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ORIGINAL ARTICLE

Will Artificial Gametes End Infertility?

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Abstract In this paper we will look at the various ways in which infertility can be understood and at how need for reproductive therapies can be construed. We will do this against the background of research with artificial gametes (AGs). Having explored these questions we will attempt to establish the degree to which technologies such as AGs could expand the array of choices that people have to reproduce and/or become parents. Finally, we will examine whether and in what ways the most promising developments of such technologies are likely to bring about the "end of infertility".

Keywords Artificial gametes · ARTs · Eligibility for ARTs · Infertility · Medical need · Need of ARTs · Parenthood

Introduction

It is estimated that around 5 million children have been born through IVF and related assisted reproductive technologies (ARTs) [12]. But for each successful parent, there will have been many others for whom treatment failed, or who were unable to access it in the first place. ARTs have helped millions of people, but this is

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only a subset of those who need medical help to have a child. Now a new reproductive technology is on the horizon which may change all this. It has been suggested that the development of artificial gametes (AGs) could 'democratise reproduction', and even 'end infertility'. Indeed, a Google search for 'end of infertility' will return a considerable number of hits referencing AGs. In this paper, we explore the idea that AGs,—rather than 'ending infertility', will require a redefinition of the term.

The Development of Artificial Gametes (AGs)

A number of different avenues of research are currently being explored, in the hope that it may be possible to produce viable gametes in vitro. Animal research is ongoing with reprogramming of embryonic stem cells (ESC) as well as induced pluripotent stem cells (iPSC), in labs across the world [14, 20–22, 32]. In 2004, scientists reported obtaining offspring using gametes derived from female mice [23] and in 2011 another team reported obtaining viable male and female offspring using gametes derived from two male mice [9].

The successful development of AGs for reproductive purposes would mean that gametes could be obtained using genetic material from the prospective parents, whether or not they ever had viable gametes of their own. Sperm has been cryopreserved and used successfully in reproduction for decades, but not eggs. Women typically no longer have viable gametes by the time they reach menopause, whereas men do not necessarily lose their fertility as they age. From this perspective, the menopause would no longer create the sort of infertility that it now does for women. AGs could extend female fertility indefinitely. Thus, at least in principle, the applicability of AGs in human reproduction would help mitigate some of the natural inequalities between men and women [30].

Should it become possible to make eggs from cells taken from men, and sperm from cells taken from women, men could become genetic mothers, and women genetic fathers [11]. Moreover, an individual could produce both sperm *and* eggs, to become the sole genetic parent of his or her child. If any individual could produce sperm and eggs, irrespective of age, gender, sexuality, relationship or health status, it might seem that AGs really do have the potential to 'end infertility'.

Taking a step back to look at the context of the application of reproductive technologies, it is easy to see that once AGs are available, how they are regulated and offered will be a very important element of whether or not their advent brings more equality in terms of ending infertility, or on the contrary, deepens inequalities—for example if certain groups are denied access, or if the costs are prohibitively high. Because of the promise to facilitate a genetic link between parent and child, the creation of AGs might make parenthood more appealing for some who might have assumed they would never be able to have genetic offspring, or pragmatically because of difficulties related to gamete donation or adoption processes [15]. In this sense, such a technology would change the meaning of *infertile*—to the point of making it empty of content—in principle.

There are, of course, often concerns about the effects of ARTs, especially new and experimental ones, on the resulting child [18, 33]. While potential harm to offspring is clearly an important issue, for the purposes of this paper, we do not explore this angle. We assume that the remedies for infertility we are considering fall within whatever harm-based parameters have been set.

What is Infertility?

It has been suggested that AGs will 'end infertility' [6]. But what exactly is meant by this claim, and how would AGs achieve this? 'Infertility' is a deceptively simple term, and can be interpreted in many different ways [16]. Even among scientists and medical practitioners, debate is ongoing as to the proper definition of infertility [17]. The UK's National Institute of Clinical Excellence (NICE) sets out the following definition in its guidance on fertility treatment [25]:

Definition of infertility

A woman of reproductive age who has not conceived after 1 year of unprotected vaginal sexual intercourse, in the absence of any known cause of infertility, should be offered further clinical assessment and investigation along with her partner.

This might seem an appropriate model on which to base our analysis of AGs. However, as a definition of infertility it has some puzzling implications. Some of the people who fall into this category will conceive naturally: there are many cases of people conceiving spontaneously despite seeking treatment after a prolonged period of non-conception [31]. It would be strange indeed to say that women who conceive naturally and give birth to healthy offspring are nevertheless infertile. NICE's approach also seems oddly elliptical. A lesbian couple could describe themselves as 'infertile' according to its provisions. Likewise, a postmenopausal woman might also claim to be infertile. In practice, these claimants would *not* be treated, because although not stipulated here, it is generally assumed that eligible patients will be of 'normal' reproductive age, and the unprotected intercourse will be heterosexual.

In fact, although NICE labels the information above as a 'definition of infertility', on closer inspection one can see that it is not *phrased* as a definition at all. Rather, it serves as a guideline to help clinicians decide which patients should be *eligible* for further investigation and treatment. If we take it that eligibility and infertility could be separate concepts, it becomes evident that some eligible patients may not be infertile, and vice versa. This separation may help to clarify the questions at issue. We are then able to explore the ways in which infertility can be understood, and how AGs might 'end' this. We can also look at whether eligibility criteria are likely to prevent the infertile from accessing AGs.

Infertility as the Inability to Have a Biologically-Related Child

Adoption is one way of providing offspring for people who long for a child but it is usually not categorised as a remedy for infertility [8]. Conventionally, when we say of someone that they are infertile we mean that they cannot have *biological* children. John Robertson links the biological component of infertility with a corresponding biological aspect of treatment arguing that 'IVF and other non-coital techniques are means of treating infertility [27]', because they produce 'biologically related offspring'. It seems fair to assume that Robertson would regard AGs as being another 'non-coital' means of biological reproduction. But the role that biology is playing here is not at all straightforward. As Sarah Franklin says, '[…] *genealogy* and *reproduction* can be seen as two of the most important, but vague and undertheorized, terms in contemporary critical thought [13]'.

What Kind of Biological Relationships are We Talking About?

There is a tendency to talk of biological offspring and of reproduction as though there were some kind of single self-evident truth about what this means. John Robertson's work on reproduction, for example, reiterates the word 'biologic' on almost every page as he sets out his views on reproductive autonomy and its links with biological phenomena. But while there may have been necessary truths about these things in the past (i.e. when it was not possible to conceive a child outside the womb, and when the child to whom one gave birth necessarily had to be one's genetic offspring), this is evidently no longer the case.

The terms 'genetic' and 'biological' tend to be used interchangeably. However, many reproductive possibilities, including surrogacy, AGs, and cloning, further subdivide the concept of biological parenthood, allowing for distinctions *within* the 'biological'. Not only this, but it is already possible with technologies currently available to subdivide the concept of genetic parenthood: through mitochondrial transfer, children may be born who carry genetic material from three individuals [1, 5, 10]. As the technological options multiply, there is more scope for people to interpret the meaning of biological reproduction in ways that appeal to their own priorities. Some women who suffer from fertility problems wish to gestate their offspring themselves rather than use a surrogate. The experience of pregnancy may be the thing which they find most meaningful. For other people, the idea that their own genes are present in their offspring may be of supreme importance.

In 2007, the BBC reported that a woman had received an ovarian tissue transplant from her sister. The recipient preferred to receive ovarian tissue rather than eggs because 'she wanted to be "responsible" for maturing the egg in her own body [4]'. The biological process of oocyte maturation was a central component of her reproductive aspirations. If this example were applied to a man, we might see still another interpretation of biological reproduction. A man who cannot produce sperm could undergo a testicular tissue transplant. This would result in the production of sperm that might be genetically unrelated, but would nevertheless enable the man to 'beget' a child through heterosexual intercourse with a fertile partner. The child

would in some senses be the biological child of the 'begetter' and in others the child of the tissue donor.

Again, the centrality of the biological component in reproduction seems to give way, under scrutiny, to a variety of separate concerns and possibilities. The ways in which a person can be biologically connected to a child thus include:

i. Maturing the gametes that go to create the child in one's body
ii. Contributing genetic material:

a. Egg

i. Chromosomal
ii. Mitchondrial

b. Sperm

iii. Gestating the child
iv. Begetting the child through intercourse

Of these biological relationships, AGs could contribute to II.a.i, and II.b. (Women with mitochondrial mutations would still need to derive their mitochondrial DNA from other sources, therefore AGs would not necessarily end the infertility caused by mitochondrial disease.) This leaves many biological aspects of reproduction unresolved. AGs address only genetic relationships. To say that they 'end infertility' therefore implies a narrow, geneticised understanding of reproduction. This is a very common perspective, but it is not obvious that it is adequate to encompass all the aspects of reproduction that people value or find important.

Technology such as AGs which could enable everyone to produce gametes might, of course, circumvent some of the difficulties involved with the proliferation of ARTs, and the complex biological questions they raise. If we *do* embrace a purely genetic account of reproduction, the appeal of AGs is much stronger. We would no longer have to identify the 'real parents' from among those with different biological connections to children as outlined above [19, 24]. People would not be obliged to use donated gametes or reproductive tissue grafts, and therefore it might be that advances in this area would tend to re-focus on the specifically genetic aspect of reproduction. Correspondingly, some of the challenges to legal and social understandings of parenthood could be avoided.

If we understand infertility to be essentially an inability to produce genetic offspring, we might believe that AGs could end infertility. If not, we may nevertheless find that AGs can end *genetic* infertility, if not other fertility problems. However, there are further issues to consider before we can say with confidence that AGs *would* end genetic infertility.

Is *Everyone* Who Cannot Have Genetic Offspring Infertile?

We have noted the way in which definitions of infertility can be intertwined with eligibility criteria. This can make it difficult to establish what we mean by infertility, and hence, whether AGs will in fact end it. We have also shown that the concept of a 'biological child' is actually highly complex, and may differ from person to

person. However, if we take the inability to have *genetic offspring* as our starting point, we can explore this a bit further. Here is a list of people who might wish to access ARTs:

1. Single
2. Homosexual
3. The partner of someone who is unable or unwilling to reproduce
4. The carrier of a genetic condition which may be passed on to offspring
5. The parent of a sick child who needs a tissue from an HLA-matching sibling
6. Inexplicably unable to conceive
7. Impotent
8. Surgically sterilised
9. Clinically infertile (e.g. blocked fallopian tubes, azoospermic)
10. Pre-pubescent
11. Postmenopausal

This list is not designed to be exhaustive, but it shows the diversity of ways in which people's reproductive projects might be constrained. These constraints arise from a variety of factors, some biological, some social. Let us consider a theoretical individual, Jane, whose fertility or infertility (and hence eligibility for treatment with AGs) we are trying to determine. If we consider infertility to be the incapacity to have a genetically own child, Jane, by herself, is *necessarily* infertile; indeed, any individual would be infertile regardless of his or her own physiological capabilities. Human reproduction is necessarily collaborative: one needs someone to reproduce with (at the very least, gametes from another person).

Currently, one of the reasons for our failure to regard single people as infertile is the fact that we have no means of enabling them to have genetic offspring—unless we use other people's gametes. But if AGs offer men and women the capacity to have both eggs *and* sperm generated from their own non-reproductive cells, it would be possible at least in principle to produce complementary gametes from a single individual so that one could reproduce with oneself as it were. Infertility might thus seem to extend to all single people who cannot produce genetic offspring unaided but *could* produce them if offered treatment. If we accept this, then we might think that AGs could indeed end infertility. However, as previously noted, AGs would not resolve other aspects of biological infertility. For example, men might still fail to find someone to gestate their offspring. And women who are unable to gestate their genetic offspring might still regard themselves as infertile in this sense.

To regard all individuals as being infertile may seem counter intuitive, however. Individuals, it might be argued, are not 'really' infertile, if their inability to reproduce is entirely contingent on their singleness rather than any biological fact. And in fact, single patients are often explicitly excluded from existing fertility treatments, as is the case in France or Sweden or Italy, and until recently in the UK. If we understand infertility to encompass singleness, AGs would go some way

towards ending this. But it is unlikely, without major changes in eligibility criteria, and commonly held assumptions about fertility, that this would be accepted. Therefore, AGs do *not* seem likely to end infertility for all single people.

However, if we define infertility more narrowly so as to exclude singleness, we may be able to define a group of people whose infertility might seem less counter-intuitive, and whose infertility could perhaps be ended with AGs.

Infertile Couples

If being unable to produce genetic offspring without a partner is not a satisfactory definition for infertility, we must look for some additional factor. Let us suppose that Jane is no longer single; she has embarked on a relationship—with John, who cannot produce sperm—and finds herself unable to reproduce. *Now* we might deem her infertile, and if certain other conditions are fulfilled (depending on the regulatory framework), Jane and John could request and obtain assistance in their pursuit to become parents, for example, by being treated with donated sperm.

However, in this scenario too there is a conditional component to Jane's infertility. When single, Jane may be in total reproductive health, but she is contextually infertile, as she could reproduce if she found a fertile male partner. Likewise, Jane as John's partner could reproduce if she found a fertile partner—James, let's say, who *can* produce sperm. However, the response to such couples is not usually to advise them to alter their circumstances (find another partner), but to use medical technology to help them reproduce.

Now let us compare Jane and Maria, who wish to have a child together, with Jane and John, who also wish this. Neither couple can spontaneously or *naturally* achieve this without assistance, because neither of them has any sperm (see also [2, 11], and [28]). In this situation, they are confronted with legislation making it explicit that sexual dimorphism of the prospective parents is part of the definition of infertility. For example, according to French legislature, medical assistance may only be provided to couples formed by a man and a woman of reproductive age—until recently (2011), they also had to be married to each other or had lived together for at least the last 2 years.

In each of the cases described above, the patient seeking and receiving treatment (Jane) is physiologically capable of having genetic offspring; and in both cases, her reproductive aspirations cannot be fulfilled in the context of the social tie between her and her partner, or in single Jane's case, the social fact of her singleness. By implication, a single woman should have a partner. If her partner happens to have no sperm, she will be eligible for treatment—but only if her partner is male. Jane's infertility thus appears to be a strangely labile social construct. It fluctuates depending on her social situation, despite the fact that her biological make-up remains identical in each scenario considered: she could have a child if she found a fertile male partner.

To differentiate between the three cases discussed: Jane, Jane-and-John, Jane-and-Maria, seems to imply that the choice of a specific heterosexual partner is treated as unconditional, whereas the fact of being homosexual, or single, is not. The fulfilment of Jane's reproductive aspirations as a single or homosexual patient is

conditional on her changing her relationship status or her sexuality! It is not clear that either of these changes is easier to achieve than finding a different—fertile–heterosexual partner. Indeed, heterosexual partnerships are known to be fluid and subject to change, and this can lead to many difficulties in the context of ARTs, where heterosexual partners may split during or after treatment [3]. Yet the heterosexual partnership is taken as an immutable fact, whereas the other relationship choices are treated as mere contingencies. By implication, single or homosexual Jane *could* have chosen differently and perhaps *should* have done so.

It is tempting to think we could resolve this apparent anomaly by focussing on John. *He,* after all, is the one who is physiologically incapable of having genetic offspring without medical help, whatever his relationship status. If we construe Jane and John as a couple, we need not concern ourselves with Jane's reproductive health, provided that one of the couple is genuinely incapable of having genetic offspring. However, here we encounter some of the same problems, and a new one.

Provided that John's partner is Jane, he is eligible for treatment (or rather, Jane is, since it is she who will undergo that treatment). But for John and his partner Jason, treatment is *not* provided, despite the fact that John is incontrovertibly incapable of producing genetic offspring. If John wants treatment within the French system, for example, he can only access it if his partner is female. Thus, his eligibility for treatment is, like Jane's, conditional on his choice of partner rather than his biological status. Conversely, even if he *were* biologically capable of producing sperm, he might be deemed eligible for treatment if his female partner was unable to conceive. In John's case, then, just as in Jane's, his eligibility for treatment depends primarily on his choice of partner rather than on any biological fact pertaining to him.

The other problem to emerge when we think about John's infertility with respect to his relationship with Jane is that although the couple may be given access to fertility treatment, this treatment does not necessarily enable John to have genetic offspring. If Jane is treated with donated sperm, the resulting child has no genetic link with John at all. This being so, it is hard to understand the role that John's biological infertility plays in this collaborative reproductive endeavour with Jane.

Provided that Jane is with John, she 'needs' treatment. Yet this treatment neither remedies her own infertility (since she is not incapable of producing genetic offspring) nor John's (since it neither cures his azoospermia, nor provides him with a genetically-related child). In Jane's quest for treatment, John seems to be a cipher: an indication of an authentic heterosexual partnership. No effort is made to remedy John's condition, but *Jane's and John's reproductive aspirations are fulfilled*. Here, the link between biology, infertility and eligibility has become so tenuous as to disappear entirely. This leaves us with the realisation that treatment is being allocated on the basis of social judgements: the patient's relationship choices are evaluated, and treatment is provided or withheld accordingly. This seems clearly at odds with the idea that fertility treatment is allocated on the basis of intrinsic biological infertility [26].

Contextual and Intrinsic Infertility

Perhaps a simpler, binary separation could be made between potential fertility patients. All of the people who fall into categories 1–5 above might be capable of

producing biologically related offspring. In all these examples it is not straightforwardly the case that the person cannot conceive a genetically related child; it is more that the content of their reproductive aspirations (whether to have a child with a particular partner, free of a particular gene, or matching a particular tissue-type) mean that their reproductive goals cannot be met in their current circumstances without medical help. We might ask, then, whether we should separate a merely contextual 'inability to fulfil one's reproductive aspirations in one's current circumstances' from a more biological definition: 'physiologically incapable of having genetic offspring at all without medical help'.

If patients fall into any of the categories from 7 to 11, they would be unable to have genetic offspring *whatever* changes they might make to their social circumstances or aspirations. There is nothing conditional or contextual about their infertility. Perhaps these, then, are the people who are properly understood to be infertile, whose needs could most clearly be met through AGs, and whose infertility would thus be ended.

It is worth noting that category 6 is problematic or unstable in some respects. On the basis outlined above, it is not clear whether patients who fall into this category would, or would not be infertile. Unexplained infertility is a failure to conceive which is not attributable to any identified medical problem [7]. Many couples fall into this category: according to recent data in the UK, the percentage of unexplained infertility is at about 25 % of all cases [25]—indeed according to some experts, "unexplained infertility is one of the most common diagnoses in fertility care [7]".

If our patient Jane falls into this category, she *might* be able to conceive with a different partner, but she will not know whether this is the case unless she makes the attempt. Clearly, in some cases of unexplained infertility, there will be an underlying physiological cause which, however, doctors have been unable to identify. In other cases there may be no intrinsic physiological problem, and indeed many people who seek fertility treatment as a result of unexplained infertility will go on to conceive naturally [31].

Suppose for the moment we allow category 6 to sit alongside categories 7–12, recognising however that some of those in category 6 will prove not to be infertile. We can ask whether the provision of AGs for all those in categories 6–12 would 'end infertility', while those in the other categories are excluded since these claimants are not intrinsically infertile. Azoospermic John would then be eligible for treatment, though single Jane would not. This might seem reasonable at first glance, but it is worth noting that these categories do not map neatly onto current eligibility criteria for fertility treatment either. Indeed, many patients who fall into the latter categories are—again–explicitly excluded. Post-menopausal women and those who have undergone sterilisation are usually debarred from access to IVF in the UK. Yet these are most clearly those who cannot conceive genetic offspring without medical help.

To categorise the post-menopausal woman and the pre-pubescent child as being infertile may seem to stretch the concept too far once again. However, if we want to adhere to the contextual/intrinsic distinction, this seems unavoidable. If we *were* to adopt this approach, AGs would offer the chance of genetic reproduction to many who are currently unlikely even to contemplate the prospect. For these people, infertility would be ended—but for many people it will simply be unconvincing to

argue that the provision of AGs to a 70 year old woman 'ends' her infertility. For the purposes of this paper, we will not try to answer whether we *should* regard such a patient as infertile. Rather, we seek to highlight the degree to which AGs' potential to 'end infertility' calls into question the meaning of the word.

What Generates the Need for Fertility Treatment?

We have noted that in even some of the least controversial cases above, it can be hard to say exactly what it is that treatment seeks to remedy. When Jane receives treatment with donated sperm because her partner John is azoospermic, neither of them is 'cured' of their infertility. If Jane herself is the one who cannot conceive, because of blocked fallopian tubes, for example, the use of IVF does not render her fertile per se in the way that a successful surgical unblocking of those tubes would. Because of this, it is easy to see why some commentators regard fertility treatment as intrinsically different from 'authentic' medical interventions.

Simone Bateman, for example, suggests that medicine should properly aim at the correction of medical pathologies, and that reproductive technologies do not fulfil this aim [2]. However, perhaps this is too restrictive an understanding of medicine and its purposes. Habbema et al. argue that fertility treatments deal with non-conception as a symptom in the same way that back pain or insomnia might be dealt with even if the underlying cause cannot be identified or remedied. The fact that the condition is not corrected per se, they suggest, does not necessarily mean that it is outwith standard or accepted medical provision [17]. This appears fairly reasonable: as suggested above, there are many therapeutic endeavours—the provision of reading glasses, for example—that do not attempt to 'cure' a pathology, but provide a means of managing it.

Nevertheless, it is vital to note that this claim is missing an ingredient. Habbema claims that non-conception is what is treated by reproductive technologies. This is important, since it is precisely the question of what *is* the symptom being treated that makes fertility treatment problematic. Non-conception *may* be a symptom which is addressed in fertility treatments. But it is not the *only* symptom which plays a part here. Crucially, it is not even a *necessary* symptom for people seeking treatment. Those seeking PGD, for example, may be perfectly able to conceive, but wish to avoid having a child with a particular gene. This leads one to wonder whether there *is* any necessary symptom to be identified here that applies in every situation where fertility treatment is sought.

When the question is addressed in this way, it becomes clear that indeed there is a common feature in all these cases: *the aspiration to have a* (*specific kind of*) *child* must necessarily be involved. A person may be infertile all her life, but never realise the fact unless she develops the aspiration to have a child. When this happens, it is *not* usually just *a* child that is desired, but a child with a particular genetic make-up. Unlike many other medical conditions, then, the recognition of fertility problems is often entirely contingent on the patient's forming a particular wish. Fertility may only be of value to a person as a means to an end. Treatment focuses on the *object* of the reproductive aspiration—a (specific kind of) child—rather than on the restitution

of the capacity itself. Therefore the aspiration, rather than any other symptom, is what is treated, regardless of whether the patient is suffering from a reproductive pathology.

It can be controversial to suggest that reproductive aspirations are even partly related to social or contextual circumstances. Much of the rhetoric in favour of widening access to fertility treatment is based on assumptions that reproductive aspirations are *biological* rather than social. By implication, they are necessary, not contingent, and hence non-negotiable, and intrinsically worthy of medical intervention in ways that other aspirations may not be. However, the biological purity of reproductive aspirations is untenable for many reasons. Becoming a parent is an event that has a direct bearing on people's sense of identity. Despite the rhetoric of unconditional parental love, people's desire to reproduce is often highly conditional. It is not necessarily just offspring that is desired but a whole array of reproductive hopes and relationships. Reproductive technologies feed into this highly complex network of desires and aspirations in ways that unavoidably engage with the social as well as the physiological context in which they are formed.

Given that reproductive aspirations are what is being treated in fertility clinics, it is much less clear that the intuitive importance of biology in defining either infertility or eligibility for treatment can be sustained. Many people form reproductive aspirations which cannot be met without medical help. We could define infertility thus: 'an inability to fulfil one's reproductive aspirations in one's current situation'. AGs would offer the technical possibility to end such infertility—provided that the reproductive aspirations in question have a specifically genetic component. Of course, many if not most reproductive aspirations *do* have a genetic component. But the very breadth of AGs' potential to meet people's reproductive aspirations is itself a problem here. Once we accept that reproductive technologies are a means of fulfilling people's reproductive aspirations, it becomes much less clear that there are coherent clinical reasons for providing treatment only to some people, and not others.

But where fertility treatments are offered as part of a publicly funded health service, this is likely to cause difficulties. The more people whose reproductive aspirations could be fulfilled through AGs, the more expensive this will be for funders. If AGs can end infertility, we face the prospect of a vastly expanded patient group, all of whose claims are equally valid: reproductive aspirations may be held just as strongly by the single as by heterosexual couples, by postmenopausal women as by young women.

Conclusion: AGs Will Not Enable Everyone to Become a (genetic) Parent

Given the way in which infertility and eligibility are construed in many countries, it is not at all clear that the advent of a new technology such as AGs would end infertility for any or all of the people who might wish to access it. Many of the currently available technologies are not provided to certain patients, on the grounds that they are not infertile, even though they cannot produce genetically-related offspring. Conversely, some people who do receive treatment are not necessarily infertile.

One might argue, of course, that current approaches to defining infertility and its links with eligibility are simply not adequate. Therefore, the prospect of AGs may offer an opportunity to think further about the links between biology, infertility and treatment. Is there a better way of interpreting infertility? An approach that is less normative, more coherent, and more biological? If so, would this make it more likely that AGs would end it?

With the advent of AGs, there will be a far larger group of people whose reproductive aspirations cannot be fulfilled as a natural corollary of their social context and sexual preferences—but *can* be met through reproductive technology. At the same time, the possibility for people to become genetic parents will neutralise some of the objections to reproduction using donor gametes or embryos: such as that by using ARTs, these people do not become *real* parents, but birth parents (if they carry the pregnancy) or legal parents of other people's genetic offspring; or that infertile women's and gay men's parenting projects require other women to subject themselves to the discomforts and risks of egg donation.

If AGs end infertility, it seems that they simultaneously *create in*fertility for all. That is: currently some people (postmenopausal women, single people, same sex couples, prepubescent children, etc.) cannot reproduce, even though they may not suffer from an identifiable reproductive pathology. As long as there is no technological means of enabling such people to have biological offspring, they are not regarded as being infertile, or as having a need for fertility treatment. But as soon as the means of rendering them biologically fertile come into existence, they may have a claim to be regarded as *in*fertile just as much as anyone else. So in some respects the development of artificial gametes may engender new needs, foster new desires and create new pathologies [29].

If AGs become reasonably safe for use in reproduction, this does not automatically imply that (individual) incapacity to have a biological child will cease to be an impediment to reproducing or to becoming a parent. At the moment, the only way in which we may become parents without having to submit ourselves to scrutiny and decision-making by third parties, is to have reproductive sex and this in fact is only the case for women and their male spouse if they are married, because the only way for a man to be recognised automatically as a child's father is to be married to the birth mother. If Jane cannot participate in conception, or she chooses a partner who cannot participate in conception with her (such as azoospermic John or Maria), then the realisation of her reproductive aspirations will ultimately depend on other individuals (healthcare professionals, social services employees, policy-makers, etc.). This means that even when we have become technically able to help *anyone*, whether single or partnered, with a same sex or a different sex partner, old, infertile or subfertile, it is unlikely that *everyone* will be able to achieve their reproductive plans successfully. What *will* change is that "fertility" will depend more on societal and legal decision-making than on biological factors.

Should we decide to not discriminate between prospective parents in any way, resources are always limited and will not cater for all—not without a considerably higher allocation. Then this will collide with other needs that our societies and health care systems are also expected to cater for. Letting go of funding *any* fertility

treatments will however also not bring about *fertility for all*, as for all those who cannot reproduce on their own and cannot afford the high costs of treatment (and probably, at least at the beginning, the even higher costs of new forms of treatment), the lack of financial resources will determine who can and who cannot overcome their infertility. Thus neither funding for all nor funding for no one will alleviate everyone's infertility. More likely, advances in ARTs will expand and increase demand, and make it even more difficult to justify access as well as funding criteria. All this takes place in a context of changing norms in the Western world, bringing about greater acceptance of nonconventional lifestyles such as gay relationships, which further increase the demand for assistance with reproductive projects. Furthermore, greater acceptability of *hands on* fatherhood as well as single parenting and later parenting also has the potential to increase demand.

In this environment, the claim that AGs will 'end infertility' is impossible to substantiate. Access to fertility treatment encompasses social norms and expectations about relationships, gender, sexuality and age. AGs may challenge some of these norms and expectations; they may act as a catalyst that forces us to acknowledge that we need to deliberate and negotiate in order to establish the meaning of 'biological' terms such as reproduction and parenthood. But in and of themselves, they cannot provide the solution.

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