as seen in #2. (IUD – intrauterine device; Mx – management; UIP – unintended pregnancy).

The model started with the population of postpartum women who gave birth at the UNMH from 2010-2012 (average over three years) who were medically eligible to receive an IUD or implant. These counts were generated through the Clinical and Translational Science Center (CTSC) data warehouse services based on ICD-9 and CPT codes *(see Appendix*). The base case analysis applied to women of average health and fertility, ranging from 15 to 44 years of age. The models above have been simplified and truncated for clarity. Some key features of a decision tree:

Square – represents a decision node, typically at the start of a tree that indicates a decision point between two alternative options (immediate versus interval).

Circle – chance node that shows a point where two or more alternative events for a patient are possible; these are shown as branches coming out of a node. For example, after IUD uptake or placement, patients can either retain their IUD or it might fall out. The sum of the probabilities of each branch from a chance node should equal to one.

Triangle – these are the terminal nodes that represent the end of the pathway.

Moving left to right, the first probabilities in the tree show the probability of an event happening. Subsequent probabilities are conditional, meaning its probability given that a previous event has occurred. At the decision node, we are comparing the practice of immediate postpartum versus interval LARC initiation. For each strategy, a certain proportion of women will actually have it placed, and among those who had it placed, a certain number will have their IUDs fall out based on the expulsion rate at 3 months. Some will choose to have the IUD re-inserted while others switch to other forms of birth control. Subsequent probabilities are determined by pregnancy or failure rates of each birth control methods, as well as the distribution of outcomes of unintended pregnancies (*i.e.* how many end up in delivery, induced and spontaneous abortion and ectopic pregnancy).

To explain how the model works, first we determined the cost and utility per outcome. For example, the total cost for vaginal delivery is $18,511 and the utility of having an unintended pregnancy and delivering vaginally is 0.88 (a patient who is not pregnant has a utility of 1.0). We then determined the probability of each branch within a chance node. For example, 95% of women actually had an IUD placed in the immediate postpartum period. Of these 95%, 83% retain their IUD while the rest experienced an expulsion. The probability of getting pregnant while on an IUD is .08% and 56% of these pregnancies end in deliveries. Among women who deliver, 77% are vaginal deliveries. At each terminal node, all of these probabilities were multiplied (0.95x0.83X.008x0.56X0.77) to get the total probability of that event happening (*i.e.* the event of having an unintended pregnancy that ends in vaginal delivery when an IUD is retained after immediate postpartum placement). This total probability was multiplied with the cost ($18,511) and utility (0.88) to get the expected values, and these expected values were summated per strategy and compared.

Model Structural Assumptions and Parameter Estimates. The following were the structural assumptions and parameter estimates of the model:

1. In order to provide a pure comparison, all women within the study population were assumed to either initiate LARC immediately postpartum or at 6 weeks follow up.

2. Women who failed to initiate the IUD or implant were assumed to either initiate use of the combined oral pill/patch/ring, deoxymedroxy progesterone acetate (DMPA)

injection, other forms of less effective birth control (no method, emergency contraception, sponge, condoms, diaphragm, withdrawal and natural family planning), or implant or IUD at a later date based on the frequency distribution of contraceptive use among women within the reproductive age in the US (Guttmacher Institute Fact Sheet). For women who have IUD expulsions or implant removals, these probabilities were more favorable towards birth control use based on published (Singh, Rogers 2014) data since this group of women are assumed to be more motivated to practice contraception.

3. The annual probability of unintended pregnancy with IUD or implant use were based on an average between the lowest and highest failure rates in general from observed population-based failure rates (Trussell 2011).

4. Complication and side effects of IUD initiation/use were not included in the model since it is assumed (based on systematic reviews) that there is no difference in perforation, infection, pain and bleeding rates between the two timing strategies (Grimes, Lopez 2010, Kapp and Curtis 2009, Mwalwanda and Black 2013). IUD discontinuation rates were based on reported spontaneous expulsion rates. Implant removal considered discontinuation of use from bleeding irregularities and all other causes. Weighted averages were calculated to determine expulsion and removal rates used in the model.

5. The range of values that were used in the sensitivity analysis (SA) were either confidence intervals lifted directly from published studies, set by the research team (which include a panel of experts), for which a wider range was used, or all probabilities between 0 and 1.

7. The indirect costs were assumed as the "average" loss of productivity based on median wage rate, regardless of educational level and socioeconomic status.

8. Expansion of the time horizon to 2 to 5 years assumed continued use of the birth control method women were using at the end of year 1. For the implant, costs were calculated to reflect removal and re-insertion at the end of year 4.

Model Clinical Inputs: A search strategy guided by a Bioinformatics expert was employed. The search terms Economics OR Cost and cost analysis AND intrauterine devices OR desogestrel were applied in the PubMed database, filtered for human studies and English language (*published in LoboVault* http://hdl.handle.net/1928/24738*)*. Additional searches within the Contraception journal and the Guttmacher Institute literature were also conducted and the reference section of published systematic reviews were hand-searched for relevant articles. From this, we were able to determine the rates of actual IUD/implant placement, expulsion/removal rates, percent of women within the US and New Mexico population using specific methods of birth control, pregnancy rates within 1 year of birth control use, and the outcomes of unintended pregnancies. Whenever possible, values specific to probability estimates in New Mexico were used.

Model Cost Inputs: Direct medical costs include those associated with the LARC insertion itself, including device/drug costs, procedure and follow up costs. Device/drug costs were based on published average wholesale price (AWP) with adjustments specific to New Mexico, while procedure costs were based on the Medicare Fee Schedule (Trussell, Henry 2013, Trussell, Lalla 2009). The total initiation costs for contraceptive methods were calculated from these and include the drug/device, physician consult, insertion, follow up and removal. Other direct medical cost include the outcomes of unintended pregnancy such as the cost of vaginal delivery, cesarean delivery, ectopic pregnancy and induced and spontaneous abortions and were taken from HealthCare Utilization Project (HCUP.net) and MEDPAR Inpatient Hospital National Data. Direct non-medical costs include transportation costs as well as the cost of having an infant during its first year of life. Indirect costs, which pertain to lost productivity, was estimated using the median hourly wage in New Mexico with an 18% adjustment on gender gap. These were applied as opportunity costs on time spent traveling, time spent at the clinic, time spent hospitalized because of the pregnancy outcome, and time spent on maternity leave. Adjustments for mistimed pregnancy were also performed separate from the base case analysis. Calculations were adjusted using medical inflation rates from the Consumer Price Index and expressed in US 2014 dollars.

Estimating Costs from Different Perspectives. In pharmacoeconomics, the model perspective defines the costs that are included in the analysis. All direct medical and non-medical costs (except for transportation) were included in all the perspectives used. Transportation and indirect costs were estimated specifically for calculating total costs using the societal perspective.

a. State perspective

   In New Mexico, it is estimated that Medicare/Medicaid reimburses approximately 14% less of the published AWP of drug costs and devices (Medicaid.gov 2012). In terms of procedural costs for the consult, insertion, follow up and removal of these methods, the previous works of Trussell and colleagues based on the

Medicare Fee Schedule was utilized for the study models (Trussell, Henry 2013, Trussell, Lalla 2009).

The average cost of hospitalization for an uncomplicated vaginal and cesarean delivery, as well as an ectopic pregnancy were lifted directly from the average Medicaid/Medicare reimbursement rates in 2010 and 2011 (HCUP.net and MEDPAR database).

Since national inpatient data estimates has a tendency to show skewed abortion reimbursement costs (*i.e.* data are overestimated since only the small number of complicated and life threatening cases of abortion are hospitalized), these costs (spontaneous and induced) were again estimated from the previous work of Trussell and colleagues in 2013 (Trussell, Henry 2013). This study assumed more realistic estimates of about 10% of spontaneous abortions occurring in non-hospital outpatient clinics. Additional data from Jones and colleagues in 2011 allowed us to estimate that only 4% of induced abortions were done in the hospital setting (Jones and Jerman 2014). Based on the frequency distributions of abortions occurring in the hospital inpatient, hospital outpatient and non-hospital setting, as well as the costs reimbursed by Medicare/Medicaid, we calculated the weighted average costs of abortion procedures.

b. Private Insurance perspective

Commercial insurance costs were estimated based on AWP and differences in physician reimbursement rates. According to Gencarelli and Goff, private insurance reimbursement rates of drugs and devices are generally higher than public-payer insurance (Goff 2001, Gencarelli 2002). The range is between 2-20% less than the AWP and for the base case analysis, we used the midpoint of 9%.

In New Mexico, the overall private insurance physician reimbursement rate is 29% higher than Medicare/Medicaid (US GAO Report 2014). For office procedures/visits, this difference is about 26%, while it can be as high as 31% for inpatient procedures. These values were then multiplied with the State costs to come up with private insurance cost estimates.

c. Hospital perspective

Costs included in analyzing the model from the hospital perspective included the immediate insertion of the IUDs and implant. Based on data from HCUP.net and MEDPAR, we estimated that hospitals expend an amount equal to about 26.5% of public-payer reimbursements related to vaginal and cesarean deliveries. The costs of immediate LARC insertion were calculated by multiplying this percentage with the State costs.

Procedure costs for vaginal and cesarean deliveries and ectopic pregnancies were calculated from the amount not reimbursed by public-payer insurance, again based on data from HCUP.net and MEDPAR. In cases of spontaneous and induced abortions, costs were computed based on the percentage of these cases that were managed in the hospital setting. Due to the lack of published data, we used a conservative estimate that approximately 50% of the average cost of state reimbursements both for the medical and surgical management of abortion procedures (among the small number of those done in the hospital setting) are borne by hospitals.

d. Societal perspective

Costs incurred from the societal perspective include all possible medical expenses that are associated with birth control initiation and pregnancy outcome at a time. To avoid double counting, these were calculated by summing up private insurance and hospital costs. The absolute values associated with state cost were already encompassed in the private insurance costs. Numerically, this is represented by the following:

Societal Costs = State Costs + (Private insurance cost – State Costs) + Hospital Costs

Additionally, estimates pertaining to direct non-medical costs (such as transportation and infant care for the first year of life) and indirect costs were included in computing the total societal costs.

Model Health Utility Inputs. The utility values that women place when having an unintended pregnancy were estimated based on studies by Sonnenberg and colleagues in 2004 and Schwarz and colleagues in 2008. The former study estimated it using a convenience sample of women, and have been referenced to in other cost-utility studies on LARC (Sonnenberg, Burkman 2004). These values were used in the base case analysis, since they were also the most conservative. The work of Schwarz and colleagues was based on a cross sectional sample of women using various methods including the visual analog scale (VAS), time trade-off and standard gamble techniques (Schwarz, Smith 2008). The range of values reported from all three techniques were used in the sensitivity analysis.

The end result compared the cost per quality of life year gained for each unintended pregnancy avoided between the two timing strategies (i.e. incremental cost utility ratio). Secondary analysis allowed us to report the incremental cost per unintended pregnancy that is prevented (incremental cost effectiveness ratio, ICER), as well as extended the model for up to five years, using an annual discount rate of 3%. Additionally, the incremental ratios using hospital and third party payer (state-funded and private insurance) perspectives were determined. The individual values generated from the models were applied to the population estimates garnered from the CTSC data warehouse review. The study population was also stratified based on postpartum mode of delivery (vaginal versus cesarean delivery), patient population age (< 18 y/o and > 18y/o), and insurance status (state funded, private insurance and self-pay/EMSA).

Sensitivity analyses were performed to test the robustness of the model, again using TreeAge Pro computer software. Univariate sensitivity analyses on model inputs were conducted and these include the following: actual IUD/implant insertion rates, IUD expulsion/implant removal probabilities, QALYs and outcomes and the costs of birth control initiation and unintended pregnancies. The range of values used were either based on standard deviations, range of all possible values in literature or set up to +/- 50% of the mean value. For actual insertion and expulsion/removal rates, all possible values between 0 and 1.0 were used.

Monte Carlo simulations were also applied to define confidence intervals for the main outcome (cost per QALY), and to test the “model’s robustness to simultaneous multivariable changes” (Salcedo, Sorensen 2013). This allowed us to run 10,000 simulations using all the possible combinations of distributions of model parameter values. The parameters varied in the probabilistic sensitivity analysis (PSA) included uptake and expulsion rates, IUD/implant continuation after expulsion/removal, pregnancy rates with IUD/implant use, and the costs of IUD/implant initiation and pregnancy outcomes. We assumed beta distribution for the clinical parameters and a normal distribution for the cost parameters, using standard deviations from literature.

Chapter 4

Results and Data Analysis

Description of study population. From the years 2010-2012, more than ten thousand women delivered at the University of New Mexico Hospital (UNMH). On average, about 3,239 of these women per year were medically eligible to receive the IUD and contraceptive implant either immediately after delivery or at six weeks postpartum. Majority (60%) of these women were Hispanic. Of the non-Hispanic population, 17% were Whites and 11% were Native Americans. About 92% were older than 18 years of age. Seventy eight percent (78%) delivered vaginally, while 22% gave birth via cesarean section. These values closely mirror the state cesarean section rate of 23.3% (Menacker and Hamilton 2010).

In terms of insurance status, 18% had commercial insurance, 49% relied on a state-covered third party payer, while more than a third (~33%) were uninsured. There were about 11 prenatal visits per pregnancy while only about 46% had any form of postpartum follow up. Among these women who had a postpartum visit, the average number is 1.5 per pregnancy.

Tables 1 and 2 show the probabilities for the model clinical parameters. For the expulsion/removal rates of IUDs and implants at 3 months, we calculated a single value from the weighted average of expulsion rates of prospective observational and randomized controlled trials (RCTs) that compare immediate versus interval LARC based on their sample sizes.

Table 1. Clinical Inputs for the Decision Analytic Model.

Parameter	TCu380A Paragard®	LNG IUD Mirena®	ENG implant Nexplanon®	Source
Immediate Insertion - actual IUD/implant placement prior to discharge	0.950	0.950	0.950	(Echeverry 1973) (Ogburn, Espey 2005)
Interval Insertion - actual IUD/implant placement on pp follow up	0.600	0.600	0.600	(Ogburn, Espey 2005)
Immediate Insertion - IUD expulsion/implant removal rate (overall)	0.172	**0.211**	0.131	*Weighted average:* *TCu380A*: (Eroglu, Akkuzu 2006) (Bonilla Rosales, Aguilar Zamudio 2005, Celen, Moroy 2004, Feldblum, Caraway 2005, Morrison, Waszak 1996, Chi, Wilkens 1985, Van Der Pas, Delbeke 1980, Thiery, van Kets 1982, Lara Ricalde, Menocal Tobias 2006, Meirik, Rowe 2009, Wu, Hu 2000, Letti Muller, Lopes Ramos 2005, Zhou and Chi 1991, Lara, Sanchez 1989) *LNG IUD:* (Whitaker, Endres 2014, Dahlke, Terpstra 2011, Chen, Reeves 2010, Hayes, Cwiak 2007) *ENG implant:* (Tocce, Sheeder 2012, Wilson, Tennant 2014, Darney, Patel 2009)
Immediate insertion - IUD expulsion rate (vaginal delivery)	0.178	-	-	
Immediate insertion - IUD expulsion rate (CS)	0.126	-	-	
Interval Insertion - IUD spontaneous expulsion/implant removal rate (overall)	0.024	0.024	.247	
Percent of women who continued the IUD after expulsion	0.670	0.670	-	(Whitaker, Endres 2014, Chen, Reeves 2010)
After IUD expulsion/implant removal - Percent of women using DMPA pp	0.098	0.098	0.060	(Singh, Rogers 2014): birth control plan postpartum among a cohort of NM women
After IUD expulsion/implant removal - Percent of women using the implant/IUD pp	0.042	0.042	0.414	
After IUD expulsion/implant removal - Percent of women using PPR pp	0.538	0.538	0.329	
After IUD expulsion/implant removal - Percent of women who are using *other** forms of BC pp	0.322	0.322	0.197	
Pregnancy rate with IUD in place	0.008 (year 1)	**0.002 (year 1-5)**	-	(Trussell 2011)
Pregnancy rate with Other* method of BC	0.279	0.279	0.279	*Weighted average:* (Trussell 2011, (Singh, Rogers 2014)
Pregnancy rate with Other+ method of BC	0.668	0.668	0.668	*Weighted average:* (Trussell 2011, Guttmacher Institute 2015)

Table 1, Continuation…				
Parameter	**TCu380A Paragard®**	**LNG IUD Mirena®**	**ENG implant Nexplanon®**	**Source**
Pregnancy rate with implant use	0.001	0.001	0.0005	(Trussell 2011)
Pregnancy rate with PPR use	0.090	0.090	0.090	
Pregnancy rate with DMPA use	0.060	0.060	0.060	
When IUD/implant not placed - Percent of women with *other+* forms of BC pp	0.677	0.677	0.677	Guttmacher Institute 2015: prevalence of birth control use in the US
When IUD/implant not placed - Percent of women with implant/IUD use pp	0.004	0.004	0.045	
When IUD/implant not placed - Percent of women with pill use pp	0.244	0.244	0.244	
When IUD/implant not placed - Percent of women with DMPA use pp	0.030	0.030	0.030	
When IUD/implant not placed - Percent of women with IUD/implant at a later date pp	0.045	0.045	0.004	
Percent of UIP ending in vaginal deliveries	0.233	0.233	0.233	(Menacker and Hamilton 2010); rates specific to NM
Percent of UIP ending in CS	0.767	0.767	0.767	

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; CS – cesarean section; pp – postpartum; DMPA – deoxymedroxy progesterone acetate injectable; PPR – pills, patch, ring; BC – birth control; ABO – abortion; UIP – unintended pregnancy; Other* - male condoms, diaphragm, withdrawal and natural family planning; Other+ - no method, emergency contraception, sponge, condoms, diaphragm, withdrawal and natural family planning; NM – New Mexico. *Highlighted in bold are the rates specific to the levonorgestrel-containing intrauterine device.*

Table 2. Outcomes of unintended pregnancies per birth control method.

Method	Ectopic pregnancy[a]	Delivery[b]	Induced ABO[b]	Spontaneous ABO[b]	TOTAL
TCu380A IUD	0.03	0.56	0.28	0.13	1.00
LNG IUD	0.50	0.29	0.15	0.07	1.00
IUD (combined)	0.27	0.43	0.21	0.10	1.00
Implant	0.01	0.57	0.29	0.13	1.00
PPR	0.01	0.57	0.29	0.13	1.00
DMPA	0.01	0.57	0.29	0.13	1.00
Other*	0.01	0.57	0.29	0.13	1.00
Other+	0.01	0.57	0.29	0.13	1.00

[a] (Trussell, Henry 2013)
[b] Rates were calculated from the estimated outcome of unintended pregnancies in New Mexico: 58% deliveries, 29% induced abortions and 13% spontaneous abortions (Finer and Kost 2011).
IUD – intrauterine device; LNG – levonorgestrel; PPR – pills, patch, ring; DMPA – deoxymedroxy progesterone acetate injectable; ABO – abortion; Other* - male condoms, diaphragm, withdrawal and natural family planning; Other+ - no method, emergency contraception, sponge, condoms, diaphragm, withdrawal and natural family planning.

Table 3 represents the costs for each birth control method by perspective, while Table 4 shows procedural costs involved including physician consult, insertion cost, removal cost and follow up. The combination of these two tables showing the *total initiation costs* is seen in Table 5. The cost per insertion strategy (immediate versus interval) for IUD/implant initiation is also shown.

Table 3. Costs of drugs/devices based on perspective.

Birth Control Method	**2014 AWP**	**State (AWP-14%)[a]**	**Private (AWP-9%)[b]**	**Hospital (State x .265)[c]**	**Societal (Private+hospital)[d]**
TCu380A IUD	**627.66**	539.79	571.17	143.04	714.22
LNG IUD	**737.92**	634.61	671.51	168.17	839.68
Implant (upfront)	**692.13**	595.23	629.84	157.74	787.57
Pills, patch, ring (9 months)	**522.70**	449.52	475.66	0.00	475.66
Pills, patch, ring (12 months)	679.51	584.38	618.36	0.00	***618.36***
DMPA (9 months)	**176.21**	151.54	160.35	0.00	160.35
DMPA (12 months)	234.94	202.05	213.80	0.00	***213.80***
Others* (9 months)[e]	**138.57**	119.17	126.10	0.00	126.10
Others (12 months)*[e]	184.75	158.89	168.13	0.00	***168.13***
Others+ (9 months)[f]	**17.36**	14.93	15.80	0.00	15.80
Others+ (12 months)[f]	23.15	19.91	21.07	0.00	***21.07***

AWP – average wholesale price; IUD – intrauterine device; LNG – levonorgestrel; DMPA – deoxymedroxy progesterone acetate injectable; Other* - male condoms, diaphragm, withdrawal and natural family planning; Other+ - no method, emergency contraception, sponge, condoms, diaphragm, withdrawal and natural family planning.

[a] Based on the average wholesale price in New Mexico from the Medicaid Covered Outpatient Prescription Drug Reimbursement Information by State 2012.
[b] Private insurance average wholesale price range is between 2-20% less (Goff 2001, Gencarelli 2002); we used the midpoint which is 9% to estimate how much commercial insurance companies reimburse for the cost of drugs/devices.
[c] Hospital costs for the intrauterine devices and implants were estimated based on average cost to charge ratios for vaginal and cesarean delivery for 2014, as a portion of state reimbursement.
[d] Societal cost represent the total potential expense for each drug/device; state costs are already encompassed within private costs so they were not added separately to avoid double counting.
[e] Driven by cost of diaphragm, including fitting and supplies.
[f] Driven by cost of male condom.

Table 4. Procedure cost for each contraceptive drug/device by perspective.

Procedure Costs	Method	State[a]	Private (State x 1.26)[b]	Hospital (State x .265)[c]	Societal (Private + hospital)[d]
Consultation	TCu380A IUD	72.39	91.21	0.00	91.21
	LNG IUD	72.39	91.21	0.00	91.21
	Implant	43.51	54.82	0.00	54.82
	Pills, patch, ring	43.51	54.82	0.00	54.82
	DMPA	43.51	54.82	0.00	54.82
	Others*	29.83	37.58	0.00	37.58
	Others+	0.33	0.42	0.00	0.42
Insertion	TCu380A IUD	75.60	95.26	20.03	115.29
	LNG IUD	75.60	95.26	20.03	115.29
	Implant	131.59	165.80	34.87	200.67
	Pills, patch, ring	0.00	0.00	0.00	0.00
	DMPA	0.00	0.00	0.00	0.00
	Others*	0.00	0.00	0.00	0.00
	Others+	0.00	0.00	0.00	0.00
Removal	TCu380A IUD	173.67	218.82	0.00	218.82
	LNG IUD	173.67	218.82	0.00	218.82
	Implant	194.71	245.34	0.00	245.34
	Pills, patch, ring	0.00	0.00	0.00	0.00
	DMPA	0.00	0.00	0.00	0.00
	Others*	0.00	0.00	0.00	0.00
	Others+	0.00	0.00	0.00	0.00
Follow up visit	TCu380A IUD	72.39	91.21	0.00	91.21
	LNG IUD	72.39	91.21	0.00	91.21
	Implant	0.00	0.00	0.00	0.00
	Pills, patch, ring	0.00	0.00	0.00	0.00
	DMPA	98.59	124.22	0.00	124.22
	DMPA (12 months)	131.45	165.63	0.00	165.63
	Others*	0.00	0.00	0.00	0.00
	Others+	0.00	0.00	0.00	0.00

IUD – intrauterine device; LNG – levonorgestrel; DMPA – deoxymedroxy progesterone acetate injectable; Other* - male condoms, diaphragm, withdrawal and natural family planning; Other+ - no method, emergency contraception, sponge, condoms, diaphragm, withdrawal and natural family planning.

[a] Based on the Medicare fee schedule (Trussell, Henry 2013).
[b] Private insurance cost in New Mexico is estimated to be 1.26% of the total state reimbursement, based on physician reimbursement rates of office procedures (US Government Accountability Report 2014).
[c] Hospital costs for insertion of intrauterine devices and implants were estimated based on average cost to charge ratios for vaginal and cesarean delivery for 2014, as a portion of state reimbursement.
[d] Societal cost represent the total potential expense for each procedure; state costs are already encompassed within private costs so they were not added separately to avoid double counting.

Table 5. Initiation costs of birth control methods by perspective.

BC initiation		State	PI	Hospital	Societal
(device/drug, consult, insertion)	TCu380A IUD Interval	$687.78	$757.64	$0.00	$757.64
	TCu380A IUD Immediate	$615.39	$666.43	$163.08	$829.51
	LNG IUD Interval	$782.61	$857.98	$0.00	$857.98
	LNG IUD Immediate	$710.21	$766.77	$188.21	$954.97
	Implant Interval	$770.32	$850.45	$0.00	$850.45
	Implant Immediate	$726.82	$795.64	$192.61	$988.24
	Pills, patch, ring	$493.03	$530.48	$0.00	$530.48
	DMPA	$195.04	$215.17	$0.00	$215.17
	Others*	$149.00	$163.68	$0.00	$163.68
	Others+	$15.26	$16.22	$0.00	$16.22

IUD – intrauterine device; LNG – levonorgestrel; DMPA – deoxymedroxy progesterone acetate injectable; Other* - male condoms, diaphragm, withdrawal and natural family planning; Other+ - no method, emergency contraception, sponge, condoms, diaphragm, withdrawal and natural family planning.

Table 6 depicts the procedural costs for each possible outcome of an unintended pregnancy by perspective. Table 7 shows the prenatal, transportation, infant care and indirect costs associated with each outcome. These are summarized in Table 8. Finally, utility values for having an unintended pregnancy are presented in Table 9.

Table 6. Procedural costs for outcomes of unintended pregnancies.

Outcome		Procedural Costs 2014
Vaginal delivery	mean hospital charge	$11,620.34
	mean hospital cost	$3,425.39
	Medicare/Medicaid (State)[a]	$2,622.51
	Hospital cost [b]	$802.89
	Private insurance cost [c]	$3,435.48
	Societal cost [d]	$4,238.37
Cesarean delivery	mean hospital charge	$19,593.70
	mean hospital cost	$5,691.80
	Medicare/Medicaid (State)[a]	$4,648.40
	Hospital cost [b]	$1,043.40
	Private insurance cost [c]	$6,089.41
	Societal cost [d]	$7,132.80
Ectopic pregnancy	mean hospital charge	$26,678.32
	mean hospital cost	$7,395.05
	Medicare/Medicaid (State)[a]	$4,556.95
	Hospital cost [b]	$2,838.10
	Private insurance cost [c]	$5,969.61
	Societal cost [d]	$8,807.71
Spontaneous abortion	Medicare/Medicaid (State)[a]	$939.39
	Hospital cost [b]	$349.98
	Private insurance cost [c]	$1,211.82
	Societal cost [d]	$1,561.79
Induced abortion	Medicare/Medicaid (State)[a]	$808.19
	Hospital cost [b]	$301.19
	Private insurance cost [c]	$1,042.57
	Societal cost [d]	$1,343.76

Values for mean hospital charge and mean hospital cost were taken from the HealthCare Utilization Project (HCUP.net) using the diagnosis related group (DRG) specific to the average costs of uncomplicated vaginal delivery (DRG 775), cesarean delivery (DRG 766) and ectopic pregnancy (DRG 777) for Medicaid patients from 2010-2012.

[a] State costs were estimated by multiplying the mean hospital cost to the opportunity cost of the procedure (ratio of Medicaid reimbursement and covered charges from the MEDPAR Inpatient Hospital National Data).
[b] Hospital costs were calculated by subtracting the state costs from the mean hospital costs.
[c] Private insurance costs were calculated by multiplying the state costs by 1.31, estimated from the difference in physician reimbursements between Medicaid/Medicare and commercial insurance in New Mexico for inpatient procedures (US Government Accountability Report 2014).
[d] Societal cost represent the total potential expense for each procedure; calculated from the sum of private insurance and hospital costs; state costs are already encompassed within private costs so they were not added separately to avoid double counting.

Table 7: Prenatal Care, Direct non-medical and Indirect costs by perspective

Direct non-medical costs and prenatal care		**2014**	**State**	**Private**[e]	**Hospital**	**Societal**
Transportation[a]	Two-way	21.20	0.00	0.00	0.00	21.20
Prenatal care[b]	Vaginal and CS delivery	2,585.03	2,585.03	3,334.69	0.00	3,334.69
	Adjusted for mistimed pregnancy[d]	-	1,123.04	1,448.73	0.00	1,448.73
Infant Care[c]	Vaginal and CS delivery	6,956.39	6,956.39	8,973.74	0.00	8,973.74
	Adjusted for mistimed pregnancy	-	3,022.15	3,898.57	0.00	3,898.57
Indirect costs (wage lost)		**2014**	**State**	**Private**	**Hospital**	**Societal**
Traveling[f]	0.72 hour (43.2 minutes)	9.03	0.00	0.00	0.00	9.03
Time spent at Clinic	1 hour	12.54	0.00	0.00	0.00	12.54
UIP Outcome based on average length of stay (LOS): wage lost	Vaginal delivery: 2.1 LOS (16.8 hours)[g]	210.67	0.00	0.00	0.00	210.67
	Cesarean delivery: 3.1 LOS (24.8 hours)[g]	310.99	0.00	0.00	0.00	310.99
	Abortion: 1.5 LOS (12 hours)[g]	150.48	0.00	0.00	0.00	150.48
	Ectopic: 1.7 LOS (13.6 hours)[g]	170.54	0.00	0.00	0.00	170.54
Maternity Leave[h]	Vaginal delivery: 2 weeks (112 hours)[g]	1,404.48	0.00	0.00	0.00	1,404.48
	Adjusted for mistimed pregnancy	610.17	0.00	0.00	0.00	610.17
	Cesarean delivery: 4 weeks (224 hours)[g]	2,808.96	0.00	0.00	0.00	2,808.96
	Adjusted for mistimed pregnancy	1,220.33	0.00	0.00	0.00	1,220.33

CS – cesarean section; LOS – length of hospital stay

[a] From CNT.org and Oakridge National Lab; total driving cost for New Mexico/#miles = $.50/mile; average of 22 miles (one way) for medical/dental procedures
[b] (Monea and Thomas 2011)
[c] (Rohde 2012)
[d] Trussell 2009; assuming 60% of unintended pregnancies are actually mistimed with a 3% discount rate in 2 years, using the formula: cost*[1-(0.6/(1.03)^2)].
[e] Private insurance costs calculated by multiplying state costs by 129%, estimated from the overall difference in physician reimbursements between Medicaid/Medicare and commercial insurance in New Mexico (US Government Accountability Report 2014).
[f] Indirect cost for traveling estimated from average time to get to work, 21.6 minutes one way in New Mexico (US Census.gov).
[g] Indirect costs calculations based on an 8-hour work day.
[h] Women's Health USA 2011

Table 8. Total costs for each unintended pregnancy outcome based on perspective.

Societal Perspective					
	Vaginal delivery	CS delivery	Ectopic	Induced ABO	Spontaneous ABO
Transportation	21.20	21.20	21.20	21.20	21.20
Prenatal care	3,334.69	3,334.69	0.00	0.00	0.00
Procedure	4,238.37	7,132.80	8,807.71	1,343.76	1,561.79
Infant Care	8,973.74	8,973.74	0.00	0.00	0.00
Indirect-Travel	9.03	9.03	9.03	9.03	9.03
Indirect-LOS	210.67	310.99	170.54	150.48	150.48
Indirect-Maternity Leave	1,722.81	3,445.62	0.00	0.00	0.00
TOTAL	**18,510.51**	**23,228.07**	**9,008.48**	**1,524.47**	**1,742.50**
State Perspective					
	Vaginal delivery	CS delivery	Ectopic	Induced ABO	Spontaneous ABO
Transportation	0.00	0.00	0.00	0.00	0.00
Prenatal care	2,585.03	2,585.03	0.00	0.00	0.00
Procedure	2,622.51	4,648.40	4,556.95	808.19	939.39
Infant Care	6,956.39	6,956.39	0.00	0.00	0.00
Indirect-Travel	0.00	0.00	0.00	0.00	0.00
Indirect-LOS	0.00	0.00	0.00	0.00	0.00
Indirect-Maternity Leave	0.00	0.00	0.00	0.00	0.00
TOTAL	**12,163.93**	**14,189.82**	**4,556.95**	**808.19**	**939.39**
Private Insurance Perspective					
	Vaginal delivery	CS delivery	Ectopic	Induced ABO	Spontaneous ABO
Transportation	0.00	0.00	0.00	0.00	0.00
Prenatal care	3,334.69	3,334.69	0.00	0.00	0.00
Procedure	3,435.48	6,089.41	5969.61	1,042.57	1,211.82
Infant Care	8,973.74	8,973.74	0.00	0.00	0.00
Indirect-Travel	0.00	0.00	0.00	0.00	0.00
Indirect-LOS	0.00	0.00	0.00	0.00	0.00
Indirect-Maternity Leave	0.00	0.00	0.00	0.00	0.00
TOTAL	**15,743.91**	**18,397.83**	**5,969.61**	**1,042.57**	**1,211.82**

LOS – length of hospital stay; ABO – abortion.

Table 8, Continuation…					
Hospital Perspective					
	Vaginal delivery	CS delivery	Ectopic	Induced ABO	Spontaneous ABO
Transportation	0.00	0.00	0.00	0.00	0.00
Prenatal care	0.00	0.00	0.00	0.00	0.00
Procedure	802.89	1,043.40	2,838.10	301.19	349.99
Infant Care	0.00	0.00	0.00	0.00	0.00
Indirect-Travel	0.00	0.00	0.00	0.00	0.00
Indirect-LOS	0.00	0.00	0.00	0.00	0.00
Indirect-Maternity Leave	0.00	0.00	0.00	0.00	0.00
TOTAL	**802.89**	**1,043.40**	**2,838.10**	**301.19**	**349.98**

LOS – length of hospital stay; ABO – abortion.

Table 9. Utility values of outcomes of unintended pregnancies.

Parameter	Condition	Values used in Base case analysis[a]	Range used in Sensitivity analysis[b]
Unintended pregnancy outcome	Not pregnant	1.000	-
	Vaginal delivery	0.879	0.487 - 0.997
	Cesarean delivery	0.847	0.487 - 0.997
	Spontaneous abortion	0.942	0.487 - 0.997
	Induced abortion	0.962	0.487 - 0.997
	Ectopic Pregnancy	0.917	0.487 - 0.997

[a] (Sonnenberg, Burkman 2004); [b] (Schwarz, Smith 2008)

Base case analysis. Results of the base case analysis using the societal perspective show that the strategy of immediate LARC insertion dominated interval initiation. Immediate LARC insertion is less costly and more effective. For each delivery/postpartum woman, interval (versus immediate) insertion results in an additional average marginal cost of $1,549, loss of 0.015 QALY, and an additional incremental cost of $2,249 for each unintended pregnancy prevented *(Tables 10 and 11)*.

The total costs for the entire population of women who delivered, calculated based on the average number of women who were eligible to receive LARC at both timing insertion strategies, are also shown in Tables 10 and 11. If we consider this total population of postpartum women in NM, immediate LARC insertion is associated with cost savings of $4.5M to $5.6M, additional QALYs of 45-52, and prevention of 506 to 552 unintended pregnancies per year.

Table 10. Summary of costs and QALYs gained per LARC insertion strategy.

TCu380A IUD		**Immediate Insertion**	**Interval Insertion**
No. of deliveries eligible 2010-2012 N = 3226/year	Cost (per case)	$1,495.87	$3,006.67
	QALY (per case)	0.996	0.982
	Cost/QALY (per case)	$1,501.88	$3,061.78
	Marginal Cost/QALY (per case)	**-$1,559.90**	
	Total Costs	$4,825,676.62	$9,699,517.42
	Marginal Total Costs	**-$4,873,840.80**	
	Total QALYs gained	3213	3168
	Marginal Total QALYs gained	**45**	
	Marginal Total Cost/QALY gained	**-$107,914.29**	
LNG IUD		**Immediate Insertion**	**Interval Insertion**
No. of deliveries eligible 2010-2012 N = 3222/year	Cost (per case)	$1,606.52	$3,023.92
	QALY (per case)	0.997	0.982
	Cost/QALY (per case)	$1,611.35	$3,079.35
	Marginal Cost/QALY (per case)	**-$1,467.99**	
	Total Costs	$5,176,207.44	$9,743,070.24
	Marginal Total Costs	**-$4,566,862.80**	
	Total QALYs gained	3212	3164
	Marginal Total QALYs gained	**48**	
	Marginal Total Cost/QALY gained	**-$94,493.33**	
ENG implant		**Immediate Insertion**	**Interval Insertion**
No. of deliveries eligible 2010-2012 N = 3267/year	Cost (per case)	$1,488.33	$3,206.90
	QALY (per case)	0.997	0.981
	Cost/QALY (per case)	$1,492.81	$3,269.01
	Marginal Cost/QALY (per case)	**-$1,776.20**	
	Total Costs	$4,862,374.11	$10,476,942.30
	Marginal Total Costs	**-$5,614,568.19**	
	Total QALYs gained	3257	3205
	Marginal Total QALYs gained	**52**	
	Marginal Total Cost/QALY gained	**-$107,410.63**	

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; QALY – quality adjusted life year.
Total values for costs and quality adjusted life years were calculated from the average total number of women who delivered at the UNMH from 2010-2012 who were medically eligible to receive the IUD or the implant on either insertion strategy.

Table 11. Summary of costs and unintended pregnancies per LARC insertion strategy.

TCu380A IUD		**Immediate Insertion**	**Interval Insertion**
No. of deliveries eligible 2010-2012 N = 3226/year	Cost (per case)	$1,495.87	$3,006.67
	UIP prevented (per case)	0.961	0.804
	Cost/UIP prevented (per case)	$1,556.58	$3,739.64
	Marginal Cost/UIP prevented (per case)	**-$2,183.06**	
	Total Costs	$4,825,676.62	$9,699,517.42
	Marginal Total Costs	-$4,873,840.80	
	Total UIP prevented	3100	2594
	Marginal Total UIP prevented	**506**	
LNG IUD		**Immediate Insertion**	**Interval Insertion**
No. of deliveries eligible 2010-2012 N = 3222/year	Cost (per case)	$1,606.52	$3,023.92
	UIP prevented (per case)	0.965	0.808
	Cost/UIP prevented (per case)	$1,664.79	$3,742.48
	Marginal Cost/UIP prevented (per case)	**-$2,077.69**	
	Total Costs	$5,176,207.44	$9,743,070.24
	Marginal Total Costs	-$4,566,862.80	
	Total UIP prevented	3109	2603
	Marginal Total UIP prevented	**506**	
ENG implant		**Immediate Insertion**	**Interval Insertion**
No. of deliveries eligible 2010-2012 N = 3267/year	Cost (per case)	$1,488.33	$3,206.90
	UIP prevented (per case)	0.965	0.796
	Cost/UIP prevented (per case)	$1,542.31	$4,028.77
	Marginal Cost/UIP prevented (per case)	**-$2,486.46**	
	Total Costs	$4,862,374.11	$10,476,942.30
	Marginal Total Costs	-$5,614,568.19	
	Total UIP prevented	3153	2601
	Marginal Total UIP prevented	**552**	

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy.
Total values for costs and number of unintended pregnancies prevented were calculated from the average total number of women who delivered at the UNMH from 2010-2012 who were medically eligible to receive the IUD or the implant on either insertion strategy.

Cost perspectives. The costs per QALY gained and unintended pregnancy prevented were also calculated using different perspectives *(Table 12*). As expected, the third party payer perspectives (both state and private insurance) parallel the base case result and show immediate LARC initiation as the dominant (less costly, more effective) strategy. Based on the hospital perspective, on the other hand, immediate LARC is still more effective, but also more costly. In terms of QALYs, the incremental cost effectiveness ratio (ICER) ranges from $3,586 to $5,255, which is way below the usual willingness to pay (WTP) threshold of $50,000. The ICER in terms of unintended pregnancy prevented is even lower, with a range of $333 to $489.

Table 12. Summary of marginal cost effectiveness results based on different perspectives.

STATE		**COST**	**QALY**	**UIP Prevented**
TCu380A IUD	Interval	$2,033.91	0.982	0.804
	Immediate	$1,049.94	0.996	0.961
	Marginal Cost/Effectiveness	*-$983.97*	*0.014*	*0.157*
LNG IUD	Interval	$2,063.69	0.982	0.808
	Immediate	$1,143.51	0.997	0.965
	Marginal Cost/Effectiveness	*-$920.18*	*0.015*	*0.157*
ENG implant	Interval	$2,204.96	0.981	0.796
	Immediate	$1,062.47	0.997	0.965
	Marginal Cost/Effectiveness	*-$1,142.49*	*0.016*	*0.169*
PRIVATE		**COST**	**QALY**	**UIP Prevented**
TCu380A IUD	Interval	$2,601.59	0.982	0.804
	Immediate	$1,264.69	0.996	0.961
	Marginal Cost/Effectiveness	*-$1,336.90*	*0.014*	*0.157*
LNG IUD	Interval	$2,589.73	0.982	0.808
	Immediate	$1,329.11	0.997	0.965
	Marginal Cost/Effectiveness	*-$1,260.62*	*0.015*	*0.157*
ENG implant	Interval	$2,735.42	0.981	0.796
	Immediate	$1,221.81	0.997	0.965
	Marginal Cost/Effectiveness	*-$1,513.61*	*0.016*	*0.169*

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy; QALY – quality adjusted life year; ICER – incremental cost effectiveness ratio.

Table 12, Continuation…				
HOSPITAL		**COST**	**QALY**	**UIP Prevented**
TCu380A IUD	Interval	$128.15	0.982	0.804
	Immediate	$180.55	0.996	0.961
	Incremental Cost/Effectiveness	*$52.40*	*0.014*	*0.157*
	ICER		*$3,586.10*	*$333.46*
LNG IUD	Interval	$126.86	0.982	0.808
	Immediate	$203.64	0.997	0.965
	Incremental Cost/Effectiveness	*$76.78*	*0.015*	*0.157*
	ICER		*$5,254.87*	*$488.71*
ENG implant	Interval	$133.52	0.981	0.796
	Immediate	$206.29	0.997	0.965
	Incremental Cost/Effectiveness	*$72.77*	*0.016*	*0.169*
	ICER		*$4,641.06*	*$431.54*

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy; QALY – quality adjusted life year; ICER – incremental cost effectiveness ratio.

Sub-group analyses.

1. Route of delivery - The rate of TCu380A expulsion when placed immediately has been reported to be increased in women delivering vaginally (Lara Ricalde, Menocal Tobias 2006, Zhou and Chi 1991, Lara, Sanchez 1989). In using weighted averages, the expulsion rate for immediate TCu380A insertion is 0.178 for vaginal deliveries, compared to 0.126 in cesarean sections. Adoption of the base case result to the total number of women who delivered vaginally in the study population shows that, even with this expulsion rate, immediate postpartum copper IUD leads to potential total cost savings of $3.7M, additional QALYs of 35, and prevention of 395 unintended pregnancies per year.

2. Adolescent population – As of early 2015, NM has one of the highest teenage pregnancy rate in the US. When the base case result is applied to the 8% of women who

deliver that are 18 years or younger, implementing immediate postpartum LARC is associated with total cost savings of $401,463, additional QALYs of 4, and prevention of 42 unintended pregnancies per year.

3. Private insurance – At present, almost all commercial insurance companies provide no coverage of immediate postpartum LARC insertion. Again, when the base case result is applied to the approximately 18% of women who deliver with private insurance, immediate LARC initiation can lead to total cost savings of $799,153, additional QALYs of 9, and prevention of 94 unintended pregnancies per year.

4. Uninsured women – As mentioned above, labor and delivery of women with no insurance are covered by EMSA, which is a state funded program. Coverage of the initiation of LARC immediate after delivery can lead to total cost savings of $1M, additional QALYs of 16, and prevention of 172 unintended pregnancies per year.

Time horizon. The base case analysis apply to a time horizon of 1 year. Extending the time horizon increases the potential cost savings, gains in QALY and prevention of unintended pregnancy. With a time horizon of 5 years, for each delivery, interval (versus immediate) insertion results in an additional average incremental cost of $2,600, loss of 0.024 QALY, and an additional incremental cost of $4,923 for each unintended pregnancy prevented *(Table 13).*

Table 13. Summary of marginal cost effectiveness results based on different time horizons.

YEAR 2		**COST**	**QALY**	**UIP Prevented**
TCu380A IUD	Interval	$3,919.49	0.975	0.731
	Immediate	$1,758.07	0.995	0.941
	Marginal Cost/Effectiveness	*-$2,161.42*	*0.020*	*0.210*
LNG IUD	Interval	$3,906.90	0.976	0.737
	Immediate	$1,845.69	0.995	0.947
	Marginal Cost/Effectiveness	*-$2,061.21*	*0.019*	*0.210*
ENG implant	Interval	$4,231.55	0.974	0.716
	Immediate	$1,734.26	0.995	0.947
	Marginal Cost/Effectiveness	*-$2,497.29*	*0.021*	*0.231*
YEAR 3		**COST**	**QALY**	**UIP Prevented**
TCu380A IUD	Interval	$4,321.77	0.972	0.700
	Immediate	$1,917.97	0.993	0.929
	Marginal Cost/Effectiveness	*-$2,403.80*	*0.021*	*0.229*
LNG IUD	Interval	$4,294.05	0.973	0.708
	Immediate	$1,999.95	0.994	0.936
	Marginal Cost/Effectiveness	*-$2,294.10*	*0.021*	*0.228*
ENG implant	Interval	$4,730.84	0.970	0.679
	Immediate	$1,892.15	0.994	0.935
	Marginal Cost/Effectiveness	*-$2,838.69*	*0.024*	*0.256*
YEAR 4		**COST**	**QALY**	**UIP Prevented**
TCu380A IUD	Interval	$4,540.97	0.971	0.685
	Immediate	$2,024.68	0.993	0.922
	Marginal Cost/Effectiveness	*-$2,516.29*	*0.022*	*0.237*
LNG IUD	Interval	$4,511.82	0.971	0.692
	Immediate	$2,118.45	0.993	0.927
	Marginal Cost/Effectiveness	*-$2,393.37*	*0.022*	*0.235*
ENG implant	Interval	$5,508.61	0.968	0.658
	Immediate	$2,868.02	0.993	0.927
	Marginal Cost/Effectiveness	*-$2,640.59*	*0.025*	*0.269*

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy; QALY – quality adjusted life year.

Table 13, Continuation…				
YEAR 5		**COST**	**QALY**	**UIP Prevented**
TCu380A IUD	Interval	$4,686.96	0.970	0.675
	Immediate	$2,100.22	0.992	0.916
	Marginal Cost/Effectiveness	*-$2,586.74*	*0.022*	*0.241*
LNG IUD	Interval	$4,662.80	0.970	0.682
	Immediate	$2,212.26	0.993	0.920
	Marginal Cost/Effectiveness	*-$2,450.54*	*0.023*	*0.238*
ENG implant	Interval	$5,723.74	0.967	0.643
	Immediate	$2,961.50	0.993	0.921
	Marginal Cost/Effectiveness	*-$2,762.24*	*0.026*	*0.278*

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy; QALY – quality adjusted life year.

Adjustment for mistimed pregnancies. Many unplanned pregnancies occur in women who desire a future pregnancy at another time in their lives and these pregnancies are considered to be mistimed. This means that these pregnancies would have still occurred, but at a later date. Assuming that 60% of unintended pregnancies are actually mistimed and would occur two years later, we adjusted the costs of vaginal and cesarean deliveries, as well as the costs of prenatal care, infant care for the first year of life and indirect costs related to delivery and maternity leave. Table 14 shows the summary of marginal cost-effectiveness using an annual discount rate of 3%. Even with these adjustments, the results of the base case both for year 1 and year 2 (*i.e.* immediate LARC insertion is the dominant strategy) are maintained.

Table 14. Marginal cost effectiveness when societal costs are adjusted for mistimed pregnancy.

			Cost	QALY	UIP prevented
TCu380A IUD			**Cost**	**QALY**	**UIP prevented**
	Year 1	Interval	$1,757.50	0.982	0.804
		Immediate	$1,249.58	0.996	0.961
		Marginal cost effectiveness	*-$507.92*	*0.014*	*0.157*
	Year 2	Interval	$2,219.20	0.975	0.731
		Immediate	$1,387.91	0.995	0.941
		Marginal cost effectiveness	*-$831.29*	*0.020*	*0.210*
LNG IUD			**Cost**	**QALY**	**UIP prevented**
	Year 1	Interval	$1,801.46	0.982	0.808
		Immediate	$1,388.19	0.997	0.965
		Marginal cost effectiveness	*-$413.27*	*0.015*	*0.157*
	Year 2	Interval	$2,251.64	0.976	0.737
		Immediate	$1,521.75	0.995	0.947
		Marginal cost effectiveness	*-$729.89*	*0.019*	*0.210*
ENG implant			**Cost**	**QALY**	**UIP prevented**
	Year 1	Interval	$1,905.00	0.981	0.796
		Immediate	$1,262.55	0.997	0.965
		Marginal cost effectiveness	*-$642.45*	*0.016*	*0.169*
	Year 2	Interval	$2,436.88	0.974	0.716
		Immediate	$1,397.54	0.995	0.947
		Marginal cost effectiveness	*-$1,039.34*	*0.021*	*0.231*

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy; QALY – quality adjusted life year.

One way sensitivity analyses (SA). Table 15 gives the summary of the threshold values of the different parameters in the model. The model is sensitive to the rates of actual LARC placement, pregnancy rates from use of IUDs, implants and other forms of birth control methods (as a group) that women use when the IUD/implant is not placed, the cost of immediate LARC insertion and the utility of avoiding an unintended pregnancy. In table 15, immediate IUD/implant insertion is less costly and more effective compared to interval insertion as long as the actual rate of immediate insertion is at least 60% and when the actual rate of interval insertion is less than 90%. Immediate LARC is also dominant when the pregnancy rate from IUD/implant use not greater than 40%, and when the pregnancy rate from other methods (when it is not placed) is greater than 3 to 10%.

Interval insertion becomes the dominant strategy only when the cost of immediate LARC insertion exceeds $3,000 in terms of QALYs and exceeds $10,000 in terms of unintended pregnancies prevented.

Table 15. One way sensitivity analysis: threshold values of parameters that affect cost effectiveness results.

Model Parameter	**TCu380A**		**LNG IUD**		**ENG implant**	
	QALY	**UIP prevented**	**QALY**	**UIP prevented**	**QALY**	**UIP prevented**
Actual IUD/implant placement at interval insertion	0.918	0.932	0.905	0.926	0.976	0.973
Actual IUD/implant placement at immediate insertion	0.621	0.612	0.630	0.616	0.584	0.586
Pregnancy rate - IUD/implant use	0.482	0.538	0.529	0.563	0.404	0.440
Pregnancy rate - use of Other+ forms of birth control	0.100	0.030	0.124	0.036	0.034	no effect
Cost of immediate IUD/implant insertion	$3,188.86	$10,690.29	$3,215.99	$10,715.99	$3,622.53	$11,672.76
Utility of avoiding an unintended pregnancy	0.715	-	0.727	-	0.703	-

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy; QALY – quality adjusted life year

Probabilistic sensitivity analyses (PSA). Monte Carlo simulation using 10,000 iterations was employed in evaluating the decision analytic model. It allowed us to test the robustness of the model because values of different parameters were sampled many times over based on their statistical distributions. Table 16 gives a summary of the results. PSA showed that all three models demonstrate the dominance of immediate LARC over interval insertion 95% of the time. The average cost and effectiveness for each LARC method, as well their standard deviations, are also shown.

Table 16. Summary of probabilistic sensitivity analysis results

		Immediate LARC dominates Interval LARC (% of the time)		Average Costs	SD	Average E	SD
TCu380A IUD	QALY	0.9451	Interval	$3,001.78	1,184.77	0.935	0.038
			Immediate	$1,498.76	555.19	0.987	0.018
	UIP Prevented	0.9544	Interval	$3,005.67	1,180.83	0.804	0.104
			Immediate	$1,491.15	523.50	0.962	0.050
LNG IUD	QALY	0.9376	Interval	$3,018.71	1,185.97	0.936	0.039
			Immediate	$1,603.44	520.46	0.988	0.017
	UIP Prevented	0.9516	Interval	$3,017.34	1,195.05	0.808	0.106
			Immediate	$1,609.49	534.06	0.965	0.051
ENG implant	QALY	0.9705	Interval	$3,203.27	1,161.49	0.932	0.038
			Immediate	$1,481.81	512.16	0.988	0.017
	UIP Prevented	0.9720	Interval	$3,205.85	1,161.67	0.796	0.103
			Immediate	$1,486.91	545.90	0.964	0.051

LNG – levonorgestrel; IUD – intrauterine device; ENG – etonogestrel; UIP – unintended pregnancy; QALY – quality adjusted life year; E – effectiveness; SD – standard deviation

Figures 4 to 9 show the cost-effectiveness scatter plots for each LARC method in terms of QALYs and unintended pregnancies prevented. These graphs provide a pictorial representation of cost and effectiveness when the model was run 10,000 times, based on the distribution of all possible values of the model parameters. Majority of the points are seen in the left upper quadrant, showing that interval insertion is both more costly and less effective compared to immediate insertion. The ellipses show the 95% confidence interval, meaning that we are confident that cost-effectiveness results would fall on this area 95% of the time.

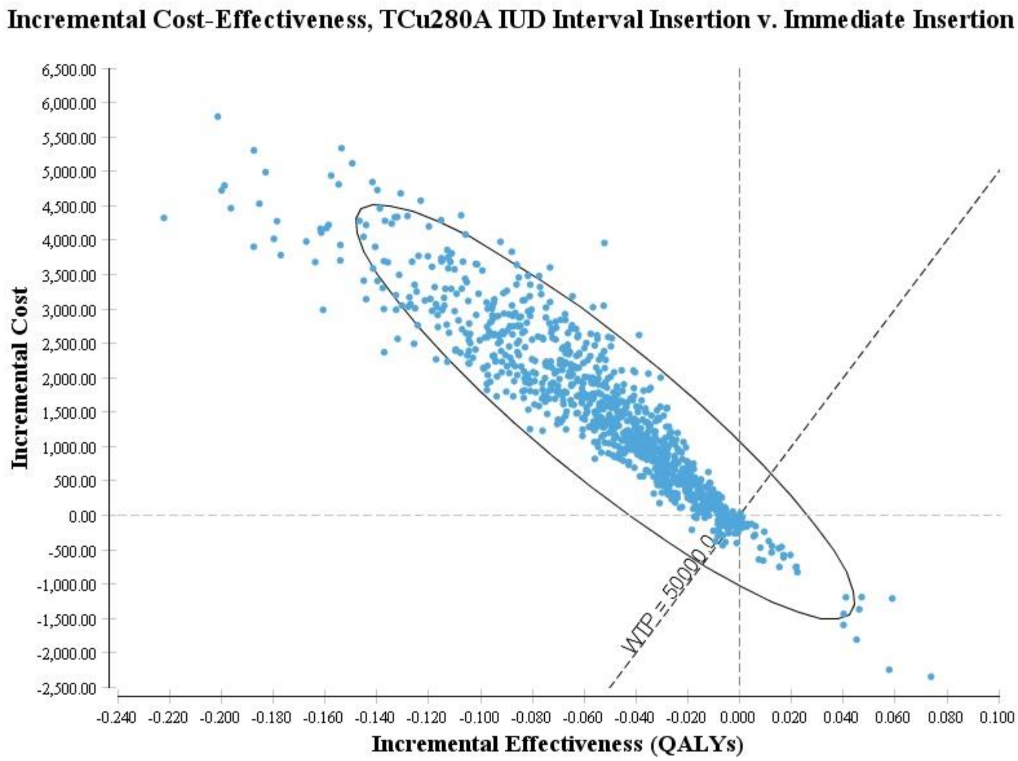

Figure 4. Incremental cost-effectiveness scatterplot for the TCu380A IUD with effectiveness expressed as quality adjusted life years (QALYs). IUD – intrauterine device.

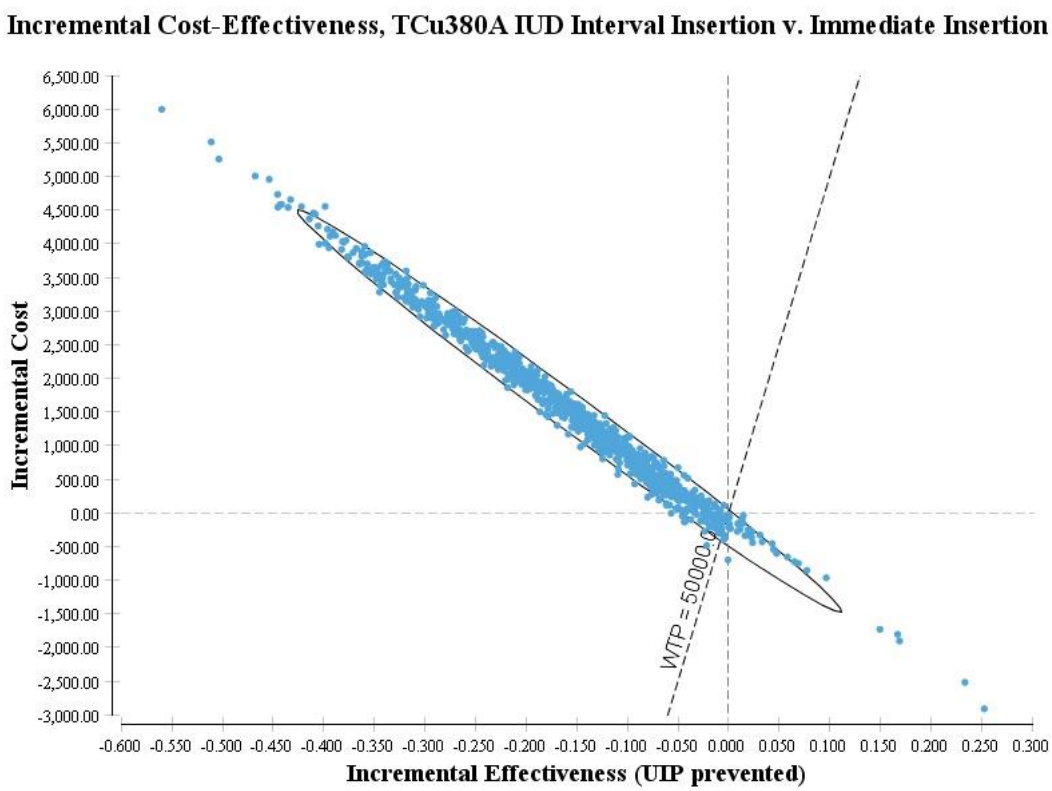

Figure 5. Incremental cost-effectiveness scatterplot for the TCu380A IUD with effectiveness expressed as unintended pregnancies (UIP) prevented. IUD – intrauterine device.

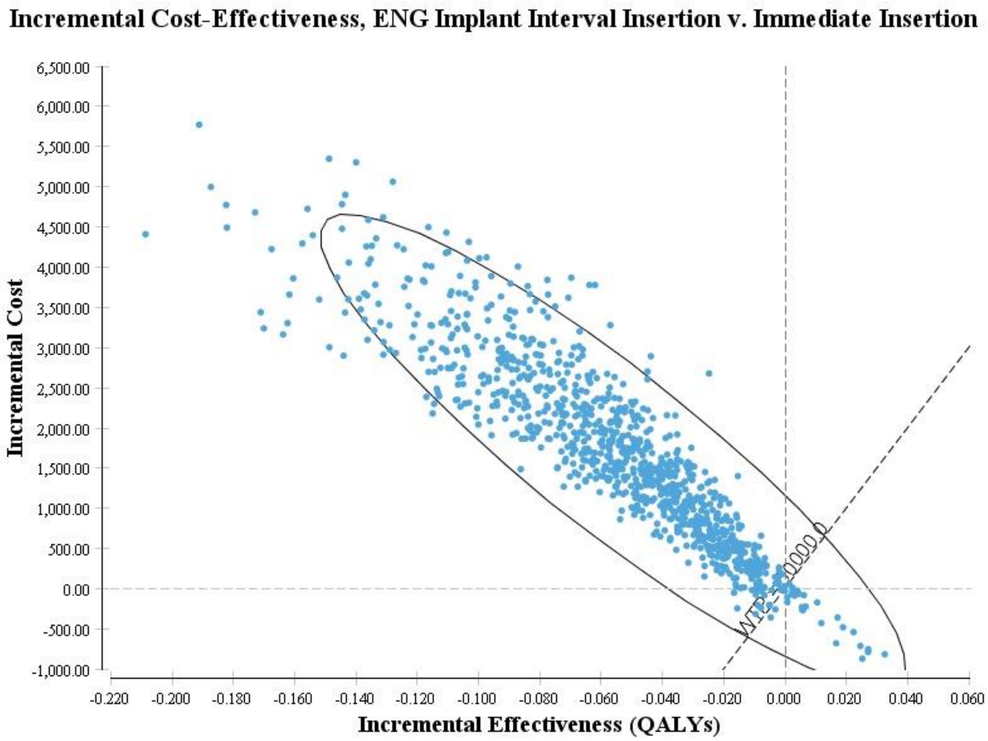

Figure 6. Incremental cost-effectiveness scatterplot for the levonorgestrel (LNG) IUD with effectiveness expressed as quality adjusted life years (QALYs). IUD – intrauterine device.

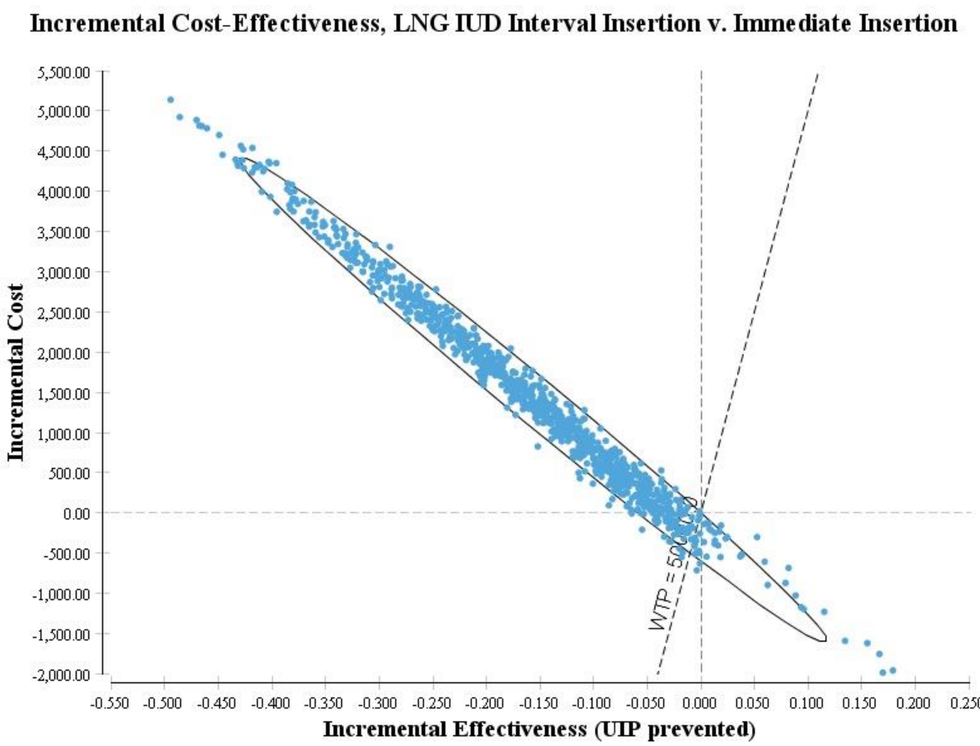

Figure 7. Incremental cost-effectiveness scatterplot for the levonorgestrel (LNG) IUD with effectiveness expressed as unintended pregnancies (UIP) prevented. IUD – intrauterine device.

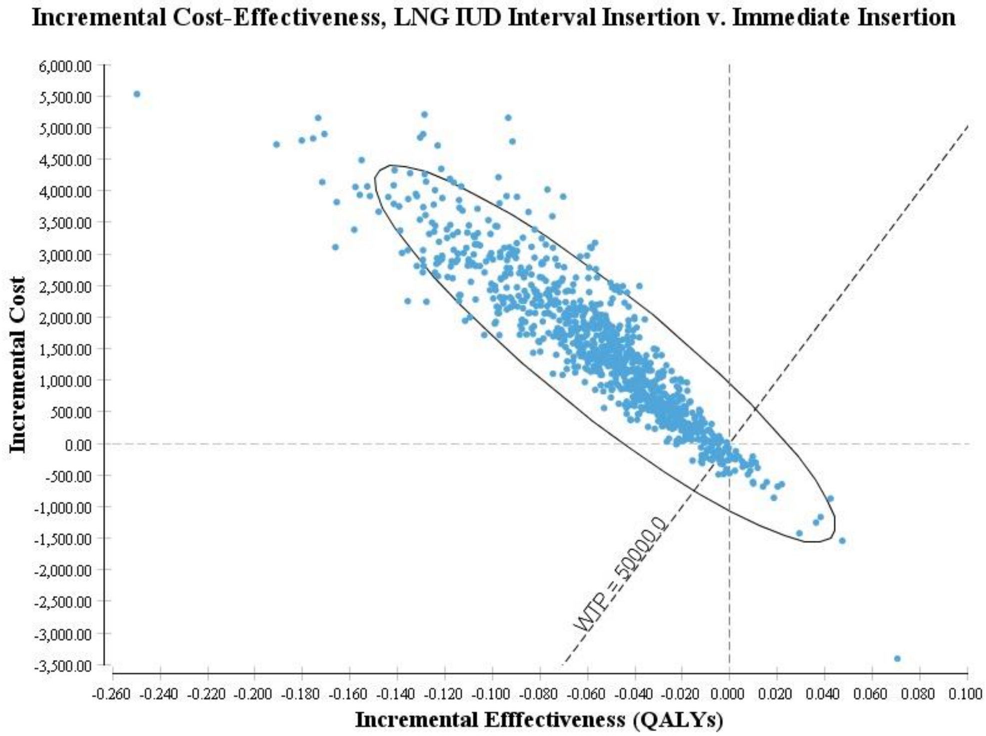

Figure 8. Incremental cost-effectiveness scatterplot for the etonogestrel (ENG) implant with effectiveness expressed as quality adjusted life years (QALYs).

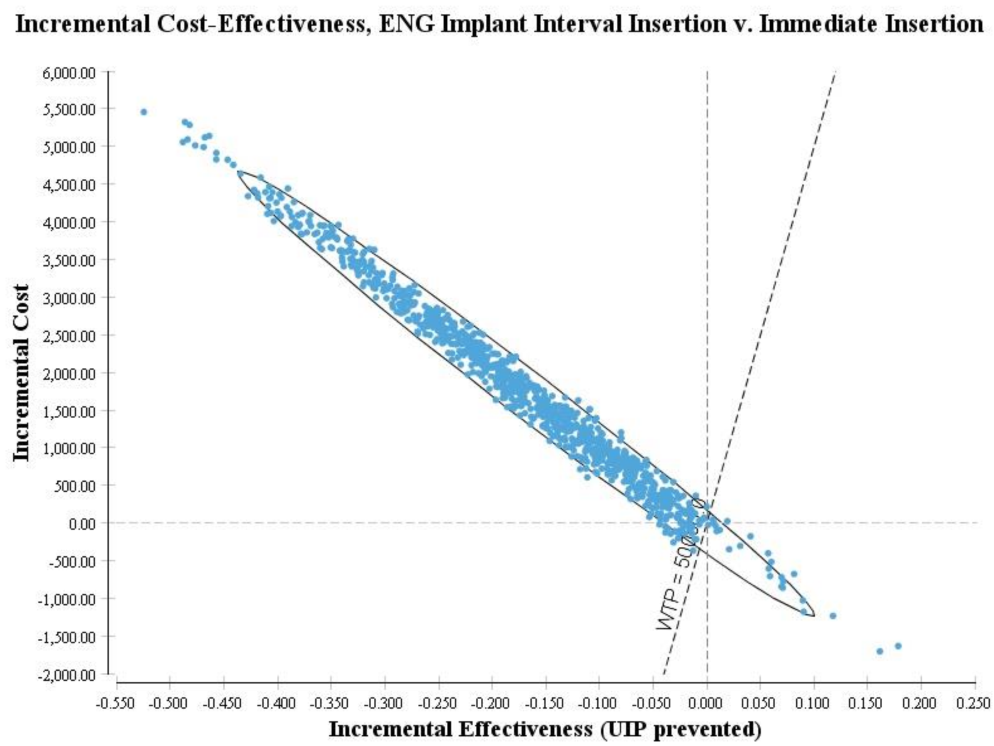

Figure 9. Incremental cost-effectiveness scatterplot for the etonogestrel (ENG) implant with effectiveness expressed as unintended pregnancies (UIP) prevented.

Chapter 5

Discussion

Long acting reversible contraceptive methods such as the IUD and implant have been shown to be cost-effective healthcare interventions that lead to the prevention of unintended pregnancies. Although unintended pregnancies cause substantial distress to women, very few studies have conducted economic analyses that looked at its impact on quality of life. A quality adjusted life year (QALY), which represents a year in perfect health, is the recommended metric of health outcomes for cost-effectiveness analysis in health care (Siegel, Torrance 1997). Using this cost-utility approach demonstrated through modeling that immediate postpartum LARC is beneficial to women and to the society as a whole.

Base case analysis: QALYs and Unintended pregnancies prevented

The base case analysis show that immediate postpartum LARC is both less costly and more effective compared to interval insertion. This supports previous findings that IUDs and implants are cost effective. Previous studies have shown that LARC use is the strategy of choice when compared to no method use and when compared to other user-dependent methods of birth control. One study by Washington and colleagues in 2015 compared timing of insertion strategies for the IUD, and demonstrated that immediate initiation is less costly and more effective compared to interval insertion (Washington, Jamshidi 2015).

This present analysis is unique in using the societal perspective. This takes into consideration indirect costs, which relates to the lost in productivity when women have unintended pregnancies. Results of this study indicate that indirect costs contribute up to 12% of the additional costs associated when providing LARC at 6 weeks post-delivery compared to immediate insertion. Indirect costs were estimated from potential lost wages using the usual 8-hour work day, and therefore could actually be higher, had we placed a value on lost productivity based on a 24-hour period.

Trussell and colleagues estimate that about 60% of unintended pregnancies are actually mistimed, based on the National Survey of Family Growth (NSFG) (Trussell, Lalla 2009). Mistimed pregnancies are not entirely avoidable when calculating costs, since they are postulated to occur at a later date. Even when adjustments for mistimed pregnancies were applied to the base case analysis, the additional costs still exceed those of previous studies. This underlines the contribution of indirect costs in estimating the total burden of having an unintended pregnancy.

Analysis using different payer perspectives

Analysis of the models using different payer perspectives also support the base case results. Third party payer perspectives, both state and commercially funded, show dominance of immediate LARC insertion in terms of QALYs and unintended pregnancies prevented. Cost savings were higher using the private insurance perspective mainly because of higher reimbursement rates. In New Mexico, the average provider reimbursement is 29% higher with commercial insurance plans compared to Medicare/Medicaid. Average wholesale prices of drugs and devices can also be higher with private insurance by as much as 12%, compared to state-funded insurance.

The hospital perspective shows that immediate LARC insertion is more effective but more costly than interval initiation. It shows an ICER of less than $5,000 per QALY and less than $500 for each unintended pregnancy prevented. These values are way below the usual willingness to pay threshold in pharmacoeconomics set at $50,000 per QALY. Essentially, if an intervention gives an incremental ratio of less than this threshold, then it is an acceptable strategy of choice.

Sub-analysis based on postpartum population

Immediate postpartum LARC still dominates interval insertion even if the model was applied to the adolescent population. The same holds true when we stratify the postpartum population based on route of delivery. Despite increased IUD expulsion rates with vaginal delivery (versus cesarean section), immediate postpartum LARC remains less costly and more effective both in terms of QALYs and the number of unintended pregnancies prevented.

Time horizon

The decision model in the study used a time horizon of 1 year. Extending this time period to 5 years shows consistent increase in the cost-effectiveness of immediate postpartum LARC. The high upfront costs of LARC is negated given the low failure rates, with associated decrease in unintended pregnancies and increase in quality of life.

Sensitivity Analyses

LARC methods are cost-effective because of high compliance and continuation rates (Mavranezouli 2009). In previous studies, the rate of expulsion with immediate insertion has been a concern, with recommendations supporting LARC use as long as it is less than 54% (Washington, Jamshidi 2015). In the present study, the rates of expulsion had no effect on the relative cost effectiveness of immediate postpartum LARC compared to interval LARC.

Results of the one way SA show that the models were most sensitive to the actual placement of LARC in the immediate postpartum versus the interval 6 week period. Immediate postpartum LARC remains dominant as long as actual insertion rates are greater than 60%. Only when the follow up rate (and actual insertion) of interval LARC is at least 90%, then it becomes the dominant strategy. In our models, we assumed a 95% rate of actual placement for immediate insertion and 60% for interval insertion, based on the previous works in literature ((Echeverry 1973, Ogburn, Espey 2005)

Results were also sensitive to the pregnancy rates with the IUD or implant in place. In the models, interval LARC becomes dominant only when pregnancy rates with an IUD or implant in place are higher than 40 to 56%. Prospective and post marketing surveillance reports show that LARC methods consistently have failure rates of less than 1%.

The pregnancy rate associated with other methods of birth control (used when no IUD or implant is placed postpartum) also affect the robustness of the model to the base case results. Interval LARC becomes the strategy of choice when this rate is less than 3 to 12%. In this study, this weighted rate was driven largely by no method use (which has a failure rate of up to 85%), based on the frequency distribution of contraceptive use by the general population of reproductive aged women in the US (Guttmacher 2015).

The cost of immediate LARC initiation is also important to consider when using our models. As long as the costs of insertion is less than $3,000 when QALYs are used as the effectiveness measure and less than $10,000 in estimating unintended pregnancies prevented, immediate postpartum LARC remains less costly and more effective.

The results of the sensitivity analyses emphasizes advantages of placing LARC immediately postpartum compared to interval insertion, given the high loss to follow-up in this population of postpartum women and the improbable values needed for birth control pregnancy rates in order for it not to be cost effective. PSA results using Monte Carlo simulation also show that the models were consistently cost effective, about 95% of alternative models generated. The immediate postpartum period provides the perfect opportunity to initiate LARC methods.

Application to the New Mexico population

Applying the marginal cost effectiveness value of immediate postpartum LARC to population estimates in New Mexico gives a bigger picture of its societal impact. As seen in the review of UNMH births from 2010-2012, an average of 3,200 women were medically eligible to receive the IUD and implant per year. When followed during the postpartum period, only 46% show up for a follow up visit. Although a number of other factors can account for this, this value is lower than the parameter used in the models or in previous reports.

Private insurance costs specific to the women from New Mexico show potential cost saving of $800,000 per year from improvements in quality of life and prevention of unintended pregnancies. Similarly, coverage of the uninsured population with immediate postpartum LARC can lead to cost saving of up to $1M. These findings could be used to support policy changes that expand LARC coverage to these populations. Since the financial benefit of immediate insertion does not accrue directly to the hospital most hospitals are unlikely to provide LARC devices for insertion immediately after birth (IUD) or prior to discharge (implant) unless they are confident they will be reimbursed by third party payers.

Study limitations

1. As with other cost effectiveness studies on LARC, the clinical inputs used in the model were based largely on observational studies of fair quality and with a few randomized clinical trials (RCTs). However, the prospective cohorts in these studies were highly generalizable (Grimes, Lopez 2010).

2. The study did not include comparisons of immediate/interval IUD initiation with delayed postpartum insertion, which encompasses the time beyond 10 minutes of placental delivery and up to less than 6 weeks postpartum. The reason for this exclusion is two-fold. One, this practice is not popular in the state and two, there is limited research within this timing strategy, except for the first 48 hours after delivery. These few studies indicate that the IUD expulsion rates for this time period are even higher than immediate insertion (Grimes, Lopez 2010).

3. Estimates for utility values were taken from a convenience sample of women from a previous study (Sonnenberg, Burkman 2004). Although sensitivity analysis show robustness of the models to these parameters with use of values from a cross sectional study of women (Schwarz, Smith 2008), it is recommended that population estimates be conducted and sought out.

The results of this study emphasizes the *societal* benefits of immediate postpartum LARC over interval insertion. Despite increased expulsion rates for the IUD and bleeding irregularities leading to removal for the implant, the strategy of immediate insertion remains the less costly and more effective alternative. This study is also *innovative* because it is the first to look at both forms of LARC in the immediate postpartum period and considered direct non-medical and indirect costs, which were often overlooked in previous studies. These results have implications in patient counselling, as well as in expanding LARC coverage. Importantly, the decision models created can be adopted to estimate national data sets, as well as US states that provide no immediate postpartum LARC insurance coverage.

Appendix

De-identified data set for defining study population

1. Number of women in 2010, 2011 and 2012 who were eligible for immediate Postplacental Mirena (levonorgestrel-containing) IUD

This was determined by getting the number of women who were admitted at UNMH for labor and delivery (CPT codes based on vaginal/cesarean/vaginal-after-cesarean delivery 59409, 59410, 59514, 59515, 59612 and 59614) minus the patients who (aside from being pregnant) were diagnosed with*--

a. Chorioamnionitis (ICD9 code 658.41), puerperal sepsis (ICD9 670.02, 670.12 and 670.22)

b. Postpartum hemorrhage (ICD9 code 666.14 and 666.04), Cervical and high vaginal laceration (ICD9 665.30 and 665.40)

c. Third degree laceration (ICD9 code 664.21 and 59300); for c and d, the CPT for the mode of delivery has a modifier -22 attached

d. Fourth degree laceration (ICD9 code 664.31)

e. Systemic lupus erythematosus (ICD9 code 710.0)

f. Hepatocellular adenoma (ICD9 code 573.9)

g. Malignant liver hepatoma (ICD9 155.0, 155.2 and 197.7)

h. Breast cancer (ICD9 174.0 to 174.9, 198.81, 233.0)

i. Sexually transmitted infections (gonorrhea and chlamydia) complicating delivery (ICD9 647.11 and 647.21)

j. AIDS (ICD9 042)

k. Pelvic tuberculosis complicating pregnancy (ICD9 647.31)

l. Complicated Organ transplants (ICD9 code 996.8)

2. Number of women in 2010, 2011 and 2012 who were eligible for immediate Postplacental Paragard (Copper-containing) IUD

This was determined by getting the number of women who were admitted at UNMH for labor and delivery (CPT codes based on vaginal/cesarean/vaginal-after-cesarean delivery 59409, 59410, 59514, 59515, 59612 and 59614) minus the patients who (aside from being pregnant) were diagnosed with*--

a. Chorioamnionitis (ICD9 code 658.41), puerperal sepsis (ICD9 670.02, 670.12 and 670.22)

b. Postpartum hemorrhage (ICD9 code 666.14 and 666.04), Cervical and high vaginal laceration (ICD9 665.30 and 665.40)

c. Third degree laceration (ICD9 code 664.21 and 59300); for c and d, the CPT for the mode of delivery has a modifier -22 attached

d. Fourth degree laceration (ICD9 code 664.31)

e. Systemic lupus erythematosus (ICD9 code 710.0) with coagulation problems (ICD9 649.31 and 666.31)

f. Sexually transmitted infections (gonorrhea and chlamydia) complicating delivery (ICD9 647.11 and 647.21)

g. AIDS (ICD9 042)

h. Pelvic tuberculosis complicating pregnancy (ICD9 647.31)

i. Complicated Organ transplants (ICD9 code 996.8)

3. Number of women in 2010, 2011 and 2012 who were eligible for immediate postpartum contraceptive implant

Again, this was determined by getting the number of women who were admitted at UNMH for labor and delivery (CPT codes based on vaginal/cesarean/vaginal-after-cesarean delivery 59409, 59410, 59514, 59515, 59612 and 59614) minus the patients who (aside from being pregnant) were diagnosed with*—

a. Systemic lupus erythematosus (ICD9 code 710.0)

b. Breast cancer (ICD9 174.0 to 174.9, 198.81, 233.0)

c. Hepatocellular adenoma (ICD9 code 573.9)

d. Malignant liver hepatoma (ICD9 155.0, 155.2 and 197.7)

4. For each of the populations in #'s 1, 2 and 3, their frequency distribution in terms of race, ethnicity, age (13 to 18 y/o versus 19 years old and above), and financial class and insurance plans. Among those who are self-pay and indigent, how many of them have PENDING EMSA at the time of discharge from the Mother Baby Unit or the OB Special Care/High Risk Maternity.

5. For each of the populations in #'s 1, 2 and 3, what is the average number of prenatal visits (hospital/clinic encounters) and how many of them actually showed up for the standard postpartum check-up (based on hospital/clinic encounter).

* The exclusion criteria were determined based on categories 3 and 4 (3 = A condition for which the theoretical or proven risks usually outweigh the advantages of using the method

and 4 = A condition that represents an unacceptable health risk if the contraceptive method is used.) of the U.S. Medical Eligibility Criteria for Contraceptive Use, 2010: Adapted from the World Health Organization Medical Eligibility Criteria for Contraceptive Use, 4th edition for the particular birth control method.

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