Abortion and Infertility

Gregory K. Pike, Ph.D.*

ABSTRACT: The purpose of this article is to examine one potential factor that might negatively impact female fertility, namely induced abortion. While there appears to be a general consensus that there is no association between abortion and infertility, amongst the publications that do exist there is nevertheless evidence to the contrary. Moreover, given the variety of reasonable grounds for a link, and the insufficient attention to the subject by researchers, a re-examination of the field is warranted. Abortion, whether surgical or medical, is one of the most common medical procedures undertaken by women, so even a small effect could influence large numbers of women, and therefore couples.

If it were known that abortion was an underlying cause of infertility, it would be an ethical and legal requirement for medical professionals to inform women before consent is obtained. A case could even be made that if research were inconclusive, inadequate or preliminary, women should nevertheless be informed.

Introduction

Fertility is often taken for granted. It seems natural to assume that when a couple try to conceive, they will be successful and pregnancy will occur. Usually there is no reason to think otherwise, so when that doesn't happen, and the months go by with no conception, emotions can be intense. There may be a slowly dawning realization that something is not right, that one or the other's fertility is compromised. Couples may start to worry that their hopes and dreams for children may not eventuate.

Fertility is deeply valued, and to discover that there is a problem can be devastating. In Mahlstedt's analysis of the psychological aspects of the experience of infertility, common outcomes were depression, anger, and guilt. Depression from a variety of losses, anger from the "confusion, ambiguity, and unfairness of it all," and

* Senior Research Fellow, Bios Centre, London. Bachelor of Sciences with Honors in Physiology; Doctor of Philosophy.

"intense guilt for being infertile and for being upset about it."[1] The depth of anguish that is possible was captured by one infertility patient, who described the experience in the following way:

> My infertility is a blow to my self-esteem, a violation of my privacy, an assault on my sexuality, a final exam on my ability to cope, an affront to my sense of justice, a painful reminder that nothing can be taken for granted. My infertility is a break in the continuity of life. It is above all, a wound—to my body, to my psyche, to my soul.[2]

The causes of infertility are not always clear, but may be physical or psychological. The latter is implied by the many anecdotal accounts of successful pregnancy after long periods of trying through stressful circumstances, sometimes for years. Indeed, one of the more common anecdotes is a natural conception following one achieved through artificial reproductive technology (ART), or upon giving up on unsuccessful ART.[3]

Knowledge about the relevant factors that may affect fertility is important information, at the community level when it comes to causes such as sexually transmitted infections (STIs) that may be influenced by behavioral management, but also as part of the informed consent process when medical procedures impact fertility, such as lower abdominal surgery.

What Is Known About Infertility and Its Causes?

Infertility' is defined as failure to conceive after 12 months of trying, and may not necessarily indicate a permanent state.[4] This somewhat loose and unnuanced measure serves as a starting point for further investigation into the complexity of possible causes, and what therapies may be possible. Primary infertility refers to infertility where there has been no prior pregnancy that resulted in a live birth, whereas secondary infertility refers to those where there has been a previous pregnancy resulting in a live birth. These definitions therefore include failure to sustain a pregnancy within the definition of infertility.

Obtaining accurate figures for the prevalence of infertility is inherently difficult because of uncertainty about the numbers of couples attempting pregnancy versus those not. However, some estimates suggest that around 10%-12% of the population experiences infertility.[5] In the UK, the National Health Service (NHS) puts the figure at 1 in 7 (14.3%).[6] In their analysis of population surveys from across the globe, Boivin

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[1] Mahlstedt PP (1985) The psychological component of infertility. *Fertility & Sterility* 43(3):335-346.

[2] Jorgenson MA (1981) On healing. *Resolve Newsletter*, December, p1. Cited by Mahlstedt PP (1985) *Op. Cit.*

[3] Marcus AP *et al.* (2016) Spontaneous pregnancies following discontinuation of IVF/ICSI treatment: an internet based survey. *Human Fertility* 19(2):134-141, DOI: 10.1080/14647273.2016.1196296.

[4] The term 'subfertility' is also used, and denotes a longer than average time to achieve pregnancy. Problems with maintaining a pregnancy, such as repeated spontaneous miscarriage, can also be seen as a form of subfertility.

[5] Datta J *et al.* (2016) Prevalence of infertility and help seeking among 15,000 women and men. *Human Reproduction* 31(9):2108–2118.

[6] https://www.nhs.uk/conditions/infertility/ Accessed 14 Aug 2019.

et al. found that the 12-month prevalence for developed countries varied from 3.5% to 16.7%, and for less developed countries, from 6.9% to 9.3%.[7] If there is a link between abortion and infertility, it might be expected that because illegal abortions are more prevalent in developing countries, and such abortions are more risky, infertility might be more, rather than less prevalent. But this data suggests otherwise. Alternatively, more restrictive abortion legislation and lower rates of abortion in developing countries may lead to a lower rate of infertility.

Infertility may result from causes in women, men, or both, and for a significant number of cases the cause is unknown. Although there is considerable uncertainty, estimates suggest that about one third of cases are female factor, one third are male factor, and for the remaining third, there are both female and male factors. In approximately 30% of cases of female infertility the cause is unknown, whereas for male infertility, the figure is about 50%.[8]

A detailed description of all known causes of infertility is beyond the scope of this article; however, because the focus is on abortion, the list that follows refers to factors known to affect female infertility,[9] some of which will be the subject of more detailed analysis later, inasmuch as they are known to be linked with abortion.

- Polycystic Ovary Syndrome (PCOS) and other ovulation problems
- Fallopian tube damage
- Sexually transmitted infections
- Endometriosis
- Fibroids
- Pelvic Inflammatory Disease (PID)
- Genetic factors
- Immune factors
- Hypothalamic-pituitary factors
- Environmental factors—toxins, pesticides
- Previous tubal ligation

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[7] Boivin J *et al.* (2007) International estimates of infertility prevalence and treatment-seeking: potential need and demand for infertility medical care. *Human Reproduction* 22(6):1506–1512.

[8] Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), US National Institutes of Health. What do we know about idiopathic or unexplained infertility in females and males? See *https://www.nichd.nih.gov/health/topics/infertility/conditioninfo/causes/unexplained* Accessed 15 Aug 2019.

[9] Nordqvist C (2018) Infertility in men and women. *Medical News Today*, See *https://www.medicalnewstoday.com/articles/165748.php* Accessed 15 Aug 2019; American Pregnancy Association, See *https://americanpregnancy.org/infertility/female-infertility/* Accessed 15 Aug 2019; NICHD, What are some possible causes of female infertility? See *https://www.nichd.nih.gov/health/topics/infertility/conditioninfo/causes/causes-female* Accessed 15 Aug 2019; Infertility FAQs, Centers for Disease Control and Prevention. See *https://www.cdc.gov/reproductivehealth/infertility/index.htm* Accessed 15 Aug 2019; Fertility Conditions, Fertility Network UK, See *https://fertilitynetworkuk.org/fertility-faqs/fertility-conditions/* Accessed 15 Aug 2019; Infertility Causes, National Health Service UK, See *https://www.nhs.uk/conditions/infertility/causes/* Accessed 15 Aug 2019; Mathur R, Female infertility, Causes. *Bupa UK*, See *https://www.bupa.co.uk/health-information/womens-health/female-infertility*. Accessed 15 Aug 2019.

- Uterine problems
- Overweight or underweight
- Use of substances like tobacco, alcohol; illegal drugs like cannabis and cocaine
- Adhesions following surgery
- Diabetes
- Previous ectopic pregnancy
- Cervical factors
- Physical and emotional stress and amenorrhea

None of the governmental or advocacy organisations accessed to produce this list mention abortion when discussing female infertility. Moreover, when some of those same organisations present public information specifically about abortion they expressly state that abortion does not cause infertility. For example, the UK's NHS says that "Having an abortion won't affect your chances of becoming pregnant again and having normal pregnancies in the future."[10] However, the same page of information does acknowledge a "very small risk to your fertility and future pregnancies if you develop a womb infection that isn't treated promptly." The information goes on to discuss PID and its link with infertility.

The British Pregnancy Advisory Service (BPAS) says, "There is no proven connection between abortion and future infertility, ectopic pregnancy or other pregnancy complications."[11] However, BPAS are careful to preface that statement with the *proviso*, "If your treatment is uncomplicated it won't cause any issues with future pregnancies." Given the complication rates, particularly for medical abortions, that *provisio* conditions the later assurance.

Marie Stopes UK states, "It will be possible to become pregnant again almost immediately after an abortion."[12] However, this sidesteps the question about whether an abortion could affect fertility. A future pregnancy can be possible, yet also adversely affected by abortion. The information is therefore ambiguous and unhelpful.

Planned Parenthood (PP) asserts, "Abortions don't cause infertility …."[13] PP does however preface that statement by saying: "Unless there's a rare and serious complication that's not treated, there's no risk to your ability to have children in the future." This implies that complications serious enough to affect fertility are rare (0.01% to 0.1%; ie between 1 and 10 per 10,000 abortions[14]), and only present a problem if untreated.

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[10] Abortion risks, NHS. See *https://www.nhs.uk/conditions/abortion/risks/* Accessed 15 Aug 2019.

[11] British Pregnancy Advisory Service, Abortion Frequently asked questions: will abortion affect my ability to get pregnant in the future? See *https://www.bpas.org/abortion-care/considering-abortion/* Accessed 15 Aug 2019.

[12] Marie Stopes UK, Frequently asked questions: will having an abortion make it difficult for me to get pregnant in the future? See *https://www.mariestopes.org.uk/frequently-asked-questions/* Accessed 15 Aug 2019.

[13] Planned Parenthood America, What facts about abortion do I need to know? See *https://www.plannedparenthood.org/learn/abortion/considering-abortion/what-facts-about-abortion-do-i-need-know* Accessed 15 Aug 2019.

[14] These definitions have been determined by the Council for International Organizations of Medical Sciences (CIOMS), an organisation established by WHO and UNESCO. They are described in the CIOMS

However, some quite serious abortion complications are not rare (eg blood transfusions required in up to 0.6% of medical abortions,[15] and PID in up to 4.9% of surgical abortions[16]), and as medical abortions overtake surgical ones and increasingly occur away from medical care, the risk of complications going untreated is likely to increase.

In summary, the message being conveyed to women is that there is no link between abortion and infertility. This public message may also be provided to women in their informed consent interactions with medical professions, but it is more than likely not addressed at all.

What Are the Reasonable Grounds For a Link Between Abortion and Infertility?

There are at least six possible ways by which a surgical or medical abortion might impact fertility. While these may be described as reasonable grounds for a link—or for some, theoretical grounds—for many the evidence is sufficient to suggest that an abortion should be expected to lead to at least some infertility. If other research that is more specifically directed to the abortion/infertility link does not reveal this, an explanation is needed.

Cervical Damage

Complications arising during the process of surgical abortion may lead to damage of the cervix from instrumentation. The NHS cites a risk of cervical damage of 1%.[17]

Given the role of cervical competency in fertility (including favourable mucous generation to enable sperm entry and survival), damage could lead to fertility problems as sperm may not pass a damaged cervix. Indeed, the NHS, in its information on infertility, cites cervical scarring and problems with mucous generation as potential causes of infertility.[18] A significant proportion of cases of infertility remain unexplained, and while a link via cervical damage from abortion remains theoretical, it should be the subject of further research.

Infections and Pelvic Inflammatory Disease (PID)

Following a surgical or medical abortion, pre-existing or acquired infection can lead to the development of PID. PID refers to inflammation of the upper reproductive tract (endometrium, fallopian tubes, ovaries, or pelvic peritoneum), caused by infectious agents. The types of infection associated with PID involve cervical pathogens like

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training manual, which can be found at *http://www.who.int/medicines/areas/quality_safety/safety_efficacy/trainingcourses/definitions.pdf*_ Accessed 28 Jun 2018.

[15] Winikoff B *et al.* (2012) Extending Outpatient Medical Abortion Services Through 70 Days of Gestational Age. *Obstet Gynecol* 120:1070–76.

[16] Charonis G & Larsson PG (2006) Use of pH/whiff test or QuickVue Advanced® pH and Amines test for the diagnosis of bacterial vaginosis and prevention of postabortion pelvic inflammatory disease. *Acta Obstetricia et Gynecologica* 85:837-843.

[17] See *https://www.nhs.uk/conditions/abortion/risks/* Accessed 15th Aug 2019.

[18] *https://www.nhs.uk/conditions/infertility/causes/*.

Chlamydia trachomatis and *Mycoplasma*, Bacterial Vaginosis (BV) pathogens, respiratory pathogens, and enteric pathogens, but the exact agents responsible are not always clear.[19] The majority of PID is caused by sexually transmitted cervical pathogens or BV associated microbes.[20] PID can lead to scarring of the fallopian tubes, which in turn may block the passage of the egg, sperm, or embryo, causing infertility. An additional negative impact on fertility via damage to the endometrium caused by infection, is theoretically possible, although unproven at this stage. In support of this possibility, Heisterberg *et al.* found a significant elevation in the risk of spontaneous abortion (miscarriage) in women with PID compared to those without.[21] That is, they were able to conceive but could not sustain the pregnancy.

PID affects about 8% of all US women of reproductive age,[22] and may be symptomatic or asymptomatic (subclinical), making it a difficult condition to diagnose. It is estimated that approximately two thirds of cases may be asymptomatic, and therefore are likely to remain undetected.[23] Of the symptomatic cases, between 10% and 20% will lead to infertility and ectopic pregnancy.[24] For asymptomatic cases, a greater concern about risk to infertility exists. In a study of asymptomatic PID (which can be accurately assessed via biopsy) and infertility, Wiesenfeld *et al.* found that women with asymptomatic PID had a 40% reduced incidence of pregnancy compared with women without asymptomatic PID, even though both groups were equally attempting pregnancy.[25] This means a 40% decline in fertility.

Brunham *et al.* note that "most women with tubal-factor infertility do not have a history of *clinically* diagnosed pelvic inflammatory disease" [26] [*emphasis added*], and yet they have similar tubal damage to women with a diagnosis. In other words, most women likely had asymptomatic PID, which went undiagnosed and caused tubal damage.

But even when treatment is undertaken, infertility can still occur. The US *Pelvic Inflammatory Disease Evaluation and Health* (PEACH) study found that even when PID was symptomatic and treated with antibiotics, after 3 years, 18% of women nevertheless reported infertility.[27] In the study by Wiesenfeld *et al.* referred to above, women

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[19] Brunham RC *et al.* (2015) Pelvic Inflammatory Disease. *N Engl J Med* 372:2039-2048. DOI: 10.1056/NEJMra1411426.

[20] Brunham RC *et al.* (2015) *Op. Cit.*

[21] Heisterberg L *et al.* (1986) Sequelae of induced first-trimester abortion. A prospective study assessing the role of postabortal pelvic inflammatory disease and prophylactic antibiotics. *Am J Obstet Gynecol* 155(1):76-80.

[22] See Ness et al (2005), ref #1.

[23] Brunham RC *et al.* (2015) *Op. Cit.*

[24] Ibid.

[25] Wiesenfeld HC *et al.* (2012) Subclinical Pelvic Inflammatory Disease and Infertility. *Obstet Gynecol* 120:37–43.

[26] Brunham RC *et al.* (2015) *Op. Cit.*

[27] Ness RB *et al.* (2002) Effectiveness of inpatient and outpatient treatment strategies for women with pelvic inflammatory disease: Results from the Pelvic Inflammatory Disease Evaluation and Clinical Health (PEACH) Randomized Trial. *Am J Obstet Gynecol* 186:929-37.

were selected who were known to be at risk of PID because of the infectious agents they carried, and so were all treated with a range of antibiotic therapies, and yet the 40% reduction in fertility occurred despite that treatment. Moreover, 15% of women had *recurrent* PID,[28] which "markedly worsen[s] the reproductive outcomes."[29] Heisterberg *et al.* observed something similar, finding that 41% of women with postabortal PID had another episode within a year, compared with 5% of women who did not have postabortal PID.[30]

It is understandable then that Brunham *et al.* express concern about why "the long-term outcome of treated pelvic inflammatory disease remains so dismal."[31] One thing does seem clear, and that is that ensuring pathogens do not ascend to the upper genital tract is critical. Wiesenfeld *et al.* found that when infections did not ascend, PID did not occur, and hence there was no impact on fertility.[32] PID, symptomatic or asymptomatic, is the link with infertility rather than the presence of the pathogens alone in the lower genital tract. However, the presence of the pathogens is a prerequisite for their entry into the upper genital tract, and so when they are present at the same time that access to the upper genital tract occurs, PID can occur. Hence, in populations where pathogens are more prevalent, the risk of PID will be higher.

This is where the link between abortion and PID occurs. That is, abortion, whether surgical or medical, involves an untimely and extensive breach of cervical integrity, enabling vaginal pathogens to ascend into the upper genital tract and cause PID, which, as has been shown, causes infertility in perhaps between 10% and 40% of cases.[33,34]

What evidence is there that abortion is a factor in the development of PID? Before considering that question, it is necessary to note that the known pathogens responsible for PID are more prevalent in women seeking abortion.[35] In Stevenson and Radcliffe's analysis of a range of studies from the 80's through to the mid-90's, rates of infection with *Chlamydia* ranged from around 5% to 18% (average of 20 studies was 10.8%) for women accessing abortion.[36] The authors note that the rates are similar to those for women accessing family planning clinics and genitourinary clinics, suggesting that women accessing abortion are at similarly high risk of STIs. The figure above can be contrasted with the prevalence in a population sample of women of reproductive age in the UK, in which the figure amongst women aged

[28] Ness RB *et al.* (2005) Effectiveness of Treatment Strategies of Some Women With Pelvic Inflammatory Disease. A Randomized Trial. *Obstet Gynecol* 106:573–580.

[29] Brunham RC *et al.* (2015) *Op. Cit.*

[30] Heisterberg L *et al.* (1986) *Op. Cit.*

[31] Brunham RC *et al.* (2015) *Op. Cit.*

[32] Wiesenfeld HC *et al.* (2012) *Op. Cit.*

[33] Brunham RC *et al.* (2015) *Op. Cit.*

[34] Wiesenfeld HC *et al.* (2012) *Op. Cit.*

[35] Turner R (1993) High Levels of Genital Tract Infection Found among Abortion Patients. *Family Planning Perspectives* 25(6):279-280.

[36] Stevenson MM & Radcliffe KW (1995) Preventing pelvic infection after abortion. *International Journal of STD & AIDS* 6:305-312.

16-44 years was 1.5% in 2010-12, and had likely changed only marginally since the previous study 10 years earlier.[37]

Other recent studies have found similarly high rates of *Chlamydia* infection amongst women seeking abortion—15.7% in what the authors describe as a 'high risk population,'[38] and 12.1% in an urban US setting.[39] In a 2018 Swedish study by Carlsson *et al.*, while the infection rate prior to abortion was lower for *Chlamydia* (between 1% and 3% from 2008 to 2015), the rate for *Mycoplasma* was around 2.7% and for BV ranged from 12.4% to 19.5% per year.[40]

The high prevalence of infection in women seeking abortion is a concern because it significantly increases the risk of transmitting infection into the upper genital tract via the abortion, thereby increasing the risk of PID, above what would be expected if the infection rates were closer to population levels.[41]

What then do we know about infections after abortion, and in particular the prevalence of PID? Throughout the 80's many studies showed a high prevalence of postabortal PID, ranging from 10% to 28%, which are alarming figures given the risk to fertility, especially with the potential for undetected cases of asymptomatic PID.[42] Moreover, for patients who were *not* infected with *Chlamydia*, postabortal PID still occurred at rates between 0.5% and 10%.[43] Other pathogens must have been responsible, but as noted above, there remains uncertainty to this day about the role of all pathogens in the development of PID.

In the last couple of decades, while there are many studies looking at the incidence of infection as a post-abortion complication, there appear to be very few studies that consider the link between post abortion infection and PID. Moreover, when it comes to possible treatment, in their 2013 review of postabortal PID, Russo *et al.* note "the paucity of data on antibiotic treatment of postabortal PID."[44] Clearly this is an area where research is needed.

The prevalence of infection after surgical or medical abortion varies significantly from one study to another, so that rates for surgical abortion ranging from 0.1% to 4.7%

[37] Sonnenberg P *et al.* (2013) Prevalence, risk factors, and uptake of interventions for sexually transmitted infections in Britain: findings from the National Surveys of Sexual Attitudes and Lifestyles (Natsal). *Lancet* 382:1795–806.

[38] Baczynska A *et al.* (2008) Prevalence of *Mycoplasma genitalium*, *Mycoplasma hominis* and *Chlamydia trachomatis* Among Danish Patients Requesting Abortion. *Systems Biology in Reproductive Medicine* 54(3):127-134.

[39] Fischlowitz A *et al.* (2016) *Chlamydia trachomatis* and *neisseria gonorrhoeae* screen-and-treat protocol among young women seeking first-trimester medical or surgical abortion at an urban, public hospital. *Contraception* 94(4):425.

[40] Carlsson I *et al.* (2018) Complications related to induced abortion: a combined retrospective and longitudinal follow-up study. *BMC Women's Health* 18:158.

[41] Russo JA *et al.* (2013) Controversies in family planning: postabortal pelvic inflammatory disease. *Contraception* 87:497-503.

[42] Stevenson MM & Radcliffe KW (1995) *Op. Cit.*

[43] Ibid.

[44] Russo JA *et al.* (2013) *Op. Cit.*

have been reported,[45] and for medical abortion, from 0.016% to 6.11%.[46,47,48,49,50] In a review of the prevalence of infection from medical abortion alone across a large number of studies, Shannon *et al.* derived an average figure of 0.92%,[51] finding a large variation between UK studies and non-UK studies. This is also the figure quoted in the Practice Bulletin of the *American College of Obstetricians and Gynecologists*.[52] The NHS places the overall risk significantly higher at 10%, which may reflect concern about undiagnosed infections.[53] Infection risk has been treated with antibiotic use of between 9% and 11% for medical abortions, not dissimilar to that for surgical abortions.[54,55]

What this large variation in the reported incidence of infection after abortion indicates is that there appears to be a significant degree of uncertainty about when infection may be present, and/or limited agreement about how to assess the presence of infection. There are also variations amongst studies between different populations of women seeking abortion as well as different treatment paradigms in use for pathogens screened before abortion.

In the study by Carlsson *et al.* cited above, the authors found that "of all women who tested positive for one or several bacteria at the screening and therefore received antibiotics, 1.4% developed a postabortal infection. Among those who tested negative at the screening, 1.7% developed infectious complications."[56] While this can be interpreted as evidence of the effectiveness of screening and treating, it also highlights the ongoing risk of infectious post-abortion complications despite screening or in the absence of a positive screening result. In other words, there are unknown bacteria that lead to post abortion infections at rates around 1.4% to 1.7%—which may also lead to the development of PID.

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[45] Cited by Kruse B *et al.* (2000) Management of side effects and complications in medical abortion. *Am J Obstet Gynecol* 183:S65-S75.

[46] Cleland K *et al.* (2013) Significant Adverse Events and Outcomes After Medical Abortion. *Obstet Gynecol* 121:166–71.

[47] Mulligan E & Messenger H (2011) Mifepristone in South Australia. The first 1343 tablets. *Australian Family Physician* 40(5):342-345.

[48] Goldstone P *et al.* (2012) Early medical abortion using low-dose mifepristone followed by buccal misoprostol: a large Australian observational study. *Med J Aust* 197:282–286.

[49] Shannon C *et al.* (2004) Infection after medical abortion: a review of the literature. *Contraception* 70:183–190.

[50] Niinimaki M *et al.* (2009) Immediate Complications After Medical Compared With Surgical Termination of Pregnancy. *Obstet Gynecol* 114:795–804.

[51] Shannon C *et al.* (2004) *Op. Cit.*

[52] Medical Management of First-trimester Abortion. The American College of Obstetricians and Gynecologists & the Society of Family Planning. *Practice Bulletin* 143, March 2014.

[53] *https://www.nhs.uk/conditions/abortion/risks/* Accessed 20 Aug 2019.

[54] Urquhart DR *et al.* (1997) The Efficacy and Tolerance of Mifepristone and Prostaglandin in Termination of Pregnancy of Less Than 63 Days Gestation; UK Multicentre Study—Final Results. *Contraception* 55:1-5.

[55] Jensen JT *et al.* (1999) Outcomes of Suction Curettage and Mifepristone Abortion in the United States. A Prospective Comparison Study. *Contraception* 59:153–159.

[56] Carlsson I *et al.* (2018) *Op. Cit.*

As noted, few studies look specifically at PID after abortion, instead simply reporting infectious complications. However, the relationship between pre-abortion infection (*Mycoplasma genitalium*) and postabortal PID has been found to be strong enough for the authors to argue it is causal.[57] In addition, in their study of BV and its treatment before either surgical or medical abortion, Charonis and Larsson found that even after detection and treatment of BV, the rates of PID after abortion were 2.4% for medical abortions and 4.9% after surgical ones.[58] In this study, PID was diagnosed by assessment of symptoms. Asymptomatic PID, which is twice as common as symptomatic PID, was not able to be detected. The rates may have been somewhat lower if a more precise microscopic means of detection were used and treatment applied, but as the authors note,

> Abortion clinics are often not equipped with the optimal instruments for reliable diagnosis of BV. Limited time, difficulties in interpreting the microscopic specimens, and not least the lack of powerful microscopes lead to a situation where few physicians can make a reliable BV diagnosis and thus protect patients from serious infection.[59]

If symptomatic PID, even after antibiotic treatment, occurs at a frequency of between 2.4% and 4.9%, and infertility after PID between 10% and 20% for symptomatic cases, then in total there could be up to 1% infertility (20% of 4.9%) after abortion from PID alone. However, that figure could treble if asymptomatic PID is taken into account. Moreover, in the context of Charonis and Larsson's study, women were provided with screening and treatment for known pathogens, which would not be true for all settings, even in wealthy countries. In addition, it is likely that as abortion moves steadily from surgical to medical abortion, and increasingly outside of the medical scrutiny of the clinic, this problem could worsen further.

Rather than theoretical, the link between abortion and infertility via PID seems reasonable based upon the evidence to date.

Incomplete Abortion

Incomplete abortion is a known risk factor for the development of infection requiring surgical intervention. The foetal parts remaining are usually referred to as the 'retained products of conception' (RPOC).

After *surgical abortion*, in a Finnish registry study by Niinimaki *et al.* for the years 2000—2006, the rate of RPOC was found to be 1.6%[60] However, in a more recent paper also based upon Finnish registries (also co-authored by Niinimaki) a rate of 7.6% for surgical re-evacuation of RPOC was found for the years 2000 to 2008.[61] There appears

[57] Bjartling C *et al.* (2010) The association between *Mycoplasma genitalium* and pelvic inflammatory disease after termination of pregnancy. BJOG 117:361–364.

[58] Charonis G & Larsson PG (2006) *Op. Cit.*

[59] *Ibid.*

[60] Niinimaki M *et al.* (2009) *Op. Cit.*

[61] Mentula M *et al.* (2018) Intrauterine adhesions following an induced termination of pregnancy: a nationwide cohort study. *BJOG* 125:1424–1431.

to be no explanation for this large difference. In a Swedish study by Carlsson *et al.* a figure of 1.7% was reported.[62]

After *medical abortion* the reported rates of RPOC likewise vary enormously, depending upon the regimen being used. For mifepristone/misoprostol, a recent meta-analysis of 87 studies put the rate of abortion failure at 4.8%, with a range from 0% to 40%.[63] In that review, abortion failure included incomplete abortion and ongoing pregnancy. Since the ongoing pregnancy rate was 1.1%, the incomplete abortion rate was 3.7%. Others have found a rate of 4.1%.[64] These studies were determined from within the controlled context of a research trial. In contrast, in a Finnish register study by Niinimaki *et al.*, looking retrospectively at all abortions in Finland, the rate of incomplete abortion after *medical abortion* was 7% for adolescents and 10.2% for adults.[65] Because of other complications, this resulted in a surgical re-evacuation rate for RPOC of 11% for adolescents and 13% for adults. A similar result that likewise used Finnish registries reported a figure of 11.5% averaged over the years 2000 to 2008.[66]

When surgical re-evacuation is required after medical abortion, the risks of the procedure, such as infection, cervical and uterine damage, are additive upon the risks already inherent in the medical abortion, placing this group of women at a significantly elevated overall risk of complications that may bear upon their fertility.[67] In addition, surgical treatment for RPOC increases the likelihood that RPOC will occur in a subsequent pregnancy or abortion. The risk was increased when the initial RPOC was treated using suction curettage rather than by hysteroscopy,[68] most likely because of the "potentially greater endometrial injury in patients who underwent curettage."[69] Suction curettage is a common method of first trimester abortion.

Although considered to be relatively rare (0.15% among women undergoing hysteroscopy), the retention of bone fragments after abortion has been linked to secondary infertility.[70] In a study of three cases, the authors found that an abortion decades earlier was responsible for the fragments and most likely also for the infertility. They pro-

[62] Carlsson I *et al.* (2018) *Op. Cit.*

[63] Raymond EG *et al.* (1013) First-trimester medical abortion with mifepristone 200 mg and misoprostol: a systematic review. *Contraception* 87:26–37.

[64] Carlsson I *et al.* (2018) *Op. Cit.*

[65] Niinimaki M *et al.* (2011) Comparison of rates of adverse events in adolescent and adult women undergoing medical abortion: population register based study. *BMJ* 342:d2111.

[66] Mentula *et al.* (2018) *Op. Cit.*

[67] Di Spiezio Sardo A *et al.* (2019) Commentary on "Assessment of Risk Factors of Intrauterine Adhesions in Patients with Induced Abortion and the Curative Effect of Hysteroscopic Surgery." *Journal of Investigative Surgery*, 32(1):90-92, DOI: 10.1080/08941939.2017.1400133.

[68] Hysteroscopy allows direct visualization of the intrauterine environment using a hysteroscope, a thin lighted tube.

[69] Smorgick N *et al.* (2018) Retained products of conception: What is the risk for recurrence on subsequent pregnancies? *European J Obstet & Gynecol & Reprod Biol* 224:1–5.

[70] Winkelman WD *et al.* (2013) Secondary Infertility and Retained Fetal Bone Fragments. *Obstet Gynecol* 122:458–61.

pose more screening because "retained fetal bone fragments may be an underreported and underappreciated cause of secondary infertility among women with an antecedent spontaneous or induced abortion."[71] Moon *et al.* consider abortion to be the most common cause of intrauterine bony structures.[72]

Intrauterine Adhesions (IUAs)

Closely related to the problem caused by RPOC is the possibility of infertility from intrauterine adhesions (Asherman Syndrome). Adhesions form in the uterus after damage to the endometrial lining and, depending on the severity, may lead to infertility in up to 43% of such cases.[73]

Determining the prevalence of IUAs after abortion is problematic for the following reasons:

> Asherman syndrome may go unrecognized in women who are not trying to conceive since they may not recognize or be concerned with the symptoms. These women may have hypomenorrhea. Therefore, Asherman syndrome may be underdiagnosed because it is usually undetectable by routine examinations or diagnostic procedures such as an ultrasound scan. [74]

In their 2016 systematic review of the prevalence of IUAs following abortion, after an extensive review of the literature, Hooker *et al.* found only two studies.[75] One examined the prevalence after first trimester surgical abortion (21.2%),[76] and the other after second trimester abortion (16.2%).[77] There were none that studied women after medical abortion. In the study of first trimester surgical abortion, in nearly half (48%) of the women with IUAs, the condition was found to be moderate to severe.[78] In their recent (2019) description of Asherman syndrome and its epidemiology, Smikle and Khetarpal cite a prevalence figure of up to 13% after first trimester abortion, but without reference to where that figure came from.[79]

Since the review by Hooker *et al.* in 2016, there have been two subsequent studies examining this question. First, Mo and co-workers studied 1500 women after induced

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[71] Ibid.

[72] Moon HW *et al.* (1997) Iatrogenic secondary infertility caused by residual intrauterine fetal bone after midtrimester abortion. *Am J Obstet Gynecol* 176:369-370.

[73] Schenker JG (1996) Etiology of and therapeutic approach to synechia uteri. *European J Obstet & Gynecol & Reprod Biol* 65:109-113.

[74] Smikle C & Khetarpal S (2019) Asherman Syndrome. StatPearls Publishing LLC. *National Center for Biotechnology Information (NCBI) Books*. See *https://www.ncbi.nlm.nih.gov/books/NBK448088/* Accessed 29 Aug 2019.

[75] Hooker A *et al.* (2016) Prevalence of intrauterine adhesions after termination of pregnancy: a systematic review. The *Europ J Contracept & Reprod Health Care* 21(4):329-335.

[76] Salat-Baroux J *et al.* (1984) Postabortal hysteroscopy. In: Siegler AM, Lindemann HJ, editors. *Hysteroscopy, principles and practice*. Philadelphia, PA: Lippincott; 1984. p231–235.

[77] Kajanoja P & Aantaa K (1983) Radiographic Findings in Cervix Uteri After Prostaglandin Abortion Induction. *Acta Obstetricia et Gynecologica Scandinavica* 62(3):253-256.

[78] Salat-Baroux J *et al.* (1984) *Op. Cit.*

[79] Smikle C & Khetarpal S (2019) *Op. Cit.*

abortion and found a rate of IUAs of 17%; the majority of these were moderate to severe (59%).[80] Specific risk factors that contributed to IUAs were more severe preoperative inflammation and higher level and longer suction during the abortion. However, the 1500 women included in this study were a mixed group. They either had an abortion because of vaginal bleeding, or received suction curettage after miscarriage or incomplete abortion. This, together with the fact they also had a history of intrauterine operations, means they were not a representative sample of women seeking abortion. Nevertheless, the procedure they underwent, involving suction curettage, was the same as that used in most first trimester abortions, or to deal with many cases of RPOC after failed medical abortion or miscarriage.

Second, in a Finnish nationwide study of all women having had an abortion between 2000 and 2008, a very low rate of IUAs was found (0.015% to 0.02%).[81] In this same study, re-evacuation rates after surgical or medical abortion were 7.6% and 11.5% respectively. In a recent systematic review of IUAs after *miscarriage*, a prevalence rate of 19.1% was found, the authors identifying "the number of dilatation and curettage (D&C) procedures as the main driver behind these associations."[82] Re-evacuation after either miscarriage or incomplete abortion to remove RPOC are essentially the same procedures, hence a similar rate of IUA formation would be expected for both. This is supported by another study of IUAs after treatment for RPOC following incomplete abortion, where 17.4% of women had IUAs.[83] If evacuation after *miscarriage* leads to an IUA prevalence of around 19%, the finding that 17.4% of women had IUAs after evacuation for incomplete *abortion* is consistent with that observation.

One would therefore similarly expect about 17% of the re-evacuation cases in the Finnish study to result in IUAs, leading to an overall IUA prevalence of at least between 1.3% and 2.0% of all abortions (ie 17% of 7.6% and 11.5%). Yet, the Finnish study came up with figures approximately one hundredth of that. The authors acknowledge but understate the mismatch: "If the evacuation of retained products of conception raises the risk of IUAs, the finding that IUAs is a rare phenomenon is interesting …"[84] One possible explanation is that in the Finnish study the registry coding of IUAs by hospitals upon discharge only records the most severe cases. Women in this study who were identified as having IUAs attended hospital with 'menstrual disorders, bleeding, and/or pain.'[85] But there may have been many more who attended for the same reasons, only a small proportion of whom may have received hysteroscopic or other valid investigative

[80] Mo X *et al.* (2019) Assessment of Risk Factors of Intrauterine Adhesions in Patients With Induced Abortion and the Curative Effect of Hysteroscopic Surgery. *Journal of Investigative Surgery* 32(1):85-89.

[81] Mentula *et al.* (2018) *Op. Cit.*

[82] Hooker AB *et al.* (2014) Systematic review and meta-analysis of intrauterine adhesions after miscarriage: prevalence, risk factors and long-term reproductive outcome. *Human Reproduction Update* 20(2):262–278.

[83] Barel O *et al.* (2015) Intrauterine adhesions after hysteroscopic treatment for retained products of conception: what are the risk factors? *Fertility & Sterility* 103(3):775-779.

[84] Mentula *et al.* (2018) *Op. Cit.*

[85] Ibid.

tests to ascertain the presence of IUAs. In other words, women attending hospital with IUAs may have been missed because IUAs may not have been suspected as the cause of the symptoms cited. Alternatively, it may be that the majority of cases of IUAs never end up with a hospital attendance at all—as noted above, "Asherman syndrome may go unrecognized in women who are not trying to conceive since they may not recognize or be concerned with the symptoms."[86]

To summarise, even though the precise numbers remain unclear, the evidence for a link between abortion and IUAs is clear, specially via D&C either initially or after (re) evacuation of RPOC following surgical or medical abortion. The link between IUAs and infertility is perhaps even more established. Hence, the pathway from abortion to infertility via IUAs is sufficiently convincing to suggest it should be considered reasonable rather than theoretical.

Endometrial Thinning

The thickness of the endometrium has been shown to influence pregnancy rates in ART treatment.[87] A thin endometrium leads to poorer pregnancy rates.[88] The mechanism by which this happens is unclear, but may involve either compromised endometrial receptivity to the embryo, or difficulty sustaining embryonic development leading to miscarriage. Poor uterine receptivity has been described as a key factor in miscarriage, and embryo implantation as the rate-limiting step for IVF success.[89] This will also be true for natural conception and maintaining a pregnancy outside of the context of ART, and may constitute a link between endometrial thinning and infertility or subfertility.

The relationship between abortion and endometrial thinning is not completely clear, although the majority of studies suggest that D&C after miscarriage or induced abortion may cause endometrial thinning.[90,91,92] In a recent study of 310 infertile women, Azumaguchi *et al.* found a clear relationship and proposed a possible mechanism via 'direct physical damage to endometrial stem cells.'[93]

If such a mechanism were correct, then it would theoretically be possible for vacuum aspiration to likewise lead to some physical damage resulting in endometrial

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[86] Smikle C & Khetarpal S (2019) *Op. Cit.*

[87] Kasius A *et al.* (2014) Endometrial thickness and pregnancy rates after IVF: a systematic review and meta-analysis. *Human Reproduction Update* 20(4):530–541.

[88] Dekel N *et al.* (2010) Inflammation and Implantation. *Am J Reprod Immunol* 63:17–21.

[89] Dekel N *et al.* (2010) *Op. Cit.*

[90] Netter AP *et al.* (1996) Recurrent abortions: Unpublished syndrome suggesting the explanation of fetal death. *C R Acad Sci III 319*(7):637-638.

[91] Shufaro Y *et al.* (2008) Thin unresponsive endometrium—A possible complication of surgical curettage compromising ART outcome. *J Assist Reprod Genet* 25:421–425.

[92] Davar R *et al.* (2013) Dilatation and curettage effect on the endometrial thickness. *Iran Red Crescent Med J* 15:350–355.

[93] Azumaguchi A *et al.* (2017) Role of dilatation and curettage performed for spontaneous or induced abortion in the etiology of endometrial thinning. *J Obstet Gynaecol Res* 43(3):523–529.

thinning. If that were so, then the large number of first trimester vacuum aspiration abortions being undertaken could lead to a small by significant effect on endometrial thinning and therefore infertility or subfertility. Moreover, such cases—as well as many D&C cases—would likely not be identified unless treatment for infertility was sought.

In 2018, Wang and co-researchers confirmed much of what was suspected about the link between abortion and endometrial thinning. In their study of the relationship between abortion history and IVF outcomes, they found that prior induced abortion was associated with endometrial thinning as well as higher rates of miscarriage and lower rates of clinical pregnancy.[94] As the number of surgical abortions increased the outcomes worsened, which is suggestive of a causal relationship. These researchers also found that infertile women with a history of abortion had a much higher incidence of uterine cavity problems such as polyps and IUAs, compared with women without a history of abortion (74.3% v. 10.6%). Because of this, it was unclear whether endometrial thinning or other uterine cavity problems were responsible for the adverse outcomes.

Psychological Factors

The relationship between mental health and infertility is a complicated one. Some studies suggest that women with poor mental health have lower fertility; however, the studies are few in number and complicated by the fact that assessment of fertility rates by number of observed versus expected children is a difficult measure, amongst other things complicated by uncertainty about attempts to conceive.[95] Moreover, pharmacological treatments for mental illness may themselves affect fertility. Nevertheless, adverse mental health is related to infertility—women seeking treatment for infertility already have higher than average rates of depression, anxiety and PTSD.[96] A recent review found the prevalence of psychiatric disorders among infertile couples to be between 25% and 60%, much higher than in the general populace.[97]

Psychiatric symptoms might be caused by the stress of infertility itself, or there may be pre-existing psychiatric problems that are causally related to infertility. Possibly, both play a role. There is some evidence that mood disorders in particular lead to menstrual irregularities,[98] potentially via alterations in hormonal control of reproduction.[99]

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[94] Wang Y *et al.* (2018) Association between induced abortion history and later in vitro fertilization outcomes. *Int J Gynecol Obstet* 141:321–326.

[95] Williams KE *et al.* (2007) Mood disorders and fertility in women: a critical review of the literature and implications for future research. *Human Reproduction Update* 13(6):607–616.

[96] For a wider discussion and review see Rooney KL & Domar AD (2018) The relationship between stress and infertility. *Dialogues in Clinical Neuroscience* 20(1):41-47.

[97] De Berardis D *et al.* (2014) Psychopathology, emotional aspects and psychological counselling in infertility: a review. *La Clinica Terapeutica* 165(3):163-169.

[98] Williams KE *et al.* (2007) *Op. Cit.*

[99] Meller WH *et al.* (1997) Luteinizing Hormone Pulse Characteristics in Depressed Women. *Am J Psychiatry* 154:1454-1455.

The process of ART itself is often difficult and stressful, and many studies have shown that it can lead to adverse mental health outcomes coupled with lower pregnancy rates.[100,101] This latter finding reinforces the idea that adverse psychiatric symptoms may play a role in infertility. If that is indeed true, then factors linked to the development of psychiatric disorders may be risk factors for infertility.

The role that abortion plays in the development of adverse mental health outcomes has been the subject of much discussion and debate.[102] Many studies point to an association between the two that has the hallmarks of a causative relationship.[103,104,105,106,107,108] Others deny any role for abortion in adverse mental health outcomes.[109,110,111] Other forms of early pregnancy loss such as miscarriage are related to adverse mental health outcomes like PTSD, anxiety and depression,[112] yet do not attract the same controversy as abortion and mental health.

Any link from abortion to infertility via adverse mental health is theoretical and controversial, and yet both elements of the putative link—from abortion to adverse mental health and from adverse mental health to infertility—are worthy of further research.

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[100] Pasch LA *et al.* (2016) Addressing the needs of fertility treatment patients and their partners: are they informed of and do they receive mental health services? *Fertility and Sterility* 106(1):219-205.

[101] Baldur-Felskov B *et al.* (2013) Psychiatric disorders in women with fertility problems: results from a large Danish register-based cohort study. *Human Reproduction* 28(3):683–690.

[102] Reardon DC (2018) The abortion and mental health controversy: A comprehensive literature review of common ground agreements, disagreements, actionable recommendations, and research opportunities. *SAGE Open Med*. 6: 1-38.

[103] Fergusson DM, Horwood LJ & Boden JM (2008) Abortion and mental health disorders: evidence from a 30-year longitudinal study. *British Journal of Psychiatry* 193(6):444-451.

[104] Sullins DP (2016) Abortion, substance abuse and mental health in early adulthood: Thirteen-year longitudinal evidence from the United States. *SAGE Open Med* 4:1-11.

[105] Bellieni CV & Buonocore G (2013) Abortion and subsequent mental health: Review of the literature. *Psychiatry and Clinical Neurosciences* 67:301-310.

[106] Lafarge C *et al.* (2013) Women's experiences of coping with pregnancy termination for fetal abnormality. *Qualitative Health Research* 23(7):924-936.

[107] Coleman PK *et al.* (2017) Women who suffered emotionally from abortion: A qualitative synthesis of their experiences. *Journal of American Physicians and Surgeons* 22(4):113-118.

[108] Jacob L *et al.* (2019) Association between induced abortion, spontaneous abortion, and infertility respectively and the risk of psychiatric disorders in 57,770 women followed in gynecological practices in Germany. *J Affective Disorders* 251:107–113.

[109] Munk-Olsen T *et al.* (2011) Induced first-trimester abortion and risk of mental disorder. *New England J Med* 364(4):332-339.

[110] Turnaway Study. For a full list of papers arising from this study, see *https://www.ansirh.org/research/abortion* Accessed 31 Aug 2019.

[111] UK Royal College of Obstetricians and Gynaecologists (2011) The Care of Women Requesting Induced Abortion. Evidence-based Clinical Guideline Number 7, see *https://www.rcog.org.uk/globalassets/documents/guidelines/abortion-guideline_web_1.pdf* Accessed 31 Aug 2019.

[112] Farren J *et al.* (2016) Post-traumatic stress, anxiety and depression following miscarriage or ectopic pregnancy: a prospective cohort study. *BMJ Open* 6:e011864. doi:10.1136/bmjopen-2016-011864.

Direct Studies on Abortion and Infertility

The above six reasons have explored the possible links between abortion and infertility, some with good supporting evidence and some with less, but taken together they point to some unknown but significant expected level of risk. However, they rely largely upon indirect, though largely supportable, connections between the two. What research is there that more directly addresses the question, by measuring infertility after abortion, or retrospectively studies infertile women to see whether their abortion history may have caused their infertility?

Studies such as this are difficult to undertake, a reality acknowledged by many authors. Various problems arise that are common to much epidemiological research, and some that are specific to infertility studies. For example, biases can be introduced by the way subjects are selected, because women with an abortion history may understandably shy away from participation, or there may be recall biases because women may not accurately recall events from decades earlier, or may hide past abortions differentially between groups. Additionally, because infertility is so loosely defined, there is no simple measure for it, and in any case may be caused by the male. Moreover, studies at the population level will not be able to determine who is actually attempting pregnancy—women who have had an abortion may attempt pregnancy at a higher rate than those who have not had an abortion, especially if a control group were women who had just given birth.

When abortion was legalised in many Western countries in the 60s or 70s, concerns over infertility were immediately raised, leading to several studies showing mixed results. The importance of the issue was set out in the opening sentence of a WHO study in 1984: "The possibility that induced abortion might lead to subsequent infertility has been used as a major argument against the liberalization of the laws on abortion."[113] Noting one particular exception, the authors went on to state that: "This concern is not supported by the results of most of the controlled epidemiological studies published in recent years."[114] The WHO study itself found no evidence of a link between abortion and infertility.

The exception mentioned above was a study from Greece that found a 3.4 times greater risk of infertility for women with a previous abortion compared to those without, concluding that in the group of infertile participants in the study, 45% were infertile because of their abortion(s). The authors surmised that since infertility may be experienced by about 10% of the female population of reproductive age, overall about 5% were infertile because of a past abortion.[115] A relationship was also found between past miscarriage and infertility.

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[113] World Health Organization Task Force on Sequelae of Abortion (1984) Secondary Infertility Following Induced Abortion. *Studies in Family Planning* 15(6):291-295.

[114] WHO (1984) *Op. Cit.*

[115] Trichopoulos D *et al.* (1976) Induced Abortion and Secondary Infertility. *Brit J Obstet Gynaecol* 83:645-650.

This study was discounted by WHO and others[116,117] for various reasons including that abortion was illegal in Greece at the time. Authors of the Greek study undertook a more refined one in 1993, finding that there was an increase in risk of infertility of 2.1 times for one previous abortion and 2.3 times when there were two previous abortions.[118] They also took the WHO study to task, reanalyzing the WHO data and finding an effect of abortion on infertility. Moreover, they noted that even though abortion was not *formally* legal in Greece at the time of their earlier study, it was actually *de facto* legal, and had been for many years prior.

One other important observation came from the second Greek study, and was confirmed on re-analysis by Daling *et al.*[119] That is, there seemed to be a synergistic interaction between miscarriage and induced abortion, so that the risk of infertility among women having had both was higher than would be expected from an additive effect alone.

Other studies from the late 70s to mid 80s yielded mixed results. First, Daling and co-researchers undertook two studies on infertile women, neither of which showed any effect of abortion on infertility.[120,121] However, both studies, by recruiting infertile women seeking treatment, may have missed a much larger contingent of infertile women who had not sought treatment and who may have had abortions that impacted their fertility. In the second study in 1985, in which they recruited only women with tubal damage, the authors acknowledge that they may have missed an association between abortion and tubal infertility because of the study design. They remained open to the possibility of an association.[122]

Second, in a Danish study, the latent time to pregnancy was assessed in women with or without an abortion history and was found to be the same.[123] However, a subgroup of women who had an abortion that resulted in PID did have reduced fertility at 12 months, by about 15%. This group represented about 9% of the abortion group, and therefore constitutes evidence for a possible causal link from abortion to infertility, via PID. Moreover, women with menstrual irregularities were excluded from the study, which may have meant women with infertility resulting from IUAs were not included in the study, leading to an underestimation of infertility.

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[116] Daling JR *et al.* (1981) Role of Induced Abortion in Secondary Infertility. *Obstet Gynecol* 57(1):59-61.

[117] Atrash HK & Hogue CJR (1990) The effect of pregnancy termination on future reproduction. *Baillieres Clin Obstet Gynaecol* 4(2):391-405.

[118] Tzonou *et al.* (1993). Induced abortions, miscarriages and tobacco smoking as risk factors for secondary infertility. *J Epidemial Comm Health* 47:36-39.

[119] Daling JR *et al.* (1981) *Op. Cit.*

[120] Ibid.

[121] Daling JR *et al.* (1985) Tubal infertility in relation to prior induced abortion. *Fertility & Sterility* 43(3):389-394.

[122] Ibid.

[123] Obel EB (1979) Fertility Following Legally Induced Abortion. *Acta Obstetricia et Gynecologica Scandinavica* 58(6):539-542.

Third, an elevated prevalence of infertility was found in a Norwegian study, 3.1% in the abortion group versus 2.1% in the control group, but the difference was not significant. The data for women whose first pregnancy was terminated stands out as the most likely significant effect, which the authors acknowledge; however, no analysis of significance was conducted.[124]

Fourth, in a US study based upon responses to a questionnaire, no major differences were found in cumulative pregnancy rates after abortion compared with after a live birth.[125] Nevertheless, the data did show a reduced pregnancy rate at nine months for women with a prior abortion, the authors suggesting this was due to increased contraceptive use. The study found no link between pregnancy rate and PID, contrary to other studies.

Taken together, these studies suggest the picture is somewhat more complicated than the WHO paper of 1984 implies, and for an issue of this gravity, more well-designed research is clearly needed. In 1986, Hogue undertook a review of the literature, concluding that: " … women who choose to have their first pregnancy terminated are at no increased risk of failing to conceive at a later date."[126] Importantly, Hogue qualifies that statement with another: "Exceptions include abortions complicated by infection leading to pelvic inflammatory disease (PID)." This is a less than satifactory way to report on the risks of abortion to infertility, and as noted above, the exception may be quite significant and go some way towards explaining some of the mixed results in the literature at the time. Hogue's conclusion was premature.

In the years since this early phase of research there have been only a limited number of studies. In 1993, MacKenzie and Fry followed 140 UK women after they had a second-trimester medical abortion for foetal abnormality, concluding that there was no effect on their subsequent ability to conceive.[127] However, a closer inspection of the results reveal that of the 105 patients who were trying to conceive, one was subsequently infertile, two became pregnant through ART, and three attended a fertility clinic, becoming pregnant but with no record of what, if any, treatment they received. This outcome suggests that in fact possibly six of 105 women (5.7%) were infertile or subfertile, five of whom only achieved pregnancy with medical assistance. Moreover, 35 women (of the original 140) indicated they were not trying to become pregnant *at the time of inquiry by the researchers*, meaning there was no data about whether they may have attempted pregnancy later and what success or otherwise they had.

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[124] Dalaker K *et al.* (1979) Delayed reproductive complications after induced abortion. *Acta Obstetricia et Gynecologica Scandinavica* 58(5):491-494.

[125] Stubblefield PG *et al.* (1984) Fertility after induced abortion: a prospective follow up study. *Obstet Gynecol* 62(2):186-193.

[126] Hogue CJ (1986) Impact of abortion on subsequent fecundity. *Clin Obstet Gynaecol* 13(1):95-103.

[127] MacKenzie IZ & Fry A (1988) A prospective self-controlled study of fertility after second-trimester prostaglandin-induced abortion. *Am J Obstet Gynecol* 158:1137-1140.

In the same year, a study from Manchester (UK) was published that prospectively followed abortion versus non-abortion women for ten years.[128] While no effect on future fertility was identified overall, a result that came very close to statistical significance was identified for women who had aborted their *first* pregnancy. They experienced a 14% decline in fertility. If a larger number of women were recruited, statistical significance may have been shown. This study is a good example of some of the problems encountered in research such as this because of uncertainty about intent to become pregnant, differential loss to follow up of participants between abortion and non-abortion groups over time, frequency of coitus, and changing of partners. The study did include a retrospective arm as well, but as the authors acknowledge, it had a common problem: "… recall bias of women denying previous induced abortions, which would lead to the misclassification of these women who had a previous abortion into the non abortion group and, therefore, the dilution of any real abortion effect."

One final study from the UK warrants mention. It was a study of reduced fertility rather than infertility, recruiting 2983 pregnant women and assessing changes in time to pregnancy depending on past abortions or live births. The authors found no difference in fertility between women who had aborted a pregnancy compared with those who had given birth. However, they did find significantly reduced fertility in the abortion group *after* the abortion compared with *before*. They interpreted this finding as evidence of higher initial fertility amongst these women who then had an abortion that reduced their fertility. In their study, the women who had a live birth likely had reduced fertility to start with when compared with the women who went on to have an abortion.[129]

A series of studies from China found a link between abortion and tubal infertility,[130] but these were not confirmed by a more recent study. However, in the more recent study, the relationship between PID and infertility was confirmed.[131] A similar result was found in a Mexican study.[132]

In a study of Russian couples, the rate of infertility was found to be higher than in developed countries. More specifically the cause of infertility was proportionately higher for the women than the men, and the authors attribute this to the very high incidence of abortion—"in 53.7% of women with secondary infertility the last gestation ended with an induced abortion."[133]

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[128] Frank P *et al.* (1993) The effect of induced abortion on subsequent fertility. *Brit J Obstet Gynaecol* 100:575-580.

[129] Hassan MAM & Killick SR (2005) Is previous aberrant reproductive outcome predictive of subsequently reduced fecundity? *Human Reproduction* 20(3):657–664.

[130] These papers were all published in Chinese and were cited by Chen X *et al.* (2008) Induced Abortion and the Risk of Tubal Infertility. *J Reprod Contracept* 19(4):219-225.

[131] Chen X *et al.* (2008) *Op. Cit.*

[132] Torres-Sanchez L *et al.* (2004) Is induced abortion a contributing factor to tubal infertility in Mexico? Evidence from a case-control study. *Br J Obstet Gynaecol* 111:1254–1260.

[133] Philippov OS *et al.* (1998) Estimation of the prevalence and causes of infertility in Western Siberia. *Bulletin of the World Health Organization* 76(2):183-187.

A recent Finnish record linkage study that compared women who had given birth after abortion (the comparison group) with those who had received IVF treatment after abortion (the study group), found that the factors associated with IVF use were "those generally recognised as risk factors for infertility" rather than "abortion-associated factors," such as gestational age, method, or complications of abortion.[134] But this was not so much a study of abortion as a potential risk factor for infertility, but rather whether particular *characteristics* of abortion history were associated with IVF treatment, which itself was a very narrow study group. Because the study was designed in this way, nothing was known about the more than 90% of women who were initially identified as having had an abortion in the study period, but did not give birth or seek IVF. Many, perhaps most, may not yet have even attempted to conceive. Others may have failed in their attempts but not sought IVF treatment. The comparison group was selected because a delivery had occurred between 12 and 24 months after abortion, all other women (90%) being excluded. Hence, it is unknown what fertility issues this 90% of women may have had.

Finally, there were two recent retrospective registry based studies from Taiwan, one concluding that induced abortion is not a risk factor for infertility,[135] and the other that abortion is a risk factor for infertility.[136] However, the evidence from the first of these studies is almost certainly that, in fact, the opposite is true. In the study by Lin *et al.*, the prevalence of abortion was derived from the coding used, being divided into four subgroups: spontaneous abortion (SA; miscarriage), induced abortion (IA), nonspecific abortion (NSA), and mixed type abortion (MTA). No definition was provided to describe what constituted a nonspecific or mixed type abortion, although the implication is that International Classification of Diseases (ICD-9) codes were used to derive the four groups. If so, then according to ICD, SA would mean miscarriage, IA a legal abortion, NSA an illegal one, and MTA an unspecified abortion (whatever that may be taken to mean).[137] The study aim was to assess a range of outcomes from abortion, infertility being one. Abortion in Taiwan has been legal since 1985, and the registry used in this nationwide cohort study was the National Health Insurance Research Database, for the years 2000-2013. Why there would be widespread use of a code for illegal abortion for a period when abortion was legal in Taiwan is unknown.

In the data Lin *et al.* provide, excluding miscarriages, 91.7% of all abortions fell into the categories of NSA and MTA, IA only accounting for 8.3%. Importantly, while no effect on infertility could be shown for these 8.3% of induced abortions, the impact

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[134] Mannisto J *et al.* (2019) Induced abortion and future use of IVF treatment; A nationwide register study. *PLoS ONE* 14(11):e0225162.

[135] Tao X *et al.* (2018) Relationships between female infertility and female genital infections and pelvic inflammatory disease: a population-based nested controlled study. *Clinics* 73:e364.

[136] Lin TB *et al.* (2018) Long-term physical health consequences of abortion in Taiwan, 2000 to 2013. A nationwide retrospective cohort study Medicine 97:31.

[137] The relevant ICD-9 codes relating to abortion are the following: 634 (Spontaneous abortion), 635 (Legally induced abortion), 636 (Illegally induced abortion), and 637 (Unspecified abortion).

of the 91.7% of NSA and MTA abortions on infertility was shown to be significant, leading to an increase in risk of between 1.6 times and 1.9 times, respectively. In other words, there was a significantly increased risk of infertility for 91.7% of all abortions, which were categorised as non-specific and mixed type abortions.

The second Taiwanese study used the same registry data over the same time period, but was structured differently to identify a range of risk factors for infertility. The results reveal an even higher risk of infertility from past abortions than the study by Lin *et al.*—between 4 and 5 times higher than not having had an abortion.[138]

Conclusion

In many respects, infertility is a hidden problem as much as it is a deeply personal one. Its discovery usually only happens when trying to conceive, and then perhaps after many months, or even years. It is therefore not surprising that research into its causes is inherently difficult to undertake. When this is coupled with abortion, likewise deeply personal and often hidden, as well as being morally and politically charged, the problem is compounded. Perhaps this is why there have been so few studies overall, some of which appear to be of limited value because of the inherent difficulties, but also because of methodological limitations.

It appears as if the series of studies from the late 70s through early 80s, along with the confidence of some reviewers who believed that abortion did not affect subsequent fertility, were sufficient to create acceptance that there was no need for concern. That is still very much the case, as evidenced by advice from many abortion providers and governmental organisations. However, as we have seen, even those early studies provided sufficient information to suggest that there was instead something to be concerned about. The WHO study made it clear what was at stake, and it is possible that concern over abortion politics may also have played a role in both the paucity of subsequent studies and perhaps how some of them were interpreted. Publication bias has been identified in research and commentary on abortion in a leading medical journal,[139] so it is quite conceivable that the literature as it exists is biased.

When the more recent studies are taken into account, there is sufficient evidence to suggest that there is a link between abortion and infertility that warrants more thorough investigation, and that infertility from abortion is not a rare phenomenon. It could well be in the vicinity of several percent, which, given the huge numbers of women who have had abortions, represents a large impact. An impact also felt by those women's partners.

Several studies have controlled for possible confounders, raising the likelihood that the link is causative rather than an association reflecting causes common to both abortion and infertility. That a causative link is likely is given greater strength by existing

[138] Tao X *et al.* (2018) *Op. Cit.*

[139] Baumgartner F (2019) Human embryonic stem cell research, abortion, and publication bias in the New England Journal of Medicine. *The Linacre Quarterly* 86(1):103-114.

knowledge of the mechanisms by which causation could occur. Cervical or endometrial damage, infection and PID, incomplete abortion, IUAs, and mental health problems like anxiety and PTSD, are all sequelae of abortion. And most of these are also known to cause infertility. Hence, it should logically be expected that infertility *will* be caused by abortion.

There are several factors that are of particular concern. These include infection risk that may lead to PID, especially when the majority of PID cases are asymptomatic. Infection risk has typically been thought to be lower with medical versus surgical abortions, but as medical abortion gradually overtakes surgical abortion, and increasing occurs away from the clinic, identification and treatment for PID may be compromised. Moreover, medical abortion requires careful attention to dosage, timing of drug taking, knowledge of gestational age, and route of administration. Small departures from what is a relatively precise regime will risk an increase in incomplete abortion and the presence of RPOC, further raising infection risk.

Similar to uncertainty over the presence of PID after abortion is the uncertainty about IUAs. The very few studies that do exist suggest this may be a hidden yet significant cause of infertility after abortion. And yet the research has been so limited that women will receive minimal if any guidance.

These and other issues mean that a significant question mark still hangs over to what extent abortion is a risk factor for infertility. And for something as important to woman and their partners as fertility, it is completely unsatisfactory that the current state of evidence remains unsettled. Even so, the evidence that does exist suggests that bland assurances that abortion is safe, even from causing long term problems like infertility, are unsustainable.