Non-invasive prenatal diagnosis and testing: perspectives on the emergence and translation of a new prenatal testing technology

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This thesis is submitted in fulfilment of the degree
Doctor of Philosophy

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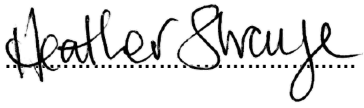
Signed  (candidate) Date 27/04/2016

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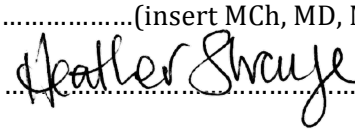
Signed  (candidate) Date 27/04/2016

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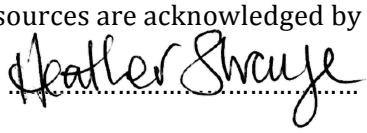
Signed  (candidate) Date 27/04/2016

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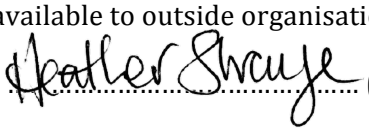
Signed  (candidate) Date 27/04/2016

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Dedication

This thesis is dedicated to my family - Mum, Katie, Granny and especially my partner Pete - in gratitude for their endless love and patience. It is also dedicated to the memory of my father Colin Strange, whose encouragement, love and support continues to be a source of enduring strength and motivation.

Summary

This thesis presents findings from a qualitative study of the emergence and early clinical translation of non-invasive prenatal diagnosis (NIPD) in the UK. Drawing from interviews with a range of experts and users I track the enrolment and translation of this new prenatal testing technology across a variety of clinical and social spaces. I show how encounters with NIPD prompt deep critical examination of the moral, social and political implications - not only of the technology - but of the established clinical practices (routine and specialised prenatal testing) and specific policy contexts (prenatal screening programmes) within which NIPD has begun to sediment. I explore how, as NIPD advances at a rapid pace and emerges within a culturally and politically complex context, the technology both aligns with and disrupts routine practices of prenatal screening and diagnosis. I show how, as the technology divides into two major strands - NIPD and NIPT - at an early stage of development, and before becoming naturalised/normalised within the clinic, scientists, clinicians and policy makers attempt to pin down, define and 'fix' the technology, drawing upon and engaging in substantive practices of division, categorisation and classification. I explore ambiguities present within such accounts, highlighting dissenting voices and moments of problematisation, and following this, I show how the 'troubling' of boundaries prompts much examination of ethical and social concerns. As a location within which interviewees explored more contentious issues, I show how abortion emerged as central to the discussion of NIPD. I proceed to show how institutionalised, professionalised bioethical debate dominates mainstream discourse, and I explain how a particular construction of the informed, individual choice-maker is mobilised in order to locate moral and political responsibility for testing in the hands of individuals, and to distance political/organisational structures from entanglement with problematic concerns. I explore how clinicians and patients respond to this positioning in multiple ways, both assimilating and questioning the mainstream discourse of 'informed choice'. In conclusion, I highlight the broader (bio)political aspects of NIPD's emergence and translation within prenatal screening and diagnosis.

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Chapter One. Introduction and Theoretical Foundations

This thesis is a critical exploration of early encounters with and reflections on non-invasive prenatal diagnosis (NIPD), an emerging and rapidly developing prenatal testing technology. The research assembles multiple perspectives on this new technology, generated in interviews with a wide range of actors – from the scientists involved in its inception through to the clinicians and families who use prenatal testing technologies. By documenting and examining a range of accounts, I explore here how NIPD testing is being categorised and classified, how it prompts discussion and examination of significant moral, social and biopolitical issues, and how it re-ignites and intensifies debates around the politics of prenatal testing.

The central aim of this research is to explore experiences of, and responses to current and emerging NIPD technologies. Building upon an analysis of accounts provided by a wide range of participants who encounter NIPD and associated technologies and practices of prenatal testing, the specific objectives of this research include:

- To examine the practical, ethical and social issues that are raised by experiences with and reflections on NIPD testing.
- To explore 'situated' responses to emerging and (possible) future applications of NIPD technology.
- To gain an understanding of how professionals, patients and parents negotiate the complexities of engaging with an emerging health technology.

By examining the public discussion and debate around NIPD, and by situating this thesis within the context of broader critical engagements with practices and technologies of prenatal testing, this thesis also seeks to examine the wider cultural and political implications of this emerging technology.

Theoretical foundations

The analytical work of this thesis draws from a number of critical sources, including Foucault's work on dividing practices (Foucault 1982), problematisation, biopower and biopolitics, Latour and Callon's work on practices of 'translation', and the sociological

examination of sorting processes and classifications as explored by Douglas, and then elsewhere by Bowker and Star.

> I have studied the objectivizing of the subject in what I shall call 'dividing practices.' The subject is either divided inside himself or divided from others. This process objectivizes him
>
> (Foucault 1982, p.326)

Whilst Foucault's conceptualisation of '*dividing practices'* is used within the quote above to illuminate practices of division and categorisation as they are applied to persons rather than technologies ('*the mad and the sane, the sick and the healthy'*), this critical approach, which foregrounds the social significance of divisions – *'modes of manipulation that combine the medicalisation of a science (or pseudo-science) and the practice of exclusion'* (Rabinow, p.8) – is central to the work of this thesis, as it seeks to examine NIPD at an emergent stage of development, before it has come to be sedimented and naturalised. Such an approach foregrounds a range of crucial (and critical) questions: what kind of divisions are being enacted, and by whom? What is being objectivised by such divisions, what is made more tangible? What is being left out, what becomes marginalised?

A clear understanding and elucidation of Foucauldian processes of division allows, in turn, for a deeper, more critical level of enquiry to be made concerning what kind of work such divisions achieve. This level of questioning is inherently political - it concerns the way in which power may or may not be exercised, and by whom:

> The flat and empirical little question, "What happens?" is not designed to introduce by stealth a metaphysics or ontology of power but, rather, to undertake a critical investigation of the thematic of power. "How?" not in the sense of "How does it manifest itself" but "How is it exercised?" and "What happens when individuals exert (as we say) power over others?"
>
> (Foucault 1982, p.337)

Examining technologies of the body, administered through a complex network of clinical practices, medical programmes, and political systems, entails that Foucault's work on 'biopolitics' is also crucial here:

> Society's control over individuals was accomplished not only through consciousness or ideology but also in the body and with the body. For capitalist society, it was biopolitics, the biological, the somatic, the corporal, that mattered more than anything else. The body is a biopolitical reality; medicine is a biopolitical strategy.
>
> (Foucault 2000b, p.137)

Foucault's work on biopolitics stresses the power that medical practices and systems hold, particularly as they come to be administered through processes that govern whole populations - *'the state has essentially to take care of men as a population'* (Foucault 2000c, p.417), for example through public health and its apparatus of sorting. His characterisation of biopolitics and biopower emphasises the extent to which processes of biopolitical control have become 'interiorised' – *'immanent to the social field, distributed throughout the brains and bodies of citizens'* (Hardt and Negri 2013, p.216) – a perspective that is crucial to the analysis presented here.

Foucault also highlights the centrality of 'problematisation' within any critical project, and it is this approach that most centrally informs the analytical perspective taken within this thesis:

> For Foucault, "problematization"… is an aspect of his genealogical method… for any period or milieu, in any text or discourse, one should look for what is problematized, for what is the subject of concern, reflection and uncertainty
>
> (Laidlaw 2014, p.32)

Problematisation both informs the *method* of critical analysis taken towards the subject at hand here, and it encourages specific focus on what comes to be 'problematised' by others – what elements of the discussion come to be framed as subjects of *'concern, reflection and uncertainty'.* Adopting this Foucauldian critical focus as a central point of reference, this thesis can move beyond simply identifying systems of division and categorisation. By shifting focus onto what is 'problematised', by highlighting how relationships are produced, reproduced and circulated, and by examining the positioning and enactment of (bio)power, stronger claims can be made concerning whose interests are foregrounded, and whose are marginalised.

Questions concerning 'dividing practices' and the objectification of the social relate closely to issues raised within the sociology of classification (Douglas and Hull 1992). A number of theorists having pointed towards the significance of classificatory processes within the rationalisation, objectification and ordering of new social forms – with Douglas particularly emphasising the significance of *'constraints of structure… that is, rules, classifications, compartments'* (Douglas 1996, p. xix), and the fundamental power that such concepts and processes hold, bringing order to the *'chaos of shifting impressions*' that would otherwise remain (Douglas 1966, p.37)

> 'I believe that ideas about separating, purifying, demarcating and punishing transgressions have a their main function to impose system on an inherently untidy experience. It is only by exaggerating the difference

> between within and without, about and below, male and female, with and against that a semblance of order is created.
>
> (Douglas 1966, p.4)

Hence, given the fundamental power of division and classification processes, persons or objects that do not fit - that can't be sorted or placed - and that lie '*betwixt and between categories'* (Latimer 2008b) 'trouble' boundaries, and are translated into sources of concern and problematisation.

Elsewhere, Bowker and Star recognise that the mechanisms by which constitutive classificatory practices are exercised are frequently not explicitly realised, that is, they appear as deeply embedded – appearing as 'routine' 'natural' and 'normal' - within everyday social practices:

> To classify is human. Not all classifications take formal shape or are standardised in commercial and bureaucratic products. We all spend large parts of our days doing classification work, often tacitly, and we make up and use a range of ad hoc classifications to do so. We sort dirty dishes from clean, white laundry from colorfast, important emails to be answered from e-junk
>
> (Bowker and Star 1999, p. 1 - 2)

The analysis that follows has been achieved by maintaining a critical awareness of how new social classifications are made, both explicitly, through processes of standardisation, and more implicitly, through everyday talk and action, to enable a critical and comprehensive account of NIPD's entry into the clinic (and into the lives of parents, clinicians, researchers and scientists). By 'tracking' (Marcus 1995, Latimer 2013) the technology from its earliest stages, and tracing its development from within a wide range of spaces, both explicit and implicit processes of ordering, rationalisation and objectification can be made visible. The highlighting of the marginal perspective specifically - that which exists outside 'internal' systems of classification and categorisation - has been characterised as being particularly valuable:

> The idea of society is a powerful image. It is potent in its own right to control or stir men into action. This image has form; it has external boundaries, margins, internal structure. Its outlines contain power to reward conformity and repulse attack. There is energy in its margins and unstructured areas. For symbols of society, any human experience of structures, margins or boundaries is ready to hand.
>
> (Douglas 1966, p.115)

Critically, for the current study, by 'tracking' the development of NIPD technology at this early, 'pre-naturalisation' stage – and by examining questioning and ambiguous accounts

in particular - the underlying norms and values that contribute to the shaping of NIPD's development and translation have been made visible. By presenting a range of encounters with the technology, accounts that have been gathered as experiences remain new, questioning and critical, the discussion can move beyond the mainstream. By attending to areas that resist clear division, definition, categorisation and classification – by turning towards *'the energy in its margins'* - contentious issues can be made visible and dissenting voices can be heard.

Also significant to the analysis presented here is a critical understanding of technology as presented within work on the sociology of 'enrolment' and 'translation'. Latimer (Latimer 1995) building on the work of Latour, explains how a technology – as it moves in and across a range of social spaces - may function as a kind of '*token*', an object which, in the hands of multiple actors, may be 'enrolled', 'translated', 'aligned' and imbued with meaning according to local understandings and processes of communication:

> Latour (1986) uses the metaphor of a 'token' to refer to any system, technology, order or artefact which social actors use as forms for communicating with others. In the hands of social actors, tokens are translated to be reconfigured and, indeed, recomposed locally and specifically. Latour (1986) gives the following account of translation:
>
> "The spread in time and space of anything — claims, orders, artefacts, goods — is in the hands of people, each of these people may act in many different ways, letting the token drop or modifying it, or deflecting it, to betraying it, or adding to it, or appropriating it"
>
> (Latour 1986, Latimer 1995)

This thesis explores a broad range of participant accounts, as provided by experts, patients and parents, each with distinct personal and professional backgrounds, and with diverse experience of prenatal testing processes. As an emergent technology that is being 'enrolled' and 'translated' – *'reconfigured and, indeed, recomposed'* - across a variety of spaces, an understanding of the process of 'local translation' is essential to the examination of NIPD. Integral to this is the concept of 'enrolment'. As NIPD reaches out across a number of spaces, and as processes of 'local translation' progress, the technology *'not only enrols but is itself enrolled'* (Latimer 1995, p.214). Emerging within a 'complex location' (Latimer 2000b), a culture that has come to be shaped by established practices and technologies of prenatal testing, NIPD is enrolled within a number of existing cultural and normative frameworks. And as the technology in turn 'enrols' others - as ideas and practices are produced and (re)produced - a corresponding generation and regeneration of particular effects occurs (Strathern 1991, p.97), with the implication that certain perspectives become foregrounded, and others marginalised. By attending to the particular ways in which technology enrolls and is enrolled – by locating where and how

certain discourses are made visible, and others are 'disposed' - the presence of powerful 'alignments' (Latour 1990) may, in turn, be made visible. Echoing Latimer (Latimer 2013) then, as she illuminates the way in which *'alignments, extensions, disposals, attachments and detachments'* contribute to the shaping of power in the (genetics) clinic, I show how, as NIPD technology enrols and becomes enrolled, as it is translated from one space to another, powerful alignments are made and (disruptive) discourses disposed.

Given the wide range of personal and professional backgrounds of study participants, the issue of identity and 'identity-work' is also of central relevance here. Participants' various personal and professional identities are affected and enacted by the ideas and values that are enrolled, and how they come to be translated. Specifically, associations with particular identities did not give rise to explanations that were 'fixed' or 'stable'. Rather, participants invoked multiple identities, with accounts shifting between various terms of reference, appealing to multiple values, and generating complex and ambiguous perspectives on the technology. Identity here, then, is understood in terms that reflect *'a critique of the self-sustaining subject of post-Cartesian metaphysics'* (Du Gay and Hall 1996)

> Identities are never unified and, in late modern times, increasingly fragmented and fractured; never singular but multiply constructed across different, often intersecting and antagonistic, discourses, practices and positions.
>
> (Du Gay and Hall 1996, p.4)

Strathern's alternative framing of identity, as being related to the lives of divisible and partible 'dividuals', as opposed to bounded and autonomous individuals (Strathern 1988, Konrad 1998, Latimer 2008b), further strengthens a perspective that emphasises the *'intersecting'* and specifically *relational* aspects of being, and highlights the centrality of social relations and discursive practices (Foucault 2000c) to questions of identity.

In summary then, this thesis approaches the examination of NIPD through a Foucauldian lens that emphasises the constitutive work of 'dividing practices', the centrality of 'problematisation' to critical analysis, and the contextual significance of 'biopower' and 'biopolitics'. Building on this, it draws from the sociology of classification as put forth by Douglas, and Bowker and Star, attending particularly to questions around what is foregrounded and what is marginalised within the discussion at hand. Drawing on the work of Latimer and Latour, the significance of processes of 'alignment' and 'enrolment' along with 'local translations' within this study of an emergent technology – where processes of 'modification', 'deflection' and 'appropriation' remain particularly active - is

also highlighted. Finally, then, I approach questions of identity and 'identity-work', emphasising the multiple and relational, rather than the individual and the rational.

Summary of the thesis and chapter contents

This thesis presents a critical account of NIPD's emergence and translation into a range of clinical and social spaces. It shows how those who come to encounter NIPD technology at an emergent 'pre-naturalisation' stage of development engage in substantive processes of division, in order to 'sort' the technology and situate it within local contexts, and to align it with existing (dominant) normative and cultural frameworks. Pointing towards the re-surfacing and intensification of difficult and contentious debates, this thesis shows how NIPD emerges as a source of significant problematisation within many of the accounts gathered here. Showing too how institutionalised discourses fail to contain more contentious aspects of debate and discussion, this thesis claims that NIPD is experienced and understood as far from benign, raising issues of significant (bio)political and cultural concern.

Within this first chapter I explain the theoretical underpinnings that inform the analysis presented within the thesis as a whole. Within chapter two I 'situate' NIPD within the larger context of prenatal testing and explain the historical development of NIPD technology. I then provide an overview of the relevant research conducted to date, pointing towards gaps in the literature, some of which this study seeks to address. Within chapter three I explain how the study was designed and conducted in the field, and I present reflections on some of the practical and ethical issues raised during the conduct of research. The central critique of the thesis is explored in chapters four to seven.

Within chapter four I show how NIPD is subject to a range of 'dividing practices', explaining how participants mobilised talk of numbers particularly, in order to both problematise and align NIPD technology with current prenatal testing practice. Picking up on the significant division that is made between NIPD and 'NIPT' I show how the technology 'troubles' the existing boundary that is constructed between prenatal 'screening' and prenatal 'diagnosis', and in doing so generates much discussion of practical, ethical and social 'issues' and 'concerns'.

Chapter five picks up on what is being 'problematised', examining particularly the discussion of abortion as it appears, repeatedly and consistently, as a source of concern. Showing how talk of abortion, whilst present throughout the dataset, was problematic – with participants struggling to identify language that would allow them to account for

their thoughts and experiences – I show how the 'difficult' issue of abortion nevertheless emerged as central to the discussion of NIPD. Drawing from Taussig (Taussig 1999), I show how the discussion of abortion here brought with it talk of 'secrecy' and 'stigma' - and being characterised as something that is widely recognised, but rarely articulated - emerges as a kind of '*public secret*'.

Chapter six examines participant accounts of the ethical and social issues raised by NIPD, and points towards the prevalence of institutionalised bioethical discourse – characterised by talk of autonomy, consent and individual choice - within both the public discussion of NIPD, and within accounts provided here by those most closely 'aligned' with the technology. Proceeding to show how those positioned further from the technology are able to attend, by contrast, to the powerful and disruptive margins of debate – and are able to explicitly problematise the technology - I show how, despite concerted efforts to contain and defuse the more contentious elements of debate, a range of 'hot' issues and entanglements (Callon 1998, Strathern 2002) continue to surface.

Chapter seven explores accounts provided by those whose professional lives are most closely aligned and entangled with the politics of prenatal testing. I show how, as NIPD gains momentum in the clinic and enters into the field of 'public health' - as discussion shifts ever closer towards talk of 'screening' and 'mainstreaming' within whole pregnant populations - significant anxieties are raised for those (potentially) charged with the task of managing and administrating this emergent and rapidly-expanding technology. Drawing on the work of Strathern, and showing how the rhetoric of 'choice' in particular is mobilised in order to responsibilise individuals and not systems, I show how issues of significant biopolitical concern and debate – such as selective reproduction and eugenics – become increasingly problematic as the discussion of moral and political 'concern' intensifies, and I show how persistent recourse to the discourse of 'individual choice' fails to maintain the division that is constructed between public health and biopolitics. Finally, by presenting accounts provided by those with significant lived experience of prenatal 'choice' – mothers who had experiences of 'risky' pregnancy, of NIPD, and of abortion – I show how such 'choices' (and associated moralities) are explicitly *not* individualised and rationalised, but appear as situated within, and constituted by, the richer context of the bodies, lives and relationships of women and their families.

Chapter eight summarises the work of this thesis, elucidating in particular some of the more critical points raised. It also discusses the future trajectory of the technology, and what implications this may hold, raising for discussion a new and emerging set of questions and concerns relevant to NIPD's ongoing development and translation.

Chapter Two. Situating NIPD

This chapter introduces NIPD by first providing an historical overview of how technologies and practices of prenatal testing have developed, and then showing how NIPD enters this frame, explaining how and where this particular technology has emerged, and how it has come to be translated within a range of clinical spaces. Following this, I explain how prenatal testing has been recognised as a site of significant sociological interest and concern, identifying and reviewing the relevant literature from within medical sociology and anthropology, science and technology studies (STS), bioethics and other relevant spaces (noting, however that many studies cross-cut such disciplinary boundaries). I outline and review the small (but growing) body of sociological, empirical and critical work that has been conducted around NIPD, highlighting the key issues raised, and identifying gaps in the research. As this study is UK-based, the account of NIPD's development and (particularly) clinical use outlined here concentrates primarily on the UK context. Since this technology is however undoubtedly global in scope, with both research projects and clinical practices taking place across geographical borders, relevant international developments are also considered here.

Situating NIPD: the history of prenatal testing.

Appealing to a pervasive and long-standing human desire to predict and influence the outcomes of reproduction (Gammeltoft and Wahlberg 2014, p.202), prenatal testing has been translated into a 'routine' and 'normal' component of prenatal care as it is practiced within the UK and many, (particularly Western), countries worldwide (Ginsburg and Rapp 1995). The range of testing technologies (including amniocentesis, chorionic villus sampling/CVS[1], ultrasound[2] and maternal serum screening/MSS[3]) that have been developed and subsequently translated into routine prenatal care are presented under a range of guises: as tools for 'screening' whole pregnant populations, for 'diagnosing' serious (and particularly *genetic*) disease in 'high risk' pregnancies, for providing

[1] Amniocentesis refers to '*the technique of extracting amniotic fluid transabdominally through a hollow catheter [needle]*' – a process that allows for diagnostic genetic testing to be carried out prenatally – and CVS is a similar diagnostic testing technique, that samples placental tissue rather than amniotic fluid (Rapp 1999, p.27 – 30).

[2] The medical application of ultrasound has resulted in the development of the field of 'ultrasonography', where ultrasound probes are used to *'send out a short pulse of high-frequency sound and detects the reflected waves (echoes) occurring at interfaces within the organs'* in order to produce images of structures in the human body. (Martin and McFerran, 2014).

[3] Maternal serum screening/MSS refers to a range of biochemical blood tests for *'numerous maternal protein markers'* and which are used for prenatal screening (and not direct diagnosis) (Wright 2009, p.33).

'reassurance' (Lippman 1991) and relieving parental anxiety during pregnancy and for enhancing maternal-fetal bonding (Roberts 2012). The proliferation of technologies and practices of prenatal testing began in the post-war period, with the realisation that amniocentesis - a technique that had previously been used for the experimental treatment of polyhydramnios[4] during pregnancy - could be used to gain information on the health of the fetus directly, and with the first major clinical application of amniocentesis being testing for maternal-fetal blood group incompatibility (Rapp 1999, p.28). Developments in the technologies of fetal medicine were concurrent with significant developments in human genetics. By the end of the 1950s, by using a '*hypotonic solution to swell the cells, giving an uncluttered view of the chromosomes*'[5] (Gardner, Sutherland et al. 2012, p.3) researchers had been able to confirm, for the first time, that humans each possessed (typically) 23 pairs of chromosomes. They were also able to clearly identify '*sex chromatin – the inactivated somatic cell X chromosome, or barr body*' (Rapp 1999, p.28) – the male human sex chromosome - the identification of which presented the opportunity to reliably distinguish male and female human cells in a laboratory setting (Moore, Graham et al. 1953). In 1959 – claimed as *'the wonderful year of human cytogenetics'* (Gardner, Sutherland et al. 2012, p.3) – came the first waves of this new genetic knowledge's medical translation – a notable instance of which was the identification of the chromosomal basis of Down's syndrome[6] (Lejeune, Gautier et al. 1959) – a move that would become central to the future conduct of prenatal testing. The translation of this new genetic knowledge within the clinical practice of prenatal testing was rapid: by 1960 amniocentesis was being used to test for fetal sex during pregnancy, and preliminary research was being conducted around testing for Down's syndrome and other chromosomal conditions[7] (Cowan 1994).

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[4] Polyhydramnios is a common complication of pregnancy, caused by an excessive amount of amniotic fluid surrounding the fetus – it can lead to early labour, increased bleeding after birth and may indicate that the fetus is in the 'wrong' position for birth (NHS, 2015)

[5] Chromosomes are bodies of genetic material found in the nucleus of every cell in the human body. Chromosomes 'carry' genes and are composed mainly of 'chromatin', within which the DNA helix is wrapped around proteins to form the familiar 'beads on a string' configuration (Bradley-Smith et al. 2010, p.60)

[6] Within his contemporary examination of Down's syndrome screening in the UK, Thomas explains how Down's syndrome is most commonly perceived: '*Down's syndrome is one of the most common chromosomal conditions in the UK, affecting approximately one to two of every 1000 live births. People with Down's syndrome are likely to have a range of symptoms including learning difficulties, shortened limbs, reduced muscle tone, restricted physical growth, a flat profile of the face, and a large protruding tongue. The condition is often identified as compatible with life, that is, as 'not lethal'. This translates to people with Down's syndrome being likely to survive childbirth and enjoying a good quality of life, although symptoms and prognosis vary significantly in each respective case'* (Thomas 2014, p.1).

[7] *'Chromosomal conditions'* are caused by abnormalities in the number or structure of chromosomes. Chromosome anomalies will typically lead to *'significant learning difficulty'* and may also cause '*congenital abnormality in one or more body organs*'. In most cases, chromosomal conditions will present where there is no previous family history of the condition and will be

Pregnancy, then, emerged as one of the first, and one of the most significant sites of interest and activity within the study and practice of human genetics.

Developments in ultrasound technology occurred alongside developments in amniocentesis, with researchers suggesting in 1958 that SONAR[8] technologies, originally developed for military use, could be medically applied as they presented the opportunity to provide enhanced imaging opportunities for the study and examination of the human body (Donald, Macvicar et al. 1958). The translation of this technology into the fields of antenatal care and fetal medicine took a number of years, and it was not until the mid 1980s that it was recognised that ultrasound could be used to observe fetal development during pregnancy (Yoxen and Hyde 1985). The visualisation of fetuses through ultrasound – as well as through concurrent developments in medical photography, which allowed for the publication of 'iconic' fetal images in LIFE magazine for instance (Duden 1993, p. 11 - 23) - represented a culturally significant moment, with '*the fetal patient*' and '*fetal subjectivity*' emerging as objects of both public and academic discussion (Mitchell 2001, p. 22 - 23).

Research on maternal serum screening tests commenced in the late 1970s, and by the late 1980s testing techniques had been improved to such an extent that the widespread routinisation of testing was recommended, specifically in order to (further) significantly reduce the number of Down's syndrome births in the UK (Wald, Cuckle et al. 1988) – the expected rate of which had already been reduced through widespread application of amniocentesis (Morris and Alberman 2009). Each of these various prenatal testing technologies have been successfully incorporated into routine prenatal care systems within the UK (where they are made available within both NHS and private prenatal care), and in many countries worldwide: amniocentesis has become '*one of the most routinized of the new reproductive technologies*' (Rapp 1999, p.1), ultrasound testing has developed into *'one of the most common rituals of pregnancy'* (Mitchell 2001, p.3) and is, along with maternal serum screening, offered to every pregnant woman receiving routine NHS antenatal care (see appendix one the Fetal Anomaly Screening Programme/FASP '*Antenatal and Newborn Screening Timeline - optimum times for testing'* for detail). Amniocentesis is also widely used within the context of 'specialist' prenatal care, within spaces such as clinical genetics and fetal medicine. Here, by contrast, testing is offered

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'*limited to a child presenting with the problem'* (NHS National Genetics and Genomics Centre, 2015a).

[8] SONAR is the acronym for 'sound, navigation, and radar'. SONAR was originally developed as an underwater system which uses reflected sound waves to detect and locate submerged objects (Atkins and Escudier, 2014)

only to women who are already known to be at 'high risk' of genetic disease or disorder. The application of CVS technology has been particularly relevant within such contexts (Caughey, Hopkins et al. 2006), as testing may be carried out at an earlier stage - from the 11th to the 14th week of pregnancy (Antenatal Screening Wales 2008b) - when compared with amniocentesis, which is usually carried out from the 15th week of pregnancy onwards (Antenatal Screening Wales 2008a). This is regarded as a significant advantage within the context of pregnancies known to be 'high risk' as it provides an earlier opportunity to either reassure and relieve patient anxiety through communication of a 'negative' result, or to provide expert counselling in the case of a 'positive' diagnosis (Evers-Kiebooms, Swerts et al. 1988).

It is difficult to overstate the extent to which these various practices and technologies of prenatal testing, and the experience of prenatal screening, have been made 'routine' and 'normal' within the vast majority of Western - or what Strathern terms 'Euro-American' (Strathern 1995) - pregnancy experiences. The NHS Fetal Anomaly Screening Programme (FASP) for instance exists specifically to ensure equity of access to screening services across the UK, and is responsible for reviewing and setting standards for NHS-based prenatal testing services. Within their 2011-12 annual report (more recent reports have not been made widely available), FASP explain that during 2011 74% (n=542,312) of women receiving prenatal care through the NHS (across England and Wales) chose to accept the offer of Down's syndrome screening. More recent documents have been made available regarding the national screening standards that FASP design and administer (FASP 2015), and although the centrality of '*informed choice'* is persistently stressed here – with FASP highlighting particularly a women's right to choose *'not to take up screening'* – they nevertheless describe how prenatal screening services are designed with the explicit aim of '*maximise[ing] timely fetal anomaly ultrasound screening/first trimester screening in the eligible population'* (FASP 2015, p. 9 - 10). Screening services then, are widespread, routinely accepted and are the subject of continuing efforts towards 'improvement'.

Debates around whether practices of prenatal screening may be understood as a top-down application of (bio)political power, or whether they are better characterised as an extension of 'reproductive choice', are prompted by such activity – and they are explored in more depth within this chapter, as I outline previous critical engagements with prenatal testing, and then again in chapter seven as I relate such questions more directly to the study at hand.

The history and trajectory of NIPD

Thus, as a novel prenatal testing technology, non-invasive prenatal diagnosis (NIPD) is emerging into a field within which prenatal testing technologies and practices are thoroughly routinised and normalised. As this new technology enters into a clinical and cultural space within which prenatal testing has become so 'normal' and 'routine', and where an established pattern of development sees a succession of technologies arrive, evolve and become translated within routine systems and practices, the emergence of '*just another big advance in testing*'[9] may have been greeted with moderate clinical, scientific or critical interest. NIPD, however, has been widely characterised as representing a *'revolutionary'* step within the on-going evolution of prenatal testing – (Greely 2011, King 2011, Palomaki, Kloza et al. 2011, Vermeesch 2012, Chiu, Lo et al. 2015) – emerging as a technology that has, within the space of just a few years, led to '*every aspect of current standard [prenatal] care being questioned'* (Chitty and Bianchi 2013). There are two clear and commonly cited reasons why NIPD testing is discussed in terms of being 'revolutionary' rather than simply routine: 1) the technology presents a number of important clinical/practical advantages over current testing methods, and 2) it is an application of rapidly developing and increasingly clinically-relevant 'next generation sequencing' (NGS)[10] genetic testing technologies (Swanson, Ramos et al. 2014), with the implication that the potential scope of NIPD testing is not simply genetic, but 'genomic'[11] (Bianchi 2012a, Adams, Berg et al. 2015).

Unlike other prenatal testing technologies which are either highly accurate but present some degree of risk of miscarriage (amniocentesis and CVS), or are 'non-invasive' (and risk-free) but provide results that are significantly less accurate than invasive testing (ultrasound and maternal serum screening), NIPD tests provide highly accurate results, at an early stage of pregnancy, without posing any risk to the health of the fetus or the mother. Test results are typically quoted – for instance within the image below - as being between 98% and 99.5% accurate (although expert accounts gathered here frequently

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[9] A description of testing provided by Chloe, an NIPD researcher interviewed for this study.

[10] 'NGS sequencing' has come to refer to a new tranche of genetic testing technologies which allow for analysis of the whole genome or exome: '*Next generation sequencing (NGS) is often referred to as massively parallel sequencing, which means that millions of small fragments of DNA can be sequenced at the same time, creating a massive pool of data… it is possible for scientists to look at the entire genetic make-up of a patient. The genome is all of the genetic material in an individual and includes all of the genes and DNA that each cell in the human body contains'* (NHS National Genetics and Genomic Education Centre, 2015b).

[11] Genomics is defined as the study of genes and their functions (as opposed to genetics which is the study of heredity) - (World Health Organisation, 2002).

suggested that NIPD tests were to be considered 99.9% accurate[12]). Questions regarding test accuracy remain however a matter of much debate (and they are explored in detail within chapter four of this thesis).

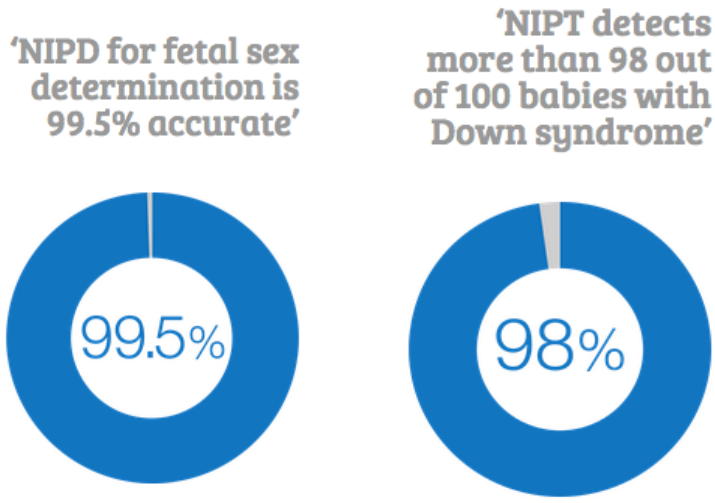

Figure 1: Test accuracy, as reported on the RAPID project website

NIPD testing has been shown to be viable from seven weeks gestation (Devaney, Palomaki et al. 2011), although many specific tests are recommended for use from around 10 weeks gestation. Nevertheless, NIPD reliably produces test results within the first trimester[13] of pregnancy (Latendresse and Deneris 2015), with laboratory 'turnaround time' being approximately 5 days (McCullough, Almasri et al. 2014, p.3). NIPD requires only a maternal blood sample in order for testing to be carried out, and is therefore defined as clinically 'non-invasive' (blood testing may, however, be understood as 'invasive' from the patient perspective - study participants here expressed some anxiety around the physical act of having their blood taken). NIPD can also be used throughout pregnancy, unlike many other prenatal testing technologies, which require women to undergo testing during a specific 'window' of time (see appendix one for detail on the timing of current prenatal tests as provided within routine NHS practice). This unique combination of practical and clinical advantages has placed NIPD in a position where its rapid and widespread implementation has, from the earliest stages of research and development, been identified as being highly '*desirable*':

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[12] Sequenom's 'MateriT21 Plus' test claims accuracy rates of more than 99.9% for certain disorders.

[13] Within medical descriptions of pregnancy a 'trimester' refers to *'any one of the three successive three-month periods into which a pregnancy may be divided'* (Martin and McFerran, 2014) – hence the first trimester refers to the first three months or 12 weeks of pregnancy.

> One of the goals of modern genetics is the development of safe and reliable prenatal diagnostic tests which do not constitute a risk to the fetus. Currently, the safety of available methods is limited by the need to obtain fetal tissue for analysis by invasive means, such as amniocentesis and chorionic villus sampling (CVS), which present a finite risk to the fetus… It is hoped that further new concepts and technological advances will now hasten the development of this field and lead to the introduction of non-invasive prenatal diagnosis into routine clinical practice
>
> (Lo 1994, p.1060 - 1065)

> The working group believes that the implementation of non-invasive prenatal diagnosis for clinically significant genetic disorders is desirable, both to improve the quality and management of antenatal care and to facilitate parental reproductive choice, and that the development of cell-free fetal nucleic acid technology for these purposes should be supported within the UK.
>
> (Wright 2009, p.46)

NIPD functions by exploiting the presence of cell-free fetal DNA/cffDNA[14] fragments that may (reliably, from around 5 weeks gestation) be found within the maternal bloodstream throughout pregnancy, and which increase in volume along with gestation and fetal growth (Lo, Corbetta et al. 1997, Wright 2009). It is because NIPD exploits the presence of fetal *genetic* material that it has come to be a viable application of next generation genetic sequencing technologies (Mardis 2008), with the *'fragmented'* form of cffDNA being particularly amenable to the application of 'shotgun sequencing'[15] techniques. The presence of cffDNA was first established by Dennis Lo and his team at Oxford University in 1997 (Lo, Corbetta et al. 1997), with this discovery following on from many years of research (carried out by Lo and his team, as well as a number of other groups worldwide) into potential non-invasive prenatal diagnosis testing methods exploiting the presence of intact fetal cells (Adinolfi 1991, Choolani, Mahyuddin et al. 2012). After success with such methods had proven elusive, the discovery of cffDNA sparked much renewed interest in NIPD, and the discussion of potential applications – many of which had been very clearly identified by those most central to NIPD research in previous years (Lo 1994) – very quickly gained pace.

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[14] Cell-free fetal DNA or cffDNA refers to fetal genetic material (in the form of short DNA fragments) that is found in the maternal plasma and serum throughout pregnancy, and that is rapidly cleared from the maternal bloodstream after birth (Lo et al. 1997). The term 'fetal DNA' is however something of a misnomer as this fragmented DNA is a product of the placenta and not the fetus itself.

[15] 'Shotgun sequencing' refers to a particular sequencing method used for determining the DNA sequence of an organism's genome, and which involves 'breaking' the genome into a collection of small DNA fragments that are then sequenced individually. Bioinformatics programs are used to look for 'overlaps' in the DNA sequences in order to place individual fragments in their correct order and to reconstitute the genome (USA National Institute of Health, 2015)

Mirroring the development of amniocentesis, the first clinical applications of NIPD were for 1) the identification of fetal blood group - where testing was (and is) used to guide the treatment of women who are 'at risk' of haemolytic disease of the fetus and newborn/HDFN[16] because of a potential blood group incompatibility and 'sensitisation' having occurred during a previous pregnancy (Avent, Madgett et al. 2009) - and 2) fetal sex - where testing is used to guide the clinical management of pregnant women who are 'at risk' of sex chromosome-linked/X-linked[17] genetic disease. Again paralleling the development of amniocentesis, the next major step in the development of NIPD came when proof-of-principle research on testing for Down's syndrome was published (Lo, Tsui et al. 2007, Fan, Blumenfeld et al. 2008) – hailed as a '*watershed moment*' (Bianchi 2012b) in the development of NIPD. This was very quickly followed by successful research concerning testing for an expanded range of trisomies/aneuploidies[18] (Fan, Blumenfeld et al. 2009, Tsui, Wong et al. 2009) and other chromosomal conditions (Bustamante-Aragones, Rodriguez de Alba et al. 2008, Sehnert, Rhees et al. 2011, Hill, Compton et al. 2014a)[19]. Another 'watershed' moment in the development of NIPD testing came when, in 2010, it was demonstrated that the 'whole fetal genome' was represented in the maternal blood (Lo, Chan et al. 2010, Thung, Beulen et al. 2015), opening up the possibility that NIPD testing would at some point be able to exploit the '*full potential*' of next-generation genetic sequencing technologies (Hall, Finnegan et al. 2014, p.38).

Cowan suggests that prenatal testing may be best characterised as a collection of practices – a cultural object of great significance, and which is at once scientific, clinical social, and personal in scope:

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[16] HDFN, known colloquially as 'blue baby syndrome' is a serious congenital form of anaemia which, '*prior to the introduction of post-delivery anti-D prophylaxis in the 1960s, accounted for the death of one baby in 2200*' (Daniels et al. 2009).

[17] X-linked diseases are caused by a mutation in a gene carried on an X-chromosome. Because males have only one X chromosome, 'recessive' characteristics will be expressed. Females can 'carry' the mutation, which may then be expressed in some (potentially 50%) of their male children (Lackie, 2010)

[18] The terms 'trisomy' and 'aneuploidy' are used interchangeable, and refer to an 'error' in the configuration of a person's chromosomes – where three (rather than two) copies of a particular chromosome is present. A number of genetic 'conditions' have been found to be caused by the presence of trisomy, including Down's syndrome, Patau syndrome and Edwards syndrome (Rapp 1999, p.28).

[19] A small number of tests for single gene disorders such as Achondroplasia (a common form of dwarfism) were also developed, (reaching standards sufficient for clinical use - see appendix three for details regarding NIPD tests currently licenced by the UK Genetic Testing Network), and research on a larger range of rare genetic conditions including Huntington's disorder (Bustamente-Aragones, Rodriguez de Alba et al. 2008), sickle cell disorder (Hill, Compton et el. 2014) has also been on-going.

> Prenatal diagnosis should be properly thought of as a sociotechnical system composed of several subsidiary parts: the medical delivery services that convince women to become patients; the means of obtaining fetal tissue from those patients; biochemical assays of the tissue; the culturing and karyotyping of fetal cells; molecular analysis of fetal DNA; ultrasound examination and guidance; and abortion.
>
> (Cowan 1994, p.35)

With NIPD's development closely echoing that of previous prenatal testing technologies - with the growth of specific testing applications following a similar developmental order, shifting from fetal blood group to fetal sex, then to Down's syndrome and on to tests for an expanded range of chromosomal conditions - the way in which the technology was (and is) being translated both scientifically *and* clinically points towards the presence of established 'pathways' from within which the routinisation and normalisation of testing may take hold. With the advent of NIPD then, 'the genomic analysis of fetal DNA' may be added to Cowan's list as another 'subsidiary part'[20]: emerging as a new development in a well-established field of research, where the clinical translation of novel technology is similarly routine, and where clinical practices – such as 'obtaining fetal tissue' and 'abortion' – sit alongside social processes – such as efforts taken to 'convince' or 'guide' women in their encounters with prenatal testing technology – NIPD emerges into a context within which a powerful alignment between bioscience, healthcare and new genetic knowledge informs the '*sociotechnical*' practice of prenatal testing.

Translating NIPD into the clinic

Building on the increasingly availability of NIPD tests, as well as the availability of established pathways for the enrolment and translation of novel prenatal testing technologies, NIPD has been introduced into clinical practice in a number of ways, and within a number of distinct spaces. Firstly, testing is used within the 'specialist' fields of clinical genetics and fetal medicine. In clinical genetics, NIPD is used within the management of pregnancies already identified as being at 'high risk' of genetic disease or disorder, either as a result of a known family history of disease, or as a result of previous experiences of prenatal diagnosis. NIPD testing for fetal sex was quickly adopted within such spaces, having been offered within NHS laboratories since 2003 (Raymond, Whittaker et al. 2010), and becoming '*the most frequently requested molecular diagnostic*

[20] Although it must be noted here that *genomic* prenatal testing is not limited to NIPD – it may also be carried out using invasive testing techniques and has been the subject of research elsewhere – with the EACH project for instance evaluating both NIPD and 'array CGH'.

test… account[ing] for more than 10% of all prenatal reports' by 2008 [21]. Testing for fetal sex is used to guide the 'management' of these 'at risk' pregnancies in a number of ways. For x-linked conditions such as haemophilia, where only male fetuses may be 'affected', testing is used to determine fetal sex at an earlier stage than would otherwise have been possible using ultrasound, and with none of the risk of miscarriage that amniocentesis or CVS would otherwise bring. If a fetus is 'diagnosed' as female then the pregnancy can go on to be managed through routine prenatal care. If the fetus is 'diagnosed' as male the pregnancy can continue to be managed through 'specialist' care services, and amniocentesis may subsequently be used to determine whether the fetus is in fact affected by the presence of disease (in these circumstances amniocentesis is often delayed until late stage in pregnancy where it brings a risk of early labour rather than miscarriage).

NIPD acts as a kind of 'interim' test in such circumstances: it is not used to *directly* guide decisions regarding abortion, but rather to guide decisions around whether to undertake further invasive testing. For a small number of conditions testing may guide the management of pregnancy more directly: for instance, if a woman is 'at risk' of carrying a child with congenital adrenal hyperplasia (CAH)[22] she may be offered NIPD for fetal sexing in order to determine whether she continues to receive steroidal dexamethasone treatment during pregnancy, or not (steroid treatment prevents 'virilisation' in female fetuses and is given prophylactically to women at known risk of CAH – NIPD would allow for those carrying male fetuses to avoid receiving unnecessary treatment[23](Dreger and Herndon 2009, Dreger, Feder et al. 2012)). Similarly, testing for fetal blood group/rhesus status – used within the field of fetal medicine rather than clinical genetics – may help guide treatment during pregnancy, allowing women who are found to have a blood group compatible with that of their fetus to avoid being administered 'anti-D' treatment[24] unnecessarily. NIPD for a range of single gene disorders - Apert syndrome, Cystic Fibrosis, Achondroplasia, Hypochondroplasia, Muenke Syndrome, Thanatophoric Dysplasia Type I

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[21] It has been noted, however that clinician knowledge of NIPD testing is by no means universal (Minear, Lewis el. 2015), and this point was very clearly echoed within a number of expert accounts gathered here.

[22] Congenital adrenal hyperplasia (CAH) is a disease of the endocrine system that can cause 'virilization' - the development of masculine traits.
in female fetuses.

[23] Although NIPD for CAH was quickly introduced, the 'treatment' of CAH – along with other sex chromosome disorders and 'disorders of sex development' - is a matter of debate, with critics claiming that the on-going medicalisation of *'benign behavioural sex variations'* is deeply problematic (Dreger 2009, Dreger et al 2012).

[24] Anti D is the rhesus-factor antibody, which is formed by rhesus-negative individuals following exposure to rhesus-positive blood: '*Anti-D immunoglobulin is given to Rh-negative women within 72 hours of giving birth to a Rh-positive child (or following miscarriage or abortion), to prevent the risk of haemolytic disease of the newborn in a subsequent child'* (Martin and McFerran, 2014)

and Thanatophoric Dysplasia type II (see appendix three for details regarding these conditions) – is also available for use within UK clinical genetics. Here, by contrast, NIPD is positioned a step closer to decisions regarding abortion, as it is able to directly diagnose the condition that a woman may be 'at risk' for. Practically, however, testing may in many circumstances be used for 'information only' rather than to guide decisions regarding abortion: a recent study examining Cystic Fibrosis patients' preferences regarding NIPD suggests that the majority of people would seek to make the most of NIPD's 'non-invasiveness' and gain information on their pregnancy in order 'to prepare' rather than to make any decision regarding termination (Hill, Twiss et al. 2015). In the case of NIPD for Thanatophoric Dysplasia - with testing being offered to women with previous experience of pre- or post-natal diagnosis, but who are at little clinical 'risk' of experiencing another affected pregnancy [25] - testing is offered explicitly to provide reassurance, rather than to satisfy any clear clinical 'need'.

NIPD for Down's syndrome has also been the subject of a significant volume of publically funded research in the UK. The National Institute for Health Research (NIHR) provided funding for a five-year (2009-2014) research programme on NIPD - the Reliable Accurate Prenatal non-Invasive Diagnosis (RAPID 2015) project, the aim of which was to '*improve the quality of NHS prenatal diagnostic services by evaluating early non-invasive prenatal diagnosis'* (Hill, Wright et al. 2014b). Early research carried out within the remit of the RAPID project led to the development of a number of UK Genetic Testing Network (UKGTN)-approved testing services (for fetal sex and single gene disorders - see appendix three) and, by the end of the study, the project had also led to the early development of in-house NHS tests for Down's syndrome, Patau's syndrome and Edwards syndrome (Chitty 2015b). The RAPID-developed trisomy/aneuploidy tests are currently being trialled and 'validated' within the UK, being offered to the small population of pregnant women who are receiving care through one of the '*Evaluation of NIPT for Aneuploidy in an NHS Setting'* study (Chitty 2015a) research sites. Currently, within the NHS, in order for women to be offered diagnostic testing for Down's syndrome (amniocentesis), they must first receive a screening test result that suggests they are at sufficient 'risk':

> FASP defines the national cut off set at 1 in 150 at term for both first and second trimester screening tests. A woman with a risk of 1 in 150, or greater (1 in 2 – 1 in 150), of having a pregnancy affected by T21, T18/T13 in the first trimester or T21 only in the second trimester will be considered to be in the 'higher risk' group and offered an invasive test

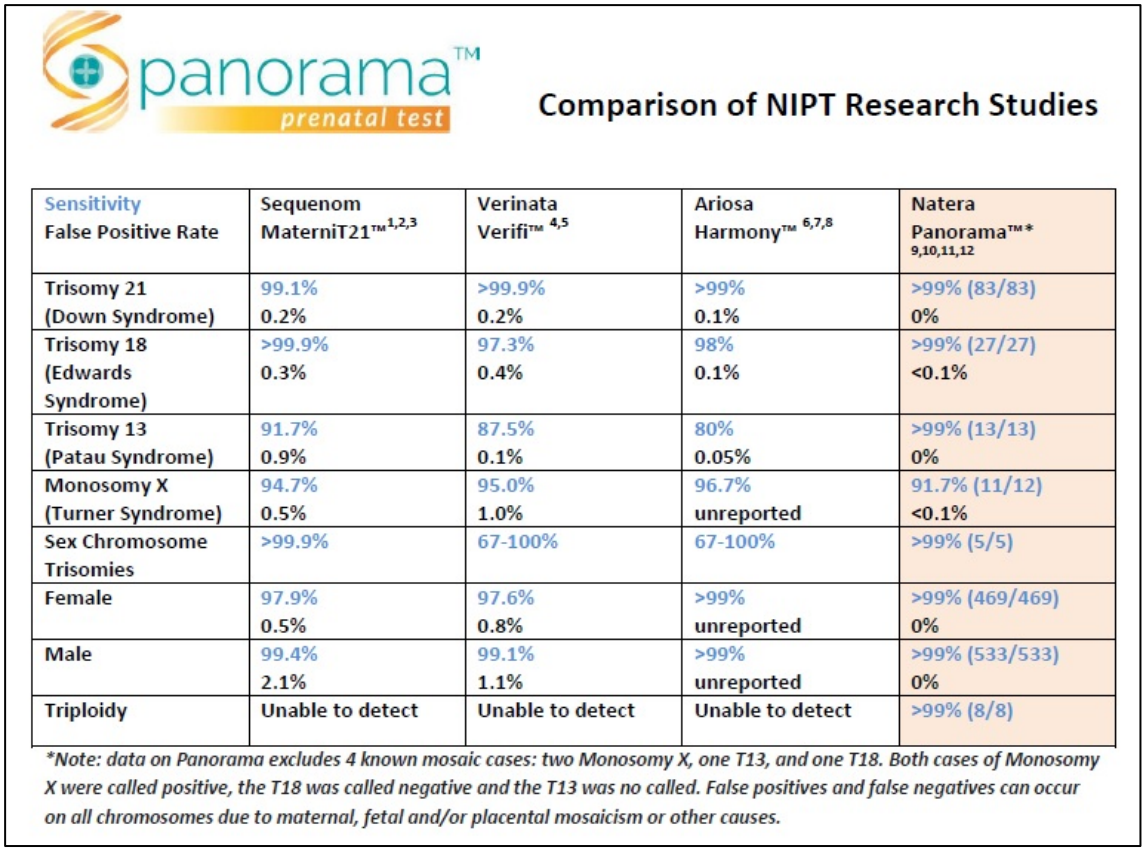
[25] For Thanatophoric Dysplasia the *'risk of recurrence for parents who have had one affected child is not significantly increased over that of the general population'* (Karczeski and Cutting 2014).

(FASP 2015, p.11)

The non-invasive Down's syndrome tests that are currently being validated are neither being offered to this group alone, nor are they being offered to any pregnant woman regardless of risk. Rather, they are being offered to women at a cut off of 1 in 1000 or greater risk (Hewison 2015), establishing therefore a new group of 'medium-risk' women and creating another (albeit safe, and in the majority of circumstances 'reassuring') step in the pathway from screening to diagnosis (Bryant 2014).

NIPD tests have, since the advent of testing for Down's syndrome particularly, been made available to purchase privately in the UK.[26] The translation of NIPD testing for Down's syndrome from the research context to the clinical context occurred rapidly, with testing being made available for the first time in the United States in October 2011 (Allyse, Sayres et al. 2012) and UK-based testing services being launched in October of 2012 (Genomeweb 2012). The growth of commercial NIPD testing has been significant, with Sequenom for instance collecting data from *'more than 100,000 clinical samples from all 50 US states and 13 other countries'* (McCullough, Almasri et al. 2014, p.1), by January 2014, just over two years since the launch of testing. By November of 2012 clinics across the UK were offering private Down's syndrome testing, and branded tests – 'NIFTY', 'Panorama', 'MAterniT21', 'Harmony' – marketed by at least seven different (global) commercial providers have now come to be available for purchase in the UK (see appendix two for further detail on the companies, tests and conditions currently tested for within UK-based private services). The NIPD development activities that commercial providers engage in are explicitly market-driven, with various companies trading on the US-based NASDAQ stock market (Sequenom, Ariosa/Roche, Natera, Verinata/Illumina) and the London stock exchange (Premaitha), and it has been claimed that the 'global market' for NIPD is likely to reach *'2.38 billion US dollars by 2022'* (Transparency Market Research 2015). A significant level of litigious activity has also been conducted around NIPD, with various companies – Sequenom, Ariosa, Illumina – suing and countersuing each other (Hawkins 2014). Each company advertises non-invasive testing products and laboratory services online, with websites commonly offering information tailored to the requirements of both parents and providers. Companies tend to complete within such spaces, explicitly, in terms of test accuracy (Skirton, Goldsmith et al. 2015a):

[26] Before tests for Down's syndrome were made available a number of NIPD tests for fetal sex were available to purchase online, on a direct-to-consumer basis from companies based the USA (Consumer Genetics – The Pink or Blue Company 2012). NIPD for fetal blood group testing is also now also available to purchase privately (Innermost Healthcare 2015)



panorama™ prenatal test

Comparison of NIPT Research Studies

Sensitivity False Positive Rate	Sequenom MaterniT21™[1,2,3]	Verinata Verifi™ [4,5]	Ariosa Harmony™ [6,7,8]	Natera Panorama™* [9,10,11,12]
Trisomy 21 (Down Syndrome)	99.1% 0.2%	>99.9% 0.2%	>99% 0.1%	>99% (83/83) 0%
Trisomy 18 (Edwards Syndrome)	>99.9% 0.3%	97.3% 0.4%	98% 0.1%	>99% (27/27) <0.1%
Trisomy 13 (Patau Syndrome)	91.7% 0.9%	87.5% 0.1%	80% 0.05%	>99% (13/13) 0%
Monosomy X (Turner Syndrome)	94.7% 0.5%	95.0% 1.0%	96.7% unreported	91.7% (11/12) <0.1%
Sex Chromosome Trisomies	>99.9%	67-100%	67-100%	>99% (5/5)
Female	97.9% 0.5%	97.6% 0.8%	>99% unreported	>99% (469/469) 0%
Male	99.4% 2.1%	99.1% 1.1%	>99% unreported	>99% (533/533) 0%
Triploidy	Unable to detect	Unable to detect	Unable to detect	>99% (8/8)

**Note: data on Panorama excludes 4 known mosaic cases: two Monosomy X, one T13, and one T18. Both cases of Monosomy X were called positive, the T18 was called negative and the T13 was no called. False positives and false negatives can occur on all chromosomes due to maternal, fetal and/or placental mosaicism or other causes.*

Figure 2: Advertisement for Natera's Panorama test, comparing rates of test accuracy with those of competing providers (December 2013).

NIPD tests for Down's syndrome have been widely used within 'low risk' pregnant populations, with several research teams (many of which are affiliated with commercial providers) publishing information on their clinical 'validation' processes (Nicolaides, Syngelaki et al. 2012, Fairbrother, Johnson et al. 2013a, Fairbrother, Johnson et al. 2013b, Taylor, Chock et al. 2014). Tests such as Sequenom's 'VisibiliT' (Karow 2014), sold at a lower price (and offering slightly less accuracy) than their other testing options, are marketed explicitly to the 'low risk' demographic.

The cost of private NIPD testing in the UK currently ranges between approximately £400 and £900 (ARC 2015), and since the majority of commercial laboratories are located outside the UK, blood samples are commonly shipped overseas for testing (the NIFTY test marketed by the Beijing Genomics Institute/BGI for instance, currently requires patient blood samples to be sent to China. Other commercial tests including Ariosa's 'Harmony' and Sequenom's 'MaterniT21 Plus' require that patient samples are sent to the USA, where their commercial laboratories are located). UK-based commercial testing providers have more recently entered into the NIPD 'market' – with Premaitha Health (a publically limited

company trading on the UK stock market) being located in Manchester, and Genesis Genetics (a USA-based company) establishing centres in both London and Nottingham.

Not only has the number of commercial NIPD providers expanded greatly since the 2012 launch of private UK testing, but the scope of testing itself has increased significantly: all commercially-available NIPD tests now report back results for fetal sex, Trisomy 13/Patau syndrome [27] and Trisomy 18/Edwards syndrome [28] (on top of testing for Down's syndrome), as part of standard practice. In addition to this, many tests now provide options to test for a greatly expanded range of conditions, including sex chromosome disorders and chromosomal 'microdeletions' which have been identified as the genetic cause of a rare genetic disease and disorder. Since this expanded range of testing is made available for anyone (with sufficient funds) to purchase, regardless of predetermined clinical 'risk' - and since previously, testing for such conditions would have been achieved through amniocentesis or CVS, being offered through a restricted range of locations for the care of 'at risk' women only - the translation of NIPD testing within this context represents the first time that prenatal testing for rare genetic disease has been made available to the 'low risk' general obstetric population at large. The significant contribution that commercial companies have made to the ongoing development of NIPD brings another powerful alignment into the frame, that of 'capital'. As NIPD technology is not only translated within clinical spaces, but commercial ones too, it enrolls with it multiple (and powerful) discourses: the discourses of 'risk' and 'reassurance' from within healthcare, the discourses of 'progress' and 'improvement' from within (bio)science and the discourse of 'competition' and 'free market capitalism' from within the market.

The current and future trajectory of NIPD

As outlined above, on-going 'progress' around NIPD has resulted in the development (and marketing) of tests that go well beyond the remit of routine clinical intervention as practiced within established prenatal screening programmes: with tests for chromosomal

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[27] Patau syndrome (or trisomy 13) is *'associated with a very poor outcome in surviving infants due to a combination of multiple congenital anomalies and severe mental retardation'* (Bradley-Smith et al. 2010, p.304). Patau syndrome is less prevalent within the population than Down's syndrome, is associated with a high rate of early miscarriage, and is frequently characterised as being 'incompatible with life'.

[28] Edward's syndrome is also *'associated with a very poor outcome in surviving infants'* with the major clinical features being: *'growth retardation, dysmorphic features, congenital anomalies, developmental disability and a short life expectancy'.* It is also associated with a high rate of early miscarriage, and is frequently characterised as being 'incompatible with life', but is of greater prevalence within the population than Patau's, being present in around 1/7900 live births (Bradley-Smith et al. 2010, p.303.

microdeletions and sex chromosome disorders not only being developed, but being very rapidly incorporated into commercial testing services (see appendix two for detail) - with five of the seven commercial tests currently on sale in the UK offering these 'expanded' testing options - the clinical translation of scientific and commercial development around NIPD has been rapid and pervasive. Whereas tests for aneuploidies (and fetal sex) are now typically 'bundled together'[29] (although parents may decline to receive information on fetal sex if they wish to do so), testing for this expanded range of genetic disease and disorder is presented as an object of 'added value' by many commercial testing services. In the image below for instance - taken from Sequenom's web advertisement for their 'MaterniT21 Plus' test, which offers to provide potential consumers with an '*Enhanced Sequencing Series'* – the additional services offered through their 'new generation' of tests are framed as 'innovative', and are described here as providing patients with the opportunity to access *'premium content'*:

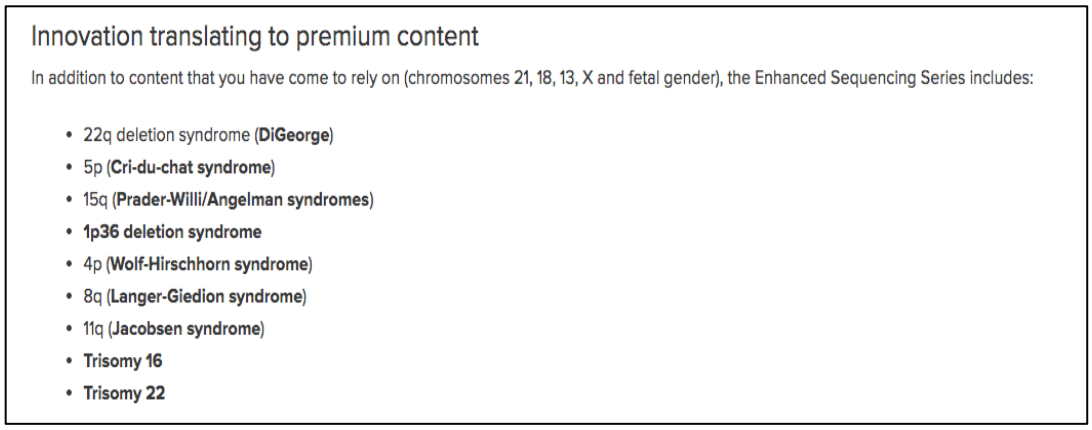

Figure 3: Online advertising for Sequenom's MaterniT21 test (27th January 2015)

It is interesting to note here too, the advert very actively normalises NIPD – with 'standard' testing for '*chromosomes 21, 18, 13 X and fetal gender*' being framed as information that has 'come to be relied upon'. Although parents may continue to choose to test for aneuploidy only, with regards the MaterniT21 test at least, these 'enhanced' testing options are offered at the same price. The expansion in the scope of commercial testing has continued onwards in more recent months, with Sequenom for instance, launching another 'new generation of tests', marketed in this new instance as being explicitly *genomic* in scope:

[29] Within the commercial sphere, testing for Patau's and Edwards' very rapidly followed testing for Down's syndrome – with Sequenom re-branding their *'MaterniT21'* test for Down's syndrome, launched in October 2011 (McCullough et al., 2014), as *'MaterniT21 Plus'* in February 2012. Identification of fetal sex was offered from the first launch of Down's syndrome tests.

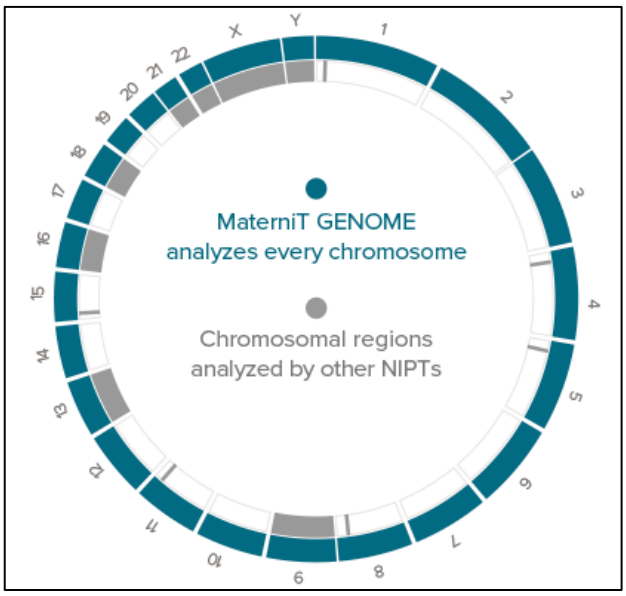

Figure 4: Online advertising for Sequenom's MaterniT GENOME test.

Sequenom's 'MaterniT GENOME' test represents another significant expansion in the scope of NIPD testing, and like their MaterniT21 and MaterniT21 plus tests, it is likely to be followed by similar testing services being developed by a range of other commercial providers – non-invasive genomic prenatal testing will too become the object of free market competition and commercial 'drive'. The full implications of genomic testing (generally speaking) have yet to be identified, with many test results providing 'incidental findings' and information on *'variants of unknown significance'*/VUS's – a context which has led those charged with providing expert guidance to recommend *'to restrict implementation of these novel NGS diagnostic technologies to deliberately target analysis and interpretation to disease associated genes consistent with the presenting patient's phenotype'* (Hall, Finnegan et al. 2014, p.5). It has also been suggested that issues raised by the application of genomic testing within the prenatal context particularly may be profound:

> The possibility of terminating the pregnancy in response to information about the foetal genome triggers two additional concerns. Terminations may be triggered by uncertainties of interpretation of the genome sequence; we have already considered such VUSs and IFs but these may now influence practice in a way that would disturb many professionals, especially as society is only beginning to adjust to the uncertainties of interpretation of genomic information. Basing serious and irreversible decisions on such provisional interpretations, which are so liable to shift in significance, could lead patients to make decision that they later bitterly regret.
>
> (Clarke 2014)

In order to situate all of the above within the larger context of how prenatal testing, and NIPD, has been approached critically – I proceed to review the most relevant critical literature published around 1) prenatal testing in general and 2) NIPD specifically.

Previous research: prenatal testing as a site of critical examination

Reproductive medicine, the practice of prenatal testing, and the various technologies employed within these spaces have emerged as significant objects of sociological interest and concern. A large body of literature has grown out of critical engagements with this area, with the fields of medical sociology and anthropology, and science and technology studies (STS) in particular producing significant work. A wide range of themes – including the biopolitics of reproduction, (womens) reproductive autonomy, medical paternalism, genetic determinism, abortion, eugenics, female embodiment, equity of access to healthcare, and the rights of people with disabilities - have been raised and explored within this large body of literature. The major moves and developments within the broad sociological discussion of prenatal testing are summarised here.

Although they are amongst the most successfully routinised and normalised applications of new reproductive and genetic technologies (Gammeltoft and Wahlberg 2014), prenatal screening and diagnosis technologies have been shown to raise significant political, economic and ethical concerns (Ginsburg and Rapp 1991, Lippman 1991, Marteau, Slack et al. 1992, Rapp 1999, Browner and Sargent 2011). The phenomena of 'routinisation' has been of key interest within much of the critical literature: it has been recognised, for instance, that the process of routinisation itself can serve to obscure many issues that are of central concern to patient experiences of prenatal care (Press and Browner 1997, Thomas 2015a). Prenatal screening and diagnosis technologies have been characterised as cultural objects of enormous complexity and transformative power (Franklin 1991, Strathern 1992b, Duden 1993, Strathern 1996), and the concrete and embodied experiences of women, as reported within key empirical texts (Rothman 1994, Rapp 1999, Mitchell 2001) have served to highlight the impacts of technological routinisation as experienced in the field.

Within her early empirical study of amniocentesis, Rothman introduced the concept of the *'tentative pregnancy'* (Rothman 1994) – using it to characterise the way in which, as they encountered new technologies of prenatal testing, women delayed their social and psychological engagement with pregnancy - with the time spent waiting for test results being experienced as particularly problematic as pregnancy becomes transformed into an

experience of *'suspended animation'* (Rothman 1994, p.100). Previous to this, Rothman described how the success of prenatal screening could be traced back to a more general move towards the increasing 'commodification' of life, a process which came to be extended through the rise of technologically-mediated and medicalised experiences of pregnancy (Bessett 2010), which in turn requires all women *'to confront a redefinition of motherhood, and question the nature and origin of the modern mother-child bond'* (Rothman 1987). In another empirical study examining the emergence of amniocentesis (Rapp 1999), Rapp describes how the task of navigating both practical and moral complexity is ascribed to women primarily, as they are required to negotiate encounters with new prenatal technologies, and become transformed into *'moral pioneers'* (Rapp 1999, p.3). Examining how processes of widespread technological routinisation lead to the increased 'normalisation' of testing, Rapp shows elsewhere how a growing and widespread cultural acceptance of prenatal testing may be seen to erode opportunities to refuse testing - with the end result that the conceptualisation of prenatal testing as an appropriate and responsible parental action becomes both clinically and socially consolidated (Rapp 1998).

Prenatal testing has been recognised as being a politically complex practice that simultaneously raises both eugenic and liberating agendas – with critics such as Duster and Raz highlighting the eugenic potential of prenatal screening as administered through 'routine' and 'normal' population-wide screening programmes – what Duster terms the '*backdoor to eugenics*' (Duster 1990) and what Raz refers to as the 'new' or 'liberal' eugenics. Picking up on such critiques, Gammeltoft and Wahlberg highlight the inherent 'selectiveness' of prenatal testing within their more recent anthropological review of reproductive technology (Gammeltoft and Wahlberg 2014). Issues around prenatal 'selection' and eugenics have been raised in connection with the critical discussion of disability and reproductive rights (Shakespeare 1998, Parens and Asch 2000, Kerr and Shakespeare 2002, Boardman 2014), with the disability rights critique problematising prenatal testing, claiming that firstly, by preventing the birth of fetuses with particular genetic 'diseases' or 'disorders' prenatal screening programmes promote the eradication of certain social groups and actively constitute cultural ideas around what types of persons are considered to be 'disposable' (Latimer 2007b, p.121, Thomas 2014, p.211) and that secondly, the value judgments inherent within selective practices foster discrimination against those living with disease, disability and disorder and contribute to the broader cultural framing of who and what is framed as 'normal'. Echoing this, Rothman asserts that systems of screening, when combined with genetic counselling, function as a form of fetal '*quality control*' (Rothman 1994, p.2), where presumptions

about the meaning of 'genetic health' are made. Rapp and Lippman too highlight the explicitly selective nature of prenatal testing technologies (Lippman 1991, Rapp 1998), with Lippman claiming that *'the primary aim of testing is the separation of those fetuses we wish to allow to develop, from those we wish to discontinue'* (Lippman 1991). The argument that genetic screening promotes social injustice has been, however, characterised as being particularly complex (Shakespeare 1998), with Shakespeare particularly recognising that prenatal screening may be viewed as being a practice that both facilitates the growth of reproductive freedom *and* large-scale social control.

The communication of information around prenatal testing is recognised as being a complex and significant process (Clarke 1991, Latimer 2007a). The power inherent within the clinical portrayal of prenatal genetic test results has been highlighted alongside the subjectivity of clinical descriptions of disease and disorder: '*every description of a genetic disorder is a story that contains a message'* (Lippman and Wilfond 1992, p.936). Elsewhere, Marteau et al. describe how women explicitly do not act as passive recipients of objective clinical information (Marteau, Slack et al. 1992), and, similarly, Lippman explains how during the decision making process women tend to alter the persuasiveness of the biomedical information on screening that is provided to them, weaving it with their own instincts and beliefs in order to create a particular kind of '*embodied knowledge'* (Lippman 1999). It also has been shown that complex decision making processes - involving the personalisation of risk information (Marteau and Lerman 2001, Edwards, Naik et al. 2013), the reshaping of statistics and the reinterpretation of the concept of 'health' (Rapp 1998) are shared by both women who accept and refuse testing. Work examining the experiences of those who 'refuse' offers of prenatal diagnosis within 'risky' pregnancies, has demonstrated that the act of '*choosing not to choose'* functions as a strategy through which parents may express 'ambivalence' towards testing, enabling them to manage the complexities of (genetically) 'risky' pregnancies as experienced through the lens of responsible parenting (Kelly 2009).

The specific issue of 'microchimerism' – the presence of fetal (or other biological) material within the maternal body (Gammill and Nelson 2010) - has also been explored by a number of critics . Within her work examining research conducted around microchimeric fetal cells, Martin (Martin 2010) demonstrates, along with the growing recognition that 'foreign' fetal material may be of significant technological and clinical value, there has come a profound shifting in the metaphorical framing of fetal cells and fetal DNA. Whereas, when the science of immunology dominated enquiry in the field, such material were described as pathological and destructive - *'insurgent foreigners'*, with the growing

recognition that fetal cells and fetal DNA could be used within a well-established and valued field of clinical practice (prenatal testing) they were purposively re-framed as *'productive immigrants'.* Elsewhere, Kelly (Kelly 2012) points again towards the intensification of interest around maternal-fetal microchimerism in the wake of developments in prenatal testing using fetal cells and fetal DNA, suggesting that the 'interface' between the mother and the fetus emerges as an *'interesting biopolitical object'* that may allow us to critically examine the dominant framing of bodies and persons as discreet and bounded *individuals*. Highlighting instead *'the permeability and permissiveness of bodies'* Kelly mobilises talk of microchimerism to challenge the dominant Western framing of the 'self' (echoing here the work of Strathern within her examination of *'dividuals'*). Fannin (Fannin 2014) approaches the topic of microchimerism by focusing in on the mechanism by which such material enters the maternal bloodstream – by crossing the *'placental barrier'*. Critically examining the way in which such a 'barrier' has been constructed and since understood, she draws on the metaphorical value of maternal-fetal microchimerism in order to *'re-imagine relations of self–other in pregnancy'* and to highlight the value of the relational, rather than the rational, within contemporary understandings of pregnancy.

NIPD research to date: empirical studies, bioethical debate.

Discussion of ethical and social issues raised in connection with the technology has been established alongside the development and clinical implementation of NIPD. The broad field of 'bioethics' particularly has been active from the earliest stages of the technology's development – and with Ethical, Legal and Social Implications (ELSI) programmes being incorporated into scientific/clinical research sites such as the RAPID project, the bioethical debate around NIPD has been correspondingly active.

Many (and some of the earliest) bioethical studies of NIPD raised the issue of 'informed consent' – and the possible erosion of standard clinical consenting practices – as a source of significant concern within the discussion of NIPD, due to the perceived ease, safety and corresponding likely routinisation of testing (de Jong, Dondorp et al. 2010, Deans and Newson 2010, van den Heuvel, Chitty et al. 2010, Silcock, Chitty et al. 2012). Responding to Van den Heuvel and Chitty's early empirical study of healthcare providers' responses to NIPD, which suggested that '*practitioners will view the consent process for prenatal diagnostic testing differently depending on whether it is an invasive or non-invasive test' (van den Heuvel, Chitty et al. 2010, p.27)* – being less likely to emphasise 'informed consent' procedures in the clinic - Deans and Newson highlight the moral and practical problems

that could be raised if consent procedures were to be relaxed in response to the 'non-invasiveness' of NIPD. They suggest that, in contrast to how the receipt of results from risk-based and probabilistic blood tests that are used for 'screening' may be presented, more robust consenting procedures and greater standards of *'pre-test information'* are necessary when women receive (diagnostic) NIPD results. Such robustness is said to be necessary because, with NIPD, women would be required to negotiate '*definitive*' test information, and address a different set of concerns (including abortion – euphemistically termed *'an important decision of great moral and emotional magnitude'* here) during their '*decision-making process'*. They claim that the definitiveness of NIPD, particularly when examined alongside clinicians' likely lack of emphasis on informed consent – entails that a renewed emphasis on '*autonomous reproductive choice'* will be required. It is suggested that this may be facilitated by ensuring that consenting procedures for NIPD remain robust, and should mirror the current consent procedures adopted for invasive testing (a claim that would have a significant practical impact if NIPD were to enter into population-wide screening programmes). Further issues around autonomy, choice and consent have been raised, with critics highlighting the possibility that - if NIPD were to be introduced into 'routine' and 'normal' population-wide screening programmes – women may feel increasingly unable to 'choose not to choose' (Kelly 2009) NIPD testing, due to the perceived ease and safety of NIPD (Hewison 2015), and the routinisation of screening programmes.

Also exploring issues raised by the possible widespread routinisation of NIPD within screening, Skotko explores the potential scenario that Down's syndrome (and any other conditions routinely tested for) may come to be '*eradicated*' within the population at large (Skotko 2009) as a result of widespread NIPD testing. Skotko asks then whether, *'with the new prenatal testing, will babies with down syndrome disappear?*' - pointing towards the widespread *'success'* (routinisation) of screening programmes which have resulted – *'since no prenatal therapeutic interventions currently exist'* - in a greatly increased number of terminations (abortions) for Down Syndrome within healthcare systems worldwide:

> In the USA, there would have been a 34% increase in the number of babies born with DS between 1989 and 2005, in the absence of prenatal testing. Instead, there were 15% fewer babies born, representing a 49% decrease between the expected and observed rates. In the UK there would have been a 58% increase in the number of babies born with DS between 1989 and 2006, in the absence of prenatal testing. Instead, there was only a 4% increase, representing a 54% decrease between expected and observed rates.
>
> (Skotko 2009, p.2)

Skotko argues that NIPD - holding the potential to result in earlier, safer, and cheaper diagnostic testing for Down Syndrome – and particularly if it were to be made available population-wide, raises significant moral and practical concerns: *'unprepared, untrained obstetricians and midwives will need to grapple with new, first trimester tests that might be quickly adopted, once made commercially available'*. He voices concerns regarding the impact that both the medicalisation of pregnancy and the normalisation of prenatal testing has had, at both the individual and social level, and asserting that *'the birth incidence of children with DS should ideally reflect societal mores and not the interventions of physicians or medical technology'*. Whilst the relevant social science literature may point to the fact that clinical practices and processes may be conceptualised as social phenomena, and are not so easily separated from '*societal mores'*, many parallels can be drawn between Skotko's reasoning here and that contained within the social science literature addressing disability rights and the *'new eugenics'.* Such concerns have been revisited in the light of significant developments in NIPD testing for Down's syndrome, with Clarke once again pointing towards the possible 'elimination' of Down's syndrome within society as a result, and raising questions of broader cultural significance:

> What would it say about our society's attitudes towards and valuation of people with Down syndrome in particular but also those with intellectual disability more generally?
>
> (Clarke 2014, p.27)

Elsewhere, Bryant has raised concerns regarding NIPD's expansion into prenatal screening, particularly if testing were to be restricted to certain 'high risk' groups only (Bryant 2014). If NIPD were to follow on from current non-invasive screening (and if its 'earliness' were to be negated as such) in this case, NIPD would operate as an additional step - and an additional delay – for the small number of women who finally receive a confirmatory diagnosis. Bryant suggests therefore that NIPD may come to be experienced as an extra psychological burden, particularly within the most 'tentative' of pregnancies:

> For some women, termination of pregnancy may actually take place at a later stage in the pregnancy than with current screening protocols. Will women feel as favourably towards NIPT once it is situated within this proposed pathway? The psychological burden of these multiple tests for pregnant women and their partners is unknown.
>
> (Bryant 2014, p.2)

Providing empirical evidence to support the claim that NIPD raises (public) concerns regarding possible routinisation, Kelly and Farimond present findings from their qualitative research examining public and lay perceptions of NIPD (Kelly and Farrimond 2012, Farrimond and Kelly 2013). Four distinct public 'viewpoints' emerged from their

data: NIPD was simultaneously viewed as; *'discrimination against the disabled; a positive clinical application; appropriate for severe disorders only; [and] a personal choice'* Responses that paralleled the disability rights critique were particularly strong – with the 'trivialisation' of selective reproduction and 'therapeutic' abortion being raised as a particular issue of concern. The identification of this perspective as dominant was highlighted as particularly significant, particularly given that more critical voices *'are often marginalised or drowned out by more dominant clinical and medical discourses in debates about new genetic technologies'*. A *'consensus of concern'* was identified as being present throughout the data: every participant rejected the idea, for instance, of *'NIPD being available outside traditional clinical pathways (e.g. commercially/DTC)'.*

Zamerowski et al. conducted an early empirical study on NIPD, asking how high-risk women might respond to NIPD-type testing (Zamerowski, Lumley et al. 2001). Responding to a survey, women who were currently experiencing high-risk pregnancies, and who planned to have an invasive test (amniocentesis or CVS), responded favourably to the technological promise of NIPD: '*only half of the women would seek invasive testing after a normal blood test*'. A similar study, conducted with women undergoing routine anomaly scans and female medical students (Kooij, Tymstra et al. 2009), produced more conflicted results: *'our respondents do not agree about making the test generally available: a majority of the pregnant women support a general availability of NIPD, whereas the students are far more reluctant'*. Some degree of consensus was reached regarding two issues: participants were highly critical of testing for late onset disease, and they also *'clearly rejected'* identification of fetal sex in order to facilitate non-medical sex selection. A survey of women in their third trimester of pregnancy (Tischler, Hudgins et al. 2011) demonstrated that most women show an *'interest'* in NIPD *'primarily because of increased safety for the fetus, although a significant minority are uninterested or ambivalent'.* Another survey-based study (Sayres, Allyse et al. 2011), examining attitudes toward the clinical implementation of NIPD as reported by obstetric healthcare providers in the USA, also reported a widespread level of concern related to testing for single gene disorders and non-medical sex selection. Very few respondents reported a high level of knowledge of NIPD and a general *'uncertainty among obstetric providers about the details of implementing cell-free fetal DNA testing'* prevailed. The study also described how healthcare providers held the general perception that *'patients face strong social pressure to undergo testing',* and that they particularly valued the role of counselling in prenatal testing. Echoing the concerns of participants here, critics elsewhere have raised concerns regarding the potential for NIPD to be used for (illegal) 'social' sex selection and other

'non-medical' purposes (Newson 2008, Tasinato, Montisci et al. 2011, Chapman and Benn 2013).

Having incorporated ELSI research into the original design of the research, the RAPID project has yielded much information regarding the possible practical and ethical impact of NIPD. Interview based studies with women who had experience of NIPD for fetal sex reported that participants were '*overwhelmingly positive'* about the technology:

> The participants valued a test that was easy to conduct, could be performed early in pregnancy and posed no risk to the fetus…. Moreover, NIPD was viewed as a positive development, which facilitated reproductive autonomy as it expanded the reproductive choices available to women.
>
> (Lewis, Hill et al. 2012a, p.2)

Although the disadvantages of NIPD were felt to be '*minor in comparison'*, a number of themes of concern were identified, including: miscarriage risk, increased anxiety, connection to a potentially 'unwanted' fetus, being robbed of surprise, and the possible future misuse of technology (Lewis, Hill et al. 2012b). The RAPID team have also conducted research on patient experiences of testing for single gene disorders, where again 'opinions about NIPD were very positive' (Hill, Compton et al. 2014a). Concerns were raised, however, with participants stressing the need or test accuracy to be high '*in order for the test to be used for subsequent decision making about termination of pregnancy'.*

De Jong et al. explicitly address the concerns raised by a NIPD's potential expansion toward whole genome testing, pointing towards problematic issues raised in connection with the autonomy of the future child, which may be directly threatened in the case of testing for late-onset disorders (such as Huntington's disease) or 'susceptibility genes': *'testing for such conditions is generally regarded as unacceptable, not just because benefits for the child that might outweigh any burdens are absent, but also because it deprives the individual of his or her right to self-determination'* (de Jong, Dondorp et al. 2011). Such a perspective is mirrored within typical approaches to the testing of children within clinical genetics, and is well supported within the literature (Clarke 2014, Hall, Finnegan et al. 2014), with Deans, Clarke and Newson claiming particularly that '*in most cases, using NIPT to test for adult-onset conditions, carrier status or non-serious traits presenting in childhood would be unacceptable'* (Deans, Clarke et al. 2015, p.19). The bioethical discussion here is closely linked to more general discussions of routinisation within the social science literature: it is suggested that, once certain testing applications have become routine, an expanded range of tests are likely to be made available, simply in virtue of their being

technologically feasible rather than socially, morally or culturally appropriate (de Jong, Dondorp et al. 2010). A handful of recent studies have shown that previously-undetected cases of maternal cancer may be 'diagnosed' as a result of NIPT testing (Romero and Mahoney 2015, Sample 2015, Bianchi, Chudova et al. 2015a), and bioethical commentary has quickly followed (Newson and Carter 2015), with critics pointing towards the emergent *'dilemma of overdiagnosis'* that 'incidental' maternal cancer diagnoses entails. Additionally, with the expanding use of NIPD for the testing of rare genetic disease, comes the possibility that information regarding the father's health may be generated, with critics suggesting that in such circumstances steps ought to be taken to ensure that informed consent is provided by both parents prior to testing taking place (Skirton, Goldsmith et al. 2015b)

More recent clinical and empirical studies of NIPD experiences have highlighted the speed with which tests for Down's syndrome particularly have been translated into the clinic (Geifman-Holtzman, Berman et al. 2014, Krechmar 2014, Nishiyama, Sasaki et al. 2014, Xiong, Berman et al. 2015), and have also suggested that with the advent of such tests then the uptake of prenatal screening more generally is likely to increase (van Schendel, Dondorp et al. 2015x). Fears around the expansion and routinisation of testing have been expressed (Agatisa, Mercer et al. 2015), and a recent Japanese study suggested that women who seek out NIPT tend to have higher levels of anxiety or depression (Suzumori, Kumagai et al. 2015).

Summary

Within this chapter I have shown that, although a growing amount of research and critical commentary concerning NIPD is being produced, the empirical work conducted to date has been limited in scope. Additionally, many such studies have been closely affiliated with scientific research programmes, and do not approach the discussion of NIPD from an explicitly critical perspective that problematises the technology and its implications. Accounts of NIPD patient experiences, being conducted from within NHS-based research sites, accordingly attend to the voices of these patients in particular, and the voices of patients and providers involved in the private provision of NIPD testing for Down's syndrome have yet to be highlighted and examined. There are also no ethnographically informed accounts of NIPD published to date, and data on the day-to-day, routine and

mundane practice of NIPD 'in the clinic' is also currently absent from the discussion[30]. What also emerges as particularly notable here is that the pace and breadth of research and development around the science of NIPD (particularly since the inception of this study) has been significant, and that new applications of this novel technology continue to emerge, and become translated, at great speed. With tests entering into both 'routine' prenatal care and 'specialised' diagnostic testing services, the way in which NIPD has come to 'reach out' into the clinic, and into the lives of patients and professionals involved in prenatal testing, has become increasingly complex. NIPD's move into the field of prenatal screening – an activity that is '*centrally located in UK reproductive politics*' (Thomas 2014, p.13) - is particularly significant, as this brings with it the recognition that testing is not only a site of medical and social activity, but (bio)political activity also (Lippman 1991, p.34). In addition to this, the market-driven activities of commercial companies have had significant impact on the trajectory of NIPD research, as well as its translation into the clinic, emphasising the technology's near-diagnostic accuracy, and expanding the range of genetic conditions tested for. The development of this novel prenatal testing technology is then, very clearly marked by a powerful alignment between healthcare, bioscience and capital, and the various discourses they enrol. Within the next chapter then, I explain how the current study has been designed and conducted, in order that this complex field of technological, clinical and commercial activity may be examined at an emergent – and particularly active – stage.

[30] The conduct of such work has, historically, been challenging as there have been no obvious spaces within which NIPD is consistently or continually employed. With the rise of private testing services however (and with the potential 'mainstreaming' of the technology within the NHS) opportunities to conduct ethnographic examinations of NIPD may arise.

Chapter Three. Design and Conduct of the Study.

This chapter provides an account of the methodologies employed during research, explaining how the study at hand was designed and conducted. As a site of rapid change, and a location within which a range of difficult, sensitive and contentious issues were likely to be discussed, the task of designing and conducting a close critical examination of NIPD presented numerous practical and ethical challenges, the scope of which is also outlined here.

Study design and participant recruitment

As this research commenced NIPD testing was, within the UK, being carried out exclusively within NHS laboratories and clinics. Although NIPD had been used within NHS clinical practice since 2003 (Hill, Lewis et al. 2012b), the experts (fetal medicine consultants and clinical geneticists) that I spoke to prior to the study design being drafted (in order to begin to identify and locate the field) explained that the use of NIPD for fetal sex within the clinic was extremely intermittent, and where it was perhaps more frequent (within specialist clinics that provided testing for fetal blood group), clinicians explained that patients were not actively involved in 'choosing' NIPD over any other test in such circumstances. Whereas this presents as an interesting finding in itself, it indicated that clinical spaces available for study at the outset of this research would not generate significant levels of patient discussion regarding the technology. Since no clinical locations could be identified within which NIPD was being used with enough regularity that would enable meaningful observational research on patient and professional experiences of NIPD to be conducted, a research design that concentrated centrally on the generation of a wide range of qualitative interviews, and to enrich this, the gathering of relevant textual and visual material (in the form of clinical and scientific publications, media coverage, clinical documentation and other written material), was therefore designed.

Since NIPD was being used within the remit of NHS services, the conduct of interviews with NHS patients and staff with experience of NIPD (and other prenatal testing technologies) was identified as being crucial to this study. The process of gaining access to staff and patients with experience of NIPD for fetal sexing (the most frequently used application) and/or NIPD testing for single gene disorders (used infrequently by comparison) was therefore prioritised. Approaching the design of the study with an awareness that NIPD for Down's syndrome testing was (at the time) in development, and in order to gain some understanding of how NIPD's possible incorporation within Down's

syndrome screening programmes may come to be approached and understood, the design of the study was expanded to include 'parent' participants with experience of routine screening tests. Recognising the particular value of gaining an understanding of patient experiences with refusing and accepting prenatal testing (Rapp 1998, Kelly 2009), for both this group of participants, and for all patient participants, individuals would be eligible for inclusion on the basis of having been offered testing. Adopting a strategy that would involve participant recruitment through NHS clinical services entailed that ethical approval would need to be sought from an NHS Research Ethics Committee (REC) prior to the commencement of recruitment and fieldwork. Detailed plans for the conduct of the study were designed, therefore, with the rigorous requirements of NHS research (which highlights particularly the significance of '*participants' safety, rights, dignity and well-being'* (NHS National Research Ethics Service 2010, p.2)) being of foremost concern. The administration of this task was complex as I was required to submit documentation to a number of regulatory bodies and institutional departments (including Cardiff University, Research and Development/R&D Departments at all clinical sites, the National Institute of Social Care and Health Research Clinical Research Centre and the NHS Research Passport service) in order to gain approval to commence fieldwork. Although the online Integrated Research Application System (IRAS), which facilitated the application process to both the REC and individual R&D departments, was also complex, the task of completing the form was beneficial to the study design in that all potential practical and ethical issues were addressed thoroughly in advance within the submitted project protocol (see appendix eleven). Although the overall approval process was somewhat time-consuming, the final study design benefitted greatly from the expert oversight of both the NHS REC, and the various R&D departments located at each clinical site that came to be included.

Before the project protocol could be finalised and ethical approval sought local Clinical Investigators/CIs who would be able to assist with participant recruitment and the general conduct of the study needed to be identified. At the outset of this study very little information was made publically available concerning exactly where, how and by whom NIPD testing was being used within the UK, and the identification of potential CIs was correspondingly problematic. The successful identification of local CIs was facilitated greatly by the expertise of the clinical supervisor assigned to the study, who was able to make contact with a number of clinicians on my behalf (and arrange for me to meet with them prior to study design, in order to help identify the field), and was eventually able to secure informal agreements for participant recruitment to take place within three different NHS clinics across the UK. Although this greatly facilitated the study design and recruitment processes, since CI's were identified through the clinical supervisor, the

sample cannot be considered as fully representative. The input of the clinical supervisor was also invaluable to the design of the final study documentation, as she was able to ensure that the information provided was consistent, clear and accurate (see appendices four to nine), and would communicate the information required to patients effectively. In order to recruit 'parent' participants a number of key non-clinical contacts (leaders of mother and baby groups) were identified using publically available (online) business directories. Local NHS CIs were required to collaborate on the process of applying for NHS ethical approval and were fully informed with regards the conduct of the study, and their obligations within it, prior to the REC meeting taking place. The REC raised very few issues of concern during the meeting. One REC member expressed some concern that women with experience of a 'difficult' pre- or postnatal diagnosis could be recruited onto the study, and that this may provoke some distress on behalf of the participant. It was however explained that the participation of such individuals was seen to be particularly valuable within the study, as such experiences would be integral to a well-rounded understanding of how NIPD may come to be broadly experienced and discussed. Approval was granted subject to minor amendments after the first NHS REC meeting in January of 2013. The study was subsequently 'adopted' onto the NISCHR clinical research portfolio, and was included in the UK Clinical Research Network's online portfolio database.

This study involves the recruitment of participants from a number of different groups:

Service users

- NHS patients with experience of NIPD testing
- NHS patients with experience of invasive prenatal testing (Amniocentesis or CVS)
- Members of the public with experience of routine prenatal screening tests
- Private patients with experience of NIPD testing

Service providers

- NHS professionals who work with NIPD testing
- NHS professionals who work with current prenatal testing (specialist/diagnostic or routine/screening)

NIPD developers

- Persons involved in the clinical and commercial development of NIPD testing

Partners

- Partners of service users, recruited through a process of "snowball sampling"

As

Figure 5: Participant cohort – extract taken from Research Protocol version 2.1 (see appendix 11 for detail).

outlined in the approved study protocol, it was expected that a maximum of 55 participants would be recruited onto the study. This total was envisaged to include (a maximum of) 40 'service users', 10 'service providers', 5 'NIPD experts' and 5 'partners'. Since I would be responsible for carrying out, transcribing and analysing all interview data it was felt that a maximum of 55 participants would more than sufficient. Specific inclusion and exclusion criteria were also set, in order to guide local CI's in the identification of potential participants:

Participants will be included if they are:

- Women with direct personal experience of NIPD.
- Women with direct personal experience of current prenatal testing, either routine or specialist/invasive (Amniocentesis/CVS).
- Service providers with direct professional experience of NIPD
- Service providers with direct professional experience of current prenatal testing, either routine or specialist/invasive (Amniocentesis/CVS)
- Professionals with experience in the field of NIPD development
- Partners of women with personal experience of either NIPD or current prenatal testing

Participants will be excluded if they are:

- Persons unable to communicate fluently in written or spoken English.
- Persons unable to provide fully informed consent.
- Under the age of 18.

Figure 6: Inclusion and exclusion criteria - extract taken from Research Protocol version 2.1 (see appendix eleven for detail).

The phrase, '*direct personal experience*' was interpreted as indicating that participants' experience of testing would relate to their own previous experiences of pregnancy. As mentioned, potential participants who had both accepted and refused testing were eligible for inclusion, and it was expected that the 'service' provider group would include (but not be limited to): genetic counsellors, fetal medicine consultants and nurses, haemophilia consultants and nurses, and midwives. It was noted that recruiting women who had refused testing in the clinical setting may prove to be difficult, as local CI's had previously

indicated that databases containing information on such patients were often informally kept, and that contact details would not be available in many cases.

In order to protect the confidentiality of potential patient participants local NHS CIs were made responsible for identifying patients who met the inclusion criteria, distributing information packs directly to those they had identified as being eligible (I supplied each CI with a number of printed information packs containing participant information sheets, consent forms, reply slips and stamped, addressed envelopes – see appendices four, five and six for further detail). Information sheets invited potential participants, if interested in taking part in the study, to contact me via phone, email or post. The majority of participants contacted me via postal reply (using the reply slip and pre-paid envelope contained in each pack), and requested that I either call or email them in order to arrange a suitable time and location for the interview to take place. Non-NHS recruitment was carried out concurrent to NHS recruitment, with group leaders making information packs available to eligible parents in this context.

As I had permission to make use of already-established professional networks in order to identify eligible expert participants, I was able to access this group of participants more directly. This process was also less time-consuming and allowed for interviews with expert participants to commence within a few weeks of ethical approval being granted. Within the first year of the study (and with interest around NIPD intensifying) I was provided with numerous opportunities to participate in and contribute to meetings, seminars and conferences, communicating information on the proposed research to a range of academic and clinical audiences. Observation and participation in such activities helped 'situate' the study within the wider frame, and it was also through this route that I was able to identify and recruit a number of key experts in the field, who may otherwise have remained unknown to me. Since I had permission to make use of '*snowball sampling'* (Atkinson 2001) techniques[31], these participants were in turn able to identify further expert participants for possible inclusion within the study. The group of experts I encountered were exceptionally open and willing to help me with the conduct of my study - very frequently information on additional potential participants was offered spontaneously, without interviewees being asked directly about the identification of additional potential interviewees. This recruitment strategy also presented the

[31] The research practice of "snowball sampling" involves working with participants who are willing and able to further identify additional potential participants that the researcher may otherwise not be able to reach. This particular recruitment process makes use of participants' own networks and is suitable for use in research where the target population is particularly small or difficult to reach (Atkinson, 2001).

advantage that the field came to 'define itself' to a significant degree. The recruitment of expert participants progressed rapidly, and was highly successful, with a total of 22 experts being interviewed once fieldwork was complete. The table below provides information on the number of expert interviewees recruited onto the study, provides generalised information on their professional role, and indicated whether they had any influence in the work of relevant advisory committees and/or regulatory bodies. The sample is particularly notable for its gender bias, with 18 of the 22 experts interviewed being female.

Name (sex)	Profession	Advisory/regulatory role?
1. **Beth (F)**	Scientist, NIPD research and development.	-
2. **Paul (M)**	Consultant in fetal medicine, NHS practice	Yes
3. **David (M)**	Consultant clinical geneticist	Yes
4. **Chloe (F)**	Scientist, NIPD research and development.	-
5. **Kate (F)**	Director, patient support charity	Yes
6. **Lucy (F)**	Genetic counsellor	-
7. **Emily (F)**	Scientist, NIPD research and development.	-
8. **Sam (F)**	Trainee genetic counsellor	-
9. **James (M)**	Consultant in fetal medicine, NHS and private practice.	-
10. **Linda (F)**	Manager, public health	Yes
11. **Rob (M)**	Director, patient support charity	Yes
12. **Erica (F)**	Consultant clinical geneticist	-
13. **Rachel (F)**	Genetic counsellor	-
14. **Cerys (F)**	Nurse and midwife	-
15. **Laura (F)**	Scientist, NIPD research and development.	-
16. **Naomi (F)**	Genetic counsellor	-
17. **Claire (F)**	Consultant in fetal medicine	-
18. **Will (M)**	Manager, patient support charity	-
19. **Alison (F)**	Cytogeneticist, NHS	Yes
20. **Natalie (F)**	Consultant clinical geneticist	Yes
21. **Caitlin (F)**	Midwife	-
22. **Jonathan (M)**	Manager, public health	Yes

Table 1: Expert/professional participants

Participant recruitment conducted through NHS clinics and mother-and baby groups resulted in a total of 14 patients and parents being recruited onto the study. Additionally, responding to significant developments in the field - the launch of Down's syndrome NIPD

testing within private UK clinics – a significant amendment was made to the study protocol (and was approved by the REC on the 17th June 2013). This amendment allowed for the recruitment of private NIPD patients (and their partners), and arose subsequent to the clinical supervisor having identified a clinician who would be willing to act at as local CI for the recruitment of private NIPD patients. Although it was feasible only to recruit a small number of private patients (n=3) as additional participants in the study (due to time constraints and an already-high rate of participant recruitment), this step was regarded as particularly worthwhile since it would represent one of the first instances where private NIPD patients would come to participate in UK-based qualitative research. A final total of 17 NHS and private patients, and parents, were recruited onto the study:

Name (sex)	Patient or parent?	Experience of testing?
1. **Frankie (F)**	Parent	Ultrasound only
2. **Sarah (F)**	Parent	Ultrasound only
3. **Jess (F)**	Parent	Ultrasound only
4. **Martha (F)**	Parent	Ultrasound only
5. **Katie (F)**	Parent	Ultrasound and MSS
6. **Jo (F)**	Parent	Ultrasound only
7. **Liz (F)**	Parent	Ultrasound, MSS and amniocentesis
8. **Rebecca (F)**	Parent	Ultrasound, MSS and nuchal translucency scan
9. **Simon (M)**	Parent	Ultrasound only (partner)
10. **Joan (F)**	Patient (NHS)	NIPD (fetal sex)
11. **Rose (F)**	Patient (NHS)	Ultrasound, MSS and NIPD (fetal sex)
12. **Abi (F)**	Patient (NHS)	Ultrasound, amniocentesis and NIPD (fetal sex)
13. **Jodie (F)**	Patient (NHS)	Ultrasound and NIPD (fetal sex)
14. **Cara (F)**	Patient (NHS)	CVS, NIPD (fetal sex)
15. **Louise (F)**	Patient (private)	NIPT (Down's syndrome – Harmony)
16. **Alana (F)**	Patient (private)	NIPT (Down's syndrome - NIFTY)
17. **Jamie (F)**	Patient (private)	NIPT (Down's syndrome - NIFTY)

Table 2: Patient and parent participants

In addition to the participants interviewed, one parent (a father), two experts (a consultant clinical geneticist and a midwife) and two patients (one mother who had used NIPD for fetal sexing, and one who had used private Down's syndrome testing) were lost to follow-up during the recruitment process. Restricted efforts were made to re-contact these participants by attempting to communicate via only one additional phone call/email,

as it was felt that any further effort to re-contact would risk causing distress or would represent an invasion of privacy. The final proportion of expert and patient/parent experts recruited onto the study was significantly dissimilar to that which had been outlined as ideal within the project protocol, with 56% (n=22) of participants being made up by the expert/professional group and 44% (n=17) being made up by the parent/patient group.

The relatively high number of expert participants recruited onto the study may relate to the significant pace at which NIPD was developing (and the correspondingly intense level of professional interest that the technology was attracting within the field), along with many experts' willingness to discuss their experiences of NIPD and prenatal testing, with many of them expressing how much they had enjoyed taking the time to talk at length with me about this emergent technology. Clear reasons for the contrastingly less prolific recruitment of NHS patients (n=5) are difficult to identify. One possibility is that the participant information sheet, being fairly comprehensive and lengthy (in order to satisfy the requirements of NHS-based research), may have prevented potential participants from feeling willing or able to take part. Another possible reason for low recruitment numbers in this regard is that the subject of discussion – pregnancy and prenatal testing - was simply not one that potential participants felt willing to speak about with an unknown person, and with many of the patient interviews that were conducted prompting significant self-reflection on the part of participants, this may likely be the case. Additionally, only one partner/father was recruited onto the study – this may have resulted from similar concerns regarding the sensitivity of the topic, and could further have resulted from a reluctance to take part because their participation would be known to their partner (and could re-invigorate discussion of the matter between them). The lack of data gathered here concerning the male or partner perspective is unfortunate since the perspective of this group regarding experiences of pregnancy and prenatal testing is known to be under-researched (Steen, Downe et al. 2012).

Conduct of the fieldwork

Fieldwork began on the 15th March 2013, when the first expert interview took place. This phase of the study continued until the end of March 2014, with expert interviews taking place from March to October 2013, 'parent' interviews taking place from June to September 2013, and patient interviews taking place from July 2013 to March 2014. Fieldwork sites were located across England and Wales, and the remote or distant location of a number of interview sites required that I travel significant distance, and stay

overnight in the local area. To ensure safety during the conduct of fieldwork, I familiarised myself with Cardiff University's 'Lone Worker Guidance' and 'Health and Safety in Fieldwork' policies, ensuring that I took every possible step to secure my own safety. Key to this was the communication of my whereabouts to a colleague or other responsible person (close family member) throughout.

Interviews

The majority of interviews were conducted face-to-face (n=36), with the remainder – two private NIPD patient interviews – being conducted over the phone. Interview schedules were designed to assist with the conduct of interviews (see appendices seven and eight for detail) – in practice, however, these were used only as a rough guide to the themes which were to be covered during the interview, and individual questions did not follow a particular order, and were not phrased in any particular way. All interviewees received a copy of the study consent form (see appendix four) prior to meeting with me, and at the outset of the interview we went over the contents together, to ensure that the consent provided was genuine and as 'informed' as possible. In order to gather accounts that were as rich as possible, and in order to gain an understanding of how interviewees' experiences with and reflections on NIPD related to the broader contexts of their everyday professional (and personal) lives, a 'narrative' approach to the conduct of interviews was adopted (Sandelowski 1991). This approach – which required me to minimise my own input to the conversation as much as possible, and which allowed participants to guide the form and structure of the conversation to a significant degree- proved highly successful, with the resulting dataset being rich and diverse.

Although the task of conducting face-to-face interviews often required significant amounts of travel in order for me to meet with interviewees (with the majority of interviews taking place in participants' homes or workspaces), this approach presented a number of distinct advantages. Firstly, I was able to gain some understanding of the locations within which experts (particularly) conducted their daily professional lives, with many of them guiding me around their departments, 'showing' me the objects – next generation sequencers and other laboratory equipment for example – and spaces (laboratories, clinics and offices) that contributed to the shaping of their daily lives. Secondly, by traveling to locations local to them, I was able to spend additional time with participants prior to and after interviews had taken place. This presented the advantage of allowing a greater sense of familiarity to develop between myself and interviewees, with the result that both participants and myself were increasingly 'at ease' throughout the interview process. Telephone

interviews presented a different set of advantages and disadvantages. Whilst they may not have resulted in a similar sense of familiarity and ease being developed between myself and participants, the conversations generated were nevertheless informal, and were particularly direct. The conduct of telephone interviews with private NIPD patients in particular also facilitated the inclusion of this (particularly at the time during which fieldwork was conducted) select group of women within in the study – with interviewees reporting that they felt they were better able to 'fit in' the time for a phone call rather than a face-to-face meeting.

Three 'vignettes' outlining different scenarios within which NIPD may come to be used, were also designed to assist with the conduct of interviews (see appendix nine). This method of qualitative data collection has been previously identified as an effective way of generating discussion on attitudes, perceptions and beliefs, particularly within the fields of social and health research (Hughes and Huby 2002) and within the examination of 'sensitive' topics (Barter and Reynold 1999). The vignettes were designed with the guidance of the clinical supervisor, and they suggested three possible (and feasible) pathways for the future development of NIPD technology: 1) entry into routine Down's syndrome testing as offered within 'high risk' pregnancies only, 2) entry into prenatal screening for Down's syndrome as offered within all pregnancies, and 3) continued entrance and expansion within private prenatal testing services. The vignettes were designed to be useful particularly in circumstances where participants had very little or no prior knowledge of NIPD – with parents recruited through mother-and-baby groups for example. Because NIPD was yet to enter into the routine prenatal testing space at the outset of the study, it was expected that the vignettes would be used centrally within the conduct of participant interviews, in order to elicit discussion of the technology with persons who had no direct experience of the technology – a group that was expected to make up a high proportion of the total population recruited onto the study. However, because I had the opportunity to adapt the study design to attend to the rapidly shifting technological and clinical landscape surrounding NIPD, I was in fact able to recruit a high number of participants who had direct personal or professional experience of the technology, and as a result of this, the vignettes were in fact rarely used during the conduct of participant interviews. Within the vast majority of interviews the discussion of themes and topics that had been outlined in the 'interview schedules' occurred naturally, during the course of on-going conversation. The vignettes proved useful within a small number of interviews however, prompting more lengthy and in-depth discussions of the technology than may otherwise have been possible with participants who had no direct experience of NIPD.

Transcription, follow up and textual data collection.

All interviews were audio-recorded (with participant's prior permission), and were transcribed verbatim. The transcription stage occurred concurrent with the fieldwork, and it also represented the first instance during which formal data analysis was conducted: as transcription progressed (carried out using Microsoft Word) in-text notes and comments were inserted, the contents of which were later used in order to generate a preliminary list of potential themes. Interview transcripts were 'cleaned', primarily to ensure that participant anonymity was maintained – pseudonyms, for instance, were assigned and any potentially identifying information (such as specific locations, names of family members, or diagnoses of rare disease) was removed. Recognising particularly that any discussion of prenatal testing is '*a highly charged one*' (Rapp 1999, p.17) some descriptive information, relating to expert participants' particular professional roles for instance, was generalised to an extent which has minimal impact on the context within which the data is presented, but which maximises the safeguarding of participants' privacy and confidentiality. Where significant pauses or hesitations were present within the audio data, these were transcribed – but in order maintain clarity - and since I am not conducting a discourse analysis, less significant hesitations were removed during the inevitably reductive step of transcribing interview data from audio to text.

Any contact with participants following the interview process has been minimal: although during the interview process I emphasised that participants (particularly parents and patients) would be free to contact me directly with any concerns or queries they may have following the interview, none of them did so. Having prepared relevant material in advance of the fieldwork, I provided information on patient support groups, helplines, relevant clinical contacts and other potential sources of information where appropriate during the interview process. A single private NIPD patient contacted me via email a few days after the interview had taken place, as she felt that she had cut our phone conversation short, and we had a brief exchange of emails within which she raised and answered a small number of additional questions. Contact information has been securely stored (in order to comply with standard archiving procedures – see appendix eleven for detail), will continue to be stored for ten years following completion of the study, and will be used to provide all participants with a summary document at the completion of the study (subsequent to the thesis being examined).

Alongside the gathering of participant accounts of NIPD, I engaged in a parallel process of textual data-collection, assembling a large number of media reports, scientific publications and (online) information regarding commercial testing. A 'Google Alerts'[32] system was set up at the beginning of the project, in order to identify new information published online in relation to the following terms/phrases: "cell free fetal", "non invasive prenatal diagnosis", "non invasive prenatal testing" "NIPD" and "NIPT". This method of gathering data was particularly effective in the first year of the study when NIPD remained an emergent and little-discussed technology. Much of the material gathered in this way related not to the direct clinical or scientific development of NIPD, but to the numerous global markets within which the technology was entering. The year-on-year volume of material gathered through this strategy has increased greatly over the course of the study. In addition to this, I conducted regular web searches in order to identify newly published material on NIPD, using search engines as well as social media to gather information around the on-going development of the technology. Having presented work at various conferences, and having become embedded within the field to some degree, much information was volunteered to me by contacts working in the field of NIPD and prenatal testing more generally. The resulting dataset is vast, and diverse, and is drawn upon throughout this thesis to inform and contextualise the analysis of participant accounts.

Reflections on the fieldwork: practical and ethical issues

Interviews conducted with patients and parents, the majority of which were conducted in participants' homes, generated extremely rich, and often lengthy accounts. Within her reflective account of conducting in-depth qualitative interviews with other women, Finch points towards the relative ease with which female researchers may be able to gain access to such accounts:

> In the setting of the interviewees own home an interview conducted in an informal way by another woman can easily take on the character of an intimate conversation
>
> (Finch 1993, p.74)

Interactions between interviewees and myself, positioned in these cases as researcher, stranger and *'friendly guest'* (Finch 1993, p.74), produced some of the most engaging and challenging fieldwork experiences encountered within the study. Every patient and

[32] The 'Google Alerts' system (https://www.google.co.uk/alerts) allows registered users to 'track' online information associated with particular terms or phrases. Summary emails containing information on all material gathered may be received hourly, daily, or weekly.

parent interviewee welcomed me warmly into their homes - I was given tea and coffee, and with many participants realising I had travelled some distance, many of them offered me food, gave me recommendations of where I might otherwise eat and drink, and drove me back to my onward transport or accommodation. The openness with which many participants approached the interview process also entailed that the interview space was very often shared by other family members. Babies and young children were frequently present, and with many of them having been born as a result of the pregnancies that NIPD (or other forms of) testing - the central focus of our conversations - had taken place within, their presence prompted much, and at times difficult, emotional reflection on the part of interviewees.

The emotional impact of these and other reflections varied according to the specificities of participants' experience – memories were at times affirmative – with parents recalling the benefits of reassurance that testing had provided them with during pregnancy, and speaking warmly of clinicians who had helped guide them through their experiences of 'risky' pregnancy. Such discussions also prompted the revisiting of more difficult memories however, with interviewees turning their minds back towards experiences of testing – and associated points within their pregnancy – where the future health or continued existence of the child that was now with them had perhaps been uncertain. The 'consenting' process was treated as an on-going rather than a discreet form-filling activity, and as such if participants expressed distress or discomfort at any point during the interview, I took steps to ensure that they were actively willing to continue – giving them time to calm their nerves, and explaining once again that we could stop the interview process at any time. Information on relevant support services was offered in such circumstances, but was rarely, however, accepted. Most participants declined to receive any further information subsequent to the interview, explaining how they felt that the process of talking through their experiences – of having someone listen without criticism or question – had indeed raised difficult memories and emotions, but would, they felt, be beneficial in the long term. It has been suggested the qualitative interview space may function as location, not only for research, but as a kind of therapeutic or 'counselling' experience, as approached by the interviewee:

> Some aspects of qualitative research interviews are strikingly similar to aspects of therapeutic interviews. For example, empathy and listening skills are emphasized as being important for both research interviews (particularly qualitative interviews on sensitive topics) and for counseling or therapy interviews.
>
> (Dickson-Swift, James et al. 2006, p.858)

Although I had not fully expected the interview space to function so clearly as a 'therapeutic' space prior to the fieldwork being conducted, the perspective outlined here - which acknowledges the blurring of the boundaries between 'research' and 'therapy' - helps to explain the context within which many patient interviews came to be approached. Many interviews (with patients especially) did indeed function as a location within which participants were able to talk at length about something that mattered deeply to them, and to someone who very actively wanted to listen. A number of interviewees explained that during the course of the interview they had spoken with me about 'difficult' events that they had never (or very rarely) openly discussed with either friends or close family members. Although one of the major differences between the therapeutic and the qualitative interview space is that *'in the former, the therapist is listening to the participant and helping that person, whereas in the latter, the participant is helping the researcher by providing information'* (Dickson-Swift, James et al. 2006, p.859) and although this was, of course, very much the case here – the success of my research depended on the gathering of rich participant accounts - interviewees (including experts and professionals) very frequently expressed gratitude for being given the opportunity to talk about their experiences, and although it was important, for instance, not to overstate the potential therapeutic benefits of participation within study documentation sent out before interviews were conducted (in the Participant Information Sheet for example, see appendices five and six), by the conclusion of the fieldwork stage it had become clear that many interviews did indeed present some level of *'therapeutic payoff'* for many participants.

As mentioned, the majority of patient and parent interviews were conducted in participants' homes, very frequently with young children present. On a number of occasions other family members (partners and parents) also made themselves present, intermittently, throughout the interview process. This represented a significant challenge to the ongoing conduct of fieldwork, as many of the conversations held between interviewees and myself were both highly sensitive, and deeply personal. Very often these family members were actively interested in the conversations that they perceived we were engaged in, asking questions about the research project (and in the case of families where rare disease had been diagnosed – asking whether I knew of any potential future therapeutic interventions), and offering opinions on NIPD and prenatal testing. My priority within such situations however was the safeguarding of participant privacy and confidentiality. In order to maintain confidentiality I paused interviews as family members entered a room, and I spoke with them separately (as much as possible) about their particular questions and concerns, answering them to the best of my ability whilst

stressing the limitations of the research at hand, and trying to avoid covering any topics that might come to influence the remainder of the interview at hand. Within the majority of circumstances any audio recording of such moments that had been collected was disregarded during the transcription process, with concise notes being made on the general topic of conversation, rather than a verbatim textual account being generated. In certain instances the interviewee actively invited their partners into the conversation, and as such partner responses were transcribed, with the proviso that steps were taken to completely anonymised the data (I explained once more to these partners that the conversation was being audio-recorded, and they consented to the transcription process at the time of interview). Whilst the unexpected presence of partners and other family members represented a challenge to the conduct of fieldwork, it also presented a valuable opportunity to gain further insight into participants' experiences of testing, and a number of such instances are highlighted within the analysis presented here.

A number of patient interviews covered particularly 'sensitive' topics of discussion, with interviewees becoming visibly upset at intermittent stages throughout the interview process. Whilst I was well prepared for the task of managing interviewee safety and wellbeing, and although I had considered the potential impact that the conduct of research may have on my own wellbeing in advance of fieldwork taking place, I was perhaps not fully prepared for the emotional impact that the experience of so actively listening to these 'difficult' accounts would have. I found, for instance, that for a number of the most 'difficult' or 'sensitive' interviews I delayed the task of transcription. Once I engaged in the transcription (and analysis) process I did indeed find the task of repeatedly revisiting interviewee accounts of illness, testing, pregnancy and abortion was an emotional one – having spent several hours with such participants, attending to some of the most intimate details of their lives, I experienced a deep and ongoing sense of empathy towards them. The guidance of my supervisors – both academic and clinical – was invaluable at this stage, and although such accounts were practically and emotionally challenging, they emerged as particularly valuable within the context of the dataset as a whole, as they provided particularly rich and detailed illustrations of the patient experience.

Throughout the course of this research, contact with the field of clinical genetics, and with professionals involved in providing genetic counselling in particular, has been consistent. Professionals from within the field of clinical genetics were closely involved in the original research design, contributed to the process of clinical supervision and became key clinical contacts in the field. A significant number of the expert interviews that came to be conducted were with professionals working within clinical genetics (n=7), and as NIPD

technology continued to emerge as relevant within this field, I became familiar with the growing body of literature published within professional journals (de Jong, Dondorp et al. 2010, Hill, Finning et al. 2011, Lewis, Hill et al. 2012b, Lewis, Hill et al. 2014a) and other spaces within which the genetics' professional's perspective was highlighted (Stoll 2013, Resta 2015). In addition to this I was involved in teaching (on bioethics) as part of the Cardiff University MSc genetic counselling course, and I spent four days each year attending a residential ethics course with MSc students. Taken together, all of this activity contributed to a strong sense of 'familiarity' with the field of clinical genetics and genetic counselling. To some degree at least I had become 'enrolled' within this space, and had become acquainted with – and at times had adopted – the language of clinical genetics, speaking perhaps of 'termination' rather than 'abortion', 'fetuses' rather than 'babies', and being familiar with concepts such as 'non-directiveness'[33] from the outset. As analysis of interviews with genetics professionals progressed I made concerted effort to 'distance' myself from the language, and the normative frameworks, that had become natural within clinical genetics – to re-orientate myself as a critical outsider, rather than a close affiliate.

Analysis of the data

Data were analysed in light of Clarke's postmodern interpretation (Clarke 2003) of the established analytical process of 'grounded theory' (Glaser, Strauss et al. 1968). Traditional 'grounded' approaches to qualitative research stress the active generation of theory through the process of analysis itself, rather than through the strict application of a pre-established theoretical framework:

> Grounded theory is a general methodology for developing theory that is grounded in data systematically gathered and analysed. Theory evolves during actual research, and it does this through continuous interplay between analysis and data collection.
>
> (Strauss and Corbin 1994, p.273)

Grounded theory involves a process of 'coding' data, and subsequently attending to where codes reappear, in order to identify *'plausible relationships'* (Strauss and Corbin 1994, p.280) that may in turn form the basis of an emergent theory. Supplementing this

[33] The field of genetic counselling adopts, explicitly, a 'non-directive' approach towards interaction with patients. This entails offering experts guidance and information, whilst simultaneously adopting a position of emphatic neutrality regarding the decisions or choices a patient/client in fact makes. The concept of 'non-directiveness' has been problematised however, and critical accounts have come from both those approaching the clinical genetics profession from the outside, as well as those working within the field itself (Anderson 1999, Clarke 1991, Farsides et al. 2004, Latimer 2007a)

approach – regenerating and updating it - Clarke describes how, although such traditional forms of grounded theory remain *'epistemologically sound'* – involving an interpretive, constructionist approach - the *'complexities and instabilities'* of contemporary social life demand that a broader, and explicitly post-modern analytical framework is developed. Clarke therefore outlines a revised *'situational'* approach, through which researchers are able to *'draw together'* a range of studies, *'of discourse and agency, action and structure, image, text and context, history and the present moment'.* Working within this broad frame then, interview data were analysed in relation to a range of textual (and visual) data, including media reports, clinical and scientific publications, and advertising material. Such an approach allows for *'thick descriptions'* (Geertz 1973) to be generated, which can then 'situate' the research findings within a broad range of individual, collective, organisational, institutional, temporal, geographical, material, cultural, symbolic, visual and discursive contexts (Clarke 2003, p.554) and assist with the task of *'going from a text to the cultural presuppositions which underlie it'* (Agar and Hobbs 1982). The specific way in which differently-situated data, from different *'registers'* of social life (Latimer 2008a) were analysed and interpreted involved attending to stabilities and instabilities as they appeared and re-appeared within and across these different forms of data, as well as the multiple and competing discourses that were enrolled and enacted. The final analytical 'text' therefore draws from a wide range of registers, which are generated across a range of moments and occasions, and which contribute to the building of a comprehensive – but necessarily partial – form of ethnographic truth (Clifford 1986).

The material collected within the interview dataset as a whole was grouped together into accounts provided by: NHS patients; private patients; parents; NIPD research experts; clinicians and policy makers. The analysis process was conducted iteratively, with themes at first being generated within individual accounts (the transcription process contributed greatly to this stage), being analysed then as they appeared within groups, and finally being considered in relation to one another across the dataset as a whole. This approach provided a rigorous data interpretation, where crosschecks and balances were built into each stage of the analytical process. Analysis was conducted using paper copies of interview transcripts: although the large volume of textual material generated may have lent itself to being managed through a CAQDAS software[34] package (Ritchie, Lewis et al. 2013) (and such an approach was piloted), it was felt that the 'situational' and iterative approach to analysis adopted here was best served by repeated and in-depth immersion in data generated through participant accounts, and that the use of any kind of CAQDAS

[34] CAQDAS refers to a range of software programs that have been designed to assist with the task of qualitative data analysis (www.surrey.ac.uk/sociology/research/researchcentres/caqdas)

software may risk creating some level of 'distance' between the data and the researcher (Weitzman and Miles 1995, p.815).

Data were read and re-read alongside the literature, with the critical analysis of each area informing the other, allowing for the identification of recurrent themes, and the eventual mapping of relationships between them. The theoretical foundations as outlined in chapter one contributed to the specificities of the critical approach adopted towards data analysis, with instances of 'problematisation', practices of 'division', 'moves' and 'translations' and practices of 'sorting' and 'classification' being the subject of particular attention. Within the final crosscutting stage of analysis I was able to attend then to broader processes – the exercise of power and the emergence of 'alignments' – enabling for the identification of connections between the research at hand and the wider sociological and cultural frame.

Theoretical framework: impact on study design and data analysis.

As outlined in chapter one, the theoretical framework adopted within this study draws upon established theories of problematisation (Laidlaw 2014; drawing on Foucault, 2002), division (Foucault 1982), biopolitics and biopower (Foucault 2000b, Foucault 2000c), categorisation and classification (Douglas 1966, Bowker and Star 1999). A perspective that highlights the centrality of processes of enrolment/translation (Latour 1986, Latimer 1995) and questions of relationality (Strathern 1991), is also adopted as part of the framework. Following the work of established scholars, who explicitly recognise the relevance of such literature within the critical examination of practices and technologies of prenatal testing (Lupton 1999, Martin 2010, Lowy 2014, Thomas 2014) a critical awareness of how such processes and questions relate to the sociological study of prenatal testing informed the design and conduct of this study – leading, for instance to the development of specific research objectives that foreground the relevance of 'practical, ethical and social issues' and the 'complexities' of experience (see page 1).

With regards the recruitment of participants onto the study, the aim was to gather a broad range of accounts from those most closely implicated in the design, governance and use of emergent NIPD testing technologies: participants were targeted for inclusion on the grounds that they had experience with NIPD or closely-related technologies, and explicitly *not* because they would be more or less likely to produce accounts that attended to the concepts and questions central to the theoretical framework. Whilst the theoretical framework was set aside with regards this aspect of the study, as the process of data

analysis began the framework became central once more, and emergent themes that related to the concepts and questions central to the framework were attended to closely (as described in the section above).

Summary

This chapter shows how the research at hand has been designed and conducted, and reflects on some of the practical and ethical issues that have been raised during fieldwork particularly. Study design was guided, primarily, by the aims and objectives of the research: to track the development of emerging NIPD technology, to gain an understanding of how those encountering the technology at an early stage of development and 'implementation' understand and interpret their experiences, and to reflect critically upon the 'issues' and 'concerns' that might be raised.

Recognising that the perspectives of women and clinicians in particular would be central, recruitment strategies were designed to target these populations. In order to facilitate the 'tracking' of the technology, a strategy for recruiting experts in the field was also designed. The conduct of the fieldwork involved, centrally, the carrying out of interviews informed by a 'narrative' approach which sought to generate rich and comprehensive participant accounts. Alongside this, a range of textual and visual data was identified and collected, in the form of publications, reports and other relevant artefacts. The transcription of interview data represented the first stage of data analysis, and was followed by a lengthy and immersive process of reading and re-reading data situated across a number of different 'registers'.

The conduct of the fieldwork brought with it a number of practical and ethical concerns, including the conduct of interviews around 'sensitive' topics, the navigation of family members' presence within the interview setting, the need to deal with my own responses to 'difficult' and emotional conversations, and the requirement that I reflect back on my own professional alignments with the field of clinical genetics in particular. The data analysis process was informed by a grounded and postmodern understanding of how to approach differently situated accounts, and involved the examination of data generated from across a range of social registers. Data were analysed 'on paper' with the final 'textual body' (Clifford 1986) being composed as a result of repeated readings of the literature and the eventual mapping and exploration of themes and relationships between them.

Within the remainder of the thesis then, I build upon that which has been outlined up to this stage: drawing from the theoretical foundations, informed by an understanding of how NIPD has come to be situated within the clinic and within larger social and cultural spaces, I examine in detail the participant accounts that have been generated as a result of the study design and conduct outlined here.

Chapter Four. NIPD and NIPT: Divisions and Categorisations

Introduction

This chapter explores questions of how NIPD, as it becomes enrolled and translated - shifting from the laboratory to the clinic, and entering into lived experiences of pregnancy - is being divided, categorised and classified. It explains how various dividing practices, and efforts made to 'sort' NIPD into different types, carry with them a number of important implications. Examining interview accounts alongside data from different registers of social life – including online advertisements and textual and/or visual artefacts - I show how substantive processes of division and categorisation, along with processes of enrolment and translation, achieve tangible outcomes, both practical and rhetorical. I identify the particular divisory and classificatory moves that are made, and examine what such moves accomplish, suggesting for instance that a discursive shift from talk of NIPD to 'NIPT' helps 'smooth' the way for NIPD's translation, allowing specific testing technologies to pass from the research context, and into the routinised world of the clinic. As these emergent NIPD tests are translated within a range of clinical spaces, bringing with them the potential for change and disruption, (rhetorical) work is done to classify and frame NIPD in terms which allow for alignment with the familiar categories of 'screening' and 'diagnosis'. Such alignments, however, are problematised within participant accounts of the technology, with the broad discussion of division, categorisation and classification processes being characterised by a deep sense of ambiguity - cutting across expert accounts in particular - as they struggle to pin down, define and 'fix' this emergent technology.

Talk of numbers, with particular reference to test accuracy, is prevalent here – with the difference between the numerical category of '100%' on one hand, and anything less than 100% on the other, being frequently discussed. A range of scholars have noted the social and cultural significance of numbers-talk, particularly with regards the ongoing development of biologically (and bodily) orientated 'counting technologies' and the subsequent rise of *'the quantified self'* (Lupton 2013). The performative power of numbers, as they become increasingly present within technologically-mediated understandings of the body and the self – allows for their translation into *'potent political and cultural agents'* (Verran 2013, p.28). The political and cultural significance of numbers-talk within the division, classification (and rationalisation) of NIPD is evident within both the accounts generated here, as well as the approaches taken by commercial companies to promote their new non-invasive tests.

Participant reflections on the development and division of NIPD also prompted much critical examination and problematisation of *established* technologies and practices of prenatal testing. As they account for NIPD's 'disruptive' emergence experts suggest here that the division made between technologies and practices of 'screening' on the one hand, and technologies and practices of 'diagnosis' on the other – allowing for avoidance of entanglement with more problematic and contentious issues, such as selective abortion and eugenics, (Duster 1990, Rothman 1994, Clarke 1997, Rapp 1999, Shakespeare 2006) - is tentatively held, and thinly constructed. Drawing on these ambiguous and critical accounts, it is demonstrated that, as a new and emerging technology, NIPD 'troubles' the boundary that has been constructed between 'screening' and 'diagnosis' – destabilising categories that have been repeatedly employed to organise, manage and sort technologies of prenatal testing, and to align them with broader social and cultural norms. Raising both professional and personal anxieties around the potential collapsing of this divide, I show how conversations around NIPD and 'NIPT' begin to prompt renewed and intensified examination and problematisation of routine, normalised and naturalised testing practices.

NIPD as 'not yet natural'

As NIPD reached beyond the research context, and as a variety of tests were developed, marketed, trialed, approved and implemented within a range of clinical spaces, the technology came to enter into the lives of an increasingly broad range of actors. Those who regularly engage with NIPD, in both practical and discursive contexts, now include researchers, laboratory scientists, research managers, clinicians, policy makers and advisors, pregnant women and their families. As they engage with and experience NIPD in multiple and heterogeneous ways, and as they attempt to make sense of their encounters by describing, defining and categorising the tests that they use, each of these groups - as well as the individuals amongst them - contribute to the shaping and constitution of this new and evolving technology.

Despite having been enrolled within a range of social spaces, and despite possessing a history that stretches back at least a decade (see chapter two), NIPD is still very frequently characterised as being a technology that remains in the early stages of development. The Royal College of Obstetricians and Gynecologists (RCOG) for instance, considering possible routes for the 'implementation' of NIPD, and examining the 'ethical issues' raised, presents NIPD as new and problematic, a source of clinical, ethical and policy-related 'challenges': '*This paper reviews the issues that underlie the decisions that maternity services and policy*

makers need to take in response to this new technology' (Soothill 2014). Situated within the context of routine and widespread prenatal testing programmes, and particularly when held in comparison with other prenatal testing technologies – such as ultrasound or amniocentesis – familiar and trusted objects that have been 'in the clinic' for decades, NIPD continues to be framed as a new arrival in the field, widely characterised as a technology that has not (yet) become 'routine', 'normal' or 'natural'.

As early encounters with and conversations around NIPD play out, a shifting set of understandings - of how the technology can be defined, how it can be divided, what kind of information it generates, what kind of 'issues' it raises, and what broader social and cultural meanings it carries - are being generated, questioned, contested and examined. The presence of particularly ambiguous and critical characterisations during the emergent stages of a technology's development has been well documented within the literature addressing technologies and their classifications. As Bowker and Star explain, those who encounter and examine technologies at the point where they begin to spread out – as they become translated within the social world, and acquire new social and cultural meanings - are able to highlight some of the more contingent aspects of development that, through processes of 'sorting' and ordering, may eventually come to be rationalised, 'contained' and forgotten:

> The more naturalised an object becomes, the more unquestioning the relationship of the community to it; the more invisible the contingent and historical circumstances of its birth, the more it sinks into the community's forgotten memory.
>
> (Bowker and Star 1999, p.299)

With fieldwork taking place at a point in time during which NIPD had not yet become 'routine' or 'natural' within many of the spaces and contexts it was being translated within, the technology was frequently characterised as being new and exiting, alien and untrusted. The deeply ambiguous and shifting perspective that was adopted by David (a clinical geneticist who also contributed to the work of a number regulatory and advisory bodies), for instance, points towards a deep vein of doubt and uncertainty within the discussion of NIPD during this 'pre-naturalisation' stage. Reflecting on how the technology may come to be positioned within the field of fetal medicine and/or within routine prenatal care, David characterises NIPD technology as something that holds both 'routine' and 'revolutionary' potential:

> 'it's much less of a leap than the introduction of amniocentesis'

> 'there is nothing to stop it, very rapidly, giving much, much more information'
>
> 'you could imagine, in a society with a well funded system, that within five or ten years you could have virtually no children with chromosomal anomalies or recessive disease'
>
> (David, consultant clinical geneticist)

As David explored his thoughts and reflections on NIPD across the space of the interview, his characterisation of the technology was gradually transformed. Approaching the development of NIPD as a relatively benign occurrence at the outset, as he discussed the possible translation of the technology within the clinic - situating it within the context of a 'society' likely to capitalise on the large volume of information that may be produced, by the end of his account a significant 'move' is made, with NIPD emerging as a technology that holds the (potential) power, not only to impact on individual experiences of pregnancy, but to transform whole populations – '*you could have virtually no children with chromosomal anomalies or recessive disease'.* As a subject of significant concern, reflection and uncertainty then, within David's account (and within many more accounts that are presented here) NIPD's emergence is fundamentally and thoroughly problematised.

From NIPD to 'NIPT': a shift in language

As NIPD expands out in both social and technological terms – as different types of test are translated within a range of spaces - the process of defining, categorising and classifying the technology becomes increasingly complex. The complexities of NIPD's development and translation to date has given rise to an evolving set of descriptions and labels, which are both used to refer to the technology at large, and to describe particular types of test and/or their application. During the early stages of development (and at the outset of this study) the terms 'non invasive prenatal diagnosis' or NIPD could reliably be used to refer to and describe the technology at hand. However, as various divergences in the trajectory of NIPD's development have taken place, and as NIPD has entered into, and become increasingly familiar within a number of different social spaces - being subject therefore to 'local translations' - a far broader range of descriptors has emerged. A diverse range of terminologies and acronyms are now present within the public discussion of NIPD (and within participant accounts examined here). Common descriptors now include: 'non-invasive prenatal testing' ('NIPT'), 'non-invasive prenatal screening' ('NIPS'), 'high accuracy screen', 'harmony', 'panorama', 'nifty' – and each of these are present within the interview data gathered here. Although a wide range of descriptors have emerged, the most notable and persistent shift to occur within the scientific and professional literature

– and within the accounts examined here - has been a gradual but very clear and consistent move away from talk of NIPD and towards increased talk of 'NIPT'. 'NIPT' rather than NIPD has, progressively, been adopted as the standard descriptor within more recent scientific publications (Bianchi 2012a, Agarwal, Sayres et al. 2013, Allyse, Sayres et al. 2013, Curnow, Wilkins-Haug et al. 2015, Bianchi, Chudova et al. 2015a, Chitty 2015b), media reports (Hughes 2015, Cooper 2015a) and sociological and bioethical discussion (de Jong, Maya et al. 2015, Deans, Clarke et al. 2015, Munthe 2015). Talk of 'diagnosis' has then, in many instances, been replaced with talk of 'testing'.

The shift in focus from NIPD to 'NIPT' can be traced back within this public discussion of NIPD, to a clear point of divergence in the trajectory of research, and the eventual translation of this into the clinic. Subsequent to the publication of proof-of-principle papers demonstrating that testing for Down's syndrome would be possible via analysis of cffDNA, the major focus of research around NIPD (particularly within the commercial context) became Down's syndrome testing, rather than testing for fetal sex or rare single-gene disorders. During the early stages of this research, the NIPD description remained fairly stable, and the technology was still discussed in terms of diagnosis, or with reference to the potential for diagnosis. However, upon the publication of a first wave of clinical studies assessing the performance of NIPD tests for Down's syndrome amongst the pregnant population (Nicolaides, Syngelaki et al. 2012, Beamon, Hardisty et al. 2013, Chetty, Garabedian et al. 2013, Jackson, Dever et al. 2013, Fairbrother, Johnson et al. 2013a, Fairbrother, Johnson et al. 2013b), the use of the term 'NIPT' gained significant momentum. Although the specificities of testing – the accuracy figures produced, the timing of the testing during pregnancy and the methods employed – quoted within such studies are closely comparable to those published in research papers on NIPD for Down's syndrome, the emergence of these studies shifted the context of discussion significantly, with this body of work containing little to no talk of either NIPD or 'diagnosis'. The division of the technology into two distinct streams – NIPD and 'NIPT' - became increasingly commonplace, and as the technology continued to gain momentum in the clinic, this divisory process became increasingly visible.

The mainstream public presentation of the technology in the UK - through spaces such as the RAPID project website for instance - very clearly divides the range of tests that are now available into two distinct categories of NIPD and 'NIPT':

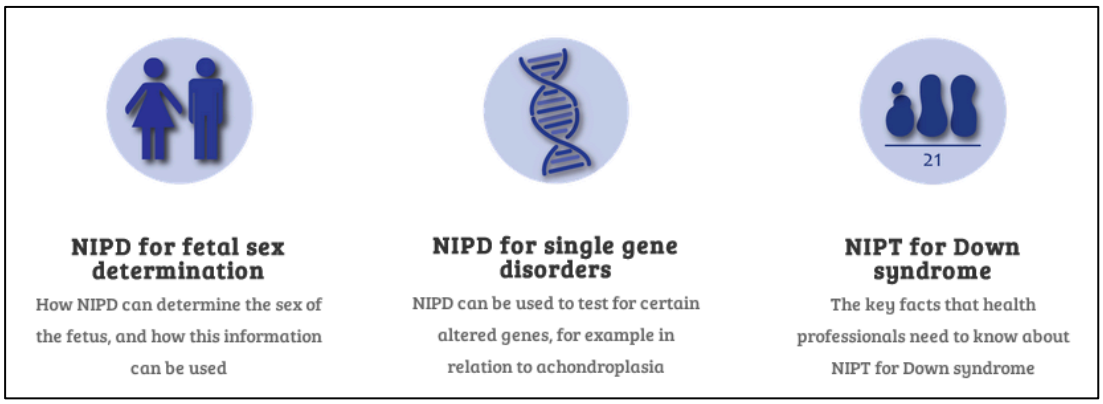

Figure 7: Image from the RAPID project website

The explicit and persistent division of the technology into NIPD and 'NIPT' within this image (and within the discussion at large) is a significant classificatory move – it contributes to the sorting and objectification of the technology – and is boundary-making. Within this emergent categorical system then, NIPD is used to refer to tests for fetal sex and single gene disorders, and 'NIPT' is used (primarily) to refer to tests for Down's syndrome. Accordingly, talk of non-invasive 'diagnosis' becomes limited to the discussion of how testing has been translated within specialist clinical contexts – spaces such as fetal medicine and clinical genetics - where tests for fetal sex and single gene disorders are used for 'targeted' testing within pregnancies that have been defined as 'high risk'. Spaces are forged then for both NIPD and 'NIPT', through their respective classification as tools for diagnosis and tools for screening, to become enrolled and translated in the clinic.

NIPD to NIPT: the shift from diagnosis to screening

The clear division of NIPD from 'NIPT', the location of this division as being centered around Down's syndrome testing particularly, and a reluctance to attach a label of 'diagnosis' to the emerging tranche of (commercial) Down's syndrome tests, was very clearly articulated within accounts given by many expert interviewees here. As I raised the recent move from NIPD to NIPT with Emily for instance (a researcher closely involved in the UK based development of NIPD) she explained how she regarded this shift as being related very directly to the accuracy of test results and the corresponding categorisation of specific test applications:

> *So I've noticed the fairly recent change from NIPD-*
>
> (laughs) yep. Um well, NIPD is diagnosis, and I think that's still valid for single gene disorders because it will be a distinct diagnosis of a condition, it will be a clear yes or no answer. But with the aneuploidy, people are very reluctant to say it's a diagnosis, because the test is, it's 99% accurate

> but it's not 100% accurate, so they are much more hesitant to actually say diagnosis.
>
> (Emily, NIPD researcher)

Accounts such as that provided by Emily suggested that the categorisation of new Down's syndrome tests as being appropriate for 'NIPT' rather than NIPD was due to the perceived (relative) inaccuracy of this group of tests. The presence of small 'false positive' and 'false negative'[35] rates, which entail results that are not '*100% accurate'*, prevent such tests from smoothly entering into the category of 'diagnosis'. Such accounts suggest that *any* margin of error – however small (*'it's 99% accurate'*) - acts as a barrier to the enrolment and translation of these new Down's syndrome tests within the 'diagnostic' class.

Echoing such accounts, critics and commentators have repeatedly suggested that the successful development of 100% accurate NIPD tests for Down's syndrome is unlikely to ever materialise (Zhou, Liang et al. 2013, Neufeld-Kaiser, Cheng et al. 2015, Wang, Sahoo et al. 2015, Bianchi 2015b), due to a range of '*technical issues'* including *'early gestational age… maternal obesity…multiple pregnancies… placental mosaicism… and maternal conditions'*[36] (Soothill 2014, p.4 - 5). The widespread realisation that non-invasive tests for Down's syndrome were unlikely to produce 'fully diagnostic' results – which could claim to be 100% accurate - may have acted as a barrier to the continued development of testing, if this were the *only* form of testing that would allow for the successful translation of the technology. Despite the technology being subject to such intense and detailed scrutiny, the unsettling presence of small but significant margins of error, did not, however, prevent such tests from entering into clinical practice. Rather, as made evident in the accounts presented here, it altered the *descriptions* that were used to refer to specific categories of testing, and shifted the specific pathways such tests would come to

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[35] The 'false negative' rate refers to the number of diagnoses that are present in a population, and that are missed by screening. The 'false positive' rate refers to the number of diagnoses that are falsely made by any given screening test. In the majority of circumstances false negatives incite greater anxiety than false positives, as this means that the disease screened for (such as cancer) may go untreated. Within the prenatal testing context 'false positives' incite greater anxiety as these may lead to the abortion of 'healthy' and not 'affected' fetuses.

[36] Because successful NIPD testing depends upon there being a certain proportion of cffDNA in the maternal blood, and because this material increases with gestation, if testing is carried out at too early a point in pregnancy NIPD may fail to produce results. Maternal obesity is thought to affect testing similarly, as the proportion of maternal DNA remains higher for longer. The presence of a tumour can also affect test accuracy as they release fragmented DNA in a similar fashion to fetuses, and multiple pregnancies can entail that testing is inaccurate for individual fetuses. Because the DNA is in fact placental in origin, 'confined placental mosaicism' – where the placenta possesses a trisomy and the fetus does not, can also lead to discordant results.

take[37]. By publically and purposively framing the technology in terms of 'testing' rather than 'diagnosis' - by dropping the label of NIPD and speaking only of 'NIPT' - a (lucrative) space opens up for the technology (and its commercial applications) to be translated within: tests that are less than 100% accurate, but that produce results that reach ever-closer towards the upper end of such limits become highly 'useful' within spaces where population-wide screening (and not diagnosis) is the matter at hand.

This new orientation towards practices of prenatal screening, particularly as it is focused around testing for Down's syndrome specifically, entails significant implications. Screening for Down's syndrome has been routine within the UK since the late 1980's (Cuckle, Wald et al. 1984), and is integral to standard prenatal care within a large number of healthcare systems worldwide (Chadwick, ten Have et al. 1998, Reid, Sinclair et al. 2009) . 'NIPT' tests for Down's syndrome were not simply made 'useful' for 'screening' and not 'diagnosis' as a result of inaccuracies, but because they tested for a disease – a syndrome – that was already the subject of routinised, normalised population-wide prenatal screening programmes. The possible application of NIPT for Down's syndrome within the prenatal screening context not only allows entry into the clinic at an earlier point than would be possible if 'diagnostic' levels of accuracy were required then, it also opens up the possibility that a far greater proportion of the pregnant population may come to encounter, and use, the technology. Recognising the significance of this move, a number of professional associations and advisory bodies - including the NHS Fetal Anomaly and Screening Programme (Fetal Anomaly Screening Programme 2015), the Royal College of Obstetricians and Gynecologists (Soothill 2014), the (American) National Society of Genetic Counsellors (Devers, Cronister et al. 2013), the American Society of Human Genetics (ASHG) and European Society of Human Genetics (ESHG) (Dondorp, de Wert et al. 2015) - began to engage in conversations around NIPD (and mirroring the scientific, clinical and commercial presentation of the technology, they too consistently adopt the term 'NIPT' and not NIPD).

If analysis were limited to the mainstream public discussion of the technology then the observed shift from NIPD to 'NIPT' may appear as linear and complete. There has been no explicit acknowledgement or discussion of this alteration in language, and the entry of 'NIPT' into conversations around the technology, and the effective division of NIPD into

[37] The translation of commercial Down's syndrome into 'routine' clinical spaces was swift. Shortly after the publication of a paper reporting on test accuracy within a 'routinely screened' population (Nicolaides et al. 2012) – for which UK patients had received discounted NIPD Down's syndrome testing on a research basis – the Fetal Medicine Centre in London became the first clinic to offer NIPD for Down's syndrome, in the form of Ariosa Diagnostics' Harmony™ test.

two separate streams, has prompted very little critical commentary or analysis from outside the scientific community to date[38] . Fieldwork commenced approximately four months after the initial introduction of 'NIPT' testing for Down's syndrome within private UK clinics – and as interviews continued over the course of the next year, the number of clinics offering NIPT within the UK steadily increased in number. This shifting clinical context greatly informed expert participants' discussion of NIPD as questions and concerns regarding the shift from NIPD to 'NIPT' were actively explored (and problematised). Within the conversations that ensued, a range of interrelated themes were explored, including: the accuracy of tests; the categorisation/classification of tests; the positioning of tests in relation to established technologies; the division of 'screening' from 'diagnosis', and the practical impact of such issues on counselling and the communication of test results. The accounts presented here explore and problematise the technology's emergence and early translation into the clinic in two distinct ways. Firstly the accuracy of new NIPD (and NIPT) tests is questioned, with particular reference to the significance of numbers, and the division that is made between 100% accuracy on the one hand and anything less than 100% on the other. Secondly, the seemingly-simple shift in language from NIPD to 'NIPT' is examined, with participants presenting both optimistic accounts of the technology, making effort to align it with current testing practice, and presenting critical and dissenting accounts, that in turn shed light on substantive processes of division, classification and categorisation, and point towards what ends such processes may achieve.

Troubling boundaries: technological comparisons and the problematisation of accuracy

Accounts of how new non-invasive tests for Down's syndrome might be categorised, and how these emerging tests may come to be positioned within the context of current (routine) Down's syndrome screening practices in the UK, were frequently interpreted in light of comparisons with well-established prenatal testing technologies such as ultrasound, maternal serum screening, amniocentesis and CVS. These technologies were highly familiar to expert interviewees - having been part of routine clinical practice for many years, from their professional perspective they had become 'naturalised' - and when contrasted with NIPD particularly, it became clear they had lost their '*anthropological strangeness'* (Bowker and Star 1999). Again in contrast to NIPD, the clinical application of these technologies had already been the subject of comprehensive processes of

[38] Questions regarding NIPT test accuracy have been explored in a handful of blog posts published from within the genetic counselling community (Stoll 2013, Daley 2014)

standardisation and regulation - their position within the clinic, and their respective classification within categories of 'screening' or 'diagnosis' appeared, within the vast majority of accounts, as secure and undisputed. Comparing NIPD directly with these established tests and technologies, interviewees explored possible points of entry into the clinic for this novel technology, reflecting on the possible future classification and categorisation of these emergent and relatively unfamiliar tests. Such comparisons typically focused in on the test's accuracy over and above all other concerns. David for example raised questions around NIPD's accuracy, and its corresponding position in the clinic, with explicit reference to comparisons with previous technologies:

> *Does NIPD strike you as similar to previous prenatal technologies? Or is it different somehow*?
>
> Well it's much less of a leap than say, the introduction of amniocentesis was, you know, before which there had been nothing, effectively. And of course ultrasound wasn't really around at that time either, not effectively. But it's clearly different than anything that's gone before. It's difficult to compare them, it's obviously less of an impact than the very introduction of any prenatal diagnosis, obviously that has to be the biggest leap doesn't it. I suppose it's a bigger step, you feel that its more reliable and it's sort of putting on a firmer footing than, say the Alfa fetal protein and other serum maternal blood tests. Those, the maternal biochemistry based tests, are risk modifying, rather than risk-determining type tests. Whereas NIPD firms that up hugely, and is putting reliability up towards the reliability that you'd get with amniocentesis and CVS. So within the maternal blood-sampling category of tests its enormously improving it's reliability.
>
> (David, consultant clinical geneticist)

After a range of comparisons is drawn between NIPD and other already-routine prenatal testing technologies, these emergent tests are eventually placed in a '*maternal blood sampling category'*. This particular classification positions the technology within the 'prenatal screening' context, to be used for the identification (or *'modification'*) of '*risk*', rather than for the generation of a concrete diagnostic result that possesses the power to confirm or deny the presence of disease or disorder. It is simultaneously recognised here however, that the positioning of NIPD alongside routine '*risk modifying'* blood tests, rather than *diagnostic* tests (amniocentesis and CVS), may in fact be problematic. NIPD is described here as achieving a '*firmer footing'* than any previous blood testing technologies, with the appearance of its greatly-increased accuracy, and its corresponding '*reliability*' suggesting that NIPD may not so easily be placed alongside established technologies of screening. An alternative characterisation of NIPD - as a technology that, once placed within their confines, 'troubles' established boundaries – shifting away from the screening ('*blood sampling'*) category, and inviting closer (but not exact) comparison with diagnostic tests, starts to surface. Accordingly, the clear division that has been made between technologies of 'screening' and 'diagnosis', a process which had resulted in the

rationalisation and ordering of testing as it appears in the clinic, begins to destabilise. Such disruptions – the 'troubling' of these boundaries - are far from benign as they carry the possibility that practices attached exclusively to diagnosis – such selective abortion – may, with the advent of NIPD, come to align themselves with practices of 'screening' too.

Questions regarding the accuracy of tests - involving close examination of the rates of false positives and false negatives that were being generated (the 'sensitivity' and 'specificity' of the tests[39]) - were explored within many other expert interviews. The close examination of test accuracy contributed to processes of sorting, and the classificatory positioning of NIPD, as well as the on going questioning of NIPD's orientation in relation to established technologies and practices of 'screening' and 'diagnosis'. Questions of whether NIPD tests were *'accurate enough'* to be placed in 'diagnostic' categories, and if not, how they might come to achieve this, frequently played out within experts' accounts of the technology's emerging position within the clinic.

> And then there is the issue of accuracy, and what do you do? Where do we put the test? You know, do we do this as a first line test for everybody? And I think if it comes back as- I mean it's giving a risk essentially, it's trying to be a diagnostic test, but it's not accurate enough.
>
> (Erica, clinical geneticist)

Within such accounts NIPD technology was framed in terms of possessing a particular intended trajectory; that of eventually achieving entry into the category of 'diagnosis'. It was suggested that, despite having successfully entered into the clinic as a *'high level screening test'* (a category that was emerging alongside 'NIPT'), an underlying desire to produce *'100%'*, technically 'perfect' results, which could in turn generate categorical, diagnostic – and crucially not *'risk'* based - information, remained present. Reflecting on the move that had been made from NIPD to 'NIPT', Laura (a researcher involved in the UK based development of NIPD) accounted for this shift by raising talk of test accuracy, and imagining a future for the technology that would allow, eventually, for complete diagnostic accuracy to be achieved:

> *And I've noticed recently there's been a shift from talking about NIPD to talking about NIPT, what do you think-*
>
> So that stems from the fact that it's not considered a diagnostic tool in certain cases. So obviously with the Down's syndrome test, because it doesn't have a 99.9% accuracy rate at the moment it's still considered a high level screening test, and if the test did show that the fetus had the

[39] 'Sensitivity' refers to the proportion of patients (or test results) where disease is correctly diagnosed. 'Specificity' refers to the proportion of patients (or test results) where diagnosis of disease is missed (Mallett 2012).

> condition they would still recommend that you had invasive testing to confirm the result. And for that reason they don't want to call it a diagnostic result. So that's why they are calling it NIPT. And then people call it the harmony test because that's what it's called if you offer it privately.
>
> *So you envisage that NIPT may turn back towards NIPD at some point on the future?*
>
> Yeah. Ultimately you want it to be a diagnostic test because you want to eradicate the need to have invasive testing.
>
> (Laura, NIPD researcher)

Laura's optimistic and hopeful account of NIPD's continued development nevertheless provides a description of the technology which highlights that, at this stage of entry into the clinic, tests for Down's syndrome were being used tentatively, with further invasive testing being required in order *'to confirm'* results that suggest Down's syndrome is present. Crucially, the testing remains one step away from experiences of abortion in such circumstances, with 'positive' results being used only to guide decisions regarding further invasive testing, and not to legitimate direct access to abortion.

Accounts of whether NIPD was in fact likely to produce 'perfect' results which would enable the technology to be treated as diagnostic, varied greatly, with individual perspectives regarding questions of accuracy being shaped by the broader context of interviewees' professional identities. Within his work examining the clinical uptake of pharmacogenetic testing, Hedgecoe (Hedgecoe 2008) has shown how experts' refusal to use any particular type of testing may be understood as relating more closely to a lack of 'usefulness' rather than to any process of 'resistance': experts negotiate the 'usefulness' of specific tests by taking into consideration a range of features, including '*knowledge, the differing interests of clinicians and researchers, how context influences the value of tests' accuracy, the economic aspects of such tests and general cultural aspects of the clinic'* (Hedgecoe 2008, p.2). This characterisation of expert approaches towards novel (clinical) testing technologies plays out clearly within the expert accounts gathered here. Specific descriptions of the technology's 'usefulness' were presented in light of professional understandings of what might be required for the technology to achieve successful categorisation as a 'diagnostic' test, both in terms of technical standards (sensitivity and specificity etc.) as well as more direct practical achievements that would allow for translation into the clinic. Accounts provided by experts closely aligned with the

laboratory-based aspects of testing - those with a cytogenetics[40] background for instance - tended to characterise NIPD as a promising tool for screening, but one that would remain unable to achieve standards of accuracy sufficient to allow tests to be categorised as 'diagnostic' according to their terms. Comparing NIPD with technologies that were, within this context, everyday and highly familiar objects (amniocentesis and CVS), NIPD was framed as a technology which possessed inherent, unavoidable and perpetual limitations:

> *There's been a shift towards NIPT. What do you think that-*
>
> Because it's never going to be a diagnostic test. And I actually feel that it will probably never be a diagnostic, because of the cell type that you are looking at and, what you- you know I think it's just with the cell type you are looking at, you are never going to be 100%.
>
> *Um, no tests are 100% are they?*
>
> Yes, if you have an amniocentesis. It's a diagnostic test. A CVS is a diagnostic test as long as you look at the cultures as well. So they are diagnostic tests.
>
> *And they are 100% reliable?*
>
> Yeah.
>
> (Alison, cytogeneticist)

Alison divides prenatal testing technologies (generally speaking) into two very separate categories, drawing particularly here on the persuasive and symbolic power of numbers - NIPD fails to become 'useful' for Alison specifically because it is *'never going to be 100%'*. Firstly, it is suggested that complete diagnostic reliability – 100% accuracy – can be achieved, and Alison makes effort to 'clarify the facts' here, stressing that both amniocentesis and CVS tests can and do in fact achieve complete diagnostic accuracy (as the category is constructed here). In order for emergent NIPD tests to be categorised as 'diagnostic' within such an account, they must produce results that achieve comparable levels of technical excellence, providing complete, 100% reliable (and therefore diagnostically accurate) results. Anything less than 100% accurate - including NIPD – may not be classed as diagnostic on such an account. As Alison highlights NIPD's lack of 'usefulness', the technology is 'disposed' of and marginalised, separated from the mainstream. To support this divisory move, Alison not only underlines the persuasive power of numbers, she draws from her expert (cytogenetic) knowledge, pointing towards NIPD's problematic reliance on certain fallible *'cell types'*, mobilising them within her (boundary-making) description of NIPD's failure here. Alison's particular professional

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[40] Cytogenetics refers to a branch of science *'that links the study of inheritance (genetics) with that of cells (cytology), [being] concerned mainly with the study of the chromosomes, especially their origin, structure, and functions'* (Martin 2015)

identity contributes to her characterisation of NIPD as being subject to significant limitations, and her closeness to the laboratory context brings with it a highly critical perspective on the fine-grained performance - the '*sensitivities and specificities*' - of emerging 'NIPT' tests.

Critical focus on the small-but-significant limitations of NIPD appeared repeatedly across the dataset, being raised as a potential source of concern within accounts provided by interviewees from a broad range of professional groups, including those positioned much closer to the translation of testing within clinic (and further from the lab). Suggesting then that that the impact of issues around NIPD test accuracy were unlikely to be limited to the lab, or to discussions relevant to the research community alone, a critical awareness of these '*limitations*' allowed interviewees to present particularly *'sceptical'* and dissenting accounts of NIPD's translation into the clinic. Discussions around test accuracy provided a space for dissenting interviewees to highlight their perceptions of the *'issues'* they felt were being raised by NIPD's early and *'problematic'* entry into the clinic. Informed by their professional identities, and their closeness with clinical encounters involving prenatal testing, they were able to point towards the potential impact such limitations may have on the women who would come to use the tests within pregnancy. As I asked Rachel, a genetic counsellor, about what she thought the shift in language from NIPD to 'NIPT' might signify, aware of some of the *'problems'* that UK based NIPD researchers had faced – '*certain results have bitten them on the bum'* - she pointed towards the centrality of *'issues'* around test accuracy*:*

> *There's been a move from calling it NIPD to NIPT, what do you think about that?*
>
> Well I think that's quite interesting and I think that's because um, certain results have bitten them on the bum. Because the test is limited, the test can throw up issues, you know.
>
> *At what point do you think, how will it become a robust enough test-*
>
> I think it's experience. Before I did this job I was a clinical scientist, I worked in a cytogenetics laboratory. So from a professional point of view I have a lot of experience of when tests throw up results that are problematic in interpretation… So it's not surprising that sometimes, I would imagine, and from the evidence I've seen in the literature, that sometimes these are going to be reflected in the non-invasive results. So it's not a surprise, and perhaps I come from a position that's perhaps, not sceptical, but that is not surprised that results come out and bite you on the bum, so to speak... So therefore I think, you know, it's not fair to say to women that this is the panacea, this will give you the yes or no answer, because tests are not like that, life is not like that, results are not like that. Genetics is not that simple.
>
> (Rachel, genetic counsellor)

Here, Rachel draws very clearly upon her specific professional identity, and the values inherent to the clinical genetics perspective – *'from a professional point of view I have a lot of experience of when tests throw up results that are problematic in interpretation… genetics is not that simple'* – in order to present an account of NIPD that highlights the more 'problematic' aspects of emerging tests. Rachel appeared as a dissenting and critical voice within the discussion of the technology throughout - elsewhere in the interview, for instance, she explained that although NIPD for fetal sex had been made available for her to use within the genetics clinic for a number of years (Rachel spent much of her professional life providing expert genetic counselling to *'couples who are seeking information about either a diagnosis in their family, or something that's going on in the pregnancy'*), she '*rarely*' felt that NIPD would be experienced as useful to the patients that she counselled:

> So basically speaking we talk about what the advantages and disadvantages of it are, what the limitations are, because you know there is an error rate. I think you need to stress to the patient, you know it isn't 100% accurate, and that in my experience has really influenced what women have done… I don't know whether that's down to counselling style or practice, but I think that perhaps it's not always reflected in other centres.
>
> (Rachel, genetic counsellor)

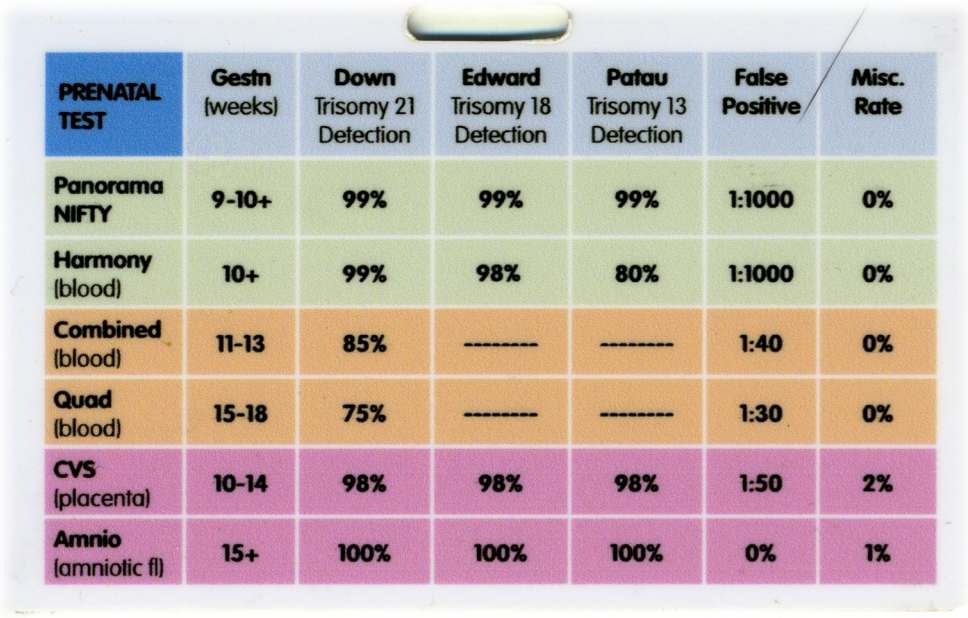
Once again NIPD is 'disposed' of, and marginalised, as its lack of 'usefulness' - its inability to deliver anything other than 'risk-based' information and to provide clinicians and patients with diagnostic certainty - is highlighted here. Whilst elsewhere, Natalie (a consultant in clinical genetics) – echoes Rachel's account of NIPD: '*we do offer it, you know – it is talked through. We talk through what it will do and what it won't do…. and for most of the women, they would rather not bother, they would rather go straight to the CVS*' - a number of other clinicians – those who reported using NIPD on a regular basis (and who had some involvement in UK-based NIPD research, by recruiting patients to provide blood samples, for instance) - expressed frustrations regarding what they perceived to be a lack of 'belief' in the accuracy of NIPD, and a corresponding lack of '*understanding*' regarding NIPD's clinical utility:

> *Have you come across any challenges whilst working with NIPD?*
>
> Um, we have had partly, issues of understanding from fetal medicine people about how accurate it is, and whether we ought to confirm diagnosis, and that's an on-going debate.. and we occasionally see people who say well I don't want to do that, I just want the CVS anyway... A local centre is just repeating the free fetal DNA, because they are not happy to confirm by scan… but there are also the people that don't believe in the accuracy. We've spent some time trying to give them the figures and explain to them.
>
> (Erica, consultant clinical geneticist)

The significance of identity comes to the fore within these competing and contrasting accounts of NIPD. Professionals working within locations more closely aligned with NIPD (Laura and Erica for instance) - those whose professional identities were more invested in the success of the technology - imagined a future path of development within which NIPD may achieve standards of diagnostic accuracy sufficient for it to become a replacement for amniocentesis and CVS – to '*eradicate the need for invasive testing'* - expressing frustration at clinicians' unwillingness to approach the test as a clinically 'useful' tool. By contrast, Rachel and Natalie approach the test from within locations that are distanced from the conduct of NIPD research, and their professional identities are aligned more closely with the everyday work of the clinic, and the experiences and perspectives of their patients. Approaching the technology critically, as relative 'outsiders', and examining how 'issues' and 'problems' regarding NIPD's accuracy – however small (*'they are 99.9 accurate')* - might come be translated and experienced within the clinic, they are able to preserve a space for clinical judgement in the face of proliferating technological developments, and therefore maintain what Latimer terms '*the alignment of the clinic and the gene'*:

> The alignment of the clinic and the gene helps to revive medical dominance in a number of ways…. the dysmorphology clinic appears to be being reborn as a site of knowledge production rather than just as a space for the consumption of a science that is developed elsewhere… at the same time as participation in the clinic tasks mothers and fathers with choices that may determine the future, they are also entangled in deferral, in the need for more knowledge, more genetic techno-science, and more clinical judgment.
>
> (Latimer 2007b, p.29 - 30)

Within her work examining the contemporary conduct of dysmorphology – another (closely related) field within which the work of the 'new genetics' appears as central - Latimer shows how clinicians (and parents) work in ways that maintain spaces of '*deferral*'. Specifically, technologies are not passively defused, but actively translated, mobilised in ways that preserve the power of medical knowledge and clinical judgement: the contemporary genetics clinic becomes '*a site of knowledge production rather than just as a space for the consumption of a science that is developed elsewhere'*. Similar processes of 'deferral' are visible here: through adopting a '*sceptical*' and dissenting approach, drawing on their professional identities and responsibilities as spaces within which the power of emergent technologies may be translated or denied, by refuting NIPD technology's diagnostic potential and its corresponding 'usefulness', and instead emphasising its unreliability, Rachel and Natalie actively preserve a space for the exercise of clinical judgement and the stability of current practice.



PRENATAL TEST	Gestn (weeks)	Down Trisomy 21 Detection	Edward Trisomy 18 Detection	Patau Trisomy 13 Detection	False Positive	Misc. Rate
Panorama NIFTY	9-10+	99%	99%	99%	1:1000	0%
Harmony (blood)	10+	99%	98%	80%	1:1000	0%
Combined (blood)	11-13	85%	--------	--------	1:40	0%
Quad (blood)	15-18	75%	--------	--------	1:30	0%
CVS (placenta)	10-14	98%	98%	98%	1:50	2%
Amnio (amniotic fl)	15+	100%	100%	100%	0%	1%

Figure 8: card with comparative information on prenatal test accuracy

The image reproduced above is a scanned copy of a small plastic card (wallet-sized) given to me by a research participant (towards the end of the fieldwork stage, in February of 2014), who had been provided with several copies whilst visiting a clinical site she had regular contact with (but was not formally affiliated with). The card was distributed to GPs in England and Wales, and was also made available to midwives, student midwives and obstetric trainees.

The expert accounts explored above concerned the discussion of both NIPD for fetal sex and 'NIPT' for Down's syndrome – and with the Down's syndrome tests entering private clinics as a new development whilst the fieldwork interviews were being conducted, participants frequently discussed the technology – NIPD *and* 'NIPT' - as a whole, shifting between talk of specialist care and diagnostics on the one hand, and routine care and 'screening' on the other. In contrast to the accounts above however, a number of experts whose professional identities were more closely affiliated with practices of routine screening – and who had become more familiar with the emerging 'NIPT' tests for Down's syndrome – began to suggest that issues regarding accuracy would not be of continuing concern, and that the new tranche of commercially-developed tests would not be required to provide complete (100%) diagnostic accuracy in order for non-invasive Down's syndrome testing to become widely regarded as 'useful'. Whereas the accounts highlighted above either suggested that 1) NIPD tests were currently lacking diagnostic power, but would eventually become "100%" accurate, or 2) NIPD could never provide complete reassurance and act as a 'replacement technology' for diagnostic tests, this group of experts denied the need for complete accuracy, suggesting instead that current (or near-future) testing standards were likely to be '*accurate enough*' for the technology to

provide a similar level of reassurance as (and act as a replacement for) a range of routine prenatal testing technologies, including some of those usually treated as 'diagnostic':

> As you get better at it, the chances of the laboratory producing abnormal genetic results because they've screwed up, I think, is infinitesimally low. And I think that to me, my thinking is that NIPT is just a non-invasive CVS, and if you are prepared to accept CVS as being accurate enough to act on it, then I think quite soon it should be much the same for NIPT.
>
> (James, private NIPT provider)

> *Do you have to have 100% specificity, sensitivity?*
>
> You can't. It- I mean amniocentesis isn't 100%. Nothing is 100%. So I think- I think you can't have 100, 100. But if you knew, that there was potentially a risk with something like CVS, it almost becomes- makes CVS negated in that position. And it would still be ok, but women would still have it be told, actually do you know what- this is still not 100%. And you could have, for example, if it's a female fetus then potentially you've got an issue on amnio. Um, it's very, very rare you know, but there is always going to be that tiny, tiny, tiny risk of error.
>
> (Linda, public health policy)

Both James and Linda, as they discuss the accuracy of 'NIPT', shift the conversation away from talk of problems with the emergent technology, and instead point towards what they perceive to be corresponding shortfalls in accuracy produced by tests already treated – and trusted - as 'diagnostic'. Unlike those whose professional alignments with diagnostic testing technologies led them to emphasise the need for complete reliability, for James and Linda *'nothing is 100%'*. By denying the possibility of '100% accuracy' they are able to align NIPD more closely with routine and trusted 'diagnostic' technologies, not by claiming that the emergent technology achieves 100% accuracy, but rather by re-interpreting what the class of diagnostic means, pointing towards the embeddedness and widespread acceptance of prenatal tests (CVS) which - they suggest – may in fact be regarded as less than 100% accurate. Echoing the image of the text on the card (in figure 5, above), both Linda and James directly compare NIPT with existing (and trusted) technologies such as CVS[41], in order to highlight the emergent technology's power – with James suggesting that 'NIPT' may be treated as equivalent to CVS, and Linda suggesting that the emergence of NIPT may effectively 'negate' the test's 'usefulness', given the risk of miscarriage that CVS presents. These accounts lie in stark contrast then to those provided by experts elsewhere and the emergence of such profoundly different accounts of NIPD's (and other testing technologies') 'accuracy' once again points towards constitutive power of *'local translations'*. Whereas Alison (cytogeneticist) very clearly asserted that both

[41] The card in fact presents NIPT as achieving greater – (98 - 99%) - accuracy than CVS (98%).

amniocentesis and CVS were completely (*'100%'*) reliable, the possibility that *any* prenatal test may produce results that, once translated into the clinic, would be received as completely reassuring and trusted – 100% accurate - is questioned here. The 'diagnostic' class of prenatal tests is destabilised, and correspondingly, concerns around the need to achieve 'perfect' results are placed aside. Although the same boundaries are being 'troubled' here, and although the same divisions are being questioned, NIPD is explicitly not 'disposed' of or marginalised here, but is enrolled within new spaces, and aligned with trusted technologies and practices. Drawing once more on the persuasive power of numbers, appearing as *'potent political and cultural agents'* (Verran 2013, p.28), experts here are able to 'make room' for NIPT, carving out a space that exists '*betwixt and between*' (Latimer 2008b, drawing on Douglas, 1966) current technologies of screening and current technologies of diagnosis, and contributing to the successful translation of the technology from the research context into the clinic.

NIPT and prenatal screening: promises and (further) problematisations

As emerging NIPD and/or NIPT tests carve out new - but contested - spaces within the clinic, as they lie *'betwixt and between'* categories, they hold the potential to both align with and sediment within current practices and processes, *and* to disorder and disrupt. The multiple emergence and translation of NIPD and 'NIPT' testing carried with it significant complexity – with experts attending to both the 'promise' of the technology as well as the 'problems' they felt it might bring. As a technology that 'troubles' boundaries and de-stabilises established categories, it generated significant, and at times polarised, debate and discussion.

Echoing the perspective put forth by Linda and James, clinicians working in the field of fetal medicine responded to the 'promise' of NIPD - and although they recognised that the tests may not come to achieve perfect diagnostic accuracy, and would require the use of invasive testing as a follow-up – they felt that emergent and 'evolving' non-invasive tests for Down's syndrome would come to present significant advantages over current *screening* technologies at least. Paul, for instance, expressed hope that the new 'NIPT' tests would reduce the 'complexity' of screening, by generating information that was persuasive and 'reassuring' enough to be communicated in clear, and near-categorical terms that would be *'far less difficult to explain'*:

> It's going to be interesting to see how that test evolves. What's happening at the moment is that they are given a very high accuracy rate, so if the test comes back as negative that will be very reassuring for women, and if it comes back as positive, most of those women at the moment are having a confirmatory CVS. But actually you don't really mind having a

> confirmatory CVS when you are told that it is a 99.99% chance that your baby is going to be affected. And I think there will be a little bit of confusion, but I think in many ways there will be far less confusion than there currently is with the screening test. Because first of all, many of the medical staff who offer the combined screening don't really fully understand the whole process, and I think its actually a complex issue to explain to a woman, this concept of low risk and high risk, and quantifying that risk, and what is an acceptable risk for her, versus what is you know deemed an acceptable risk by public health doctors. To actually have been given a test, a blood test which says your baby is extremely unlikely to have Down's syndrome, or your baby is extremely likely to have it, it would be far less difficult to explain.
>
> *So you think the test could be treated as diagnostic?*
>
> Pretty much, I think it wont be long.
>
> (Paul, consultant in fetal medicine)

For Paul, as he approaches the test from within a context where the issue of 'risk' brings significant complexity – *'I think its actually a complex issue to explain to a woman, this concept of low risk and high risk, and quantifying that risk, and what is an acceptable risk for her, versus what is you know deemed an acceptable risk by public health doctors'* - perfect diagnostic accuracy is *not* required in order for NIPD to become 'useful'. If the results that are produced by 'NIPT' tests are accurate enough to be framed and communicated in terms of being *'extremely likely'* or *'extremely unlikely'*, rather than involving 'complex' numerical interpretations of risk or chance, the desirability of these emerging tests is greatly increased. Paul presents an optimistic account of NIPD's (and NIPT's) emergence here, establishing the presence of a 'useful' space for tests that present near-diagnostic (but not quite diagnostic) results, those that lie 'betwixt and between'. For Paul, the technology holds significant promise, bringing the potential to impart greater 'reassurance' and *'far less confusion'* within the clinic.

Strengthening his optimistic account of NIPD, Paul describes the problems that are experienced by both patients and clinicians, as they are faced with the task of interpreting screening tests which provide risk-type (and not categorical) results. Explaining the difficulties (that he nevertheless presents as *'the interesting bits'* of his job) with which such issues are approached in the clinic, he points towards the emotional *'quagmire'* that patients become enrolled within as a result of encounters with 'uncertain' screening tests:

> *I'm interested in when something becomes diagnostic, it's interesting-*
>
> It is. These are the sorts of things that make my job interesting. Because, my definition of high risk will be very different from yours, and anybody else's… I mean it's one of the most enjoyable bits about my job, how you help the patient navigate their way through that quagmire.
>
> *And how do you, if someone is struggling…*

> Well I think I try and, I try to get away from this concept of high risk and low risk, and I try to say well look, this is a figure that, a cut-off that has arbitrarily been decided by national health policy. But actually let's stop using the word risk, let's just say the chance of your baby having Down's syndrome is one in seventy, and you've got to imagine yourself in a room with sixty-nine other people and I'm going to say to you, look one of you is carrying a baby with Down's syndrome, and you've got to imagine looking around, and do you feel reassured enough that there are sixty-nine other people in that room? Or do you think, well actually there don't seem to be that many people in this room, and I want to know. I try not to use emotive language… when you start telling people they are high risk it has a huge amount of an impact in terms of how they perceive their risk.
>
> (Paul, consultant in fetal medicine)

By highlighting the difficult and complex processes of contextualisation and interpretation that must currently be 'navigated' as clinicians and patients enter the *'quagmire'* - as they face 'difficult' encounters with routine screening tests - Paul underlines the practical and psychological advantages that NIPD's greater level of accuracy, and the correspondingly greater sense of 'reassurance' and lesser sense of 'confusion', could bring to the clinic. The perception that NIPD presents significant 'advantage' here, rests on the assumption that the presence of Down's syndrome within pregnancy is fundamentally problematic – a perspective and a value that underpins the practice of routine prenatal screening (Thomas 2014). As Paul approaches the test from within a space where Down's syndrome testing is 'natural' and 'normal' – and as his professional identity is bound up in the underlying values of a culture within which the systematic, population-wide testing has become so thoroughly routine - the possible presence of Down's syndrome is very clearly constructed as a 'poor' outcome (for women who have 'chosen' screening at least). A clear division is made between 'healthy' babies, and those that are 'affected': for instance, when discussing the scenario of applying 'risky' testing to a pregnancy where the presence of Down's syndrome is *'99.99%'* certain, CVS is no longer presented as something that brings significant clinical 'risk' as it may lead only to the demise of an 'affected' fetus and not a 'healthy' baby: *'you don't really mind having a confirmatory CVS when you are told that it is a 99.99% chance that your baby is going to be affected'.* Divisions made between the healthy and the affected, the normal and the abnormal, appear repeatedly throughout the dataset, and are explored in greater depth within chapters seven and eight.

The characterisation of NIPD as producing results that may quite clearly be distanced from those generated by current screening tests, feeds into positive characterisations of the technology explored elsewhere, as it is once again presented as a possible method for improving and 'simplifying' clinical practice:

> You could say its a lot simpler, because when you are explaining a screening test you have to explain all these things, like it won't give you a

> yes or no answer, it will give you a risk. And then if you are a high risk, that means less than one in 150, or more than one in 150. And then you have to think about an invasive- and actually that's a lot of information to take in if you've never really been pregnant before and you don't know anything about it. Whereas, if I was just to turn and say, we can offer you a blood test, it's highly accurate, over 95%, and it will tell you yes or no whether the baby has Down's syndrome. That's simple. That's like most tests you take where you get a yes or no answer. In fact screening is the only test I know of where you get a risk and not a yes or no.
>
> (Laura, NIPD researcher)

Situating NIPD within the context of current prenatal screening practices, and imagining a future where testing will effectively *'tell you yes or no whether the baby has Down's syndrome'*, even if it fails to achieve 100% accuracy, *Laura* characterises the technology as representing a significant step forward – one that negates the 'issues' raised as clinicians and parents negotiate what Paul described as *'arbitrary'* cut-off points, and one that may be presented – particularly to those with little prior experience of pregnancy or testing – as a simple, clear and easy test. Similar discourses, which stress the 'simplicity' and 'clarity' of NIPD, and which once again draw on the power of numbers to highlight the 'confidence' with which test results may be approached, are employed within the online advertising material that is published by commercial NIPT providers:

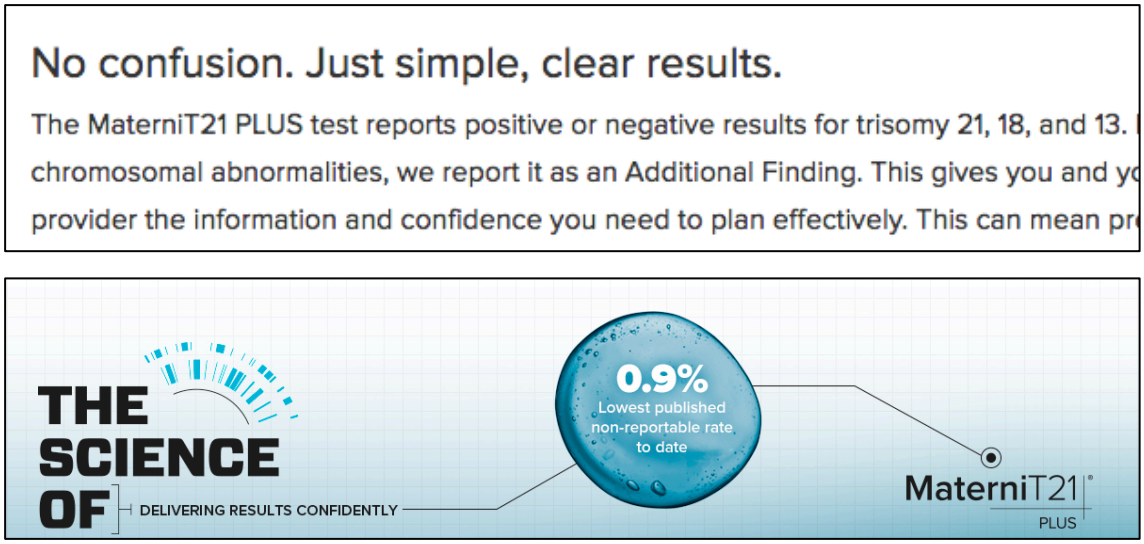


Figure 9: Online advertising material published by Sequenom

These discourses – of reassurance and rationality - are circulated and re-circulated as the NIPD becomes enrolled and translated within an increasing range of clinical and social spaces. Whereas more dissenting voices mobilised talk of (in)accuracy to point towards NIPD's *lack* of usefulness, repeated talk of particular (and powerful) numbers as they appear here – *'100%'*, *'99.9%'*, *'0.9%'* – enables the discussion of accuracy to function as a

tool for enhancing reassurance and for providing certainty – such talk 'fixes' the position of the technology as it stands in comparison with routine tests, contributing to the sedimentation of NIPD within the clinic, and anchoring the technology within a complex and contested socio-cultural backdrop.

Persistent talk of numbers also brings a greater sense of *rationality* to the discussion of NIPD. Whereas older 'invasive' technologies, involving the insertion of needles, the close examination of pregnant bellies, and the extraction of fluids and tissue, appear as 'messy' and disruptive – relating to bodily objects and occurrences, and bringing talk of 'risk' – numbers appear as contrastingly rational and benign, as *'neutral, apolitical, unbiased, and more accurate than human perceptions and judgments'* (Lupton 2013, p.27). Elsewhere within her account Laura explains that many of the NIPD patients she had spoken with reported feeling *'more likely to trust a test that is done in a lab',* and less likely to trust tests and examinations that are done in the clinic, which are seen to present risk of *'human error'* – *'somebody's tired or missing something or you know, is not that experienced'*:

> *So you think the sort of, mechanisation, is valued?*
>
> Yeah I think generally if you tell somebody you are taking a blood test and you are sending it off to the lab, they feel far more confident in that, than if you are rubbing a thing in their stomach and looking at something on the TV

Laura draws from discourses here which emphasise the value of the rational over the relational: ultrasound examinations are presented not as a way of 'looking at' babies or fetuses – they are looking at 'something' – a remote object and an 'other' – a thing on a TV. Situated within such discourses, NIPD may be characterised as representing a clear advantage over other tests, specifically because it negates the 'bodily' and relational aspects of testing, and presents information that is quantifiable, rationalisable and objective. Within her work examining the rise of the 'quantified self', Lupton describes how the enrolment and interiorisation of such discourses has become increasingly powerful as 'technologies of the self' (Foucault 1997, p.154) proliferate, and provide '*a greater degree of control over the messiness and unpredictability of the fleshly body'*:

> From the beginning of discussions of the quantified self concept… the discourse of trusting data over embodied knowledge, the machine over the human, was evident. Data appeared to offer certainty, while the body's perceptions were represented as untrustworthy, inexact, inaccurately mediated through human experience as opposed to being objective
>
> (Lupton 2013, p.27)

The valuing of the rational both plays out, and is subsequently questioned, within an account of 'NIPT' testing provided by Alana, a private patient who had purchased the test for 'reassurance' during her second pregnancy. Alana had *'wanted to be as prepared as possible'* for her second pregnancy – she was a full-time professional and explained that she had very little spare time outside of work hours: *'I work in consultancy, it's quite long hours. It's not going to be easy with a second child'*. She described how she had undertaken a great deal of *'research'* on the testing before approaching private providers and explained that she had decided to seek out NIPT because *'it just seemed like a better option than just a scan, which isn't particularly accurate'*. Alana described how she 'believed' in the test because *'these things have to come with really strict monitoring and, um, governance procedures I guess, for them to be able to offer it',* and she was reassured particularly by the knowledge that the technology was being trialled within the NHS - *the NHS is planning on rolling it out as an experiment* - (Alana's sister had recently been offered NIPT as part of a clinical trial, and it was for this reason that she came to know about the test). As she reflected back on her feelings regarding test results however, Alana began to question her confidence in the test results – explaining for instance that she planned to seek out additional (ultrasound) testing to check that the sex of the baby (as reported by the NIPT test) was correct – and repeatedly stressing her underlying mistrust of the results - '*I only know what I've been told':*

> *So once you've had the baby, you'll know.*
>
> Um, I guess so. But you don't really do you. I mean if we, touch wood, have a healthy baby girl then that is everything the test has said. But then, that could have happened with us not having the test, or it could have happened if the test is only 40% accurate. You just don't really know. I mean all it does- you know you have to believe what you are told, and let it put your mind at rest… So yeah, I believe it, but you haven't got a lot of choice but to believe it. I have got no reason not to believe that the results are accurate, you just go with what you are told, don't you?
>
> (Alana, private NIPT patient)

NIPD results are experienced here – despite Alana previously describing how she felt the test would provide *'pretty much a yes or no answer'* - as a matter of belief, and not certainty. The test's rationality, its remoteness from bodily experience – translates here as a source of doubt rather than reassurance – she felt that she simply had to 'trust' the results of the test, and explained that even if the results appeared to be accurate after birth, she felt this could be a matter of coincidence: '*that could have happened with us not having the test, or it could have happened if the test is only 40% accurate'*. The ambiguities present within such an account suggest that despite an overwhelming focus on talk of accuracy, and despite the repeated mobilisation of numbers in order to persuade and to 'fix' the position of emerging tests, the sense of certainty and reassurance such discourses

are employed to achieve may not successfully be translated within the patient experience - with even the most 'informed' and 'rational' of patients questioning such objectivised and rationalised framings of pregnancy.

'NIPT' in the clinic

Approaching the technology from within the context of the private clinic, those involved in the commercial provision of 'NIPT' for Down's syndrome suggested that the test was already operating in a way that would allow for the presentation and communication of results as near-categorical information. Reflecting back on the rapid development of NIPT, these experts explained how, as developments in commercial testing services progressed, and as NIPT's accuracy – as presented within the lab reports sent through by test developers - has increased, the way in which test information was communicated in the clinic very quickly altered in response, with tests eventually being presented as *'99.9%'* accurate:

> Now, as well as getting a kind of positive or negative result, and with a negative result you are saying that you would have excluded 99% of Down's babies, you are also able to give an idea of the accuracy and validity of the tests, and most of them are coming back with an error rate of one in ten thousand. So for the bulk of those, once they are reported, patients don't know about this until they have had the test, but once they are actually reported, they are actually getting a test which has really got a 99.99%, rather than 1% risk of error. And now that we are getting large numbers through with that sort of result we are saying to them it's 99% plus…
>
> (James, private NIPT provider)

Accounts provided by patients who had purchased the new Down's syndrome tests very clearly echoed such perspectives, as they too quoted figures of *'99.9'* percent accuracy, and spoke of the test being 'massively reassuring' and *'as good as you are going to get':*

> *How do you feel about the accuracy?*
>
> Yeah I mean frankly, you can't beat sort of 99.9. And I think that in anyone's mind you would feel massively um, reassured by that. You and I both know you are never going to get 100% with anything, frankly. So 99.9 really is as good as you are going to get it. So I think as soon as I found that out, it was 99.9 then absolutely that gave me the confidence in the results really. But yeah I didn't have any issues with that at all. Because like I said, you know, it doesn't get much better than that.
>
> (Jamie, private NIPT patient)

Any characterisation of the technology as being closely comparable with routine screening tests has faded here, with both clinicians and patients stressing the extremely high rates of

accuracy that commercial NIPT testing achieves. Although the success of testing is very clearly and repeatedly underlined, with the 'near-diagnostic' character of results being consistently foregrounded, at least one aspect of the division between screening and diagnosis is very actively maintained. Elsewhere, James explains that, although the results of 'NIPT' are so persuasive, and so highly accurate, invasive testing is nevertheless required as a confirmatory follow-up upon receipt of any 'high risk' or 'positive' results: *'if it's negative accept that you are probably ok, if it's positive then you probably need to go on and have a confirmatory diagnostic test and make whatever decision you are going to'*. The 'decisions' alluded to here, the 'choices' that are prompted where diagnostic information is provided prenatally - involve the abortion (termination), or not, of fetuses diagnosed with Down's syndrome (or any other conditions tested for). Within such accounts these emergent 'NIPT' tests – so frequently compared with diagnostic tests elsewhere (and by the same interviewees) - are aligned instead with current screening practices, and in being framed as such, they remain one step away from decisions regarding the abortion of 'affected' pregnancies. As an emergent technology that remains in the pre-naturalisation stage here, NIPT does not yet possess the power to 'legitimate' access to abortion via the clinic. Maintaining the stability of established dividing practices, women are still required – no matter how persuasive 'NIPT' results are made – to continue to pass through established pathways of (medical) legitimisation, by accepting (and waiting for[42]) confirmatory diagnostic testing before seeking abortion.

The separation of 'NIPT' from the practice of abortion is not, however, presented as a 'fixed' or permanent approach, and it is recognised that given time, non-invasive tests for Down's syndrome may effectively replace invasive tests, and may eventually allow for abortion decisions to be made: *'NIPT is just a non-invasive CVS, and you are prepared to accept CVS as being accurate enough to act on it, then I think quite soon it should be much the same for NIPT'*. If 'NIPT' tests for Down's syndrome may be thought of in terms of being 'just a non-invasive CVS' - if they do not need to achieve complete (100%) diagnostic accuracy and function instead as a new kind of 'near-diagnostic' test, then the re-framing and the re-positioning of NIPD as 'NIPT', as a test that is separated from the practice of prenatal diagnosis and the associated practice of selective abortion, becomes highly problematic. The collapsing of the boundary between screening and diagnosis in response to NIPD/T could represent a powerful moment in the development of prenatal testing. If 'NIPT' were to become established within routine prenatal screening, and emerges as a

[42] With NIPT taking place at around ten weeks gestation, and providing results within five days, women who receive a 'positive' NIPT result may face a wait of around four weeks before they can access 'confirmatory' amniocentesis results.

test that is 'accurate enough' to legitimate abortion decisions, such a move would represent the first time that effectively diagnostic prenatal tests enter into the prenatal care of the *'low risk'* pregnant population[43]. Currently, women (and their pregnancies) must pass through robust clinical categorisation processes, and must be categorised as 'high risk' in order to gain access to diagnostic testing (within the NHS). The possibility that access to risk-free, highly accurate and early non-invasive prenatal testing may become routinised and normalised within the clinic, and that this may lead to the 'normalisation' of selective abortion within whole pregnant populations, prompts much anxiety and discussion, particularly from within the clinical genetics community. Old debates – around abortion and eugenics particularly – open up once more in the face of NIPD and 'NIPT' (and are explored in detail within subsequent chapters).

Summary

Within this chapter I have shown how NIPD, examined during a 'pre-naturalisation' stage of development here, is not experienced as benign and unproblematic, but is subject to much criticism and concern, and emerges as an area of intense problematisation. I show how, as the technology emerges within multiple fields and contexts, and as experts struggle to clearly 'fit' and align the technology with established tests and practices of prenatal testing, NIPD is subject to substantive 'dividing practices', which result most clearly in the separation of the technology into two streams: NIPD and 'NIPT'. I show how the emergence of tests for Down's syndrome, despite concerns raised around inaccuracy, are made 'useful' particularly within the field of prenatal screening – a location within which Down's syndrome testing has become routinely and thoroughly enrolled. Examining more dissenting accounts of the technology's early development, I show how NIPD 'troubles' the boundaries that have been constructed between technologies and practices of 'screening' and 'diagnosis'. Proceeding then to highlight the way in which professional identities contribute to the interpretation and 'local translation' of the emergent technology, I show how experts more closely aligned with the practice of 'diagnosis' persistently emphasise problems of (in)accuracy, denying NIPD testing's 'usefulness', and 'disposing' of it within the context of the clinical spaces they work within. Such disposals allow more dissenting actors to mitigate the power of emergent technologies and to preserve a space for clinical judgement. I then show how, by contrast, those more closely aligned with 'screening' deny the need for NIPD's 'complete accuracy',

[43] All of the 'NIPT' patients interviewed for this study would have been categorised as 'low risk' – none of them had received a 'high risk' screen result prior to seeking out NIPT, and none had a family history of disease.

re-interpreting the 'diagnostic' category, and highlighting the 'usefulness' of near-diagnostic 'NIPT' tests, making efforts to align them with and enrol them within the routine practice of prenatal screening. I describe how clinicians charged with the task of navigating current screening tests respond positively to the discourse of 'simplicity', 'clarity' and 'reassurance' that 'NIPT' brings to the field, and I show how talk of numbers is mobilised particularly (across a range of registers) in order to highlight the (valued and persuasive) rationality of the test. I show, however, that such discourses are not unproblematically translated to the patient experience of testing, with the 'rational' and 'objective' aspects of testing bringing a remoteness and a lack of relationality to the context of lived experiences of pregnancy and testing. Finally, I show how NIPT tests arrive in the (private) clinic as highly persuasive, holding the potential to become 'accurate enough' to replace diagnostic tests and to further 'trouble' the boundary between screening and diagnosis. With this move comes the opening up and intensification of discussion and debate around selective abortion and eugenics, themes that are explored in depth within the following chapters.

Chapter Five. NIPD and Abortion: Encounters with a Public Secret

Introduction

Abortion emerged as one of the most significant, recurrent and problematised themes of discussion raised within this examination of NIPD. Talk of abortion occurred within almost every fieldwork interview conducted, with the range of people who chose to approach and explore the issue being particularly diverse: patients, parents and professionals alike consistently identified abortion as being very closely linked to their experiences with, and reflections on, NIPD. Talk of abortion cut across the entire data set, being spoken about in connection with diverse experiences of pregnancy, reproduction and motherhood. Abortion was raised by pregnant women who had purchased tests through private clinics, by mothers who were managing the everyday impact of their child's disease, and by parents who had declined the use of all prenatal testing. It was raised by clinicians who had decades of experience in fetal medicine and prenatal care, by scientists who had little or no contact with patients, by professionals who also identified as patients, and by consultants and genetic counsellors whose routine professional practice involved close contact with abortion, as a direct result of their work with prenatal testing and diagnosis. It was in connection with conversations around abortion particularly that participants' moral concerns regarding NIPD, as well as the practice of prenatal testing more generally, began to surface. It was also within the context of conversations around the ethics of NIPD and abortion that further areas of problematisation regarding the possible (bio)political implications of NIPD (with participants questioning the influence of routine prenatal screening programmes on the shaping of reproductive choice, and raising concerns around the social construction of 'normal' pregnancies and disease) started to emerge (and the full implication of these conversations are explored in following chapters).

As participants discussed their experiences and thoughts on NIPD, and as they approached the topic of abortion, they also engaged in conversations around the politics and morality of abortion more generally. The Abortion Act 1967 (1967) legalised abortion throughout England, Wales and Scotland for the first time (the act does not extend to Northern Ireland), and although the act did not completely decriminalize abortion, requiring for instance that *'two registered medical professionals'* provide expert opinion in all cases, it gave all women the right to seek an abortion under the following circumstances:

> (1) Subject to the provisions of this section, a person shall not be guilty of an offence under the law relating to abortion when a pregnancy is

terminated by a registered medical practitioner if two registered medical practitioners are of the opinion, formed in good faith—

> (a) that the pregnancy has not exceeded its twenty-fourth week and that the continuance of the pregnancy would involve risk, greater than if the pregnancy were terminated, of injury to the physical or mental health of the pregnant woman or any existing children of her family; or
>
> (b) that the termination is necessary to prevent grave permanent injury to the physical or mental health of the pregnant woman; or
>
> (c) that the continuance of the pregnancy would involve risk to the life of the pregnant woman, greater than if the pregnancy were terminated; or
>
> (d) that there is a substantial risk that if the child were born it would suffer from such physical or mental abnormalities as to be seriously handicapped.

(The Abortion Act 1967, article 1)

Although the Abortion Act has remained in place since 1967 (being subject to only minor amendments, such as those designed to incorporate the Human Fertilisation and Embryology Act) debates around the 'ethics' of abortion have remained contrastingly active. Abortion continues to be approached as a topic of on-going philosophical and bioethical debate (Theodosiou and Mitchell 2015), with issues such as the moral status of the embryo/fetus (Jensen 2014, Kluge 2015), a clinicians' right to exercise conscientious objection (Gerrard 2009, Faundes, Duarte et al. 2013, Nordberg, Skirbekk et al. 2014), the medicalisation of abortion experiences (Lee 2003, Dadlez and Andrews 2010) and the impact of abortion legislation on women's reproductive autonomy (Smyth 2006, McDaniel 2015) attracting continued - and heated - discussion. The legal status of abortion (particularly with reference to 'clause D', outlined above - abortion on the grounds of *'physical or mental abnormalities'*) - has also recently attracted renewed political interest, with the unofficial parliamentary *'Inquiry on Abortion on the Grounds of Disability'* (Bruce 2013), led by Fiona Bruce MP, being put forward in February of 2013. Reporting back in July of 2013, the Inquiry made a number of recommendations, including '*either reducing the upper time limit for abortions on the grounds of disability from birth to make it equal to the upper limit for able bodied babies or repealing Section 1(d) altogether.'* – a move which would represent a significant change to existing legislation, either severely limiting or completely preventing access to abortion for fetal abnormality (and impacting on the routine practice of screening and diagnosis significantly). The Inquiry's recommendations, however, received considerable criticism from expert witnesses who demonstrated the deep incongruities present within a discussion which pitted women's reproductive rights against the rights of those with disabilities – showing how women were disproportionately responsibilised within the report, which also failed to attend to

the relevant broader systematic and cultural perspectives on disability: '*the starting point for an analysis about discrimination should not be on the isolated issue of abortion, but upon a society that industriously pays lip service to the equality and dignity of existing individuals with disability'* (Priaulx and Horan 2013, p.42). The problematic ethical and social issues raised within prenatal care systems that provide prenatal testing without corresponding access to abortion services had also been explored previously (Ballantyne, Newson et al. 2009), with critics suggesting that those responsible for the development of prenatal testing technology and also who *'witness its implementation'* – *'geneticists, physicians, policy makers'* – should work to ensure safe, legal and equitable access to abortion services, particularly given the centrality of *'reproductive autonomy'* to the discussion of prenatal testing at large.

Participants' conversations around abortion and NIPD then, were emerging within a broader cultural context characterised by an active, and somewhat polarised, debate around the ethics of abortion itself, particularly as it is discussed in connection with disability and 'fetal abnormality'. Although it is explicitly *not* my aim here to draw conclusions around the social, moral and cultural questions raised within such debates – my role here is to illuminate the way in which those encountering NIPD approach and make sense of abortion, and to examine how various abortion discourses impact on (particularly women's) experiences of NIPD. I do, however, approach the discussion at hand from a perspective that, echoing Priaulx and Horan, avoids ascribing moral responsibility to certain individuals or 'groups' – such as patients or providers - and instead recognises the centrality and profound relevance of broader social and cultural factors within the discussion at large.

It has been shown that direct talk of abortion and abortion experience*s* is very frequently absent from mainstream and/or public discussions of prenatal testing in general (Thachuk 2007), as well as NIPD more specifically (Farrelly, Cho et al. 2012). It has also been shown that when abortion is raised as an issue of interest or concern, it is often glossed over, remaining unexamined, and presented instead as an *'essential component of reproductive choice'* (Simpson 2010, p.29). Within more critical spaces, however, the acute relevance of questions regarding abortion to the discussion of prenatal testing has been recognised, and the close alignment of abortion and prenatal testing has been thoroughly problematised (Ballantyne, Newson et al. 2009, Fisher 2011, Aune and Moller 2012). Paralleling the recent statement from Priaulx and Horan (quoted above), a number of scholars have noted that discussions regarding the morality of abortion, as practiced in conjunction with prenatal testing, tend to position the interests of two marginalised and

vulnerable groups - women, and those diagnosed with disease or disability – in direct opposition with one another (Sharp and Earle 2002, McLaughlin 2003, Tsuge 2010). It has been demonstrated that the presence of such dilemmas continues to raise complex problems for both feminists and disability rights activists (Shakespeare 2006, Mackenzie 2007), as well as the people living with disability who are caught in-between (Boardman 2014). The impact of such dilemmas was explicitly recognised within the interview data generated here. Kate, director of a charity that provides support for parents and patients as they navigate diagnoses of genetic disease and (related) decisions around prenatal testing, pointed towards the presence and significance of this problematic context to the discussion of NIPD – claiming that even those who are '*pro-choice*' and who would be generally supportive of the 'issue' of abortion at large, '*struggle*' with the moral complexity of abortion as it is experienced and understood in connection with prenatal testing:

> It's also interesting this sort of general area of, of the pro-choice world if you like- it's quite sensitive and ethically charged. Which is the other difficulty, you are not going to get swathes of people taking up this cause because there are people who ostensibly are pro-choice who struggle with this area of choice, because of the disability rights issues etc. so it's tricky.
>
> (Kate, policy maker)

Mirroring these wider social and political debates around abortion, and especially 'therapeutic' or 'selective' abortion, participants approached the discussion as a clear location for the problematisation of prenatal testing, entering into conversations around abortion with much concern, reflection and uncertainty. Concentrating centrally on what is problematised, I explore how NIPD and its relationship to abortion, provoking a set of complex and challenging responses, represents a point which must be pressed.

The 'public secret'

> This reconfiguration of repression in which depth becomes surface so as to remain depth, I call the public secret, which, in another version, can be defined as that which is generally known, but cannot be articulated.
>
> (Taussig 1999, p.5)

Within this chapter I draw particularly on Taussig's concept of the '*public secret*', exploring the idea that abortion, as described in this context particularly, manifests as something that is hidden but ever-present, a kind of object that *'is generally known, but cannot be articulated'*. Descriptions of abortion, although frequent within participant accounts of NIPD, were characterised by much concealment and ambiguity: abortion, as discussed within this context appeared to function very clearly as a kind of *'public secret'*. The link

between abortion and secrecy, as well as the related issue of stigma, has been articulated elsewhere. A number of studies, the majority of which report on experiences of abortion occurring outside the context of prenatal care, have explored the relationship between abortion, secrecy and stigma in depth (Thachuk 2007, Ludlow 2008, Sanger 2012, Cowan 2014). These studies show that, although abortion exists as a topic of much political and moral debate and discussion, and although the legalisation of abortion is often assumed to bring an *'implied social acceptance'* (Thachuk 2007) women very frequently experience abortion in silence, as a source of stigma and shame. It has been shown that many women adopt, therefore, 'strategies of non-disclosure' in order to protect against the possible harmful social and psychological effects (Astbury-Ward, Parry et al. 2012) that the 'revelation' of abortion experiences may bring. Strategies of 'concealment' adopted to mitigate against stigma and shame have, in turn, been shown to entail *'profound psychological, behavioral and interpersonal consequences'* (Major and Gramzow 1999) for women, with prolonged secrecy and efforts to *'suppress'* feelings leading to lasting harm in the form of *'intrusive thoughts of the very thing the secret keeper is trying to conceal'*. Secrecy and stigma – along with what Ludlow refers to as the 'traumatization' of abortion - have been shown to affect abortion providers similarly, with the result that there has come to exist *'a politically and socially constructed gap between what we experience at our clinics and how we talk about those experiences in public'* (Ludlow 2008).

The clear alignment of abortion and NIPD (and by association, the practice of prenatal testing more generally) as well as the relationship between abortion, secrecy, and stigma, is examined here, through analysis of participant accounts, some of which report very directly on 'difficult' abortion experiences. I show how the phenomena of public secrecy, as constituted through the prevalence of unspoken, contested and ambiguous knowledge, envelops experiences with and talk of abortion as it materialises here. As a prenatal testing technology that is being enrolled within a cultural space where the 'public secrecy' of abortion is deeply embedded, the way in which NIPD is emerging and sedimenting in the clinic is being actively shaped by routine practices, and established repertoires for (not) talking about selective abortion. I argue here then, that despite an explicit lack of public discussion the (unspoken) practice of the 'selective' or 'therapeutic' abortion of pregnancy is central to experiences and encounters with NIPD. I show how the practice of selective abortion, although its availability may help relieve the anxiety that is experienced within contemporary 'tentative' experiences of pregnancy (Rothman 1994), offers limited (and problematic) opportunities for the exercise of reproductive 'choice' and control, and is experienced as an emotionally, practically, socially and politically contested act, enveloped in secrecy, and deeply stigmatised.

Context: the therapeutic gap

The practice of prenatal testing, whether it is carried out under the banner of 'screening' or 'diagnosis', aims to provide women and/or couples with some kind of information about the health of their unborn baby (fetus). Within a very limited number of circumstances this information may be used to inform the clinical management of pregnancy, fetal health or birth. NIPD, for instance, is used to 'diagnose' fetal sex within pregnancies that are 'at risk' of haemophilia because in these circumstances a diagnosis may help guide clinical management of birth[44]. A very limited range of surgeries and therapies have also been performed directly on the fetus or the pregnant patient: these include fetal blood transfusions where the fetus' blood type is incompatible with the maternal blood (and where the fetus is at risk of severe anemia), cardiac procedures, interventions for urinary tract obstructions, and surgical laser treatment of twin-to-twin transfusion syndrome (Van Mieghem, Al-Ibrahim et al. 2014). Access to fetal therapy, however, is very limited and remains '*reserved for well-selected fetuses at the most severe end of the spectrum*' being '*offered in a limited number of centres*' (Van Mieghem, Al-Ibrahim et al. 2014).

The limited scope for treatment of the fetus entails that in the majority of pregnancies, when a diagnosis of 'fetal abnormality' is provided as a result of prenatal testing, this information may be used to guide decision making around a single intervention: whether to continue with a pregnancy, or whether to end that pregnancy through abortion (Annas 1996, p.S6). This particular 'type' or category of abortion is frequently distinguished and divided from the practice of 'social' abortion, with legislation governing abortion in the UK making this categorisation explicit (see text quoted above). This category or 'type' of abortion is more frequently referred to as either '*genetic termination*' (Thachuk 2007) '*selective termination*' (Press and Browner 1997, Shakespeare 1998) or '*therapeutic termination/abortion*' (Clarke 1997, p.134, Priaulx 2008). This general pattern of technological and clinical development, where opportunities for testing far outweigh opportunities for treatment or therapy, has been observed elsewhere and with increasing frequency as genetic and genomic tests enter into the clinical sphere - and this phenomenon has come to be known as the '*therapeutic gap*' (Holtzman and Shapiro 1998, Kelly 2009, Gammeltoft and Wahlberg 2014). The presence of the 'therapeutic gap'

[44] Haemophilia is a blood clotting disorder which affects only males. Affected babies are at increased risk of prolonged and significant bleeding (or hematoma/bruising) during birth – if NIPD identifies the fetus as female the pregnancy can be managed within standard antenatal care services, and if it is male arrangements can be made to ensure that specialist services are available at a later date to either conform diagnosis or help manage the birth.

greatly informs the context within which contemporary discussions of prenatal testing and abortion take place:

> For many genetic disorders however, the ability to diagnose the condition has not been matched by the ability to offer an effective treatment for the condition, described as the 'therapeutic gap'. This means that until therapies are developed, prenatal testing followed by the termination of an affected foetus is the only option available for preventing the disease
>
> (Ekberg 2007, p.68) citing (Marteau and Croyle 1998).

Within her study of the '*pre-emptive cultures that shape the new predictive genetics*' - the application of which have led to the construction of new patient identities such as *'pre-ill'* and *'pre-symptomatic'* - Konrad explains how, in contrast with the prevailing culture of twentieth century Western medicine, where '*the ready availability of a cure dominated the medical repertoire'*, contemporary processes of *genetic* diagnosis take place within a clinical culture that is no longer guided by the promise of treatment or therapy (Konrad 2005). Knowledge of a genetic diagnosis leads to knowledge of prognosis: genomic medicine has introduced a new '*age of genetic prognostication'* where '*uncertainty and subjective emotion prevail in expansive proportions*' and where, in the majority of circumstances, treatment and therapy remain distant, hopeful futures. The gap between diagnosis and treatment has also been explored with more explicit reference to the prenatal context: within her work on the practice of dysmorphology, Latimer characterises the prenatal genetics clinic as a '*space of ambiguity and uncertainty*' where parents become enrolled and entangled in processes of deferral, particularly around reproductive choice (Latimer 2007a). Elsewhere, Simpson underlines how the termination '*as a ''therapeutic'' option'* is, in the majority of circumstances, the *only* choice offered by prenatal testing, and he points towards the strong alignment made between practices of prenatal testing and abortion as a consequence:

> In reproductive genetic testing, as it occurs in the West, there is an implicit link, widely taken for granted, between the results of genetic testing and the ability to act on those results by way of terminating pregnancy
>
> (Simpson 2010, p.31)

Within her seminal work on the emergence of amniocentesis and the rise of 'the tentative pregnancy', Rothman too describes how prenatal testing operates within a kind of 'therapeutic vacuum', with the result that the practice of testing and the practice of abortion are, inevitably, aligned: *'Abortion is an integral part of this new technology. Fetal treatments do not exist for these diseases'* (Rothman 1994, p.4), and elsewhere Clarke, reflecting on the tension inherent within the concept of 'therapeutic abortion' itself,

highlights the severe limitations within which practices of prenatal screening must operate:

> Prenatal screening programmes for genetic conditions and congenital malformations do not meet the standard criteria for screening programmes because the usual intervention made when an affected fetus is identified is termination of pregnancy. This is clearly not 'therapy' in the usual sense of the word, and is not in any sense therapeutic for the affected fetus.
>
> (Clarke 1997, p.134)

A number of NIPD researchers, as they discussed the clinical implications of testing, acknowledged the relevance of this 'therapeutic gap' (although they did not directly describe it as such) within the broader context of their work:

> With genetic testing as well my frustration is that for a lot of people we can't, do much to help we can tell somebody you've got a mutation in such and such a gene but at the moment there isn't actually anything practical that you can do
>
> (Beth, NIPD researcher)

> This I think people see it as a big breakthrough, but um I think the fact that you still have to have an invasive test for the aneuploidy and things like that, um it's not actually, it's not a cure of anything, there's no treatment, so it is, it's just another, it's a big advance in testing
>
> (Chloe, NIPD researcher)

Approaching the discussion of possible therapeutic interventions from within the NIPD research 'community', Beth stresses the sense of '*frustration'* that is generated when comprehensive opportunities for genetic testing and diagnosis are enrolled within the clinic, but are not matched by equally powerful interventions and treatments that may offer the opportunity to *treat* as well as *identify* disease. Chloe directly implicates the 'therapeutic gap' within the discussion NIPD's possible future, suggesting that those without an appropriate level of expertise, *'people'* who *'see it as a big breakthrough',* may overstate the significance of NIPD's emergence because they do not immediately comprehend the limitations within which NIPD is operating. NIPD's potential for positive practical/clinical impact is mitigated and limited here by its emergence within a space where *'there's no treatment'*, and where the 'choices' that test results present are accordingly limited. Despite NIPD researchers' professional enthusiasm for this '*big advance in testing'*, it was made explicitly clear that they felt NIPD technologies offered little hope of enabling treatment. Although they do not speak directly of abortion here, such accounts allude to the fact that NIPD operates within a clinical context where, with few exceptions, only one kind of decision may be made on the basis of test results: the

choice of whether to continue a pregnancy, or whether to end the pregnancy through abortion. The underlying influence of the 'therapeutic gap' constitutes one of the ways through which abortion has become so closely aligned with practices and technologies of prenatal diagnosis, and currently – given the presence of a legislative framework that requires a 'diagnosis' to be made in order for a women to access abortion via 'clause D' – the practice of 'selective', 'therapeutic' or 'genetic' abortion is limited to circumstances within which 'diagnostic' tests are used. This broader clinical, legislative and political context may contribute to the anxieties that are raised by the way in which NIPD 'troubles' the boundary between screening and diagnosis. Since this emergent technology offers the novel opportunity to provide near-diagnostic testing within 'low risk' populations, and is not limited to use within 'high risk' pregnancies, NIPD could bring forth not only the 'mainstreaming' of diagnosis, but the mainstreaming of 'therapeutic' abortion too. Anxieties raised by NIPD's possible (or probable) entry into the 'diagnostic' class prompted much discussion and examination of abortion (particularly within expert interviews), and such accounts will also be highlighted here.

Abortion and secrecy: problems with language

> Knowing is essential to its power, equal to the denial. Not being able to say anything is likewise testimony to its power.
>
> (Taussig 1999, p.6)

Whilst talk of abortion was consistently present within the fieldwork data, participants tended to approach the issue with some degree of caution and ambivalence, with only a handful of dissenting and politicised voices being willing or able to approach the topic of abortion directly. As a theme of discussion, the majority of participants raised abortion implicitly, within moments of reflection around related themes. The language that participants approached the topic with reflected a deep level of ambiguity and uncertainty regarding the topic: the terms used to describe abortion were frequently euphemistic, and the flow of conversation, whilst at other times relaxed and conversational, often became stilted and awkward. Participants' vague and elusive talk reflected the self-reported difficulty with which they approached abortion as a theme of discussion, or even contemplation - many interviewees repeatedly struggled to find language that would enable them to clearly articulate their point of view - and in place of direct talk of 'abortion' or 'termination' participants pointed towards the issue in ambiguous and euphemistic terms, employing phrases such as the '*management of pregnancy*', '*that decision*', a '*sensitive issue*', *'the final, ultimate decision'*, *'that conversation'* and *'what might have to be done'.* The prevalence of such euphemistic and vague language suggests that,

for the majority of participants, the task of clearly articulating thoughts and reflections on abortion was experienced as deeply problematic. The presence of such difficulties regarding talk of abortion has been articulated within the previous examination of emergent prenatal testing technologies:

> In the face of a confusing a traumatic experience, they often described themselves as at a loss for words. These women were working in a communicative system whose vocabulary is exclusively medical, whose grammar is technological, and whose syntax is yet to be negotiated.
>
> (Rothman 1994, p.5)

Elsewhere, Kent has described how, as a result of the proliferating medicalisation of pregnancy and the growing use of human (fetal) 'tissue' within the development of novel health technologies, contemporary cultural conceptions of the fetus are diverse, ambiguous and contradictive: we have available to us a set of *'shifting meanings and understandings of 'the fetus' as waste, corpse, research tool, baby, body part of the woman'* (Kent 2012, p.165). This conceptualisation of the fetus, as holding multiple and contradictory meanings, was also very clearly reflected within participants' struggle to find the language to articulate their position, and in the multiplicity of alternative, euphemistic terms that were utilised within talk of abortion as explored here.

Further distancing conversations away from direct talk of abortion, and adding to the complex task of producing articulate and clear accounts, a range of technical terms were also frequently utilised within the accounts generated here. Experts made use of a diverse set of clinical terms to refer either to abortion, or to the fetus: they spoke of *'T.O.P'*[45], *'feticide*[46]*'*, *'D and C'* and the *'products of conception'*[47]. Such distanced, technical language lay in clear contrast with the language present in more personal accounts of pregnancy and pregnancy loss. Mothers with experience of abortion spoke of *'having him put to sleep'*, delivering a *'dead baby'* and *'killing my child'*. Both experts and mothers were able, however, to switch between these two registers. James, for example, a fetal medicine consultant involved in the provision of 'NIPT' testing for Down's syndrome within private clinics, spoke in terms of *'TOP'* and the *'products of conception'* as he discussed the practical issues that he felt were raised by NIPT. As the focus of conversation shifted towards talk of the patient experience however, his language became warmer and more uncertain. He switched to talk of *'what they might do'*, *'the baby'*, and making decisions to

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[45] 'TOP' is an acronym for 'termination of pregnancy'
[46] The terms 'feticide' and 'D and C' are used here to refer to 'surgical' abortion methods.
[47] The phrase 'product of conception' or 'POC' is used to refer to fetal remains obtained after abortion or miscarriage (and which are often used for follow-up/confirmatory genetic testing).

'end the pregnancy' when speaking of direct contact with patients, and the potential ending of their *'wanted pregnancies'*. Abi, a mother of two young children, who had experienced medical termination[48] after a diagnosis of anencephaly in the second trimester of pregnancy, referred to her 'baby' by name throughout the interview. She also, however, explored the possibility that her baby could, in certain circumstances, be classed as *'medical waste'*: her language shifted in conjunction with her particular reflections and memories of the abortion experience. Although the range of terms used to speak *about* and *around* abortion was diverse, *direct* talk of 'abortion' or 'termination' remained rare.

Conversations with mothers in particular faltered as they struggled - somewhat unexpectedly - to explore their thoughts and feelings around abortion. Very often these conversations appeared as unintentional, with talk of abortion arising in connection with related, rather than direct questions – for instance as I asked participants about who they had spoken to about testing, or why they had sought out a particular test – the topic was stumbled across, and then lingered over. Louise had used the new 'NIPT' tests for Down's syndrome within her last pregnancy. During the interview she spoke of abortion in connection with her memories of whom she had discussed testing with during pregnancy and her thoughts around how she may have dealt with a diagnosis of Down's syndrome.

> Probably selfish reasons really, I just thought the age that we are- and I didn't really want burden [daughter] with a child who would be, potentially quite dependent. So that was in my mind really. Well, obviously it would have been heart breaking to make a decision, and I'm not sure I would have made that decision if I'd had that kind of a result. I don't know what I would have done. But I think, going into it I thought that might be what might have to be done.
>
> *Mum became upset towards the end of the interview, as she spoke about potentially having to make termination decisions…. she was breastfeeding at the time and explained that she felt emotional, tired, hormonal.*
>
> (Louise, NIPT patient and extract from field notes)

Although Louise raised the issue of abortion spontaneously - within the context of conversations around NIPD - she was unable to approach abortion directly, speaking instead only of *'that decision'*, *'that kind of result'* and the *'heart-breaking'* decision that NIPD testing may have led her to. Despite this cautious and distanced approach, Louise nevertheless experienced the conversation as distressing and upsetting. She explained after the interview that she had found it difficult to think about such issues at a point when she was so intimately involved in caring for her young child, particularly as that child had resulted from the pregnancy that she had tested. Louise explained that she had found it

[48] The phrase 'medical termination' is used to refer to methods of abortion involving the use of medication, and which involve vaginal delivery of the fetus.

difficult to talk about the testing even with those closest to her, to the point where she sought expert counselling to relieve the anxieties that she was experiencing during pregnancy. Louise described a difficult, contested and *relational* experience of prenatal testing - one which she had struggled to come to terms with - even as no 'risk' was identified, no particular diagnosis was made and the final outcome was 'positive'.

> I started seeing [counsellor] in about July, um, and she was very good, because she was obviously trained specifically. It's quite difficult to talk to your partner about these things because he's sort of feeling his feelings, and you are feeling your feelings and you kind of protect each other by not talking about it for a long time, so it just kind of builds up.
>
> (Louise, NIPT patient)

Although talk of abortion was indirect and cautious, the theme of abortion was nevertheless positioned centrally within Louise's account of decision making, and testing, and it informed her understanding of how experiences of testing during pregnancy had (or might have) impacted on the broader context of her family life. Reflecting on why she chose to seek out and use 'NIPT' testing for Down's syndrome, Louise returns to the moments where she was forced to consider the 'choice' that a diagnosis, *'that kind of result'* may have led her to confront: whether to continue with pregnancy or whether to, in order to avoid having a child who would be '*potentially quite dependent'*, have an abortion - *'what might have to be done'*. Within Louise's account then, it seems abortion operates quite clearly as a kind of 'public secret' - even as it is understood and experienced 'internally' - something *'which is generally known, but cannot be articulated'*.

Difficulties with talk of abortion were present throughout the accounts given by parents, but they were not limited to such 'personal' accounts alone. Within many expert interviews also, as conversations turned towards abortion, accounts became increasingly strained, awkward, and vague. At certain moments, as the topic of abortion entered the frame, conversations which were otherwise flowing and natural, were quite simply cut dead:

> *So, with prenatal testing the only treatment is termination-*
>
> Yes, um. Yes.
>
> (Beth, NIPD researcher)

The presence of such problematic and difficult accounts of abortion, arising as the 'issue' comes to be so closely aligned with testing, not only points towards the inadequacy of common forms of language within the context of such conversations, it points towards (despite the relevance of such conversations to the practice of prenatal testing) the pervasive 'silencing' and 'disposal' of abortion.

Abortion and secrecy: patient and provider experiences

The difficulty that participants experienced in talking about abortion, as well as the pervasive level of secrecy with which talk of abortion is approached more generally, was clearly reflected within both personal and professional accounts of abortion experiences. Abi, who had used NIPD for fetal sexing in a pregnancy occurring after her abortion[49], described how a sense of secrecy had enveloped her experience of abortion and its aftermath, and how she had, effectively, been 'silenced' by her own distress, as well as the responses of others to her experience. Abi explained for instance, that despite knowing about her pregnancy, some of her close relatives *'didn't even tell their children'* about the subsequent diagnosis and abortion. She also described how she had long-deferred talking about her abortion with those closest to her, including her partner: *'I don't know what he went through'*, and reflecting back on this, as she imagined some of the future conversations she might have concerning her abortion, Abi presented them as being extremely difficult, or even impossible to approach:

> *Were you able to talk to your mum?*
>
> Yeah, kind of cagily. Yeah I do talk to her, but I've not had the conversation yet about how do you feel having lost a grandchild. And I don't know if we ever will because of the potential- you know.
>
> (Abi, NHS patient)

Caitlin, a midwife who was involved in the provision of 'NIPT' for Down's syndrome testing in private clinics, highlighted how pervasive the sense of secrecy surrounding abortion had been to her professional experience to date. She described how she felt abortion had been approached with great caution and difficulty, even within clearly-relevant professional spaces - such as midwifery and fetal medicine - locations within which care providers may come to be very directly involved in the delivery of abortion services:

> *Have you, do you sit in on terminations in the clinic?*
>
> Um, they don't do them in clinic. But I've done- it's part of our training that we sort of get involved with them. Yeah I've never done any for social reasons, more for anomalies and.
>
> *And how was that?*

[49] Abi was offered fetal sexing, not as a direct result of any clear 'risk' of x-linked disorder, but because the 'cause' of abnormality within her previous pregnancy was still a matter of some dispute during the point at which she became pregnant. When it came to speaking about the test itself then, Abi was not completely sure *why* she had been offered NIPD.

> Um, difficult I think. The most difficult thing I have seen is a feticide. Mainly because I didn't understand what was going to happen, and you think, I was in my third year when I saw that. As a student you assume, I had read about it, I had the gist of what was going to happen, I just never realised you would see everything on screen and suddenly it's stopped moving. So that was really difficult. And after that I think I understood. It is so important when people are coming in for these tests, that it's informed consent. That they understand the test is going to give them a result that they will have to make choices about, rather than it is just, you know, another part of pregnancy. It was a big learning curve.
>
> (Caitlin, midwife and private NIPT provider)

Caitlin expresses shock both regarding the practicalities of the abortion procedure itself, *'I just never realised you would see everything on screen and suddenly it's stopped moving. So that was really difficult',* as well as the lack of attention that had been paid to abortion within the context of her midwifery training - *'the most difficult thing I have seen is a feticide. Mainly because I didn't understand what was going to happen, and you think, I was in my third year when I saw that'.* Her account both points towards the silencing of abortion within relevant professional spaces, and it makes the alignment of abortion and prenatal testing also particularly clear. Caitlin describes how her 'exposure' to this experience of abortion (the practical details of which had previously been hidden or made secret) allows her to gain clarity on the patient perspective, albeit from within the context of a professional framework that prioritises the rational – which talks of *'informed consent'* – rather than the relational: '*after that I think I understood... that they understand the test is going to give them a result that they will have to make choices about, rather than it is just, you know, another part of pregnancy'*. The particular impact of the 'therapeutic gap' within the practice of prenatal testing becomes acutely evident here: abortion is experienced as both a secretive and a deeply problematic issue, and one that arises directly out of the extremely limited *'choices'* that prenatal testing may impose. Bringing order to such a problematic and 'difficult' experience, Caitlin emphasises the value of *'informed consent'* and the corresponding need for comprehensive pre-test counselling, which, she feels would enable to patients to *'understand the test is going to give them a result that they will have to make choices about'.* Caitlin very clearly draws on mainstream discourse around the clinical practice of prenatal testing in general (Green, Hewison et al. 2004, van den Berg, Timmermans et al. 2005, van den Berg, Timmermans et al. 2006), and NIPD specifically (Wright and Chitty 2009, Silcock, Chitty et al. 2012) here, resolving the 'issue' of routinisation and abortion with recourse to a dominant professional framework which emphasises the value, and power, of *'informed consent'*. By foregrounding the discussion of *individual* reproductive 'choice' – by framing choice in terms of personal or private decision making, such discourses manage and contain the 'problems' raised by prenatal testing – such as the underlying presence (and centrality) of 'selective' or 'therapeutic'

abortion - by responsiblising *individual* women and parents rather than examining the broader social and cultural constructs that have been enrolled and translated within the clinic (the full implications of the circulation and re-circulation of such discourses are explored in chapter seven).

Contributing to the discussion of abortion as a 'secret' experience here, genetic counsellors described how their patients were frequently reluctant to engage in talk of abortion, or to even contemplate the types of 'decisions' and 'choices' that testing might bring. They explained that a pervasive lack of knowledge regarding abortion, and a general unwillingness to confront the possibility that abortion may arise as an issue of practical concern, raised many problems for them in the clinic. Naomi (a genetic counsellor working across a range of specialties), for instance, explained how many of her patients - when faced with talk of abortion - were often left completely unable to articulate their thoughts and feelings:

> I think there are some times when, you see some couples and you feel they probably have made a decision but cant quite bring themselves to say it, or admit it, you know that they maybe have made a decision that they are going to have a termination but they are just, feel they cant say it out loud. And I think you can get to a point where you're, you're kind of affirming that decision… I've seen people who won't say the word termination, just can't bring themselves to say the word out loud.

Naomi's account of her patients' struggle to articulate themselves, to speak directly of abortion, and to *'say the word out loud',* clearly echoes the accounts generated through interviews with patients and parents here. Even within the context of the semi-private and confidential space of the genetics clinic, conversations around abortion were, reportedly, negotiated through indirect and convoluted forms of communication, rather than through any direct engagement with the topic at hand. This reluctance to talk is not merely reported back here by genetic counsellors as a point of interest, it is problematised and raised as an issue that, given the centrality of abortion within prenatal testing, is seen to require some level of management or intervention. Accordingly, Naomi also describes how, when faced with such reluctance to contemplate or speak of abortion, she actively encourages patients to confront some of the more difficult issues that a lived experience of abortion may entail:

> I think people need to know. You know at the start of that process you need to know actually, what will happen when we get to the end of this. And actually practically how will that happen if we choose to have a termination, what does that involve. Because I don't think most people would really understand how a termination happens, what their options would be... and I think you can get to a point where you're, you're kind of affirming that decision. You know- but again, that's got to be used quite

> carefully, because if you time that wrong, you might sway them in one direction or another.
>
> (Naomi, genetic counsellor)

As a genetic counsellor, Naomi acts here to encourage her patients to engage directly with the decisions and 'choices' that are raised by genetic testing, in order to provide them with appropriate, balanced, comprehensive and *'non-directive'* counselling. The dominance of a 'nondirective' approach to the management of information provision and decision making within the clinician-patient relationship is central - and somewhat particular – to the field of genetic counselling (Bosk 2003, p.xv): *'Clinical geneticists, in contrast to most other medical practitioners, are said to espouse a "non-directive" method of "counselling" clients'* (Elwyn, Gray et al. 2000). It has been described how, as a result of such emphasis on the value of non-directiveness, related practices such as 'informed consent' and comprehensive 'pre-test counselling' have gained particular centrality within the genetics clinic (Petersen 1999). Naomi shows how, within the context of prenatal testing – as it is so clearly aligned with the practice of abortion - the task of providing non-directive counselling translates into the difficult challenge of breaking the silence around the 'public secret' of abortion, as she is required to enrol patients within problematic conversations and encourage them to think about some of the most 'difficult' aspects of abortion both clearly and directly: they *'need to know'* about *'how a termination happens, what their options would be'.* She acknowledges that this task is made more problematic because, not only do patients tend to have little knowledge regarding the practicalities of abortion, many do not, before arriving in the clinic, make the link between testing and abortion at all:

> I think there are people that just haven't thought about it. That happens a lot, people come and say ok well I'll have a test, and then I'll wait for the result and then I'll decide what to do. And we are saying well, you know maybe you need to think about it now, and you need to start having those conversations now… you are going to need to make a decision, and emotions are going to be heightened.
>
> (Naomi, genetic counsellor)

Secrecy and silence around abortion is figured here as a problem for those working in prenatal genetics, and one which *'needs'* to be addressed by asking the patient to confront the issues that they (and many others) have such difficulties in facing and articulating: *'we are saying, you know maybe you need to think about it now'.* Elsewhere, Rachel, another genetic counsellor (who specialised in the provision of prenatal counselling), describes coming across similar anxieties within the clinic, again raised by patients' inability or unwillingness to engage with questions of abortion:

> Sometimes, a lot of families prefer to be ostriches. They want- they know that it is in their family but actually, they don't want to raise their head above the parapet. And I think that's because they are not going to make a decision to end- because the final, the ultimate choice is are you going to start on this road because it will alter the management of your pregnancy. And some women and couples will have this conversation sort of superficially sort of pre-conceptually, saying oh yeah we would do this, but once they see that scan, once they hear that heartbeat it feels really different.
>
> (Rachel, genetic counsellor)

As genetic counsellors struggle here to deal with the significant 'gap' that exists between their knowledge of abortion, and the profoundly contrasting level of knowledge that patients approach the prenatal clinic with, their recognition of the alignment between testing and termination is explicitly emphasised: *'the final, the ultimate choice is are you going to start on this road because it will alter the management of your pregnancy'*; *'you are going to need to make a decision'.* Such conversations (being approached from within clinical spaces where established forms of *diagnostic* testing are required to legitimate access to abortion) may seem remote to the discussion of emergent NIPD tests. Given, however, the shifting trajectory of the technology as discussed within the previous chapter – the way in which NIPD has come to be so closely compared and aligned with established diagnostic technologies and practices – and the corresponding 'troubling' of the boundaries between screening and diagnosis, conversations around prenatal testing and its alignment with abortion remain acutely relevant.

Louise (who used 'NIPT' for Down's syndrome) provides a complimentary, but somewhat contrasting account of how abortion secrecy, and the alignment between testing and termination, may be understood. Speaking directly to the concerns raised by genetic counsellors as they discussed abortion and secrecy – and their patients' lack of knowledge – she explains that *'you do tend to go in with your head stuck in the ground'*. Louise also, however, highlights the difficulty with which even an 'informed' patient might approach talk of abortion:

> *How prepared were you for a positive result?*
>
> Oh, well you can never, I don't think. Obviously I was aware. I suppose subconsciously I kind of- we worked out what we might do. But you don't really know how you will react until you have that result, I think. Because there is always that- you might change your mind… you do tend to go in with your head stuck in the ground a little bit, just because it's hard to contemplate. So, um. Yes I knew there was a possibility, but I was hoping for the best really.
>
> (Louise, private NIPT patient)

Louise approached the test from a relatively well 'informed' and 'empowered' position – she had prior experience of pregnancy, had achieved a high level of education, and explained that she was highly familiar with the kind of statistics employed within NIPD testing as a result of her profession: *'I've been on the wrong side of statistical measures'.* Despite Louise's 'awareness' of the issues that came tied to testing, and having 'subconsciously' worked out how she and her partner might deal with a diagnosis, she nevertheless highlight the relationality – and not the rationality – with which such decisions are approached: *'you don't really know how you will react until you have that result'*.

Secrecy and stigma

The pervasiveness of abortion secrecy, and the difficulty with which accounts of abortion were approached and articulated, was repeatedly explained with reference to closely connected experiences of stigma. The connection between abortion secrecy and stigma has been articulated within the broader literature (Major and Gramzow 1999, Cockrill and Nack 2013, Cowan 2014), and has been raised as a particular source of concern by those reporting on experiences of working within the field of abortion provision:

> It was not unusual to discover that I was the first person to be told about these pregnancies and the only person to hear why these women decided they wanted to abort… They often talked as though they had done something wrong, and abortion was simply the price they would pay: two hundred dollars, bad cramps, and, in many cases, a big secret to keep from everyone in their lives who mattered
>
> (Simonds 1996)

Cowan explains that the connection between abortion, secrecy and stigma may be so pervasive that experiences of stigma may accompany almost every experience of abortion: *'despite its widespread prevalence, stigma concerning abortion is dramatic… Women are disinclined to disclose their abortion histories and perceive strong social disapproval in nearly every context'* (Cowan 2014, p.472) and Cockrill shows how abortion secrecy contributes to and continually reinforces abortion stigma: '*aspects of abortion stigma—such as its concealability and episodic expression—interfere with women's potential to collectively manage or dismantle abortion stigma'.*

Adding to such accounts, interviews provided here by mothers who had experience of using invasive prenatal diagnosis technology during pregnancy highlighted how central, and how stigmatised, conversations around abortion had been to their testing experiences. Cara, for instance, provides a clear account of how decision making around

testing and abortion - and open talk of abortion - can be experienced as highly problematic:

> *Cara started chatting very quickly after welcoming me with a cup of tea. Before I asked her any questions she quickly launched into telling me about her decision regarding termination of pregnancy, at a point where her brother had been diagnosed with a serious genetic illness and her young daughter was in recovery after treatment for cancer [from field notes]*
>
> Um, when I found out I was pregnant it was very soon after [1st daughter] had finished treatment, and I remember ringing [husband] and saying I think I'm pregnant. And I went to see [genetic counsellor] who is lovely, and we talked through things and she said right we'll send you- there's testing you can have if you want, and I remember saying to her I can't, you know I just couldn't progress with the pregnancy- you know, my brother was not well at all, I knew that for [genetic disease], there was no particular cure, a very difficult condition, we had just had [1st daughter] come off treatment so we didn't know what it was. And [genetic counsellor] wrote me a letter kind of summarising and referring me for the first scan, bits and pieces. And she wrote on it, um, you said you would not be able to proceed with the pregnancy, you know, blah blah, full stop. And then she wrote, this is fine. And I phoned her up and said you know, those three words. I cried. You know those words were so important to me in terms of somebody going, that's ok. Because you feel so, I don't know judged, and defensive, and that's why when you look at these things, you know in my situation I had a brother on a timescale, a daughter that had just come out of chemotherapy, and not knowing- there's a point at which it's just overload isn't it. And all those people who say you're playing god, I think you need to spend a day in someone else's shoes. I say that to people, I can't ever really articulate what it is like.
>
> (Cara, NHS NIPD patient)

Cara's positive experience of receiving support from within clinical genetics - of receiving clear and direct affirmation that her decision regarding abortion could be approved and treated as acceptable and legitimate - is contrasted here with her inability to talk to others more generally, and her clear perception of - as a result of becoming enrolled within the abortion experience - being subject to acute moral judgment. The interview itself provided a space from within which Cara was able to articulate her experience, again, in contrast to her reported inability to speak openly about her experiences of prenatal testing and selective termination elsewhere. Cara's willingness to talk about her abortion with me, coupled and contrasted with her reported experiences of feeling *'judged and defensive'* more generally, suggests that she had experienced a need or desire – accompanied by a (socially and culturally constructed) inability however - to talk more widely about her experience. Abortion's positioning as a 'public secret' seems to have a very direct impact on the experience of prenatal testing here: Cara has been silenced by secrecy and, as she explains, this entails that she *'cant ever really articulate what it is like'*. Cara's account also points towards the power of the genetics clinic – and the power of medical care - here, in being able to confer legitimacy on such difficult and contested

decisions, and provide crucial (and rare) support to those charged with facing stigmatised and deeply problematic encounters with abortion: *'those three words. I cried. You know those words were so important to me in terms of somebody going, that's ok.*

Accounts of stigma also arose within descriptions of the professional lives of those who are most closely implicated in guiding the patient decision making process around diagnosis and abortion. Natalie, a consultant clinical geneticist, explained how she felt the prenatal field stood apart from other areas of medical practice in its willingness to deal with the 'messiness' of testing, even within the context of clinical genetics: *'I think we are quite brave as a service, in that we do the hard stuff'* (an description that very clearly echoes Bosk's (Bosk 1992, p.xiv) ethnographic account of how the genetics clinic appears as a *'mop up service'*). Natalie reflects on the particular challenges that the prenatal testing context raises, as a field that is subject to intense levels of political and moral interrogation. The language that she employs also points directly towards the contested nature of prenatal genetics - she speaks of *'emotive'* work, outcomes that can end in *'tragedy'*, experiences of being accused of *'murder'*, and describes the more difficult aspects of her prenatal work as concerning *'the death of hope'*:

> *What do you think is particular about the prenatal field?*
>
> Um, I think it's very emotive. I've had the, 'you cant murder my baby, I won't let you', you know? There's a timeframe. It can, all of it can end in the death of a baby one way or another. You get the tragedy of a much wanted baby who is affected, so you will have a woman who has had eleven, twelve, thirteen terminations because of a risk of whatever. Then you will have the other side of it where there is a baby who, everything looked fine and then suddenly there is something wrong. So it's about the death of hope, expectations. I think it's hard for the counsellors, I think it's hard to tell a woman her baby is affected. I think emotionally, you know we do tough stuff in genetics all the time, but there is something about it being a baby that's really quite hard.
>
> (Natalie, consultant clinical geneticist)

Natalie's characterisation of pregnancy loss here as being about the death of 'hope' and 'expectation' is particularly nuanced and sensitive: she avoids the pitfall of having to speak of either a baby *or* a fetus - of having to emphasise either the relational *or* the rational - and articulates instead the powerful *symbolic* meaning that the idea of a 'wanted' pregnancy, and the figure of a 'healthy' baby, holds. In doing so she points towards some of the underlying social and cultural reasons why experiences of abortion in this particular context are so contested and problematic. Elsewhere, Rachel, another genetic counsellor speaks of how she feels her patients are exposed to '*common themes of being judged'* and she describes how she approaches talk of abortion or 'termination' in the clinic with much difficulty and caution:

> And I think, it's not a nice subject, and I think how do you? And in my counselling I do say look this is not a pleasant topic to talk about, it's a very sensitive area and it's a very personal area.

Sam, a genetic counselling student who had experience of counselling patients using NIPD during her clinical placements, explicitly linked experiences of testing, abortion, secrecy and stigma in relation to the development of NIPD, exploring how women's experiences of stigma and moral judgment could come to be mitigated by the early testing opportunities NIPD technology may afford:

> If a person has the option of terminating earlier, so that people are not aware of the pregnancy it might be easier for her. You know, kind of in terms of no one has to know, and she won't have stigma attached to her. So that might be an advantage, you know, to have it in Ireland anyway, it's definitely a pro. And in the UK, I'm sure people will ask questions about pregnancy and if women will choose to terminate then. You'd like to think there is no stigma, but sometimes there is, or you know gossip- and people can take that into account when they are choosing whether or not to have a termination. How will everyone else, how will society view me if I have a termination?
>
> (Sam, genetic counselling student)

Sam had previous experience of working in Ireland (where abortion is illegal under most circumstances, including after the majority of prenatal diagnoses). She is clear that, within the context of a healthcare system where abortion remains illegal, abortion is highly stigmatised. She describes how early diagnosis, and abortion, may allow women living within such constraints to preserve the secrecy that surrounds their pregnancy: *'no one has to know, and she won't have stigma attached to her'* – it recognised here then, that within such contexts secrecy can act in a way that preserves privacy and prevents harm – where the exposure or *'revelation'* (Taussig 1999) of a secret may be problematic, then '*ignorance has its uses*' (Croissant 2014). She also highlights the heavy moral pressure that women may experience in connection with their choices, because of the politicised and controversial debates that continue to surround abortion: *'people can take that into account when they are choosing whether or not to have a termination. How will everyone else, how will society view me if I have a termination?'.* Stigma, as it is employed here, functions as a powerful resource. Talk of stigma allows Sam to frame NIPD as an opportunity to enhance 'reproductive autonomy' by constructing a need for a test like NIPD, that may mitigate against broader social harm. Such an approach, whilst offering practical advantage in an already-problematic testing context (where abortion is so heavily polarised), nevertheless contributes to – and risks exacerbating – the framing of abortion as a public secret. Whilst Sam focuses upon abortion as it is experienced in Ireland (though not exclusively), such issues were also explored in relation to the UK, and again in relation to the development of NIPD in particular.

Caitlin - who was involved in the provision of private NIPD tests - explained that talk of 'termination' had started to enter into these early clinical encounters with NIPD, and she explained that she felt this was a result of the type of demographic and clinical; information that commercial test providers had been requesting. Once again, her account of how such discussions play out explicitly links experiences of testing, abortion, secrecy and stigma in relation to the development of NIPD:

> [commercial NIPT test providers] ask things, some of it I suppose seems unnecessary- so rather than just asking about previous pregnancies they want to know how many terminations, miscarriages, molar pregnancies… And I think there is sometimes a stigma attached to- especially doing these tests when you ask, is this your first pregnancy? And if they say oh no, I have had two terminations. And then you ask why. I think just to understand how people's feelings are around them, their emotions.
>
> (Caitlin, midwife and private NIPT provider)

Caitlin characterises talk of abortion here as emotional and difficult, and she relates this very directly to the *'stigma attached'* to experiences of abortion. She expresses a clear sense of reluctance around the task of initiating talk of abortion, as she describes feeling required to prompt a conversation that *'seems unnecessary':* despite her professional familiarity with pre-test counselling for prenatal screening, abortion is experienced as a 'disruptive' issue that threatens the stability of the clinical encounter, prompting atypical and uncomfortable conversations.

Kate, one of the few interviewees who clearly and directly articulated her position on abortion, and who emerged as a politicised and dissenting voice, also explored the issue of stigma, as it is connected with abortion. Kate, however, shifted the locus of conversation away from talk of 'individual' choice and decision making around prenatal testing, focusing more explicitly upon the broader social and cultural shaping of the relationship between abortion and stigma. Within her account, Kate pointed towards not only the significance of stigma, but the potentially harmful implications of abortion secrecy, particularly as the emerging technology of NIPD extends out into mainstream prenatal testing practice:

> We'd need to do more research to get to the bottom of it. My um, gut feeling it that there's more and more of a stigma around being an abortion provider or learning the skills. It's absolutely outrageous to me that not every obstetrician and gynecologist has to learn to do a D&E. It should be a part of the basic training, but no it isn't, the RCOG[50] don't want to get involved in it… I've been talking quite a lot about it in presentations I've given and often there will be doctors that come up to me afterwards and

[50] Royal College of Obstetricians and Gynecologists

> say it's such a horrible procedure to do at fourteen weeks, and you think come on you are a bloody doctor. And you know, you say I'm not asking you personally to do it but it's- removing a gangrenous leg is pretty horrible, it's, it's part of the job. So it's political, I think the anti-choice movement have been quite successful in upping the stigma, and distaste and squeamishness about abortion in general… It's quite sensitive and ethically charged.
>
> (Kate, policy maker)

Kate very clearly suggests here that abortion is approached and constructed, by policy makers and clinicians, as something that is highly stigmatised - a *'sensitive and ethically charged'* experience. She claims that the *'stigma and distaste and squeamishness'* that surrounds the practice of abortion is heavily institutionalised within UK medical practice, being present at both the organisational level - *'the RCOG don't want to get involved'* - and the personal level - *'there will be doctors that come up to me afterwards and say it's such a horrible procedure to do at fourteen weeks'*. Given, then that Kate appeared as one of the very few people who were able to talk directly of 'abortion' within the accounts provided by interviewees across the board, the data generated here (though it is a very small sample and may not be treated as representative) would seem to provide support for the claim that abortion, despite its centrality within the practice of prenatal testing, is approached with much reluctance and 'squeamishness'.

A number of interviewees made comparisons with differing political and legal contexts that surround abortion as it is practiced outside the UK. Such comparisons highlighted the presence of alternative discourses around abortion, and pointed towards how abortion secrecy and (non)talk relates closely to broader social and cultural considerations. Sam had spent a long period of time in Ireland (where abortion is illegal under most circumstances, including for the vast majority of prenatal diagnoses), and she described how her understanding of abortion had been shaped by her exposure to an education system that actively encouraged talk of abortion:

> I remember even growing up… we were taught about terminations from a really early stage, I was thirteen, fourteen and shown images of it. And I think growing up in- it's funny but I think in Ireland we have a better understanding of terminations because we are told you know, this is not what you do, and maybe we are a bit more educated on terminations than you are over here, because it is an option.
>
> (Sam, genetic counselling student)

Sam's account seems to throw into question the idea that abortion secrecy may unproblematically and consistently be experienced and understood as harmful. She explains that where access to abortion is routine (in the UK), there exists a corresponding

lack of knowledge (and a high level of secrecy and silence) around abortion. Contrastingly, she reports that there is a greater knowledge of abortion where access is denied, because people are actively *'told, you know, this is not what you do'.* Where abortion is so clearly politicised and made publically problematic then, it is explicitly *not* a matter of secrecy or silence. This may suggest that abortion secrecy, as it operates within the context of cultures where abortion is made a contentious and problematic 'concern', may function in a way that protects rather than harms those that face personal entanglement with such issues.

Professional anxieties: the routinisation of NIPD (and NIPT) and its alignment with abortion

Within the previous chapter I explored the implications of a persistent and notable shift that has occurred in the field, from talk of NIPD to talk of NIPT, and I connected this shift to practices of division, classification and categorisation. Established categories of 'screening' and 'diagnosis' were invoked, as both clinical and scientific experts compared NIPD with trusted and routine technologies, and examined specifically the *accuracy* of NIPD. As they discussed at length the meaning of NIPD's relative accuracy or inaccuracy, experts explored complex questions regarding how NIPD may fit into, or how it may trouble, established boundaries and disrupt associated clinical practices. The potential collapsing of the boundary between NIPT/screening and NIPD/diagnosis was also frequently discussed in relation to practical, moral and political 'concerns' and 'worries': experts problematised the collapse of such boundaries, making repeated reference to the potential routinisation and normalisation of NIPD.

Those involved in the development and provision of NIPD/diagnosis explicitly described tests for Down's syndrome as tools for screening and not diagnosis, stressing that if NIPT tests were to give a 'positive' result, indicating the presence of Down's syndrome, then such results ought to be 'backed up' by repeating the testing process using routine and trusted (but 'invasive' and potentially harmful) technologies such as amniocentesis or CVS. The possibility that women might seek 'termination' on the basis of NIPT Down's syndrome testing alone was repeatedly raised as an issue of concern, and gave rise to much anxiety: experts were highly apprehensive about NIPT's increasing closeness to, and possible alignment with, the practice of abortion.

A number of NIPD scientists raised this issue directly during interviews: Chloe, who was working on the UK-based development of NIPD, expressed her concern that *'because NIPT is a screening tool there would be a real risk that if somebody got a positive result they would go an have a termination, they wouldn't have an invasive test for confirmation'*. Beth,

another scientist working in the NIPD field, acknowledged that although the test was not diagnostic, because of its high level of accuracy*, 'although its only a blood test the implications are just as great as having an invasive test'.* Particular anxieties were raised around the potential generation of 'false positives', which could, if diagnostic testing was not sought as back-up, result in the termination of healthy fetuses:

> So the false positive rate, we can kind of cope with by offering women an invasive test to confirm and I think that should be, for the time being, good practice. Whether we would figure that, I don't know, it would be horrible if someone aborted a baby on the basis of a false positive result.
>
> (Beth, NIPD researcher)

Throughout many expert interviews the looming presence of 'false positives', and the possible demise - through 'therapeutic' abortion - of 'healthy' babies arose as a source of much anxiety and concern. It became clear that more powerful 'dividing practices' were being achieved through NIPT's enrolment within prenatal screening particularly – the figure of the healthy fetus/baby/pregnancy (constructed as vulnerable and valuable) was divided from the figure of the 'affected' fetus/baby/pregnancy, which was constructed as an object or an outcome to be systematically identified and, potentially, 'disposed'. This underlying (normative) division, between the 'healthy' and the 'affected', is foundational to the practice of prenatal screening, and came to inform much of the discussion and debate around NIPD. The implications of such conversations are explored in more depth within chapters six and seven.

The ambiguity and uncertainty that remains attached to NIPT, as it enters the clinic as a 99.9% accurate (but not 100% accurate) test, which 'troubles' the boundary of screening and diagnosis, leads to much professional anxiety from within clinical genetics, around potential loss of oversight and expert guidance regarding women's decision making around prenatal diagnosis and abortion. The presence of such professional identity-work, which (when successful) maintains a space for clinical judgment and expertise, echoes Latimer's account of the dysmorphology clinic, another space within which *'moments of ambiguity and undecidability create a space of deferral that legitimates the need for more expertise and more technology through which to differentiate the genetic and fix diagnoses'* (Latimer 2013, p.200).

As Natalie, a consultant clinical geneticist and head of the prenatal section of a regional genetics service, discusses her thoughts on the development of NIPT for Down's syndrome, she voices a clear sense of frustration and concern at what she views is the most likely path NIPT technology will take; the routinised and widespread application of testing within NHS-based prenatal screening services:

> Services have no business doing it unless they can manage the fallout, and I think that is the trick that everybody is missing, because we are certainly not going to step in and mop it up, they can sod off frankly. And I think this is where society and the NHS are not getting it. That if, you know it's like the Down's syndrome screening, and if, believe me it will go to the least qualified person in clinic, that's where it will end up. And that's fine, cos we are not mopping it up. Because we can't, we haven't got the hours to do it. And we will stick to, to rare diseases and, and I think it's a real shame, I think it's a real shame.
>
> (Natalie, consultant clinical geneticist)

Again, Natalie draws on the metaphor of 'messiness' to highlight in particular the difficult and challenging character of the genetics clinic (Bosk's *'mop up service'*) – a space which, she fears, may come to be managed (and perhaps colonised) by those without the appropriate and required expertise. As genetics professionals problematise the possible 'routine' and 'normal' future application of NIPT in particular, they extend their criticism beyond the discussion of the technology at hand, expressing much frustration at how *current* Down's syndrome screening is managed in the clinic. They speak of being *'aware of how flawed the Down's syndrome counselling is'* and describe fears regarding the possibility that the task of providing NIPD for Down's syndrome testing *'will go to the least qualified person in the clinic'* – a critical and dissenting position that is nevertheless very well supported by the findings of recent ethnographic work examining the provision of routine Down's syndrome screening in the UK clinic (Thomas 2014). Although these experts are approaching NIPT from within the clinical genetics community explicitly - a space where (rare and serious) 'at-risk' pregnancies are managed, and the need for diagnostic certainty is accordingly high – and a location within which concerns around the routinisation of counselling, a highly-valued practice within the genetics clinic, might be expected, similar accounts were also provided by scientists working within NIPD research:

> You think, with the Down's syndrome screening because it's- it's staggered, it's not so important, because by time you get to the point where you are having an amnio you know you are at high risk, you've been counselled, you've had everything. Whereas if we start just bleeding somebody, and then say da-da! Sorry, you've got Down's syndrome. That might be bang- might sort of smack them in the face. So this kind of- although it's only a blood test, the implications of that are just as great as having an invasive test.
>
> (Beth, NIPD scientist)

Beth's account mirrors those provided by Lucy and Natalie, and she draws the discussion back, once again, towards the contingency that surrounds the NIPD/NIPT divide: *'the implications of that are just as great'.* Within this account, fears over routinisation are explicitly connected to the potential collapsing of the screening/diagnosis boundary – NIPT testing is presented as an activity that may hold unexpected and difficult

implications: *'that might be bang- might sort of smack them in the face'.* As anxieties around the routinisation of NIPT were repeated across expert accounts, it became clear that a deeper level of anxiety lay beneath the surface. Accounts provided by clinical geneticists and scientists alike began to point towards a sense of profound discomfort and unease around NIPT's clear potential to raise concerns around more broad-ranging social and cultural issues such as an intolerance of disability, constraints on reproductive 'choice', and the widespread normalisation of genetic diagnosis:

> I do wonder if there will be a shift- well it wasn't interventional, you weren't going to put your pregnancy a risk, so why didn't you have the test?... There's much more sympathy and understanding for that position, when yes, she could have lost a healthy baby. Whereas you are not going to put the pregnancy at risk from the new technology, and therefore the question is why didn't you have it? So is there going to be less tolerance of disability, and less tolerance of not testing? I don't know.
>
> (Rachel, genetic counsellor)

Here, it is NIPD and NIPT's non-invasiveness, its departure from routine technologies of prenatal diagnosis, that prompts such acute concern. Whilst the 'invasiveness' of current testing is seen to act as a kind of barrier to widespread utilisation of prenatal diagnosis, NIPD and NIPT circumnavigate such boundaries, and in doing so, potentially place the issues raised by 'selective' or 'therapeutic' abortion – the potential exacerbation of *'intolerance'* around disability, and the associated commodification and 'perfectionism' of human life - on a far greater scale (the discussion of such issues is explored in greater depth within chapter six). Elsewhere, issues regarding the potential routinisation of NIPD and NIPT tests that expand far beyond the current scope of routine prenatal testing (but which are, increasingly, being made real – see chapter two) are explored:

> *And how would you imagine the state of NIPD science to be in five years time then?*
>
> I don't know it's a bit scary in some ways because um, like being able to sequence a whole genome, which they have shown that they are able to do, and then what do you? What do you tell someone about that, and what do you actually use it for? And what's important you know, do we really need to be investing so much in doing that? So, but I can easily see it going that way, when you speak to women about what is important to them and they sort of say they want as much information about their baby as possible, and so if you offer them a test and say well we can tell you everything, as if they are going to say no (laughs). You know, they will feel pushed into, to saying yes, I want to consume that, if it's available I want it, so.
>
> (Emily, NIPD researcher)

The account presented in this thesis, along with other critical accounts, highlights the deep and powerful alignment that exists between the fields (and values) of healthcare, bioscience and capital, which in turn facilitates the rapid and successful enrolment and

translation of testing in the clinic. Within Emily's account, however, it is parents (and not developers, commercial providers, or clinicians) who are figured as enthusiastic (if somewhat coerced – '*pushed*'), 'consumers' of this new prenatal testing technology. Emily mobilises powerful discourses of reassurance and risk (Lippman 1991), and suggests that the parents who want to know *'everything'* mobilise them too, as part of *their* quest to find *'as much information about their baby as possible'*.

Again, NIPD and NIPT's non-invasiveness, coupled with its clear potential for expansion in technological scope and in volume of use, prompts anxiety and concern around the future – and specifically because it is so closely connected to the practice of abortion. It is only through the exercise of 'selective' or 'therapeutic' abortion that NIPD threatens to diminish tolerance of disability (by facilitating selection against 'affected' fetuses) and it is only through the connection to selective abortion that widespread genetic testing via NIPD might come to raise concerns such as those outlined by Emily here (by expanding the range of conditions and diseases that are made legitimate for 'disposal'). Emily asks here - *'what do you use it for?'* - but she does not suggest an answer, and she avoids making the connection with abortion explicit. Researchers elsewhere, however, make the connection clear: Chloe (an NIPD researcher) for instance, explains that *'because NIPT is a screening tool, there would be a real risk that if somebody got a positive result they would go and have a termination, they wouldn't have an invasive test for confirmation',* suggesting that the root cause of anxiety around NIPD and NIPT's routinisation lies in the 'risk' of women choosing abortion without confirmatory diagnosis via routine, normal, trusted technologies of diagnosis, and therefore *without medical legitimisation.*

Kate, who was involved in the very early discussion of NIPD policy, and who had regular professional contact with women making decisions regarding prenatal diagnosis, suggested that such 'risks' were, in fact, very likely to manifest in practice:

> There will be those women that say, stop, I want to get off, I can't do this, I cannot go through these weeks and weeks of anxiety to be you know, for that to stay with me potentially after birth… and they say no I'm going to terminate on the strength of what is uncertain information.
>
> (Kate, policy maker)

Bryant, discussing the potential psychological effects of NIPT's routinisation within prenatal screening programmes, questions the practical and moral validity of asking women to pass through further processes of medical 'legitimation' in order to access abortion after a 'positive 'NIPT result, suggesting that:

> If NIPT is added to the current NHS screening test repertoire as a contingent test, this would, however, mean that some women will undergo

> four prenatal testing procedures before receiving a definitive diagnosis: a nuchal fold scan and a blood test, a NIPT test if the result is higher than the cut-off risk, and a subsequent invasive test if they receive a positive NIPT result. For some women, termination of pregnancy may actually take place at a later stage in the pregnancy than with current screening protocols.
>
> (Bryant 2014)

Accounts provided here by women who had used NIPT tests for Down's syndrome (via private UK clinics) seemed to point towards a possible future within which many of these professional fears and anxieties around the routinisation or normalisation of 'selective' abortion may be realised. Alana, a private patient, had used NIPD after having experience of private prenatal care within previous pregnancies. The pathway taken to NIPT technology was largely unproblematic for Alana: testing took place within a clinic she trusted, and involved a professional team with which she had already been made familiar. She was interviewed during the third trimester of her pregnancy, after having received *'screen negative'* NIPT results (Alana was told that the test had a one in 10,000 'risk' of error). Whilst Alana was positive about the testing experience overall, as she recounted the time spent waiting for results, she described the anxieties that had, at that point, come to the fore:

> You know, it doesn't matter how bad the disease is if you come back with low risk, does it? It's only if it comes back as high risk, that you start looking into it more... But it is a relief when you get your results through, and they all say low risk. Even though you didn't really know that you were anxious before. I don't think you realise how anxious you are about it until you get your results. And the phone rings and they say oh it's the clinic with your results, and at that point you kind of hold your breath, and it's at that point you kind of realise you were worried about it.
>
> (Alana, private NIPT patient)

Many professional anxieties around NIPD and NIPT's routinisation are realised here: Alana approached and passed through testing with very little knowledge of the diseases tested for, she did not place any particular value on the experience of pre-test counselling (suggesting that *'it's only if it comes back as high risk, that you start looking into it more'*) and experienced much anxiety and uncertainty as she waited for results.

Strathern suggests that *'alongside innovations in reproductive medicine come innovations in the way people turn them to their own ends'* (Strathern 1999, p.10), and within the accounts of NIPD examined here we have an example of how the anticipation of such phenomena - the shaping of an emerging prenatal testing technology by the patients who make use of it, rather than the clinicians and scientists who are directly involved in its development and application – greatly exacerbates professional anxiety around the test's

possible routinisation and normalisation. Within this context particularly, the stakes are already high: innovative *prenatal testing* technologies and practices raise issues around the 'selection' of fetuses, babies, and pregnancies, and the sorting and dividing of the population into categories of 'normal' and 'abnormal', 'healthy' and 'diseased'. Anxieties around the routinisation of NIPD also belies a deeper, and (in the majority of circumstances) concealed, anxiety around the potential routinisation of *another* prenatal technology: that of selective abortion. NIPD and NIPT's characterisation as a powerful technology, holding the potential to bring (near) diagnostic prenatal testing - and with it choices regarding selective abortion - to the pregnant population at large, begins to emerge. Such anxieties, in turn, point towards NIPD's potential routinisation to become a significant exercise in Foucauldian 'biopower':

> We should understand the society of control… in which mechanisms of command are ever more "democratic", ever more immanent to the social field, distributed throughout the brains and bodies of citizens. The behaviours of social integration and exclusion proper to rule are thus interiorized within the subjects themselves
>
> (Hardt and Negri 2013, p.216)

As technologies such as NIPD continue to become enrolled and translated into clinical practice - entering into the lives of 'high risk' women receiving specialist care in the form of diagnosis, and 'low risk' women seeking extra reassurance in the form of near-diagnostic prenatal screening - and as they begin to translate within the context population-wide screening programmes, they become internalised, embedded in the lives of all pregnant women, as they each become enrolled within systems of routine, repeated, and normalised clinical practice. The accounts highlighted here do not limit themselves to a narrow discursive focus around individual choice, autonomy and reproductive freedom: both experts and patients alike contemplate the broader *cultural* values that encounters with NIPD elucidate, and as such, the (bio)political power that NIPD and associated technologies and practices possess becomes increasingly clear.

Summary

Within this chapter I show how talk of abortion appeared as central within participant accounts of NIPD, being deeply problematised, and arising within a broader social and cultural context where the politics of abortion is an on-going matter of (polarised) debate and discussion. I show how the language with which participants approached the topic was problematic, and how talk of abortion was only rarely direct and clear – within the majority of participant accounts it emerged as a source of discomfort and uncertainty,

brought to the fore only within the context of related, and not direct, discussions. In order to illuminate the particular kind of difficulty with which abortion conversations were approached I draw from Taussig's concept of 'the public secret' – that which is generally known but cannot be articulated. I also highlight the prevalence of abortion secrecy within some of the relevant critical literature, and show how it has been widely conceptualised as harmful.

I proceed to highlight the relevance of the 'therapeutic gap' to the discussion of abortion and prenatal testing, describing how practices of prenatal screening and diagnosis operate within a wider clinical context where opportunities for treatment, beyond 'therapeutic' abortion, remain rare. I then highlight participant accounts of 'abortion secrecy', demonstrating the profound difficulties that abortion experiences – in connection with prenatal testing – may (and do) bring to pregnant women and mothers who must approach such experiences from within a social and cultural context that prevents open and direct discussion (and which is made more problematic by the vague and faltering language that is employed within mainstream discussion and debate). I show then how difficult experiences of 'stigma' are both connected to, and exacerbated by abortion secrecy, highlighting some of the more 'difficult' accounts provided by women here.

Within the final part of the chapter I explore the anxieties that are raised by professionals and experts regarding the possible routinisation of NIPD (and NIPT) and its growing alignment with routine (rather than specialist) testing, and the associated practice of 'selective' abortion. I show how NIPD's growing closeness to abortion generates much professional 'concern' and leads to rising tensions regarding the possible ethical, social and (bio)political implications of testing, the discussion of which is explored in greater depth within the following chapters (six and seven).

Chapter Six. NIPD and NIPT: Accounting for Social and Moral Implications.

Introduction

In the preceding two chapters I show how, as experiences with and understandings of NIPD and NIPT tests are explored by those encountering the technology as it is enrolled and translated within the clinic, a number of established categories and boundaries (which have been previously constructed around routine, everyday technologies of prenatal testing) are, repeatedly, called into question. The active problematisation and de-stabilisation of categories and boundaries occurred as participants both witnessed and reflected on NIPD technology's divergence into two different strands. Expert participants, particularly those with a clinical or scientific background, explained how two separate developmental trajectories were (within the mainstream/public discussion of NIPD particularly) being defined and (tentatively) separated through tests' respective categorisation as either tools for diagnosis (NIPD) or tools for screening (NIPT). Participants' awareness of the high levels of accuracy that could be achieved through NIPT testing (an emerging class of tests that achieve almost, but not quite, 100% sensitivity and specificity), particularly when examined in comparison with (and in the light of much professional experience with) established prenatal screening technologies, acted to disrupt attempts made towards a simplistic, binary process of categorisation: in and around discussions of NIPD (and NIPT) the boundary between screening and diagnosis became resolutely blurred. With the stability of screening and diagnosis categories acting as the foundation upon which routine practices crucial to prenatal care - the categorisation of pregnancies into 'high risk' and 'low risk', the division of labour in the clinic, the selective application of diagnostic 'invasive' testing – had been built, this sustained blurring of boundaries presented further (disruptive) implications. The prevailing discursive separation of prenatal screening from prenatal diagnosis, coupled with the construction of separate classifications for technologies of screening and technologies of diagnosis, had allowed for practices very closely associated with prenatal *diagnosis* – 'selective' or 'therapeutic' abortion – to be separated from the practice of prenatal *screening*. NIPT's accuracy, together with its growing applicability (and rapid accessibility) within 'low-risk' pregnancies, *and* its potential for widespread application within whole pregnant populations, was seen to further disrupt *this* boundary – moving the practice of abortion, which experts, patients and parents alike characterised and experienced as contentious, stigmatising and politically problematic, a kind of '*public*

secret' (Taussig 1999) - closer towards the routine practice of prenatal screening and, by extension, everyday experiences of pregnancy. Building on this, within the following chapter I show how the sustained blurring of the boundary between screening and diagnosis brings with it further complexity, and further problematisation, and I show how a wide range of participants navigate the growing debate that has opened up around a number of morally, socially and politically significant issues connected to the development of NIPD.

The potential social and moral significance of NIPD-like testing was discussed with prescience within Barbara Katz-Rothman's study on the emergence of amniocentesis (Rothman 1994). Speaking at a point when non-invasive diagnostic testing was an established goal within fetal medicine, but was yet to become practically feasible, Rothman suggests that many of the issues which were central to the critical examination of early encounters with amniocentesis – the risk of miscarriage, the timing of testing within pregnancy, the high level of clinical skill that testing required – would, if non-invasive testing were to arise in the clinic, cease to dominate discussion and debate around prenatal testing:

> I think that an early blood test will strip the problem down to its bare bones. I think it will take us past questions of risk, of date and technique, to confront the essential moral and ethical issues. It will take us straight to the meaning of motherhood, the ethics of abortion, and the human ability to control nature.
>
> (Rothman 1994, p.79)

The suggestion that NIPD's enrolment within the clinic, when examined critically, would not simply shed light on new techno-scientific and clinical practices, but serve to reveal and render public the '*essential moral and ethical issues*' that may be raised by technologies and practices of prenatal testing, plays out very clearly within the personal and professional accounts of NIPD gathered here. This chapter explores participant accounts of the moral and social issues they feel are raised by experiences with, and imagined futures for, NIPD (and NIPT) testing. As interviews progressed, and as participants explored in greater depth the possible implications of NIPD, much talk around 'ethical' and 'social' 'issues', 'worries' and 'concerns' was generated. Interviewees began to both explicitly and implicitly characterise NIPD and NIPT testing technologies as being not only of practical and clinical significance, but of moral and political significance too. The 'public secrets' rendered visible here – experiences of abortion, the embeddedness of abortion within prenatal screening and the inherent 'selectiveness' of screening programmes – were identified and explored as sites of particular moral and political instability and debate.

> Let me start with Callon's observations on what he calls hot entanglements. These are conditions of extreme overflowing as one might end in crises or dilemmas that seem to have many ramifications. And the usual remedy, making more and more elements of the situation explicit, often makes hot things hotter.
>
> Not only are 'hot' situations becoming more commonplace, it is becoming exceedingly difficult to cool them down, i.e., arrive at a consensus on how the situation should be described. . . Externalities are at the centre of public debates [i.e. the focus of them] with no obvious conclusions.
>
> (Strathern 2002), p. 254, drawing on (Callon 1998), p.262 – 263.

Building my analysis here around concepts mobilised by Strathern (Strathern 2002), as she draws from the work of Callon (Callon 1998) - 'hot' situations and 'hot' entanglements - I show how NIPD and NIPT testing is approached critically within the majority of participant accounts gathered here: the technology is thoroughly problematised and is identified as disruptive - it is explicitly *not* experienced and understood as a benign extension of the routine, normalised practice of prenatal testing. I show how participants very clearly identify the presence of 'hot' entanglements within the discussion of NIPD at large - moral and social dilemmas with multiple ramifications, and with '*no obvious conclusions*'. Tracing the contours of mainstream bioethical discourse around prenatal testing and NIPD, and showing how different groups variously align with and challenge such perspectives, and I also show how, despite concerted efforts to contain these 'hot' issues, a range of moral and social 'concerns' continue to be problematised, and debates remain far from defused.

To frame the discussion, I begin by showing how a particular type of moral discourse has, being circulated and re-circulated, come to dominate mainstream bioethical debate on prenatal testing and, alongside this, the growing public discussion of NIPD. I then examine participant accounts in light of the recognition that within any broad or public discussion of ethical and social issues a range of different groups (each with varying levels of influence in the debate) tend to emerge: *'views and attitudes create 'groups' of their own, minorities and majorities based on the opinion they hold'* (Strathern 2002, p.258). I divide, therefore, the analysis of participant accounts here into three broad categories: 'insiders', 'critical users' and 'outsiders'. I show how 'insiders', expert interviewees whose professional lives were very closely tied to the development and implementation of NIPD in the UK, and who have a correspondingly strong voice within the public discussion of the technology, account for the ethical and social dimensions of the technology in a way that very closely aligns with mainstream bioethical discourse. I proceed then to show how 'critical users', those who encounter NIPD within the context of their professional lives, but who are less closely involved in research and development, and whose voices are

positioned less centrally within the public debate, approach the technology with greater ambivalence and begin to extend the critical argument out, identifying and examining a broad range of moral and social 'concerns' that tend to be marginalised within mainstream bioethical discourse. Finally, I show how 'outsiders' - those without direct experience of NIPD - and whose voices lie furthest from the foreground of public debate, thoroughly problematise NIPD technology, approaching and exploring a range of morally and politically contentious issues, and pointing towards the clear and persistent presence of 'hot' entanglements.

Mainstream bioethical discourse, prenatal testing, and NIPD.

'Mainstream bioethics' is typically concerned with the ethical analysis of scientific and technological developments in Western medicine (Konrad 2005, p.37). Within the public discussion of the 'new genetics' in particular, the rhetoric of mainstream bioethics has emerged as central (Caulfield, Chandrasekharan et al. 2013), with bioethical perspectives having been actively sought from the very earliest stages of research and development in this field. As the NHGRI[51] established its multi-national scientific research programme concerning the 'decoding' of the human genome, for instance, a comprehensive Ethical, Legal and Social Implications (ELSI) Research Programme was initiated alongside, with the specific aim of generating and incorporating into practice (and corresponding regulation) a range of expert opinion on the ethical, legal and social dimensions of this emerging field of 'the new genetics'. Although the NHGRI's ELSI programme eventually attracted criticism for failing to tackle fundamental moral problems (Kerr and Shakespeare 2002, p.164), it provided a successful model for much of the large-scale research and public engagement activity that would be conducted around the 'new genetics', and was foundational to the character and the content of subsequent mainstream bioethical discourse around the ethical and social dimensions of bio- and techno-science (Latimer 2013, p.41). Contemporary public debates around the moral, social, legal and political implications of emerging technologies typically involve a broad range of participants or 'stakeholders' (Green, Guyer et al. 2011, Oliver and McGuire 2011). Effort is made to include voices from beyond the scientific and technological context, and as novel technologies develop, a range of 'public opinion' (and public

[51] The National Human Genome Research Institute (USA) was first established in 1989 to represent the National Institutes of Health (NIH) within the International Human Genome Project (HGP) which had as its primary goal the sequencing of the human genome. Since the successful completion of this project the NHGRI's mission has expanded to encompass a broad range of studies aimed at understanding the structure and function of the human genome and its role in health and disease. (National Human Genome Research Institute 2015)

support) is sought alongside (or prior to) the application of novel technologies within established systems or institutions. Bioethics has become integral to the political management of emergent techno-scientific developments, with advisory bodies such as the Nuffield Council on Bioethics - which exists to *'identify and define ethical questions raised by recent advances… promote public understanding and discussion… form new guidelines… publish reports and to make representations'* (Nuffield Council on Bioethics 2015a) - becoming embedded within the processes that shape the regulation and standardisation of novel technologies. Accounts of public opinion are gathered, generated and reproduced (in the form of enquiries, reports and clinical guidance) through the work of various advisory and regulatory bodies – institutions charged with the dual task of a) representing public opinion and contributing to consensus concerning controversies in science, and b) providing expert bioethical advice and negotiating policies that will be acceptable to scientists and their patrons (Kelly 2003, p.356). Although bioethics may tell '*a heroic story about its origins and purpose'* it has been suggested that mainstream bioethical approaches may have come to be so closely aligned with political and regulatory processes that the field has *'moved from occupying the perspective of a critical outsider to enjoying the status of a respected insider, whose primary role is to defend existing institutional arrangements and its own privileged position'* (Haliburton 2013, p.1).

The sedimentation of mainstream bioethics within contemporary scientific, clinical and technological research has, since the advent of professionalised and institutionalised ELSI research particularly, attracted much critical discussion from within the fields of medical sociology, science and technology studies and critical anthropology. Noting the *'huge proliferation of bodies concerned with ethics'* Strathern suggests that mainstream, institutionalised bioethics is explicitly *not* concerned with expanding and fostering public debate around the *'constantly overflowing'* situations that novel technologies and practices produce, but rather, operates as a tool that defuses and '*contains*' the more contentious aspects of the discussion at hand (Strathern 2002). Contemporary mainstream bioethics may be understood then, not as an inventive force, but as a passive, responsive exercise that, when it makes effort to address the issues raised by scientific and technological research, does so after the fact (Konrad 2005, p.32). A growing number of commentators have highlighted the problematic political implications that such an approach implies. Evans, for instance, suggests that processes of professionalisation and institutionalisation, which have been observed to occur widely within bioethics as its regulatory role has flourished (Kerr and Shakespeare 2002, p.161), contribute significantly to the reduction and 'thinning' of public debate:

> A bigger, deeper, more fundamental or "thicker" debate has been replaced by a smaller, shallower, more superficial or "thinner" one… the debate has

> been restricted to only a few institutionalized ends. At a time when we should be attempting to derive societal ends, we have shifted decision making to the autonomous individual...
>
> The professionals who debate this topic are not so free. They are operating with a very constrained list of universal, commensurable ends that have become institutionalised by the dominant profession in the debate.
>
> (Evans 2002, p.4, p.11)

Evans' assertion that mainstream bioethical debate has become seriously impoverished, to the detriment of critical discourse around broader '*societal ends'*, is also echoed elsewhere. Feminist theorists in particular have pointed towards the paucity of debate within contemporary mainstream bioethics, claiming that the ascendancy of individual autonomy as '*almost the only value of importance within mainstream bioethics*' has made it particularly difficult to illuminate and assert the contextual and social aspects of the discussion at hand (Widdows 2009, p.98). These critics show too, how the dominance of this narrow field of vision can entail significant implications, with mainstream bioethical views concerning issues such as sex selection or the international trading of gametes/eggs (Pfeffer 2011) serving '*to justify what is overt gender discrimination and exploitation on the grounds of individual choice*' (Widdows 2009, p.98). Elsewhere it has been suggested that the narrowing of bioethical debate, the privileging of certain voices over others and the persistent '*institutionalization of norms*' (Jelsoe et al. in Bauer and Gaskell 2006, p.45), holds significant (political) power:

> The institutionalisation of bioethics raises serious problems concerning the development of public debate… there is the serious danger of supressing the diversity of ethical opinions… and, instead imposing upon society the 'ethics of the scientific establishment.
>
> (Galloux et al. in Bauer and Gaskell 2002, p.146)

Cunningham-Burley and Kerr (Cunningham-Burley and Kerr 1999) recognise in particular that those closest to emergent technologies – the scientists and clinicians involved in early development and use – have become '*powerful players'* within bioethical discussion and debate, being able to influence discussions around the implications of technological developments, and by pointing especially towards '*beneficial applications'*.

Scholars have reflected critically on the historical construction of UK bioethics, explaining how the location of biopower – exercised here in the form of 'expert ethical opinion' - has shifted as a result of bioethicists' growing cultural influence: '*bioethicists now play an equal and sometimes greater role than doctors and scientists in publicly discussing the ethics of issues such as assisted dying, embryo research and genetic engineering'* (Wilson 2014, p.257). Such critics describe how the field of bioethics has contributed to the growth of a

'cultural' biopolitics, where ethicists contribute directly to the shaping of the moral dimensions of bioscience and biotechnology (Salter 2004), guiding the way in which mainstream debate and discussion is established and conducted. The influence of mainstream, institutionalised bioethics, its power located within '*publically accountable regulatory mechanisms'* coupled with continuing efforts made to extend the '*public control of science'* (Evans 2002, p.72), is particularly and acutely evident within the public debates around reproductive technology and reproductive medicine, and within the significant proliferation of governance and regulation in the area. As she critically examines development of the Human Fertilisation and Embryology Act (HFE Act), Franklin demonstrates how, as In Vitro Fertilisation (IVF) and related reproductive technologies gained momentum in both the lab and the clinic, a corresponding increase in the scale and volume of governance and regulation very quickly occurred alongside:

> Like nature society will not tolerate a vacuum. Parliament has succeeded in its aim, by enacting laws, to fill the 'legislative vacuum' surrounding embryos. Yet by so doing, the vacuum is not dissipated, and instead proliferates… In the end, it is not the embryo, but scientific progress which requires regulation.
>
> (Franklin 1999)

Reproductive futures were then, within this new technological context, seen to raise complex and unfamiliar issues, explicitly requiring both legislative and institutional control (Franklin 1999, p.163). In order to address these concerns the UK government commissioned, and later published, a report on the ethics of IVF technologies (Warnock 1984), and in contrast to the way IVF technology was presented by those involved in research and clinical implementation - as a treatment that promised to relieve painful experiences of infertility for 'hopeful', 'desperate' women and couples (Franklin, 1990, p.200) – this report foregrounded IVF technology's potentially-disruptive power, exploring the moral and political scope of the questions that they raised. Responding directly to the results of the Warnock enquiry, a new advisory body - the Human Fertilisation and Embryology Authority (HFEA) - was created, and from (1991) began to '*assert a strong regulatory regime'* around the development and use of reproductive technologies (Franklin and Roberts 2006, p.60).

NIPD technology is, then, emerging in an era where the regulation and governance of reproductive technologies has become thoroughly normalised. With much of the bioethical debate *'safely cordoned off'* within ELSI research programmes that do *'little to challenge practices and professional values'* (Kerr and Shakespeare 2002, p164), it is also emerging into a space where the mainstream discussion of (bio)ethical and social issues is subject to a range of reductive processes, which serve to produce a debate that is remote

and removed from experience, lacking in context and relationality, and is informed by a narrow focus on established and explicitly rational bioethical norms such as 'autonomy', 'informed consent' and 'individual choice' (Evans 2002, p.11, Chattopadhyay and De Vries 2008, Widdows 2009, Haliburton 2013). The wider influence of this mainstream bioethical approach is evident within much of the literature that addresses the ethical and social issues raised by prenatal testing. Whilst a significant body of empirical work has been conducted around parental attitudes towards and experiences of prenatal testing (Dormandy, Michie et al. 2005, van den Berg, Timmermans et al. 2005, Chiang, Chao et al. 2006, van den Berg, Timmermans et al. 2006, Favre, Guige et al. 2009, Rowe, Fisher et al. 2009, Aune and Moller 2012, Skirton, Goldsmith et al. 2014), analysis of ethical and social implications here tends to rely upon established bioethical norms of 'informed consent', 'reproductive autonomy', 'informed decision making' and 'informed choice'. Similarly, studies of parental decision making regarding prenatal testing have depended on a narrow framing which privileges the value of rationalised concepts such as 'autonomy' and 'informed choice' (Green, Hewison et al. 2004, van den Berg, Timmermans et al. 2008, Harris, Franck et al. 2012). The concept of the autonomous *individual* dominates and frames the discussion of prenatal testing's moral and social dimensions then, with the result that rational decision-making processes are foregrounded and given core value. Although many more critical accounts of the broader cultural implications of prenatal testing have been produced (Duster 1990, Rothman 1994, Clarke 1997, Rapp 1999, Shakespeare 2006, Kelly 2009, Thomas 2014), this body of work remains positioned outside mainstream bioethical discourse, and the issues that are raised – the commodification of life, the practice of 'backdoor' eugenics via routine application of selective abortion, the responsibilisation of parents, and the persistent limitation of reproductive 'choice' – remain at the margins of public debate.

As powerful discourses of autonomy/individualisation and rational/informed choice have been repeatedly mobilised within the mainstream bioethical debates on reproductive technologies they have also greatly informed the broader context within which NIPD and NIPT's development has been most publically discussed. The division between mainstream bioethical discourse and more critical accounts of testing, together with the privileging of the former within public debate, is particularly evident within the small (but growing) body of literature that has been published around the ethical and social dimensions of NIPD and NIPT. With NIPD research attracting a significant amount of public funding within the UK and Europe particularly (and with the technology's development being more commercially-focused within the USA, China and Hong Kong) the majority of studies examining the social and ethical dimensions of NIPD have emerged

from within these locations. Much bioethical research around NIPD has been produced as a direct result of large publically-funded research programmes (RAPID, SAFE[52]), which incorporated ELSI work-packages into their original research design and have produced a variety of publications as a result (Newson 2008, Deans and Newson 2010, van den Heuvel, Chitty et al. 2010, Hill, Compton et al. 2011, Deans and Newson 2012, Hill, Compton et al. 2012a, Lewis, Hill et al. 2012a, Hill, Lewis et al. 2012b, Lewis, Hill et al. 2012b, Lewis 2012c, Deans, Hill et al. 2013, Hill, Karunaratna et al. 2013, Hill, Compton et al. 2014a, Lewis, Hill et al. 2014a, Lewis, Hill et al. 2014b) – an approach that has not been mirrored by commercial organisations involved in NIPD research. Although a small number of explicitly critical studies (from scholars working outside of the remit of NIPD research programmes) have been conducted around the ethical and social implications of NIPD, and have identified the presence of more contentious issues relevant to a broader public debate - including the potential *'eradication of Down's syndrome'* (Skotko 2009), the devaluing of those with disability (Newson 2014) and the possible commercialisation and 'trivialisation' of NIPD testing (Kelly and Farrimond 2012, Farrimond and Kelly 2013) - these studies are much fewer in volume and, again, remain positioned outside the mainstream of debate. Within the more institutionalised examination of '*stakeholder perspectives'* and '*client and professional views'* the locus of discussion is once again around issues such as 'informed consent', 'informed choice' and the associated value of practices such as 'pre-test counselling', 'education' and 'training'; recommendations designed to ensure practical and visible compliance with a mainstream bioethical approach:

> These observations emphasize the need for expert pre-test counseling before screening and add to concerns that implementing NIPD may erode informed choice.
>
> (Lewis, Hill et al. 2012a)

> These findings highlight the need for careful, detailed and nondirective counselling to ensure proper informed consent.
>
> (Lewis, Hill et al. 2012a)

> This study has revealed positive views of health professionals on NIPD for the detection of CF, sickle cell disease and thalassemia, but has emphasized the requirements for informed consent and appropriate counseling as well as the need for education and training of health professionals before widespread implementation can occur.

[52]'SAFE' (Special Non-Invasive Advances in Fetal and Neonatal Evaluation) was an EU/European project *'set up to implement routine, cost-effective NIPD and neonatal screening through the creation of long-term partnerships within and beyond the European Community'.* The project led to the standardisation of fetal blood group testing through the establishment of a 'Network of Excellence' (Maddocks 2009)

(Hill, Karunaratna et al. 2013)

These studies repeatedly emphasise the perceived capacity that bioethical norms (and associated practices) hold to ameliorate any 'concerns' that might be raised. Mainstream bioethical discourse is purposively deployed here then, in order to contain issues of 'concern' and to prevent entanglement with larger, more contentious debates around the far-reaching political, social and cultural implications of prenatal testing. With this approach being so thoroughly adopted, and with the professionalisation and institutionalisation of the bioethical debate around NIPD occurring at such an early stage of development, significant (bio)power is exercised here, working to contain and defuse 'hot' entanglements. The following analysis of participant accounts seeks to demonstrate exactly which issues are being contained and which debates hold the potential to 'overflow', and to disrupt mainstream discourse. It also, however, seeks to show who encourages the 'containment' of contentious issues, and who, by contrast encourages the 'overflowing' of such issues – who encourages the broadening and deepening of debate and who is able to 'make things hotter'.

Expert 'insider' accounts: alignments and moral ambiguities

Expert interviewees from a wide range of professional backgrounds - clinical scientists, genetic counsellors, fetal medicine consultants and academics/consultants working in the broad field of bioethics, public engagement, patient advocacy and public policy – made up the 'insider' group, with their professional lives and their daily work being very closely tied to the development and implementation of NIPD and NIPT in the UK. Participants from this group provided much detailed explanation of the technology's development, describing specific encounters with NIPD and NIPT testing, and explaining how they had witnessed the gradual translation of the technology into the clinic. Reflecting back on their knowledge and experiences, as they responded to questions around the impact (and potential impact) of NIPD testing on both individual patients and potential 'target' populations, the vast majority of participants within this group began to discuss, examine and interpret the possible moral, social and political dimensions of the technology. With at least some proportion of their professional lives being involved in the development, implementation or regulation of NIPD, their accounts were informed by a detailed understanding of the technology, and a strong familiarity with the clinical and regulatory contexts within which the technology had been emerging. With a great proportion of expertise within this group coming from participants working in a laboratory-based research or academic context, these accounts also tended to be somewhat distanced from

contextualised, relational experiences of prenatal testing, pregnancy and parenthood. Additionally, since the presence of social, moral and political concerns and dilemmas linked to NIPD held significant potential to directly impact on their professional lives, participants in this group tended to address the more contentious aspects of the technology in a carefully conducted and controlled manner. As they accounted for the presence of ethical and social 'issues' and 'concerns', their approach towards the discussion very closely mirrored that which is present within the public discussion of the ethical and social issues raised by NIPD, with interviewees repeatedly identifying the concepts of 'informed consent', 'risk' and 'individual reproductive choice' as being central to the debate. The language of mainstream bioethical discourse was, in this way, actively mobilised, with interviewees repeatedly referring back to these bioethical norms as they attempted to defuse and contain the discussion of contentious issues and 'hot' entanglements.

Emily stood apart from the majority of participants interviewed for this study, in that she was guarded towards questions raised during the interview process. She was very closely involved in the management and conduct of a number of studies focusing on NIPD's development and implementation in the UK. During moments where the conversation shifted away from the technical and practical aspects of testing, the discussion of more difficult or contentious issues was avoided. Aware, perhaps that she had been guarded in this respect, as the interview came to a close Emily commented on how she felt it was unlikely to provide valuable insight *'I don't think I've been that useful. Have there been any golden quotes?'.* Despite this approach Emily did, to a limited degree, engage in conversations around the social and ethical aspects of the technology. Reflecting on the potential impact of NIPD within routine prenatal testing programmes, and aware that concerns regarding the possible routinisation of NIPD had been raised, she dismissed the idea that the technology would give rise to any particular disruptions to the status quo: *'I don't see that a non-invasive test is going to be any different, you know it's just another test that women have in pregnancy, I think it just needs to be carefully counselled'* (it is worth noting here that Emily speaks as if it is the test – and not the pregnant patient – that requires counselling. Issues regarding the rationalising and reduction of the relational, bodily aspects of the testing experience are explored in more depth within the next chapter). As I proceeded to press the issue, Emily explained how she felt the power of established regulation, combined with the presence of clearly defined clinical pathways within the NHS, would be substantial enough to offset many of the concerns that might be raised:

Ethical issues have been raised around sex selection as well, using NIPD.

> Ok. I don't. I think that's so well regulated in the UK that it's not an issue, so if someone- uh if you get referred and your sample comes to the lab, to any NHS lab I think, and it doesn't have, it hasn't come from a recognised person, it hasn't come from a genetic counsellor. If it's come from a GP, the lab's not going to test it until they've called that GP and said you need to refer this person to genetics. So I don't think it's really an issue in the UK at all.
>
> (Emily, NIPD researcher)

Although the strategy that Emily describes seems to require a significant number of players to work in harmony together – GPs, laboratory technicians, genetic counsellors – it is presented here as a straightforward, achievable solution to the potential 'problem' of NIPD's unregulated (and medically illegitimate) use as a tool for 'social' sex selection. The daily work of medical professionals is identified as central to the task of regulating and normalising NIPD technology, holding the power to contain and defuse any practical and ethical issues that may arise as testing becomes increasingly routine and widespread. Genetic counsellors in particular are identified as those who possess the dual power to both legitimate testing, and to guard against illegitimate use: *'it hasn't come from a recognised person, it hasn't come from a genetic counsellor'.* Although Emily explores the possibility that patients/consumers may choose to access NIPD testing from services located outside 'the clinic' elsewhere in the interview– '*I mean already you can get sexing direct to consumer in the States, I think. And yeah it's certainly very possible that you could do it like that, just pop in a blood sample'* – she repeatedly mobilises a vision of the future that preserves a space for medical power, a space that has already been carved out via the routinisation and normalisation of established technologies and practices of prenatal and genetic testing. By appealing to the power of existing regulation and practice, by aligning very closely with mainstream bioethical discourse and by '*doing fixed, managed medicine*' (Latimer 2013, p.198) in this way, Emily is able to present a vision of NIPD's future that simultaneously recognises *and* contains the emergence of significant social and ethical 'issues' and 'concerns', steering the discussion at hand away from the destabilising threat of the unknown (Latimer 2013, p.198).

Laura, a researcher who was also very closely involved in the development and implementation of NIPD, adopted a similar perspective. She too began by describing how she felt that NIPD and NIPT were likely to have very little impact on established programmes and practices of testing: *'I don't think the pathway will have to change considerably because I think it will be just another test that you offer, but within sort of, the current prenatal testing'.* Recognising, however, that the increased diagnostic power of NIPT, when applied within routine screening programmes, could give rise to *'difficult*' issues – *'you could say that the implications of the NIPD test are far sort of, um, more definite*

and more difficult than screening' – she very quickly adopted a discursive strategy that emphasised containment. By proceeding to outline practical solutions that once again aligned with mainstream discourse, and mobilising in particular the normative concept of *'informed consent',* Laura again highlighted the perceived centrality and power of 'informed decision making':

> Um, because you are telling, you are giving a more yes no answer, somebody that doesn't even realise they are having a Down's syndrome test could then get told their baby has Down's syndrome. They might be wholly unprepared for that kind of information. So I think we need to make sure that safeguards are in place, to ensure informed consent, and to make sure women realise they are making a decision about Down's syndrome testing. And whether that's through asking them to sign a written consent form, which might be one way of doing it, or asking them to take a few days and come back and think- to go away and think about it, and come back and make a decision. Those might be two ways that you might ensure informed consent. Um, there are probably others, but, those are things we need to think about.
>
> (Laura, NIPD researcher)

Although Laura identifies the presence of significant problems and concerns, and potential sources of harm – such as the early and completely unexpected diagnosis of Down's syndrome within a 'low risk' pregnancy – she very clearly adopts an approach that suggests that recourse to routine practices built around the established norms of mainstream bioethics (the signing of consent forms, the visible exercise of '*informed decisions'*) would be powerful enough to mitigate any harms that may be conferred by NIPD's 'mainstreaming' within the population at large. Laura's account here demonstrates both the perceived power *and* the pervasiveness of mainstream bioethical debate, a discourse that, it appears, has become thoroughly normalised within the NIPD community, even at this early stage of development.

A somewhat contrasting 'insider' account was provided by Beth, who provided a particularly rich and insightful account of NIPD's on-going development. Beth was a clinical scientist, working within the NHS, whose daily work was also very closely tied to the development and implementation of NIPD and NIPT in the UK. Although Beth had previously been involved in setting up lab-based services to provide NIPD for fetal sexing, at the time of interview the great majority of her research work focused on developing *'NIPT for Down's'* and she explained how these tests were being developed with implementation into screening programmes particularly in mind. Beth was also involved in teaching, research management, and the provision of more traditional/established lab-

based diagnostic services – such as *'prenatal testing by QFPCR[53]'* - she explained that a *'big crossover'* existed between her research work and these other components of professional life. Approaching the opportunity to talk about NIPD technology with much enthusiasm Beth provided a highly reflective and insightful 'insider' account of NIPD that stood apart in this way from those highlighted above. As she explained how she came to be involved in NIPD research, and what her daily work entailed, she naturally began to explore questions regarding the possible moral and social implications of the technology. Although her work was primarily focused on the basic science of NIPD - '*thinking about how to do things, what are the most sensible approaches, what's feasible in terms of diagnostics*' - Beth explained that, as she had been working within a multidisciplinary project team, she had maintained regular contact with colleagues working on the 'ELSI' (ethical, legal, social implications) components of UK-based NIPD research:

> So we tend to just meet as a lab group, then we meet as a project sub-group every year, which is everybody… It's good, I'm very interested- I like the ELSI stuff because it's obviously that's very different to what we do on a day-to-day basis, and because it's a bit more human you just get drawn to that a bit more.
>
> (Beth, NIPD researcher)

Echoing the accounts of other 'insiders' Beth proceeded to identify the primary ethical and social implications of NIPD as being focussed around issues such as the erosion of informed consent, the possible routinisation of NIPD testing, and the possible normalisation and/or expansion of selective termination via the population-wide application of NIPD. Drawing on her knowledge of this professionalised, mainstream ELSI discourse, Beth explained that she was particularly concerned about the possible harms that widespread routinisation of non-invasive testing might bring - *'there's a lot of evidence to suggest that when women give bloods for Down's syndrome screening for example, that they don't really understand what they are doing'* – and she discussed in some detail her understanding of related issues around the provision of information in the clinical setting, and the requirement that patients provide informed consent prior to testing:

> To start with I was quite puzzled by this whole erosion of consent. The first time I heard people talk about it I thought, ah that's rubbish. You know, you'd spend just as much time talking to people about a noninvasive- but when you realise that women don't, that pregnant women coming through the system, although the health professionals are telling

[53] QFPCR is a laboratory technique used to copy small sections of DNA in order to precisely quantify the amount of DNA present in a sample (NHS National Genetics and Genomics Education Centre 2015c).

> them the information, they might not be hearing it. So there are a lot of things that for me, um, I found quite fascinating.
>
> (Beth, NIPD researcher)

Although she had been involved in the development of NIPD and NIPT testing for a number of years it was only as a result of this growing professional familiarity with this ELSI discourse that Beth came to find the discussion of the ethical and social issues that might be involved so 'fascinating' (elsewhere she explained that she had, in the early stages of the project, been concentrating more exclusively on 'the science': '*I was at that point thinking about it in very scientific terms, and it was just a challenge to get the test to work, and you kind of forget why you are doing it'*). Beth's reported shifting in perspective supports the view that, despite being '*constrained*' by the professional environment within which they must operate, ELSI scholars are able to, at the very least, stimulate some degree of debate around ethical and social issues (Kerr and Shakespeare 2002, p.162) within professional groups that may otherwise '*marginalise more critical commentaries*', being able to help break down the kind of '*boundaries between science and society*' (Cunningham-Burley and Kerr 1999, p.647) that Beth points towards here. Beth returned to the issue of informed consent throughout the interview, repeatedly emphasising the value of professional (genetic) counselling prior to testing, and raising concerns around the potential for NIPD and NIPT testing to become available to purchase and use via illegitimate sites that existed outside of the appropriately-regulated and professionalised clinical context: *'with the kind of scenario where it could be direct to consumer… I would find that quite disturbing if it went down that route, I think it needs to be quite gently managed'.* Once again, significant power is attributed to the practice of genetic counselling in particular here, and as Beth imagines counsellors being faced with an increasing range and volume of professional challenges as a result of NIPD and NIPT, her immediate response is to suggest a course of action that would reinforce rather than challenge the status quo – strengthening routine approaches by ensuring that patients are further enabled to become both 'informed' and 'autonomous' through the receipt of '*good, balanced information*' and '*pre-test counselling'*.

As the interview progressed, however, Beth began to extend her criticism out, exploring some of the broader social, ethical and cultural implications that she felt NIPD and prenatal screening might give rise to. As part of her work on NIPD, Beth had attended a *'study day'* organised by the Down's syndrome Association (DSA)[54]. Having previously

[54] The Down's Syndrome Association is a patient support charity that 'provides information and support on all aspects of living with Down's syndrome' and also 'works to champion the rights of

described how she was *'pulled towards the NIPT'* as a result of intellectual and professional curiosity, Beth described how her perspective on the technology had altered quite significantly once she confronted the lived experience of diagnosis and disease in this way:

> And I actually went to a Down's Syndrome Association study day, and they interviewed four women who had had Down's babies, one unexpectedly- one of them hadn't had screening. And it was a really- it really made me think very hard about why we do Down's syndrome screening, because all of the women, once they had got over the fact that they had had a Down's baby when they were expecting to have a normal baby- um, it was one of the better things that had happened in their lives. And Down's, the quality of care now for Down's syndrome children, you know. Ok some are very sick, but I sometimes find it all a little bit difficult to reconcile…. And I think we- we test for it because it's traditionally- its easy to test for. You're looking for a whole chromosome 21, and it does have a high prevalence within society. But then some of the micro-deletion syndromes are much more devastating in terms of the phenotype of the children. And I remember the women on the Down's syndrome study day saying, you know what, what kind of society do we want to live in? Do we include or exclude individuals? And I found that quite challenging. Because I was at that point thinking about it in very scientific terms, and it was just a challenge to get the test to work, and you kind of forget why you are doing it. But then there are an awful lot of women that wouldn't be able to cope with having, um. So you, you have to offer information. But as an individual? I wouldn't have any genetic testing, it's funny, not for anything. I know I probably shouldn't say that as a geneticist but I feel- I guess, you know, you deal with it as it occurs.
>
> (Beth, NIPD researcher)

Within this moment, as Beth focuses in on contextualised, personal experiences of disability, and resists defaulting to issues so familiar within mainstream bioethical discourse, she alters the way in which she frames the social and moral implications, and corresponding political and cultural scope, of NIPD and NIPT. Shifting away from her previous alignment with mainstream bioethical discourse – expressed through her talk of risk, individual decision making and informed consent - Beth explores the implications of non-invasive testing technologies and practices of prenatal screening in far greater depth. Reflecting back on her exposure to questions of profound moral and political weight – '*what kind of society do we want to live in? Do we include or exclude individuals?'* – Beth recognises here the presence of key dilemmas, issues that, for her, remain contentious and *'difficult to reconcile'*. Whilst the language that Beth employs reproduces rather than challenges the divisions that the routine practice of prenatal testing frequently constructs - between *'a Down's baby'* and *'a normal baby'* for instance (Sierra 2010, p.77, Thomas

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people with Down's syndrome, by campaigning for change and challenging discrimination' DSA (2012). Continuing Pregnancy with a Diagnosis Of Down's Syndrome: A Guide for Parents. The Down's Syndrome Association.

2014, p.183) - in contrast to this, she questions the strength and location of this division, pointing towards what she recognises as the valued and valuable lives of those living with Down's syndrome: '*it was one of the better things that had happened in their lives. And Down's, the quality of care now for Down's syndrome children, you know'.* Beth not only explores the ethical and social implications of NIPD here, she extends her critical gaze out, finally and most significantly problematising the whole project of prenatal screening itself. As Beth questions the foundations of prenatal testing, a practice that is central to her professional identity, she struggles to reconcile the approach that she feels has been adopted within the 'scientific' community towards testing - where the social meaning of screening programmes is marginalised, and where routinisation and the privileging of biomedical choice takes hold, *'I think we- we test for it because it's traditionally- its easy to test for'* - with her own thoughts and feelings around the broader societal aims of the practice at large: '*it really made me think very hard about why we do Down's syndrome screening… it was one of the better things that had happened in their lives'*. Although Beth very clearly identifies and discusses here the more contentious issues raised by NIPD and prenatal screening, she retreats from any suggestion that the project of prenatal screening itself may perhaps be re-thought. And finally, as she considers how these issues ought to be dealt with, Beth appeals once more to the power of '*institutionalised ends'* (Evans 2002): *'you have to offer information'.*

Dissenting voices from the clinic: 'critical users'

Participant accounts that clearly aligned with mainstream bioethical discourse represented a minority of those gathered within the dataset as a whole, with the vast majority of interviewees approaching the ethical and social issues raised by NIPD with a much greater sense of critical dissent. Accounts provided by genetic counsellors and midwives particularly – those most frequently encountering NIPD and NIPT in the clinic at this early stage – began to identify and discuss a much broader range of ethical, social and political issues that they felt were relevant to the emergence of NIPD and NIPT. Such concerns, however, frequently held the potential to impact upon the routine, everyday processes that were so closely bound to their professional lives. Much ambiguity was therefore present within these accounts, with interviewees frequently defaulting to the power of established, institutionalised bioethical norms and discourses (and the routine practices built upon these), even as they began to explore the ethical and social implications of NIPD, NIPT and prenatal testing at a much deeper level.

Lucy was a genetic counsellor, who had worked with 'at risk' patients using NIPD (for fetal sexing) within her previous job. With her current role involving both research and teaching, she had made effort to keep up-to-date with developments in the field. Reflecting back on the content of the NIPD-related presentations and publications she had become familiar with, Lucy explained her critical perspective on the technology, identifying and exploring a number of concerns that she felt were raised by NIPD and NIPT's 'implementation', and possible routinisation, in the UK:

> The other thing that concerns me is. I'm not completely satisfied with what they are planning to do in terms of evaluation as well. It concerns me that their implementation plan involves only educating health professionals, and they think they have all bases covered because they are doing face-to-face teaching, e-learning and apps. Which is fine. But I don't think education is enough… They said they would gather stakeholder opinions. And that just, to me- I'm not sure it would generate the kind of evidence that would reassure me. What is it exactly that concerns me? I'm concerned mainly that women won't have the opportunity to make a fully informed decision. And you know, I already don't like the way it works, without NIPT. Because of the experiences that I've had. Not so much personal experiences but the experiences I've seen my friends have. And I don't know what the answer is because I don't think genetic counsellors want to take on Down's syndrome work, because that would become very routine. I suppose I'm just a little bit disappointed, that this new technology could have been an opportunity to really look at that, and to re-deign antenatal care to better meet the needs of women… I suppose it all comes back to the whole question of who drives the research agenda? Is the research agenda and the technological development agenda, is it driven by people's, the needs of the population, or is it driven by scientists and you know, people who have technical expertise and their own personal vision of the future? Um, and I think I would prefer to live in a world where there was much more social involvement in developing these agendas, but that just isn't the way it happens, because it is driven by whoever is putting the money in.
>
> (Lucy, genetic counsellor)

Lucy expresses a great deal of cynicism regarding the approach taken towards the public discussion of NIPD ethics as she had observed it occurring within mainstream UK/NHS based NIPD research. Suggesting that an overly narrow focus on professional education and the gathering of 'stakeholder' opinions would be insufficient - '*they think they have all bases covered… I don't think education is enough'* - she points towards the relative paucity and thinness of mainstream bioethical debate around NIPD. Although Lucy closely mirrors mainstream discourse as she emphasises the value of *'fully informed'* decisions, she simultaneously extends her critical gaze, problematising both NIPD and current testing technologies. Lucy uses the discussion at hand to explore problems associated with current screening practices – *'I already don't like the way it works, without NIPT*' – and suggests that, although *she* recognises that the emergence of NIPD and NIPT presents a

valuable opportunity to reflect critically upon the structure and purpose of prenatal screening programmes - by foregrounding the needs and voices of 'women' and *'the population'* at large - that such an approach had failed to be exploited so far, and would likely remain unexplored: '*I'm just a little bit disappointed, that this new technology could have been an opportunity to really look at that, and to redesign antenatal care to better meet the needs of women*'. The alternative pathway for development that Lucy outlines – one that engages critically with the routine practices and procedures which, she feels, fail to genuinely address the needs of the population at hand despite much recourse to talk of 'informed consent', – is imagined to be stifled by the vested interests of powerful others: '*is it driven by people's, the needs of the population, or is it driven by scientists and you know, people who have technical expertise and their own personal vision of the future?... it is driven by whoever is putting the money in*'. By suggesting that mainstream ELSI research around NIPD fails to attend to broader contextual factors, and by echoing critical perspectives explored elsewhere (Cunningham-Burley and Kerr 1999, Evans 2002), Lucy points towards the foregrounding of institutionalised, professionalised bioethical discourse, and the corresponding marginalisation of voices that sit outside the mainstream of debate.

Parallel concerns were very strongly articulated by Natalie, a consultant clinical geneticist with a professional background in paediatric and prenatal care. As a practicing clinician who also sat on a number of advisory committees (working in both genetic medicine and prenatal care), although she currently had very little contact with NIPD testing in the clinic, Natalie was highly knowledgeable regarding the development and implementation of NIPD in the UK. As I asked her what her thoughts were regarding *'the ELSI bit, the ethics, the legal and social stuff'* she expressed frustration regarding the pervasive presence of bioethical discourse within the discussion of NIPD - *'all this talk about ethics'* – which, she felt, was narrow in focus and failed to attend to some of the more complex and challenging practicalities familiar to the clinical perspective: '*sometimes I think they are so kind of, off the page, and could do with coming to sit in my clinic, you know. You know, and actually see what it is like to look someone in the eyes and say your baby is dead'.* Elsewhere Natalie also problematised the narrowing of public discourse around ethics, particularly within the work that had been conducted to date with 'stakeholders' in the discussion of NIPD's implications, suggesting that a far broader range of voices ought to be given an opportunity to contribute to the debate: '*I would love to see a piece of work where you get, you know, old ladies of ninety and middle aged people who are working, and kids and teenagers to talk about – what does it mean? …even if there are no decisions made, some of the conversations are practiced, for society'.* Natalie characterises bioethical debate around NIPD and prenatal testing - the *'conversations'* that she feels must be discussed and

practiced before the technology embeds within the clinic and everyday experiences of pregnancy - as one that holds significant implications for '*society*' at large. The groups she identifies here (being unlikely to be placed in a position where they must consider testing for themselves) are explicitly *not* those who are identified as key 'stakeholders' within the mainstream public discussion of prenatal testing. By framing the scope of the debate in such broad and inclusive terms, by asking to include the voices of older people, children, teenagers - people at the margins of human reproduction as it is typically framed and discussed - she begins to shift the focus of discussion and debate away from questions regarding individual decision making, autonomy and informed consent, identifying issues and concerns that are of significance to an inclusive, relational and interconnected 'society' rather than a multitude of 'individuals' whose personhood lies, centrally, in the capacity for choice (Strathern 1992a, p.144).

Rachel, a genetic counsellor specialising in the prenatal field, also suggested that mainstream bioethical debate and discussion around NIPD, NIPT and prenatal testing more generally ought to be far broader, far more critical, and involve *'society as a whole'*:

> And I do wonder whether or not, is there a much more consumerist attitude amongst testing in pregnancy? I don't know, it's for society to have some of these conversations. And I think we need to have a conversation with these women who are, perhaps at high risk of having babies with conditions, to say, well is this blood test going to be any different for you psychologically? I don't know.
>
> *I wonder- what appetite for information do you think there is amongst the pregnant population*?
>
> Yeah, because I think for the vast majority of people who find they are pregnant, and whether it is unplanned or planned, you know, they don't actually set out to test their pregnancy. You know? I don't think that's- and I do wonder whether society as a whole will actually judge, I think women, and I do wonder if there will be a shift- well it wasn't interventional, you weren't going to put your pregnancy at risk, so why didn't you have the test? Whereas I think, is there much more of an understanding or there's much more sympathy almost, to say- if someone has an affected baby, because she said well you know I couldn't put my pregnancy at risk- is there much more sympathy and understanding for that position, when yes, she could have lost a healthy baby? Whereas you are not going to put the pregnancy at risk from the new technology, and therefore, why didn't you have it? So is there going to be less tolerance of disability, and less tolerance of not testing? I don't know.
>
> (Rachel, genetic counsellor)

Although Rachel happily adopts the language of mainstream bioethical discourse throughout the rest of the interview, speaking frequently of *'pre-test counselling'*, *'informed decisions'* and *'informed choice',* as she reflects on the concerns raised through the possible expansion of NIPD and/or NIPT within the pregnant population at large, she questions the

responsibilisation of the women and families who become so routinely enrolled in screening: *'the vast majority of people who find they are pregnant, and whether it is unplanned or planned, you know, they don't actually set out to test their pregnancy. You know?'*. Rachel recognises too that such women and families - like Rapp's *'moral pioneers'* (Rapp 1999) - become uniquely charged with the task of navigating new prenatal testing technologies, and she explicitly highlights the power that broader, underlying social and political discourses hold in shaping the context within which reproductive 'decisions' and 'choices' regarding prenatal testing must be made: *'I do wonder whether society as a whole will actually judge, I think women, and I do wonder if there will be a shift- well it wasn't interventional, you weren't going to put your pregnancy at risk, so why didn't you have the test?'.* She also points here towards the persistent division that is made between the 'healthy' and the 'disabled', suggesting that prenatal testing is met with '*sympathy*' when it is seen to protect '*healthy*' babies, and suggesting that the possible routinisation of NIPT could lead to '*less tolerance of disability*' as a result of a corresponding de-valuation of fetuses and babies diagnosed with disability or disease. By suggesting too that NIPT may garner comparatively less sympathy (because the safety of 'healthy' fetuses is no longer a concern), and could in fact lead to *'less tolerance of not testing',* Lucy points towards the influence of powerful and pervasive social and cultural norms on the shaping of reproductive 'choice'. By suggesting here that - as a result of NIPD's 'non-invasiveness' - women may be under increased pressure to accept testing, and to avoid the birth of a baby with Down's syndrome (or any of the other conditions that non-invasive diagnosis/screening may come to test for), Rachel paints a picture of a world where women confront a situation where access to an increased range of prenatal testing options confers less, and not more, real choice. Here, Rachel echoes arguments previously put forth by Strathern – that within the context of modern reproductive technologies '*one might perceive choice as, in fact, lack of choice*' (Strathern 1992a, p.166). Examining within this work the impact reproductive technologies' on contemporary understandings of kinship, Strathern points towards the way in which contemporary western culture conceptualises modern personhood – *'the epitome of individualism'* - as being fundamentally constituted by a capacity for rational, autonomous choice:

> Of all the interpretations of the person that could have been selected, we are presented with an individual subject or agent who knows how to deploy resources of the incomes at his or her disposal and whose personhood lies in the capacity for choice
>
> (Strathern 1992a, p.153)

Strathern proceeds to show how, despite the seeming proliferation in '*choice*' that new technologies (and new consumer goods) bring as they operate within a capitalist, free

market and competitively-driven cultural context, the range of concrete, lived choices that such technologies can in fact offer, is severely limited:

> Choices appear exercised when they are exercised in certain well-defined 'choice-making zones… The difference between choice and no-choice conceals the extent to which, insofar as styles come from a limited range of acceptable commercial alternatives, one might perceive choice itself as, in fact, lack of choice.
>
> (Strathern 1992a, p163-6)

This problematic framing of choice – so clearly highlighted by Rachel - reappears within the data gathered here, and is explored in more depth within the next chapter, as those whose professional identities are more closely and explicitly tied to the politics of NIPD explore questions regarding 'choice' and responsibility.

Returning to Rachel's account - whereas previously the figure of the 'healthy baby' may have acted as a protective mechanism, allowing women to 'choose not to choose' (Kelly 2009) testing - with the arrival of NIPD and NIPT the 'healthy baby' may be viewed as no longer under threat, no longer holding the power to (morally) legitimate women's *non-use* of testing. Experts elsewhere acknowledged that, even if women choose *not* to use NIPD/NIPT within the context of prenatal screening programmes, they may be placed in a position where they must navigate as many (if not more) ethical dilemmas as they would if they were to accept testing:

> I mean you still may need to do all the things you need to do now but NIPD gives you an opportunity to extend the range of things that you can look for and the advice that- the support you can give to pregnant women and their partners, if you find that there are issues the that might call for difficult decisions. And of course, that- that raises all sorts of issues not just along ethical lines, and they may not all- the issues are not all, as it were unidirectional. If you could do something and you choose not to, then that equally has ethical issues that are raised, ethical consequences.
>
> (Rob, patient support and policy)

What these accounts make clear is that the issues raised by the possible mainstreaming of NIPT as a screening test are complex – they are in no way '*unidirectional*' – especially for the women charged with the responsibility of making '*difficult decisions'* and navigating the '*ethical issues'* and '*ethical consequences'* that the *offer alone* of NIPT might raise. These 'critical users' show how women become enrolled within morally, psychologically, and socially complex situations from the very point at which testing becomes available – whether they in fact 'choose' to make use of these new technologies or not seems to hold little weight – as NIPD and NIPT tests become increasingly routine and increasingly

normal those who 'choose not to choose' will become as 'responsibilised' within this on-going project of prenatal screening as those who don't:

> The quest for the 'perfect child' means that any flaws perceived in children are viewed as targets for intervention, preferably to be prevented before they are even able to manifest themselves. Parents - and particularly mothers - are charged with the primary responsibility of maximizing the potential of their children.
>
> (Lupton 1999, p.68)

Erica was a consultant clinical geneticist who, throughout most of the interview process presented an account of NIPD that was broadly supportive of the technology. Towards the close of the interview, however, Erica's perspective suddenly shifted, and she expressed a highly critical understanding of how technologies and programmes of prenatal screening come to be shaped:

> I think it's really exiting. And I think there are lots and lots of benefits for individual families who have- you know, sort of clinical genetics type families. And I think in the general population, you know, it is clearly going to happen. And what we need to think about is how we do that in the, way that does less harm, or least harm, to you know- not just to unborn babies and the fact that some may get terminated by couples who might otherwise want, but also for how those couples then feel. You know, with the whole regret thing, and termination, and do they feel that actually they made a decision in a rush. And people have said, just in terms of the standard screening, that they didn't really think through screening, they get a high risk, they feel like they are on a rollercoaster of having an amnio, then getting results. And that could happen very, very easily with this, without enough thought. And lead to a lot of psychological harm to couples. So I think we need to think that through, and it not just purely be an economic thing. Which I think is a lot of what is behind Down's screening, that if we can avoid the birth of a child with Down's syndrome we'll save a whole lot of money on their medical and educational support. And I think that's probably why we've got Down's screening in the first place. And yes there's clearly some benefits for couples who don't want a child with Down's. But I think we need to be careful with this that we remember the people in it involved as well.
>
> (Erica, consultant clinical geneticist)

Here, Erica suggests that the practice of prenatal screening has been constructed, to a significant degree, in order to satisfy economic (and political) ends, rather than in order to fulfil any pressing clinical need or 'consumer' demand: '*So I think we need to think that through, and it not just purely be an economic thing. Which I think is a lot of what is behind Down's screening, that if we can avoid the birth of a child with Down's syndrome we'll save a whole lot of money on their medical and educational support. And I think that's probably why we've got Down's screening in the first place'.* With the interview taking place against the backdrop of government austerity (an issue that was frequently raised by expert

participants), the practical implications of which have been repeatedly and directly aimed towards state-sponsored health and social care services (Roberts, Marshall et al. 2012, Black 2013, Pownall 2013), Erica recognises the profound influence of economic and political policies and pressures in the shaping of screening programmes, and, ultimately, populations.

I don't want a world where we make choices about who lives and dies: dissenting voices and the politics of NIPD/prenatal screening.

Many of the strongest, most dissenting and most politicised voices came from those whose experiences (professional and personal) of prenatal testing had not directly involved NIPD. Accounts provided by these 'outsiders' - those whose everyday experiences were not tied to specific encounters with the technology - confronted the broader moral, social and political implications of NIPD and NIPT directly, and rather than aligning with the mainstream bioethical framing of the debate, they appealed to alternative discourses such as those offered by the disability rights critique (Parens and Asch 2000, Shakespeare 2006) and critical examinations of 'backdoor eugenics' (Duster 1990). Interviews with mothers recruited through non-clinical spaces (mother and baby groups) and experts working within the broad field of prenatal care (but without regular experience of NIPD or NIPT) in particular generated very clear, robust discussions of the more contentious issues raised, not only by NIPD and NIPT, but by prenatal testing (and associated practices of screening, diagnosis and abortion) more generally.

Martha was a mum to two young boys, recruited as a participant on this study through a mother-and-baby group. She was working part-time as a writer, and had a professional background in academic research. She very quickly identified herself as being a selective, critical user of prenatal care, explaining that she (and her partner) had been resolute in their decision *not* to use any of the prenatal tests that had been offered to them during pregnancy. Firmly locating herself outside the systems of screening and diagnosis within which so many women become routinely enrolled, and having very actively explored her thoughts and feelings in this regard, she extended this position out as she explored NIPD, finally presenting a carefully-thought, dissenting and highly critical account of the potential moral and social impact of non-invasive testing.

The decision not to undergo any testing was made during both of Martha's pregnancies, despite her being *'slightly more anxious about the second pregnancy'* because, as she explained, she had experienced a miscarriage just after the first. She had been offered maternal serum screening and ultrasound testing as is routine within NHS based prenatal

care (see appendix one for detail), and her particular experience of prenatal care also included a direct offer of diagnostic testing – she had been living in Norway during the first seven months of her first pregnancy, where, as a result of her age (Martha was 36 years old during her first pregnancy, and would have been classed as an '*elderly primigravida*'[55]) she had been routinely placed into a 'high risk' category and offered amniocentesis without undergoing any prior screening. As she explained the reasoning process that lay behind her decision not to test, Martha explicitly linked the practice of prenatal screening with selective abortion and the associated '*dilemmas*' and decisions that an acceptance of testing would bring: *'if there was a problem we wouldn't want to be having to make a choice'*. She explained that despite very consciously adopting this position towards testing she and her partner had accepted multiple ultrasound scans throughout both pregnancies: *'I had all my scans here – and I had extra scans as well because I had a thyroid condition, so they were just keeping an extra check on how he was growing'*. Reflecting on this, Martha began to identify the presence of routine systems and processes, the intense normalisation of which, she felt, had led her to divide ultrasound scanning away from other, seemingly less benign, prenatal tests:

> In my head I had always very much drawn that line of, I don't want additional testing at all- I don't want Down's testing. And um, I was quite happy to go with the scan. And now I've been thinking about it, it's an odd line to draw. Because actually the scans are testing as well, but I think they are presented to you in a different way. They are presented as- it's almost your chance to see your baby, and it's- you forget that actually what they are doing is checking the health of the fetus. And, you know. So you are partaking in a test, you just don't know it.
>
> (Martha, mother with experience of routine testing)

Martha is struck here by her (when examined in the light of decisions made around other testing options) comparatively *un*critical acceptance of ultrasound testing, and her acceptance, by implication, of the selective choices and decisions that accompany any kind of prenatal testing that '*is checking the health of the fetus'*– decisions and choices she and her partner had specifically sought to avoid via their rejection of other, more obviously health and disease-focused, testing options. She maintains her distance from such selective practices, however, by rejecting the notion that she (or her partner) bears individual responsibility for testing, and by emphasising the normalising influence that the systematic routinisation of ultrasound testing within prenatal care had on her particular experience: *'you are partaking in a test, you just don't know it'*. Martha's claim that it was

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[55] The term '*elderly primigravida'* is used clinically to describe women at or over 35 years of age at the time of their first pregnancy: (Morrison, I. (1975). "The elderly primigravida." Am J Obstet Gynecol **121**(4): 465-470.)

not her or her partner, but *'they'*, (health professionals) who had been interested in the health of the fetus, and *'they'* who had presented the test in a way that constructs ultrasound examination as normal, routine and explicitly social (*'your chance to see the baby')* again underlines her assertion that responsibility for the implications of testing is not prescribed to individual women or parents, but is located elsewhere.

Martha's act of ascribing moral responsibility to routine practices, processes and systems, rather than individuals, lies in direct contrast to many of the accounts provided by those closer to the technology, those who repeatedly mobilise mainstream bioethical discourse around 'individual reproductive choice', 'patient autonomy' and 'informed decision making' – discourses that privilege the value of 'choice' and autonomous control over reproductive decision making, and locate responsibility at the *individual,* and not the social (or political) level. Martha's explicitly *critical* account of the routinisation and normalisation of testing is also supported by much of the empirical sociological work that has been conducted around everyday experiences of ultrasound. Studies have shown how routine examinations perform multiple clinical and social functions, with ultrasound tests operating, simultaneously, as tools for screening and diagnosis, as instruments of psychological reassurance, and as sources of pleasure, fun and entertainment (Mitchell 2001, p.123). Studies of more recently-emergent '4D' ultrasound scans have also shown how such tests - marketed explicitly as tools for promoting maternal-fetal 'bonding' (Roberts 2012) - further highlight and intensify the tensions that already exist between the multiple clinical and non-clinical functions ultrasound achieves, with professionals being required to '*perform serious emotional labour to balance the delicate tension of offering expertise and medically-based reassurance with providing a joyful experience for parents as consumers*' (Thomas 2015b, p.1).

Martha had no direct experience of NIPD, and had heard about the technology for the first time as a result of being contacted about this study. She explained that she had read the information sheet provided to potential participants (which contained a basic outline of the technology along with current and possible future applications – see appendix five) but that this had been *'a long time ago'*, and in order to bring the technology to the forefront of the conversation, and to shift the focus towards NIPD in particular, I offered Martha the three vignettes (see appendix nine), all of which she read through in a single sitting. Pausing to consider the scenarios outlined, Martha proceeded to very clearly articulate her position regarding the wider politics of NIPD, and prenatal testing. Taking a broad view of the technologies and practices at hand, Martha identified a range of issues that she perceived to be central to the shaping of experiences with prenatal testing, and

she extended her critical gaze out, highlighting the problematic moral and political implications of population-wide screening:

> I think it- it is really complicated, for people who have had a previous disorder in a child, that level of anxiety is really high, and that's not a nice way to go through a pregnancy. So I can totally see how having testing would help that. I think my main concern is that it just does open the door to choices, about who lives and who dies. For me. I know that people can feel like, oh it's just a fetus, and until it's born it's not a real person- and that is the case for me. I'm just not sure that we- I'm not sure I want to live in a society where we don't have variety… and it's kind of all based on a sense of Down's particularly. Which is obviously what gets the most kind of, understanding, because the testing has been around for so long, for that… there's this idea that Down's children are happy children, and that's largely true- but there's also the children for whom- they have a multitude of other conditions that go along with it, and that's a difficult thing to deal with. You know, and- so it is hard. I don't know. My kind of root feeling is I don't want a world where we make choices about who lives and dies. But it's not- it is not that simple.
>
> (Martha, mother with experience of routine prenatal testing)

Approaching NIPD technology as an outsider, Martha spoke from a perspective that was free from any need or desire to focus on a particular lived experience, or a specific testing context. In contrast to the patients and 'high risk' mothers interviewed - whose accounts of testing were so closely tied to encounters with serious genetic disease, personal experience of abortion, or a strong desire for (diagnostic) certainty - Martha was able to shift the focus of discussion away from the practicalities of testing (and the comparative advantages and disadvantages of NIPD and other testing technologies), identifying and examining a much broader set of concerns. Martha's bold and highly critical response to NIPD is directed very clearly towards some of the most contentious issues raised within the discussion of prenatal testing at large: twice within this brief moment she describes how the widespread and routine application of prenatal testing creates a system which leads directly towards ethically, socially and politically profound decisions: *'choices about who lives and dies'*. As she examines prenatal testing in more general terms, Martha once again shifts the locus of moral responsibility away from individual parents, ascribing it instead to a more generalised *'we'* of *'the world'*. Suggesting here that Down's syndrome in particular has become a central focus of routine prenatal screening programmes, as well as new prenatal technologies, largely because *'the testing has been around for so long',* she again highlights the idea that it is the systems of routinised, normalised clinical practice, (and with the larger structures that govern and regulate them) rather than the needs and desires of parents, that have a most profound influence on the shaping of reproductive choice.

Within this brief account then, and prompted by a reflection on NIPD' s potential impact on prenatal screening, diagnosis, and pregnancy, Martha raises for discussion issues that have, within a range of ethnographic and sociological examinations, been identified as central to the politics of prenatal testing. These include: the presence of competing definitions of '*normal*' and '*abnormal*' fetuses and babies (Vassy 2005, Williams 2006), the limited capacity that genetic prenatal testing and diagnosis possesses to inform (Alper 1996, Cooper, Krawczak et al. 2013, Thomas 2015b) – or *the incompleteness of the phenotype-genotype relation* (Latimer 2013, p.204) - long-standing debates around fetal personhood (Thomson 1971, Tooley 1983, Purdy 1990), and the potential eugenic power of prenatal screening (Duster 1990, Rothman 1994, Clarke 1997, Rapp 1999, Parens and Asch 2000, Franklin and Roberts 2006, Shakespeare 2006). Although she very clearly adopts an approach that is critical and dissenting, Martha recognises that the experiences and consequences of prenatal testing are multiple and diverse – *'it is really complex… it is not that simple'* – acknowledging, for instance, that the potential relief of anxiety that may be achieved through early diagnosis is of significant value within pregnancies at high risk of serious genetic disease: *'it is really complicated, for people who have had a previous disorder in a child, that level of anxiety is really high, and that's not a nice way to go through a pregnancy'.*

Recognising that prenatal testing for Down's syndrome in particular has become normalised through long-standing and widespread use - *it's kind of all based on a sense of Down's particularly. Which is obviously what gets the most kind of, understanding, because the testing has been around for so long'* - Martha also reflects on the problematic issues raised when testing programmes provide diagnoses for conditions (like Down's syndrome) which exist on a spectrum - where the resulting phenotype - the way in which a disease or condition manifests in the bodies and lives of those involved - can be incredibly varied: '*there's this idea that Down's children are happy children, and that's largely true- but there's also the children for whom- they have a multitude of other conditions that go along with it, and that's a difficult thing to deal with'.* Elsewhere, Martha touches upon the contentious and problematic politics of abortion (see chapter five for further discussion), raising questions around the selective power of prenatal testing and how this intersects with questions regarding fetal personhood: *'my main concern is that it just does open the door to choices, about who lives and dies. For me. I know that people can feel like, oh it's just a fetus, and until it's born it's not a real person- that's the case for me'*. Presenting a highly critical account of prenatal screening programmes, envisioned here as holding the power to shape populations and to determine *'who lives and who dies',* as public health strategies that contribute to the construction of '*a society where we don't*

have variety' via selective processes of testing, diagnosis and abortion, which construct boundaries between the 'normal' and the 'abnormal', she simultaneously supports the idea that - when examined on an individual basis - the '*person*' being tested is *'just a fetus... until it's born it's not a real person'*. Attending to both the problematic (bio)political power of systematic programmes of selective abortion, *and* the limited capacity for personhood that a fetus might possess (along with the contrastingly rich personhood a mother or parent holds), Martha's account highlights the both the complexity of the issues raised and the profound difficulty that is faced when attempting to ameliorate two closely related but contrasting critical perspectives. On one hand Martha wishes to recognise the value of individual freedom and preserve individual women's rights to *genuine* choice regarding their pregnancies and their bodies, and on the other she recognises the profound level of influence that larger social and political structures have on the shaping (and restriction) of 'choice' as it is experienced and situated – as it becomes translated - within and through routine prenatal testing programmes and technologies. These issues and tensions existed at the core of the discussion of NIPD, NIPT and practices of prenatal testing gathered here, and they are explored in greater depth within the next chapter, as accounts provided by those most closely implicated in the politics of prenatal testing are critically examined.

As a dissenting and critical voice positioned outside the mainstream discussion of NIPD, Martha is able to very clearly articulate many of the more contentious and problematic issues raised within the discussion of NIPD, NIPT and practices of prenatal testing more generally. Although Martha's account was perhaps one of the boldest, several other mothers, again positioned as 'outsiders' (and having also chosen not to make use of *any* prenatal testing) presented similarly critical perspectives. Jess, a mother of two, had chosen not to accept any screening during pregnancy. With her personal experience of pregnancy and motherhood no longer so closely caught up within the politics of testing (she had decided not to have any more children after experiencing two difficult births), she too confronted the more contentious issues raised directly, explicitly and directly linking, for instance, prenatal screening with abortion:

> I didn't want to have to make the decision of potentially aborting a baby… so we would rather not be put in the position where we would have to make a choice… It might sound kind of, I don't know, irresponsible in some way? But I just didn't want it- because then you are into abortion questions.
>
> (Jess, mother with experience of routine prenatal testing)

Jess hints here towards feeling some degree of moral responsibility connected with her experiences of (not) testing – suggesting that by refusing testing and 'risking' the birth of a child with a disease or condition that she had been provided with the (free, easy and

routine) opportunity to test for, the morality of her decisions may be subject to some scrutiny or judgment: *'It might sound kind of, I don't know, irresponsible in some way?'*. Jess also explained how she and her husband felt that the approach they had taken towards unspoken, contentious issues involved in testing – abortion and risk of fetal loss, the abrupt ending of a wanted pregnancy – had been received as being unusually, or unexpectedly direct, and she highlighted in particular their unusual status here as dissenting, critical users of prenatal care:

> So they offered us blood tests and stuff for it, but we said no, because- well because of the fact that if you find out you are at risk you then have to decide on whether you want to do the invasive test.
>
> *And how did they respond when you said you didn't want the test?*
>
> I think they were- I think they didn't really care, they didn't react in any particular way. Except for when [Jess' husband] was saying, well actually you are possibly killing the baby, they got a bit-
>
> [Husband, speaking in the background] They got a bit pissed off really-
>
> They got a bit pissed off by that. Yeah I think the fact that he sort of, put it so bluntly. But that's what it is. You know, there's no point sugar-coating it. Because that is essentially- that is the risk.
>
> (Jess, mother with experience of routine prenatal testing, accompanied by her husband)

Elsewhere, Frankie, who was pregnant with her second child at the point of interview, presented another nuanced, critical account of how she felt the routine application of NIPD may impact on experiences of pregnancy. Discussing her response to vignette two, which described the possible introduction of NIPD into routine screening, and its use alongside current testing (see appendix nine), Frankie reflected in particular on the stigmatisation of Down's syndrome, as well as disability more generally, that she felt was very closely aligned with practices of prenatal testing:

> [Frankie starts talking to me after reading through vignette two]
>
> If it was just a routine thing that everybody had I probably wouldn't think twice, I'd just have it done because it's part of what you have done- like there's a lot of things that you have done that you don't even realise that you don't have to do. A lot of the time you have to- or you are made to feel like you have to have stuff done, but you don't have to have anything done do you? So I probably would just go along with it, but I don't think- if I was given a choice to have it, maybe on the first one yes, but on this one I wouldn't, no, I wouldn't.
>
> *If you got a positive result from a test like that, it would be very likely that-*
>
> It would have Down's syndrome.
>
> *Yes, and you would get the result at around 13 weeks, rather than later in pregnancy. How do you think-*

> I think there would be loads of- I think it would scare a lot of people. Sometimes knowing too much isn't a good thing. It might panic mothers into thinking- like for some people that might be the worst thing in the world. Especially if it's your first kid and you don't know what's coming- I don't know. But, I suppose it's a hard one that. It's a hard one. I think, for me, I'd just get on with it and I'd wait and see. But I know it would probably scare a lot of people. But then, how many weeks can you have an abortion? So would it scare people into that maybe? I think so, probably. Yeah I think that's a bit sad, cos I think, especially with Down's syndrome- if it was something really, if it was like a genetic disease that is really, really bad for you and you know it's going to hurt you, or hurt your kid, and they are not going to have a long life and they are not going to have a good quality of life I can understand that, but Down's syndrome is such a broad- like I said, it's a broad spectrum. By giving a label Down's syndrome you make people sound like they are like a lesser person- our society looks upon them as if they are a lesser person, when actually they're not, they're just exactly the same as us, just as happy, just as nice. They're not even separate- like, it makes it sound like it is us and them, doesn't it, when actually we are just all people. So actually, I think it's a bit, a bit of a scare– not a scare tactic, but it's a grey area isn't it. But then that's the way society looks at things really and not the way- yeah that's they way we as a society looks at disability and things like that. I suppose people should be given the option really, if it's there, but then you might get irrational decisions because of that option, I don't know. You might save a lot of people a lot of heartache. I don't know it's a grey area, it's a- you could go round and round with it forever and a day I reckon.
>
> (Frankie, mother with experience of routine prenatal testing)

Frankie begins by acknowledging that she has been subject to a range of '*routine*' testing processes during pregnancy, and that, particularly within the context of first-time experiences of pregnancy, she felt that she had been positioned in a way which meant that she '*wouldn't think twice*' – with the routinisation and normalisation of testing preventing her from '*realising*' that the many routine tests she was offered were intended to be experienced as choices – '*there's a lot of things that you have done that you don't even realise that you don't have to do. A lot of the time you have to- or you are made to feel like you have to have stuff done, but you don't have to have anything done do you?'.* Having very clearly articulated a vision of thoroughly-routinised prenatal care (and the corresponding lack of agency that is ascribed to pregnant women), Frankie proceeds to claim that this routinised, normalised approach to prenatal testing contributes significantly to the broader cultural stigmatisation of disease and disorder. She suggests that the way in which prenatal testing is constructed and practiced both reflects, and is symptomatic of, a deeply problematic approach towards disability that, she feels, is taken by '*society*' at large. Here, Frankie points towards processes of classification and division that, when aligned with powerful biomedical discourses and the routinisation of practices crucial to prenatal testing – screening, diagnosis, disease and disorder – result in the stratification of society along lines constituted by conceptions of 'normal' and 'abnormal', 'diseased' and

'healthy'. These processes, she suggests, define those with disability or disease as 'other' and separate them away from 'society': *'by giving a label Down's syndrome you make people sound like they are like a lesser person… They're not even separate- like, it makes it sound like it is us and them, doesn't it, when actually we are just all people…yeah that's they way we as a society looks at disability'*. Imagining a future where NIPD is similarly routine to current screening tests (prompted by her reading of the vignettes), Frankie also reflects on the specific conditions under which this problematic approach to disease, and this process of categorising fetuses, babies, and persons as 'normal or 'abnormal', may be further re-constructed and re-forged via a more widespread normalisation of prenatal testing and selective abortion: *I think it would scare a lot of people… It might panic mothers into thinking- like for some people that might be the worst thing in the world… I know it would probably scare a lot of people. But then, how many weeks can you have an abortion? So would it scare people into that maybe?*

A minority of expert interviewees also provided highly dissenting, critical accounts of NIPD. Focussing in on broader moral and political concerns, these accounts again came from those who could be identified as 'outsiders' within the mainstream discussion of NIPD. Although they had been recruited through a process of snowball sampling, with recommendations to contact specific individuals coming from persons closely involved in the development and implementation of NIPD in the UK, their work did not (at the time of interview) involve regular encounters with NIPD or NIPT. Rather, these were professionals whose everyday work involved providing support and information regarding prenatal testing in general, to both parents and healthcare professionals. Despite their lack of direct experience with NIPD, they were highly informed with regard the field in general, and expressed much interest in the future of NIPD and its possible impact on prenatal care.

Jack worked as a regional manager for a large national (UK-wide) charity, providing support to people, and families, diagnosed with a genetic condition. The charity provided much support to people affected by Down's syndrome in particular, and having been established for more than thirty years, as Jack explained, their work was informed by a very close contextual understanding of issues that the Down's syndrome community had faced in the past (such as mass institutionalisation, and the challenge of securing access to mainstream education). As we began the interview and I asked Jack to describe to me what his work entailed, he explained that the task of dealing with questions and concerns raised in connection with prenatal testing was, he felt, peripheral to the main aims of the organisation: *'prenatal screening and early years is just a small part of what we do'.* Despite

adopting a somewhat distanced perspective on prenatal testing from the outset, he quickly acknowledged that the prenatal area was one of the most politically contentious and challenging areas of his work, and he went on to express a high level of interest in the issues and concerns that he felt NIPD, and other testing technologies, raised: '*the hot topic really, has always been prenatal screening. I mean I have worked here for 16 years, it was when I started, and you know- last week, again it was headline news'.* Although prenatal testing was of clear significance within Jack's professional life, and although he had a long career in the field, it became clear during the course of the interview that Jack had no knowledge of NIPD prior to his involvement in this study, and that his understanding of the technology remained vague. Although I explained some background to NIPD technology in response to confusion regarding particular testing methods, the particularities of NIPD, and the practical issues that so many other expert interviewees focused in on (such as test accuracy, earliness, lack of risk) prompted very little discussion from Jack. Rather, he spoke of NIPD tests as if they were equivalent to, or at least existed within the same broad category as the well-established and routine prenatal tests that he was already familiar with (ultrasound scanning and amniocentesis). The particularities of technology and clinical practice were of tangential concern to Jack: it was the broader aims, objectives and consequences of testing, along with the moral and political implications, that Jack proceeded to explore. Adopting this more explicitly socially and politically focused approach, Jack presented as a carefully measured, but clear and highly critical voice within the discussion of NIPD. As he approached the issue of routine prenatal screening programmes, and how the contentious issues they raise might intersect with his work, Jack took a path of careful and deliberate neutrality:

> And as an organisation we are very clear about providing accurate information, and we would be pro-choice. We wouldn't fall into one camp or the other, that prenatal screening is a good thing or a bad thing, it just exists, and we want to make sure that people make the best choices for them… we provide advice and support regardless of what decision women make.
>
> (Jack, patient support)

Jack's position here seems emphatically neutral, informed perhaps by a need or desire to mirror the public position of his employer: he is sticking to 'the script' of his own professional discourse (Goffman 1956, Morgan and Krone 2001). However, by framing the project of prenatal screening in explicit moral terms, and by discussing the possibility that screening could be considered *'a good thing or a bad thing',* Jack provides an account that is, especially when held in comparison with many other expert interviewees, critical, direct and politically engaged. Like Martha, Jess and Frankie, as a relative 'outsider' whose daily work is not bound up in the moral and political complexities, and consequences, of

prenatal screening directly, Jack is willing to openly problematise issues of moral, social and political concern. Reflecting, for instance, on the difficulty with which women negotiate the decisions prenatal testing requires of them, he points towards the great degree of emotional labour that is involved:

> The really nice quote from a parent- and I'll get it wrong now, it's - lifelong messages are taken from sensitive words spoken at a difficult time… she said, you will carry that information around with you, throughout your life really, and you'll never forget… you will remember every detail of, you know, the pattern on the tie of the guy that gave you the information, or the song that was playing on the way home, or whatever. So it's not to be melodramatic, and say oh, it's a matter of life and death, but ultimately there are not many more fundamentally important decisions that people make.
>
> (Jack, patient support)

Drawing from accounts of personal experience that he has encountered during the course of his career, Jack clearly points towards the high moral stakes that are raised through encounters with prenatal testing: *'there are not many more fundamentally important decisions'.* Focusing in on contextualised, complex, lived experiences of prenatal testing, Jack also highlights the profound moral, emotional and psychological consequences that prenatal testing, as it is produced and reproduced as routine and normal within the clinic, raises within the lives of the women and families faced with the task of negotiating diagnoses and their aftermath - the relational consequences of testing: *'you will carry that information around with you, throughout your life really, and you'll never forget'*. Elsewhere, Jack extends his critical gaze further, bringing the broader politics of prenatal testing into sharper focus:

> And there's the other side, you know you might get a parent who can't get speech and language therapy for their child with Down's syndrome and who has been fighting for years, and thinks- they see all this funding going into generate new technologies that may or may not become mainstream, just to identify and avoid babies with Down's syndrome being born. Wouldn't it be better if some of that was being put into supporting children with Down's syndrome who were already here?
>
> (Jack, patient support)

Significantly, Jack describes prenatal testing as a project that, at its core, aims *'to identify and avoid babies with Down's syndrome being born'.* For Jack then, prenatal screening is a problematic top-down process, driven by a concerted effort - *'all this funding'* - to shape populations along narrow and biomedically-defined lines. This, he suggests, is achieved directly through the repeated application of prenatal testing technologies (like NIPD) within the pregnant population at large. Shifting his gaze away from the issues raised within individual encounters with prenatal testing, Jack acknowledges the acute moral

concerns that population-wide testing systems administered and governed by larger political structures and economic forces – screening programmes that focus on specific disease such as Down's syndrome – may generate. Elsewhere, he makes this position more explicit, suggesting that as an 'outsider' within the debate on prenatal testing, he (together with the organisation he works for) is able to voice a *'counterargument':*

> And I think [our organisation] then, through the parents we work with, can voice that counterargument- not all people will want these tests, people may want the tests in order to prepare themselves and not in order to terminate, and having [something like] Down's syndrome is not some great tragedy.

> If ever there was a genetic test that could very accurately test for something like autism, imagine the impact that would have? And the debate that we would have about whether people would opt to have those tests or not. You know- it's because we know that Down's Syndrome is a genetic condition, and it's chromosome 21, and that there are these genes we can test for, it's become an established part of the antenatal screening programme. And most people know, who are pregnant, they know they will be offered tests. For some of the other things, they may be more surprised that they can offer tests. But Down's Syndrome is the one- people know these tests have been around for 20, 30 years.
>
> (Jack, patient support)

Jack is one of the few expert interviewees who very explicitly levels his criticism towards the aims and objectives of prenatal testing (and particularly screening) as a whole. NIPD, for him, enters into the field as just another testing technology, no more or less disruptive than any particular test that has come before. Informed by the perspectives of the parents and families that he works with, Jack moves the discussion beyond the specifics of technology, towards broader economic and political questions and concerns. Jack, Martha and Frankie's detachment from the specifics of NIPD technology, coupled with their distance from the institutionalised and professionalised discourses of 'risk', 'accuracy,' 'informed consent' and 'reproductive choice' that are so bound up within the mainstream discussion of prenatal testing, allows for a broader and more explicitly political perspective to be adopted, a position that in turn allows them to identify and explore the presence of difficult and contentious issues – or 'hot' entanglements - that despite efforts to contain and defuse, remain present within the discussion at hand.

Summary

I begin this chapter by revisiting the central points of chapters four and five, showing how the dividing practices that participants engage here in become multiple: efforts are made

to divide NIPD from NIPT, and the practice of screening is divided from the practice of ('selective' or 'therapeutic') abortion. I introduce the Strathern/Callon's concept of 'hot' entanglements, and proceed to explain how 'ELSI' work has risen up alongside developments in the 'new genetics'. Drawing from critical accounts of bioethics, I describe how processes of institutionalisation and professionalisation have led to the containment of 'hot' issues, particularly with regards emergent reproductive genetic technologies. I describe how more critical accounts of prenatal testing remain marginalised within the mainstream bioethical and public discussion, and I show how a similar pattern of development has been emerging during the early stages of discussion and debate around NIPD.

I then proceed to examine how interviewees approached the social and ethical aspects of the technology, highlighting first the perspectives of 'insiders' – those whose professional identities are most closely aligned with NIPD – who recognise but immediately 'contain' moral dilemmas and 'hot' entanglements, appealing directly to the power and persuasiveness of mainstream bioethical discourse and talk of 'informed consent' and reproductive choice'. I then approach the examination of 'critical user' accounts, showing how those with experience of NIPD (but whose work is not closely bound to the technology) begin to problematise the technology more openly, criticising in particular the shift towards screening, and adopting a critical perspective on the ELSI debate, asking that a broader range of voices to be included. These 'critical users' point towards the limitations of the technology, focusing in on what little genuine 'choice' NIPD (and other testing technologies) offers pregnant patients, and they reflect critically on the construction of prenatal screening programmes, framing testing technologies as political and cultural, and not simply clinical, tools.

Finally, I highlight the accounts of 'outsiders' – those who have no direct experience of NIPD, but who have significant experience with prenatal testing – explaining how they approach the technology with a particularly high level of critical reflection. Once again these 'outsiders' point towards the perceived limitations of the technology's 'usefulness' (as a direct result of its dependence on and entanglement with abortion), and they extend their criticism further, drawing directly from more critical disability rights and constructionist discourses as they claim that the technology contributes to both the stigmatisation of Down's syndrome (and disease and disorder more generally), and the stratification and division of society into the 'normal' and the 'abnormal', the 'diseased' and the 'healthy'. Characterising screening as a concerted biopolitical effort to shape populations in accordance with such divisions and boundaries, they highlight the high

moral stakes inherent within the discussion of NIPD and prenatal testing, and engage directly with the most difficult and contentious – the 'hottest' issues that are raised.

Within the next chapter I examine how those most directly implicated and bound to the politics of NIPD and prenatal testing – those involved in the administration and governance of testing – approach the technology, identify issues of concern, and make efforts to contain and defuse debate.

Chapter Seven. NIPT, Public Health and the Biopolitics of Choice

Introduction

This chapter explores the significant cultural, political and biopolitical implications of NIPD, and particularly NIPT's emergence into both the clinic and the broader arena of public health. Drawing centrally from interviews with a small number of study participants whose professional lives were directly implicated in the design and governance of prenatal testing services I show how the moves and processes that have been identified as crucial to a critical understanding of NIPD/T within previous chapters – the collapsing of the boundary between screening and diagnosis, the move towards and closeness with 'selective' or 'therapeutic' abortion, the widespread identification and problematisation of ethical and social issues and concerns – are navigated by individuals responsible for directing and managing public health screening programmes - those most explicitly implicated in the politics of prenatal testing. It is within these moments, as this small group of experts discuss proliferating concerns and multiple perspectives, within the context of a contentious and rapidly-changing field, that the potential *biopolitical* power of non-invasive testing (and its deployment within routine systems and processes) starts to become clear – NIPD and NIPT, together with the practices they around bound up in, begin to manifest as *political* as well as clinical tools. Where the previous chapter points towards the presence and dominance of institutionalised, professionalised bioethical discourse within both the public discussion of NIPD/T and within many of the expert 'insider' accounts gathered here, this chapter examines critically what such discourse is being employed to do - looking closely at what is being achieved through persistent and repeated recourse to the rhetoric of autonomy, informed consent and, particularly, individual choice. Picking up on how reproductive 'choices' are presented, and acknowledging that the repeated mobilisation of autonomy and individual choice may serve as '*as a sword to compel some decisions and a shield to avoid responsibility for others*' (Bosk 1992, p.xxiii), I show how the various groups who encounter NIPD/T technology (or who are imagined to do so in the future) – women, patients and professionals – come to be variously responsibilised and de-responsibilised. As public health experts direct the framing of responsibility in particular ways – actively mobilising discourses that implicate individual parents (and particularly mothers), and distancing from contrasting discourses that highlight the influence of institutions and political structures with social, cultural and (bio)political power, they point (implicitly) towards the presence of 'hot' entanglements -

most centrally '*the vexed question of new eugenic possibilities*' (Latimer 2013, p.153) that remain in the background of many discussions regarding *'public health genetics'* (Clarke 1997, p.120). The accounts examined here show how, despite efforts to contain and defuse more contentious elements of the debate around NIPD and other prenatal testing technologies, (see chapter six), issues and concerns of '*profound consequence*' (Clarke 1997, p.122) remain, surfacing as a source of much debate, concern and anxiety, particularly for those most closely implicated in the politics of prenatal testing.

NIPT and public health: mainstreaming and politicisation

> What we are dealing with in this new technology of power is not exactly society nor is it the individual-as-body. It is a new body, a multiple body, a body with so many heads that, while they may not be infinite in number, cannot necessarily be counted. Biopolitics deals with the population, with the population as a political problem, as a problem that is at once scientific and political, as a biological problem and as power's problem
>
> (Foucault 1976, p.66)

The accounts examined here were generated at a very particular moment – when the normalisation and routinisation of NIPT for Down's syndrome (at least), via some level of incorporation into established NHS prenatal screening programmes, was emerging as an increasingly likely outcome of development, and was becoming a key topic of discussion. NIPD technology, previously confined to 'specialist' clinical services such as clinical genetics, fetal medicine and haemophilia care was, as a result of these changes, becoming increasingly relevant within the field of public health. This shifting in perspective, away from NIPD and targeted diagnostic testing, and towards NIPT and population-wide screening – towards the application of near-diagnostic testing within whole pregnant populations, a Foucauldian *'multiple body, a body with so many heads that, while they may not be infinite in number, cannot necessarily be counted'* – brought the broader political, cultural and biopolitical scope of the technology into increasingly sharp focus, and as this shifting occurred, for those charged with the task of designing and governing prenatal testing services, NIPT became disruptive – transformed into a source of professional anxiety and concern, it became a 'problem' to be managed. In order to understand why NIPT was experienced as so problematic here, it is useful to first examine the way in which public health, and prenatal screening particularly has been discussed within the critical literature to date.

The field of social medicine or 'public health' has been the subject of much sociological interest and critique. It has emerged, along with other medico-political institutions such

as the hospital and the asylum (Latimer 2013, p.25) as a key site within the critical study of medicine *as* biopolitics (Foucault 2000a, Foucault 2000b). Latimer, drawing on Foucault, demonstrates how public health (along with associated technologies such as immunisation and screening) may be characterised as an explicitly biopolitical practice – a '*particular alignment of medicine and public policy'* which, as it draws upon the power of medical practice and knowledge, legitimates forms of population surveillance that '*extend far beyond the medical gaze'* (Latimer 2013, p.25 - 26). Elsewhere, Ginsburg and Rapp - within their 1991 study exploring the '*Politics of Reproduction'* (Ginsburg and Rapp 1991) published as both artificial reproductive technologies and prenatal testing technologies were beginning to proliferate - highlight the biopolitical power that prenatal screening programmes in particular possess: as '*methods of social surveillance and regulation of reproductive practices'* which hold the power to determine directly the kinds of diseases, pregnancies, fetuses and babies that are made appropriate subjects of screening, diagnosis and potential 'disposal' (Latimer 2007b, p.121, Thomas 2014, p.211), they contribute to the growth of *'ideologies and policies explicitly linking economic development to population control'.* Ginsburg and Rapp also recognise here the way in which technologies and practices of prenatal screening and reproductive care are most commonly framed by those directing their design and governance (despite their broader cultural significance and biopolitical scope): in '*liberal-individualist'* terms, as '*choice-enhancing'* technologies (Ginsburg and Rapp 1991, p.314-5) presented as means to facilitate individual, autonomous decision-making and extend personal (and not political) control over reproduction. The situating of population-wide prenatal testing programmes within the political realm of public health attracts renewed criticism as the persistent and widespread routinisation and normalisation of prenatal testing is noted alongside. Gammeltoft and Wahlberg, within their comprehensive anthropological review of selective reproductive technologies explain how, '*despite the rhetorical emphasis on self-determination',* once prenatal testing technologies and practices are situated within the broader context of public health and routine screening, the kinds of 'choices' that are in fact offered to individual parents may be viewed as highly constrained and limited – the decisions that parents and women make regarding testing are *'far from free*':

> The increasing availability of SRTs (selective reproductive technologies) has made them all but obligatory points of passage on the road to parenthood, as pregnancy surveillance has become a routine part of prenatal care. Consequently, choices are, more often than not, experienced as obligations, whether to family members, communities, or the state.
>
> (Gammeltoft and Wahlberg 2014, p.211)

A number of critics have emphasised the transformative effect that the routinisation of prenatal diagnosis, has had on contemporary experiences of pregnancy (Rothman 1994,

Rapp 1999), with Clarke emphasising the *'burden of responsibility'* that the simple offer of testing presents to women who experience pregnancy from within cultures where systems of screening and diagnosis are firmly established:

> The fact that prenatal diagnostic tests are available imposes a burden of responsibility on every couple embarking on a pregnancy, whether at increased or standard risk of having a child with a serious problem… the existence of such tests leads not only to the burden of responsibility and the sense of obligation to undergo testing, but leads to other members of society to a sense of the mother being to blame for the birth of a child with a 'preventable' condition such as Down's syndrome.
>
> (Clarke 1997, p.123)

The simultaneous situating of prenatal testing within routinised, normalised population-wide screening programmes – viewed within much of the critical literature as a Foucauldian mechanism of control, a '*form of social organisation by which social order and conformity are maintained by voluntary means'* (Lupton 1994, p.111) and which, having become so deeply embedded within 'routine' and 'normal' experiences of pregnancy, are '*ever more immanent to the social field… distributed throughout the brains and the bodies of the citizens… and increasingly interiorized within the subjects themselves'* (Hardt and Negri 2013, p.216) – along with the persistent framing of prenatal screening as facilitating autonomous, individual 'choice', has been exposed as deeply problematic by a number of critics (Lippman 1991, Duden 1993, Rothman 1994, Lupton 1999, William, Alderson et al. 2002, McLaughlin 2003). Reflecting on the incongruities present within a system that simultaneously deploys a 'public health' model which presents prenatal diagnosis as a way of mitigating harm by '*reducing the frequency of selected birth defects'*, alongside a 'reproductive autonomy' model that presents the same practice as a '*means of giving women information to expand their reproductive choices'*, Lippmann deconstructs the '*internal tensions'* and *'contradictory constructions'* that are generated by reproductive public health as practiced through screening, diagnosis and selective abortion, identifying three competing perspectives:

> 1) as an assembly line approach to the products of conception, separating out those products we wish to develop from those we wish to discontinue. 2) as a way to give women control over their pregnancies, respecting (increasing) their autonomy to choose the kinds of children they will bear or 3) as a means of reassuring women that enhances their experiences of pregnancy.
>
> (Lippman 1991, p.22)

The public health experts interviewed here then, were situated within a professional field that brought with it distinct, and significant, challenges, having 1) been subject to much dissenting and critical engagement regarding the cultural, social and political meaning of

screening and 2) having been identified as a location within which complex and contradictory accounts are repeatedly voiced. The prenatal context invites significant critical discourse – as a location where the personal, moral and political stakes are set particularly high – a space where, as Jack explained previously (see chapter six), *'ultimately there are not many more fundamentally important decisions that people make'.* Prenatal public health is a space where the consequences that individual patients or consumers may face are particularly acute – within other screening programmes (adult cancer screening, for instance) false positives may lead to unnecessary treatment or testing (Elmore, Barton et al. 1998, Brewer, Salz et al. 2007), and false negatives may entail misplaced reassurance and late or missed diagnoses (Jepson, Hewison et al. 2007). Whereas neither of these outcomes are ideal, as they may both eventually lead to difficult decisions regarding 'life and death', within prenatal public health, (because screening must operate within the context of the 'therapeutic gap') errors are experienced as even more problematic: false positives may lead to the demise of wanted, 'healthy' pregnancies and false negatives may lead to missed diagnoses of conditions for which comprehensive population-wide screening programmes have been set up to detect in the first place. Although the accounts that public health experts provide here seem, at times, less than sympathetic towards the perspective of individuals experiencing the most difficult aspects of testing, with their work being the subject of much (and highly contentious) debate, they approached the discussion of NIPT technology and its move towards screening from within an exceptionally difficult professional position.

The mainstreaming of NIPT: media coverage

The challenges faced by those implicated in the growing need for regulation and governance around NIPD and NIPT - the explicit politicisation of the technology as well as the debate that surrounds it – have, in recent months, become increasingly public as UK media coverage of NIPT particularly gained significant momentum. In June of 2015 the RAPID project reported preliminary results from their evaluation programme for Down's syndrome screening using NIPT (the NIPT for Aneuploidy Evaluation Study'[56]) and it was as a result of this that NIPT testing was, for the first time, raised as a topic of discussion

[56] The 'NIPT for Aneuploidy Evaluation Study', due to be completed by the end of March 2016, aims to validate NIPT technology and evaluate a range of aspects regarding the implementation of NIPT (for Down's syndrome) within the NHS. As was explained by expert interviewees involved in UK NIPD research, this project was intended to build directly on the work of the RAPID study, and was at the planning stage when fieldwork was being conducted. (*Strathern, M. (1992b). Reproducing the future : essays on anthropology, kinship and the new reproductive technologies. Manchester, Manchester University Press.)*

within national news headlines, attracting significant coverage with both the tabloid (MacFarlane 2015) and broadsheet (Knapton 2015, Lay 2015, Ratcliffe 2015, Cooper 2015a, Cooper 2015b) press. The following excerpt represents a full transcript of BBC Radio 4's headline report on NIPT, broadcast on the Morning of June 6th:

> Newsreader: The NHS could soon offer more accurate screening for Down's syndrome, which would reduce the number of babies facing the risk of miscarriage from more invasive tests. Doctors at Great Ormond Street hospital have piloted the blood test, which is 99% accurate. They say it cuts the number of women requiring an amniocentesis, during which a needle is inserted into the women, by 80%. Professor Lyn Chitty who led the research hopes that the National Screening Committee will recommend its widespread use.
>
> Lyn Chitty, principle investigator, RAPID project: Because it's much safer and more women will take up NIPT as opposed to invasive testing, we have picked out more babies with Down's syndrome in that cohort, than we would do otherwise, whilst significantly reducing the number of invasive tests used. So it's much safer for parents, there's a far lower risk of miscarriage.
>
> (BBC Radio 4, News Headlines, Sunday 6th June 2015, 6am)

As the newsreader introduces the technology, the objective of NIPT and its proposed implementation into NHS prenatal screening programmes is most clearly identified as being about avoiding risk of harm to healthy fetuses and babies: the introduction of NIPT into screening *'would reduce the number of babies facing the risk of miscarriage from more invasive tests'*. This statement frames the remainder of the report, with avoidance of risk becoming the central issue at hand (and with the figure of the 'at-risk' and healthy pregnancy/fetus/baby in particular working as a persuasive device); NIPT's high rate of accuracy is emphasised and the contrasting risk of harm and discomfort that amniocentesis brings is highlighted. The report proceeds then to suggest that NIPT is able to provide a solution to this problem of risk - *'it cuts the number of women requiring an amniocentesis, during which a needle is inserted into the abdomen, by 80%'*. That this particular framing appears is unsurprising given the centrality of risk discourse within contemporary discussions of pregnancy and prenatal testing (Lippman 1991, p.30, Lupton 1999, p.61) in general, as well as the prevalence of risk-talk within the literature addressing the possible use of NIPT within screening programmes more specifically (Jackson, Dever et al. 2013, Fairbrother, Johnson et al. 2013b, de Jong, Maya et al. 2015, Larion, Warsof et al. 2015, Li, Wang et al. 2015). As risk-talk is foregrounded within the discussion of NIPT and its possible extension into population-wide screening, the 'riskiness' of pregnancy is made tangible and calculable, and may be presented, therefore as governable – an appropriate object of medical and biopolitical surveillance (Lupton

1999, p.63). The discourse of risk, as it is deployed here, also achieves specific and significant biopolitical ends. Particular risks – the risk of harm to healthy fetuses, the risk of failing to 'pick out' babies with Down's syndrome - are brought into being as problems which require action (Lupton 1999, p.63), which may then in turn serve to strengthen moves made towards implementing the widespread application of this technology. If pregnancies can be framed as inherently 'at risk' if they are to be managed via routine testing technologies such as amniocentesis, and if these same pregnancies may be presented as being far less 'at risk' if they were to be managed via NIPT, then the technology's widespread application within the existing populations where prenatal testing has become thoroughly normalised – its *biopolitical* extension and application - appears increasingly justifiable. As mentioned previously, the figure of the at-risk and healthy pregnancy/baby/fetus is also doing work here – acting as a persuasive device that underlines the constructed 'need' (Lippman 1991) for prenatal testing, its mobilisation as a symbol of vulnerability and hope (Duden 1993, p.9) and its presence pointing towards the high stakes that are involved in the kinds of 'choices' that prenatal screening imposes - the survival and continuation, or not, of 'healthy', 'wanted' pregnancies/babies/fetuses.

Whilst comments made by the RAPID project's principle investigator Lyn Chitty, which follow the brief news report, echo this emphasis on risk - *'it's much safer for parents, there's a far lower risk of miscarriage'* – competing discourses are simultaneously brought into play, as it is suggested here that enhanced safety is not the sole factor to inform the development of NIPT screening. Rather, Chitty highlights very clearly the fact that, as a result of NIPT's success within the validation study, the proportion of Down's syndrome diagnoses made via screening had increased (Chitty 2015b): '*we have picked out more babies with Down's syndrome in that cohort, than we would do otherwise'.* Another figure emerges here: that of the pregnancy/fetus/baby diagnosed with Down's syndrome. Whereas the figure of the healthy pregnancy/fetus/baby had been positioned as something vulnerable, something to be protected from the 'risk' of invasive testing and miscarriage (by NIPT), the figure of the pregnancy/fetus/baby with Down's syndrome emerges as something entirely different: an object or event to be avoided, to be '*picked out',* diagnosed and identified as potentially disposable (Latimer 2007b, p.121, Thomas 2014, p.211). Media coverage elsewhere repeats these claims, with newspapers reporting that NIPT would increase the detection of 'affected babies' *and* lead to a reduction in miscarriages and the loss of 'unaffected babies' (Knapton 2015, Ratcliffe 2015).

This brief report presents limited opportunity, of course, for those involved in NIPD research to engage in any kind of detailed discussion on the implications of NIPT's entry

into routine, population-wide screening. The way in which testing is framed here however, points towards the persistent and problematic presence of underlying tensions within the discussion at large, with only a select range of potential 'outcomes' being foregrounded and made explicit. The preservation of healthy/unaffected pregnancies, fetuses and babies is presented as a key advantage of testing, with the figure of the healthy pregnancy/fetus/baby doing significant work – enabling the technology to be framed in terms of reducing risk and saving 'healthy' lives. Whilst more socially and politically contentious outcomes – the systematic identification or 'picking out' of pregnancies/fetuses/babies with Down's syndrome for instance – remain marginalised here, they can be made visible; tensions, contentious issues and 'hot' entanglements may be seen to exist just beneath the surface of this most public discussion. What is also made explicit within the report is the technology's clear potential for '*widespread use'* – its application and routinisation within the pregnant population at large, and this move brings the concerns and questions raised into particularly sharper focus - as the 'mainstreaming' of NIPT moves closer, and as the biopolitical scope of the technology becomes correspondingly clear, discussions around possible 'outcomes' and 'implications' involve greater reflection on the technology's social and political power. Whilst these tensions may be only faintly present within the media reporting of NIPT, their underlying presence greatly informed the context from within which public health experts approached the technology. As NIPD/T testing, along with the problematic 'issues' and 'concerns' that are carried along with them – entanglement with abortion, the 'mainstreaming' of diagnosis, and critical reflections on the biopolitical shaping of screening - become increasingly public, and increasingly politicised, they present as problematic for those charged with the task of 'managing' the technology and its implications.

The politics of public health and NIPT: distancing from the 'fallout'

The analysis presented here focuses largely on two expert interviews: accounts provided by Jonathan and Linda, both of whom were public health professionals involved in the management and design of prenatal screening programmes in the UK. They each worked in the broad field of public health, and although they had different professional backgrounds (Linda had worked as a midwife before taking up her current role, and Jonathan had trained and worked in business management), they adopted somewhat similar positions regarding NIPD/T technology and its implications for prenatal screening. Jonathan described himself as a '*programme manager'* whose work had a broad remit – at the time of interview he had very recently taken up a new role and was in the process of

'settling in' after moving across from a related department. At the outset of the interview, as I asked him to explain what the role of public health/screening programme manager might entail, Jonathan illustrated both the complexity and the opacity of the bureaucratic systems and processes that he regarded as being central to his daily work:

> *So you are part of a screening committee?*
>
> Um, no. Well what's happening now is we are actually part of Public Health England which is a civil service department. All public health- I'm not sure how much you know about the reorganisation, but public health is split, they've abolished strategic health authorities and [*inaudible*] in England, we've now got a body called NHS England which is a commissioning board- they run the NHS commissioning board, commission services in the NHS, sometimes centrally, and sometimes by devolving down to CCG's[57], commissioning groups, yeah? Sort of GP's, locally. And we have Public Health England, where most of the main public health- this is all about setting policy, being central to health in England, so there are different branches there to do with all sort of aspects of public health. But the OCT public health departments moved into local authority, so local authority now has responsibility. So the directors of public health are there, and they are looking at the needs of their communities, and how to improve public health across health and local authority processes. Within Public Health England there are different divisions, and prenatal sits in the Health and Wellbeing division, and there are NHS screening programmes- there are screening programme clusters. There's fetal anomaly screening, newborn hearing screening, and newborn infant examination in the one cluster, and then, sickle cell and thal[58], newborn bloodspot, and infectious diseases in pregnancy screening in another. So they make up the fetal-maternal child health screening, plus adult… So prenatal cross-references, particularly with newborn, because there's an exam crossover. And then they would report to the director of programmes, and they go to the Fetal Maternal Child Health Committee, so policy decisions go there, to be signed off. And if they agree and recommend, sign off, they go to the National Screening Committee, who sign off on them in that. The UK National Screening Committee is responsible for advising the four secretaries of state in the UK, on policy for population screening programmes. So there's, there's the non-cancer branch, there's the cancer branch, so NSC do both. And so that's how it all feeds in, so we would then provide advice to them about the recommendations for policy, and if they decide to go ahead with policy, in England then, programme managers always have a remit to, um, put the standards together that will then go- and a specification for service provision- which will then go to a National Commissioning Board to

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[57] CCG's here refers to 'clinical commissioning groups': '*groups of General Practices that work together to plan and design local health services in England. They do this by 'commissioning' or buying health and care services'*. Hill, M., D. Wright, R. Daley, C. Lewis, F. McKay, S. Mason, N. Lench, A. Howarth, C. Boustred, K. Lo, V. Plagnol, K. Spencer, J. Fisher, M. Kroese, S. Morris and L. S. Chitty (2014b). "Evaluation of non-invasive prenatal testing (NIPT) for aneuploidy in an NHS setting: a reliable accurate prenatal non-invasive diagnosis (RAPID) protocol." BMC Pregnancy Childbirth **14**: 229.

[58] 'thal' refers here to β-thalassemia - one of the most common single gene disorders found in the general population. It is a blood clotting disorder which is characterised by an inability or reduced capacity to produce the β-globin protein *(Birmingham and South Central NHS. (2015). "What are clinical commisioning groups?" Retrieved 20/09/2015, from http://bhamsouthcentralccg.nhs.uk/what-are-ccgs.)*

> commission from. And then we have a Policy Assurance Branch that would assure that those services are being delivered, according to compliance with the standards in the NHS. So that's sort of how it all fits together. Does that make sense?
>
> (Jonathan, policy maker)

The explicitly political character of contemporary public health practice is illustrated in great detail here. Jonathan situates his work within a complex hierarchical structure made up of a multiplicity of bodies, operating across a variety of levels – civil service departments, national boards and committees, internal *'branches'* and *'groups'*, local authorities, secretaries of state - and he explains how his work both '*feeds into'* and depends upon various '*signing off*' processes which involve collaboration with these various institutions, bodies and structures. Jonathan's characterisation of his daily professional work stands in great contrast to the kinds of descriptions provided by experts elsewhere, where political issues and concerns, if they surfaced at all, were discussed in terms of background context – it was only within accounts provided by policy makers that the political was foregrounded, and made a key locus of professional responsibility. The backdrop of NHS reorganisation and restructuring – the '*splitting*' and '*abolition*' of previous bodies and the introduction of new '*commissioning*' procedures within the NHS – greatly informs Jonathan's account of what contemporary public health work and the governance of prenatal screening involves, and there is very little talk (other than mention of an '*exam crossover*') of how this political work translates either practically or clinically. It has been suggested that, given the power and influence that larger political structures have upon the contemporary practice of public health, and given the current instability in public health funding, that those involved in the design and governance of public health programmes should '*hone their political skills'* and *'familiarize themselves with the economic and political arguments that are raging all around them'* (Hunter 2010). Jonathan's clear identification with the more obviously political aspects of his work may point towards the relevance of such perspectives within public health work and the various organisational and administrative tasks that he and Linda were charged with managing.

Although the political perspective very clearly takes centre-stage within Jonathan's account of the public health profession, a number of underlying health-orientated values were, however, identified alongside: screening is characterised as a practice that is motivated by a desire to satisfy the '*needs of communities*', the ultimate aim of which lies in '*improving health'*. And although the kind of talk that Jonathan engages in here is somewhat opaque, involving repeated reference to concepts or objects that require some kind of expertise to clearly understand ('OCT's', 'CCG's', 'sickle cell and thal', 'newborn

bloodspot'), he simultaneously attempts to frame public health programmes as being focused on the '*needs*' of populations, built from the ground-up, based around some kind of clinical or population-based demand and need rather than the application of a 'top-down' (biopolitical, Foucauldian) effort to shape, control and govern populations. Jonathan's account of public health work then, suggesting that it is built to satisfy (and not to construct) public 'need', quite clearly sits in direct contrast with the kinds of understandings articulated by critics elsewhere.

As conversations turned towards the practicalities and intricacies of prenatal screening, NIPD and NIPT, both Linda and Jonathan began to quite clearly engage in processes of division and categorisation – or boundary work – making concerted effort to delineate the limits of their responsibilities as public health professionals (as well as the limits of the screening programmes that they worked within). The issue of 'incidental findings' in particular – both in relation to current prenatal screening practices and the potential introduction of NIPT screening – was identified as problematic, repeatedly surfacing as a source of anxiety and concern:

> You have these major incidental findings from T21[59] screening, we don't have a T13 and T18 screening in the first trimester[60], but we have incidental findings… the combined screen is not a screen for neural tube defects. You will get a high AFP[61] but it's an incidental finding. We don't- this is one of the problems with the combined test, because it gives you a lot of information we don't screen for.
>
> (Jonathan, policy maker)
>
> *There are pieces of information that are not picked up by NIPD, things like the neural tube defects-*
>
> Yeah, except that you know, our screening in the UK, for neural tube defects is a scan. You know, we do not- the combined screen is not a screen for neural tube defects. You will get a high AFP, but it's an incidental finding, ok?
>
> (Linda, policy maker)

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[59] 'T21' here refers to 'trisomy 21' a term that is used interchangeably with 'Down's syndrome'. Similarly, 'T13' refers to Trisomy 13/Patau syndrome and 'T18' refers to Trisomy 18/Edwards syndrome.

[60] At the time of interview screening for Patau syndrome and Edwards syndrome formed part of the second trimester scan. Shortly afterwards (July 2014) the National Screening Committee recommended that screening for Patau's and Edwards form part of the first trimester scan. Di Naro, E., F. Ghezzi, A. Vitucci, N. Tannoia, D. Campanale, V. D'Addario, W. Holzgreve and S. Hahn (2000). "Prenatal diagnosis of beta-thalassaemia using fetal erythroblasts enriched from maternal blood by a novel gradient." Molecular Human Reproduction **6**: 571-574.

[61] α-fetoprotein (AFP) screening forms part of the Maternal serum screening 'quad test', and measurements of α-fetoprotein are used to identify the presence of trisomy or spina bifida. (UK National Screening Comittee (2014). First trimester combined screening for T13 and T18. London.)

The presence of unexpected or unwanted '*incidental findings*'– clinically-relevant findings that reach beyond the original aims of testing, and which provide unsought and unwanted information (Clarke 2014, p.17) – are presented as problematic by both Jonathan and Linda. As screening tests produce information beyond their remit - as they burst their boundaries and their frames – they become an increasing source of concern, and anxieties are raised: '*this is one of the problems with the combined test, because it gives you a lot of information we don't screen for'.* Responding to such disruptions, efforts are made to distance from entanglement with any difficult implications this 'extra' information may bring, with Linda and Jonathan stressing what they perceive to be the limits of their responsibilities regarding the results of such testing, and pointing towards the presence of clearly delineated boundaries that have been incorporated into the design of the screening programmes that they govern[62].

As conversations turned towards NIPD and NIPT in particular, anxieties began to proliferate, with both Linda and Jonathan emphasising the distance they felt existed between their current professional practice and any responsibility that might eventually be attributed to them regarding the governance and regulation of NIPT:

> We are not specifically looking at it in an official way, but we are aware of it… we are not directly operationally involved but clearly we are in dialogue with RAPID… we have to be clear that this is something that we can make work operationally, in the NHS structured maternity service system… we are more concerned about how, when the test has got there, how we are going to make this work operationally, in the way that services are configured on the ground.
>
> (Jonathan, policy maker)

NIPT is presented as a tangential concern here, something Jonathan, in his capacity as a screening programme manager is '*aware of*', but not '*directly operationally involved*' in. Although he speaks of engaging in '*dialogue*' with those developing the tests, the stability of current systems and practices, and not the introduction of a new technology, is prioritised here – '*we have to be clear that this is something that we can make work operationally, in the NHS structured maternity service system… we are more concerned… in the way services operate on the ground'*. Efforts made to maintain some kind of distance from NIPT persisted throughout the interviews with both Linda and Jonathan, and it became increasingly clear that the potential 'mainstreaming' of NIPT within whole

[62] The Fetal Anomaly Screening Programme publishes a 'standards' document on an annual basis, within which the remit and the limitations of the programme are set out: *FASP (2015). Fetal Anomaly Screening Programme: Standards 2015-16. London, Crown Copyright. .*

pregnant populations was being experienced and envisaged here as disruptive and problematic:

> I don't think we are there yet, I don't think it's quite cut the mustard yet… it's just too expensive, it would not be cost effective for us to introduce it to the NHS, it just wouldn't. When we've actually got a current test which is hitting detections of around the late 80's to 90's[63], for a pretty low, around 2.5 or less FPR[64]. So when you take into account the incomplete assays and everything else, actually at the moment, it's not so great. If it was really doing what it said and it was 99 for 0.1[65], well that would be a big improvement. But it's not really, that's the way they are presenting it… The reality from an NSC perspective is, I guess, if the case came forwards and said we are looking- we have a screening test for T21, should we implement it? We would probably say, no, actually it doesn't meet the evidence. So we are dealing with a very difficult programme where we are trying to manage something which is, unmanageable in a sense.
>
> (Jonathan, policy maker)

As Jonathan adopts a sceptical approach towards claims that NIPT is able to produce test results that are significantly more accurate than maternal serum screening (MSS) – '*if it was really doing what it said… that would be a big improvement… but it's not really, that's the way they are presenting it'* – his account of NIPT's accuracy, and its corresponding level of usefulness, stands in profound contrast with many of the accounts highlighted previously (see chapter four). Within the majority of interviewee accounts exploring questions regarding NIPD and NIPT's accuracy, non-invasive testing was positioned as being appropriate for comparison with 'gold standard' diagnostic-level testing as achieved through amniocentesis or CVS (and was characterised as being clinically useful to at least some degree even within the most critical and dissenting accounts). Here, by contrast, NIPT is compared relatively unfavourably with maternal serum screening (MSS) – a test that produces results that are notably less than 100% accurate[66]. For Jonathan then, NIPT is a test that is lacking utility – '*it doesn't meet the evidence'* - it is '*unmanageable*' - it is not yet useful. The contrast that lies between Jonathan's account of NIPT's usefulness and the accounts provided by experts elsewhere may relate to the considerably different professional context that he must approach the test from within: the views, values and beliefs of the professional community (here, the public health community) that he is

[63] Jonathan is referring here to the accuracy (sensitivity and specificity) of current screening tests. The figures quoted - 'late 80's to 90's' - refers to the percentage of diagnoses detected.

[64] Referring here to the 'false positive rate' of current screening tests - the percentage of diagnoses not detected.

[65] If NIPT were 99% accurate with a 0.1% false positive rate.

[66] Serum screening has been shown to identify approximately 85% of Down's syndrome pregnancies in a 'low risk' pregnant population, with a 2.7 % false positive rate. (Marteau, T. M., J. Slack, J. Kidd and R. W. Shaw (1992). "Presenting a routine screening test in antenatal care: practice observed." Public Health **106**(2): 131-141, Gardner, R., G. Sutherland and L. Shaffer (2012). Chromosome abnormalities and genetic counseling. Oxford ; New York, Oxford University Press.)

located within shapes how 'useful' the test proves to be (Hedgecoe 2008). The focus here is on NIPT's implementation within population-wide screening programmes, a context that far removed from the discreet use of NIPD and NIPT testing within the clinic, and is significantly distanced from individual, personalised, contextualised experiences of pregnancy and parenthood: '*for public health, the utilitarian perspective rules*' (Lupton 1994, p.32). NIPT, for Jonathan has not '*quite cut the mustard*' despite claims to near-diagnostic accuracy because the processes that allow for implementation within screening programmes – the processes that relate back to the complex political landscape Jonathan situated his work (and significant professional responsibilities) within - demand '*evidence*' – evidence robust enough not simply to justify the discreet use of NIPD within individual, 'high-risk' pregnancies (which are already routinely subject to diagnostic testing), but to justify the use of NIPT within screening programmes that reach out to whole pregnant populations (who, if this were to occur, would be routinely accessing near-diagnostic information for the first time).

If the 'mainstreaming' of NIPT through application within screening programmes leads to the explicit politicisation of the technology and the resurfacing of 'hot' entanglements then the stakes are set particularly high for experts such as Jonathan and Linda, whose work is most closely tied to the public and political shaping of the technology, and who may be most likely to be ascribed responsibility for what Linda terms the possible '*fallout*' of screening:

> We are looking at a whole population of women here. We are looking at 600,000 women a year, just in England. Like with NIPT, these things run away with themselves because people don't see the fallout. And actually that's our job as a public health body, to say actually, on a whole population basis what does this mean?
>
> (Linda, policy maker)

The weight of professional responsibility that managing the introduction of NIPT testing within whole populations might entail - '*600,000 women a year, just in England*' - leads both Jonathan and Linda to seek distance from NIPT, and to highlight the problematic issues that those already responsible for large-scale prenatal screening programmes currently face. Linda, for instance, describes how she is responsible for recognising and identifying substantial concerns that '*people don't see*' and that may hold significant meaning for '*our population*' at large, explaining how she feels part of her role is to slow down the pace of technological development – she is there to prevent new technologies such as NIPT from '*running away with themselves*' and disrupting current practice. Jonathan also pushes away from professional entanglement with NIPT, presenting a vision of the technology's future development that is temporally as well as practically distanced

from his daily work, suggesting that the full development and implementation of NIPT screening is, he feels, likely take place over a timespan of at least a decade:

> So I think we will probably see it replacing combined as a screening test perhaps, within about five six years time maybe, with a view to becoming diagnostic, in another five years time or so. Hopefully I'll be moving on in my career then (laughs). I might just have to think about that before I go.
>
> (Jonathan, policy maker)

NIPT's characterisation as a disruptive, problematic technology, and a source of unwanted professional responsibility is once again highlighted both by Jonathan's expression of hope that he would (personally) be able to avoid having to '*think about*' introducing NIPT into population-wide screening programmes: *'hopefully I'll be moving on in my career then'*. It became increasingly clear that the multitude of ethical and social issues raised within discussions of prenatal screening (within both the literature and the participant accounts examined here - see chapter six) impacted significantly on the way in which Linda and Jonathan approached NIPT. Each of them acknowledged that the persistent public discussion of contentious, '*controversial and sensitive'* issues presented as a significant challenge within the context of their work, and expanding on this, Linda explained how, particularly if she (or other members of her professional group) were required to speak publically about prenatal screening, she faced the acutely difficult task of 1) attending to multiple and competing perspectives, and 2) publically navigating the complexities of (a polarised, politicised) debate:

> It's such a major, major controversial and sensitive issue. You have to be really careful what you say at a national level based on this, because people find it so difficult. We have these two extremes, pro- and anti-screening , because of the controversy in the mainstream.
>
> (Linda, policy maker)

Linda emphasised the polarisation of debates around prenatal screening, especially as discussed with regards testing for Down's syndrome elsewhere - '*The difficulty with T21 is, its has always very much been an issue of- it's a choice and society has a bias, a completely polar view doesn't it*' - and as she discussed the debate in this way, she not only emphasised a sense of distance between the 'public health' perspective and any discussion of the more difficult of contentious 'issues', she also began to locate overall responsibility for the more problematic aspects of the debate elsewhere – in this instance, within '*society*' at large: '*society has a bias, a completely polar view'*.

The rhetoric of choice and the responsibilisation of others

As both Linda and Jonathan distanced themselves from any professional accountability for the broader cultural, social and political implications of screening, they began to very clearly locate this responsibility elsewhere. This was achieved, largely, by repeated reference to the centrality of 'choice': women, figured as autonomous, rational (and demanding) agents were presented as holding the power (and responsibility) to shape experiences of testing, primarily through the exercise of 'informed decision making' and 'informed choice'.

Raising for discussion the recent unofficial UK parliamentary inquiry that was held into '*abortion on grounds of fetal disability'* (and which recommended either severely limiting or completely preventing access to abortion for fetal abnormality - see chapter five for further discussion), Linda very clearly identified, divided and categorised (in explicitly '*rational*' terms) several different types of '*choice*' –

> There has just recently been this parliamentary enquiry thing hasn't there. And you know, I find that quite concerning. That people would actually try and make women- you know, influence it in that way. Because I think you can have a personal choice, and you can have a professional choice, and you can have a societal choice, and I think we are perfectly capable of rationalising those into separate compartments.
>
> (Linda, policy maker)

Linda delineates a clear boundary between the kinds of '*professional choices'* that she feels her public health work requires, and any of the '*societal' or 'personal'* choices that may be implicated in the surrounding debate. Building upon this separate framing of '*professional*', '*societal*' and '*personal*' choices, Linda began to locate responsibility for both the construction of choice, and the potential outcomes that such 'choices' might bring accordingly. Firstly, and most clearly, responsibility for the kinds of decisions that prenatal testing requires were levelled at the parents, and most specifically the women, who 'chose' to make use of prenatal screening programmes:

> It's this whole issue of how we view disability in society I guess, but ultimately, women have a choice... So you have the whole- it's not just about me, my child, our lives, how this affects my current children, my future children, my marriage and relationships, how that then impacts on society if all this breaks down, and all the rest of it. It's not only about all of that, it's about the fact that if you've got the whole of- every single person in the UK that has a disability, we might be able to achieve something positive or not, on your head. You have to make that one decision. Which is I think incredibly hard, for women.
>
> (Linda, policy maker)

Although Linda expresses sympathy here for the '*incredibly hard*' decisions she feels that women face as they engage in 'choice' around prenatal screening - decisions that not only require women to consider how their choice might impact on themselves, their current and future children, their partnerships and family life, and society at large, but must also take into consideration larger questions about '*how we view disability in society*' – she explicitly locates responsibility for such decisions on *'the heads*' of individual women: *'ultimately women have a choice… you have to make that one decision'*. Jonathan echoes this perspective on choice, highlighting the responsibility that he feels women in particular hold – '*this is not about us, this is about society and women and their choices, and I think absolutely there has to be a choice'* – identifying 'choice' as a matter of concern to '*women*' and '*society*', presenting it as explicitly *not* a matter that directly implicates those involved in the design and management of screening: *'this is not about us'*. Both Linda and Jonathan clearly present screening as a personal, and not a political project, and any professional entanglement with the specificities of choice and prenatal testing – and the implications and responsibilities that such choices and decisions might bring – is actively avoided.

Efforts to distance away from professional responsibility (and to ascribe responsibility to individual parents and mothers) became particularly acute as some of the more contentious and problematic aspects of screening were discussed. As Linda further explored conversations around abortion after prenatal diagnosis, asking whether NIPT's potential to allow for earlier diagnosis could (or should) allow women access to greater choice regarding abortion method, and, therefore, allow for greater access to earlier 'surgical[67]' abortion services, her sympathetic approach towards the positioning of individual women within screening programmes seemed to fade. Rather, she rejects calls that had been made for a service design that would prioritise women's access to earlier abortion (or allow for this kind of abortion method to be offered), stating that *'women are going to have to deal with it emotionally whether they see a fetus of whether they don't',* and suggesting that the '*difficult emotional experiences*' that the established system of screening, diagnosis and abortion entails were to be understood as an unavoidable and acceptable, if somewhat '*difficult*', outcome:

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[67] 'Surgical' abortion refers to a type of abortion method that is carried surgically, utilising vacuum aspiration/suction. This type of abortion is typically carried out between 10 and 13 weeks from conception, and is carried out under general anaesthesia. It is the most common from of abortion employed within the UK. *Ashok, P. W., A. Kidd, G. M. M. Flett, A. Fitzmaurice, W. Graham and A. Templeton (2002). "A randomized comparison of medical abortion and surgical vacuum aspiration at 10–13 weeks gestation."* Human Reproduction ***17****(1): 92-98.*

> [support groups] would be- would be absolutely convinced that we need to do these things earlier in pregnancy, so that women don't have to suffer the potential of a later abortion- and actually some women are grateful for a later termination or a spontaneous abortion, because they potentially have a fetus they can grieve for… this is actually a significant event in life, I don't know what's right or wrong, and I don't think there is a right or wrong answer to that. But I think it would be quite, quite arrogant of us to say this is how we should be, and we should always do this earlier, earlier, earlier, earlier, earlier, so that women don't have to deal with that. Because women are going to have to deal with it emotionally whether they see a fetus of whether they don't, you know… this is the trouble you see, with clinicians, with clinical care, with prenatal screening for whatever it is for, you know. Women have very difficult emotional decisions to make, and you know, that's what we find difficult as a society isn't it, to take on board. That actually you have to make a decision that might not give you an outcome you expect to have. And I think there is very much in society this view that we- that every pregnancy should have a good outcome, and that we should be advanced enough to make sure they have a good outcome, and clearly we are not. And we are never going to be, are we? It's quite difficult isn't it? Quite a difficult process.
>
> (Linda, policy maker)

Abortion is framed here in explicit moral terms – an event that prompts an examination of what kinds of choices may be '*right or wrong'*. Whereas individual women are very clearly attributed responsibility here for dealing with difficult, morally loaded decisions around abortion – '*women are going to have to deal with it emotionally… women have very difficult emotional decisions to make'* - it is '*society*' at large (and not the individuals and institutions directly implicated in the design and management of screening) that, Linda suggests ought to be dealing with the moral '*fallout*' of screening, and ought to *'take on board'* problematic questions and concerns (although Linda also attributes some degree of responsibility here to clinicians: *this is the trouble you see, with clinicians, with clinical care, with prenatal screening).* As Linda further explored and accounted for the moral '*fallout*' of screening, her account was, increasingly, characterised by a sense of frustration regarding the '*difficult*' position she found herself in when discussing such issues, and it became clear that the active responsibilisation of others – parents, women, clinicians and '*society*' at large – allowed Linda to distance herself away from the pressure, stress and responsibility that her professional involvement within public health entailed:

> People want absolutes, don't they, in life. Everybody wants absolutes. The commissioners absolutely want to be telling women what women want to hear. And women absolutely want to know what, whether they've got a baby that is meeting their perception, their picture of what they want their baby to look like or not. We've become completely- in some senses ridiculously, risk-adverse in health… and people can't seem to understand that in the twenty-first century we haven't got the technology to have perfect babies every time. And I think that's the problem, isn't it? Women, parents want absolutes, and we can't deliver them. But clinicians want to do their very best to deliver them, so any technology that potentially says I

> can tell you this, is moved on, before we know what the problems are… People are very impatient, they want answers now.
>
> (Linda, policy maker)

Here, Linda extends the responsibilisation of women much further – women are figured as being not only responsible for making choices with regards their own experiences of pregnancy, but responsible also (collectively) for inciting a general public demand for prenatal testing and screening services – '*women absolutely want to know… women want absolutes'*. The presence of this type of argument within much professional discourse around prenatal screening has previously been identified: Vassy, in her account of how prenatal diagnosis '*became acceptable'* in France (Vassy 2005), explains how, as prenatal screening for Down's syndrome was being implemented into routine prenatal care, experts appealed directly to arguments that foregrounded the supposed 'demands' and '*expectations*' of the public:

> Several things about the role of public authorities are already known… it is argued that there are often strong public expectations for the progress of biomedical science… When a new technique spreads rapidly, the reason is that the public expected it, was ready for it, and wanted it… to promote their cause they produced not only technical data about the tests but also assertions about the social acceptability of the technique. One of their main arguments was that pregnant women asked for the tests.
>
> (Vassy 2005, p.246 - 247)

Linda suggests that the demands that '*women*' place on prenatal screening services are particularly acute – for Linda, pregnant women are not only seeking perfection, they are demanding access to services that allow them to find out whether their (unreasonable) perceptions are being met: '*people can't seem to understand that in the twenty-first century we haven't got the technology to have perfect babies every time. And I think that's the problem, isn't it?'*. Alongside the responsibilisation of women here comes a persistent emphasis on the demands that Linda perceives groups located outside the boundaries of the public health profession – '*everybody'*, '*commissioners*', '*clinicians*', '*people*' – place on public health services, as well as the '*problems*' she feels are generated alongside. Women particularly then, become implicated in the persistent routinisation and normalisation of prenatal testing: it is they, and not the developers, funders and administrators of prenatal testing, that are presented as holding the power to shape and influence the way in which tests come to be used and distributed amongst the population. Women and clinicians are also attributed responsibility here for the rapid (and seemingly inappropriate) introduction of new testing technologies such as NIPT: *any technology that potentially says I can tell you this, is moved on, before we know what the problems are…. People are very impatient, they want answers now'.* Once again, any power that funders and developers

may hold is masked, and it is the populations that use testing technologies, and not those who research, design, implement and market them, who are figured as holding significant (bio)power. Further emphasising the perceived public demands for risk-free (*'we've become completely- in some senses ridiculously, risk-adverse')*, '*perfect*' pregnancies that Linda feels are generated by '*people*', '*society*', and particularly '*women*', Linda is able to locate primary responsibility for the most difficult and contentious aspects of screening within the populations that public health serves, and not within the design and management of public health technologies (such as the screening programmes she administers) themselves. Whereas critical studies point towards the profound influence that political bodies and institutions have on the shaping of women's reproductive experiences, here it is women, primarily, that are viewed as being responsible for constructing the 'need' (Lippman 1991) for prenatal testing. Linda (and Jonathan's) account of screening – presented here as a system that responsibilises women, identifies them as the primary source of demand and expectation regarding prenatal testing, and implicates them in the on-going routinisation and normalisation of testing – provides much support to those that claim prenatal testing operates as an extension of Foucauldian biopower. Masking more explicitly political contributions that are made to the design and governance of prenatal testing, screening is understood here as a system that is '*distributed throughout the brains and the bodies of the citizens*' (Hardt and Negri 2013, p.216), a successful example of the '*voluntary servitude of individuals*' (Agamben 1998) – and a clear location for the indirect but influential exercise of the '*highest functions*' of biopower:

> A form of power that regulates social life from its interior, following it, interpreting it, absorbing it, and rearticulating it… The highest function of this power is to invest life through and through, and its primary task is to administer life. Biopower thus refers to a situation in which what is directly at stake in power is the production and reproduction of life itself.
>
> (Hardt and Negri 2013, p.216)

Prenatal testing: where choice might cease to be enablement

The discourse that Linda and Jonathan drew from here – characterised by repeated talk of the autonomous, rational, individualised capacity for choice - has been identified as central to a critical understanding of contemporary (Western) personhood (and is greatly present within mainstream bioethical discourse – see chapter six). Strathern, within her examination of modern constructions of kinship and family, points towards the centrality of choice within common understandings of what it is to be the '*epitome of individualism'* (Strathern 1992a, p.153) - an '*Active citizen of the late twentieth century*' (and beyond):

> Of all the interpretations of the person that could have been selected, we are presented with an individual subject or agent who knows how to deploy resources of the incomes at his or her disposal and whose personhood lies in the capacity for choice
>
> (Strathern 1992a, p.153)

Strathern not only establishes how 'choice' has become the dominant framework from within which modern social life is examined and understood, she also argues that, despite such ubiquity, the availability of 'choice' can act as a destabilising, rather than empowering concept:

> The producer manufactures according to the consumer's choices, and the consumer purchases according to the choices the manufacturer lays out. Choice has become the privileged vantage from which to measure all action. Yet choice is by definition destabilising, for it operates as much on whim as on judgment. That at least is the cultural vision. Consumers and producers live alike by one another's choices. In fact, we could say that producers turn out the embodied choices of their customers, and consumers choose among the embodied choices of those who provide the services. One glimpses a world full of persons embodying the choices of others…. The absurdity offers the real glimpse of a situation where choice may cease to be enablement.
>
> (Strathern 2002)

Approaching choice from the perspective of her broad and inclusive '*cultural vision'* of social life, Strathern makes explicit the extent to which the context - the social and cultural framing of 'choice' – influences the degree of freedom within which an individual may act. Elsewhere, and with specific reference to how individualised, rationalised framings of choice operate within the field of prenatal genetics, Latimer picks up on the centrality (and insufficiency) of choice-discourse, as she: *'troubles simple stories about autonomous and informed choice, particularly reproductive choice, as icons of contemporary versions of what it is to be fully human'* (Latimer 2013, p.213). Strathern too, '*troubles*' simplistic accounts of autonomous and informed choice in this way, pointing towards the paradoxical effect that the proliferation of 'choice' on a '*massive scale'* (in the form of a multitude of different '*styles*', presented within restricted '*choice making zones'*) has had within contemporary, Western, consumer-led culture, and highlighting the corresponding lack of *real* choice that choice-laden areas such as the consumer goods market offers.

> The massive scale of the industry which has created choice-making zones as against the relative paucity of 'styles' available'… The difference between choice and no-choice conceals the extent to which, insofar as styles come from a limited range of acceptable commercial alternatives, one might perceive choice itself as, in fact, lack of choice
>
> (Strathern 1992a, p.166)

Strathern is suggesting here then, that pervasive recourse to talk of choice - the ubiquity of choice-discourse – as it is set alongside a persistent focus on the value of persons as individual, autonomous decision-makers, acts to conceal the fact that, when many contemporary 'choices' are critically examined, very few options, very few real choices are offered: choice may, paradoxically, manifest as 'no-choice' and may '*cease to be enablement*'.

An understanding of the profound limitations of 'choice' as figured through prenatal testing (a framing that fails to be articulated within accounts provided by public health experts) came to the fore within the contextualised, situated accounts of NIPT provided by parents and patients. As women accounted for their decision making (or possible decision making) regarding NIPT, they drew from both mainstream, unproblematic accounts of choice as well as more critical framings of what kind of options such 'choices', in fact, might bring. Jamie, who had purchased NIPT testing for '*reassurance*' (and who had received a 'screen-negative' result) had been amongst the earliest users of NIPT in the UK, having sought testing in late 2013. As I asked her how she had come to learn about the test, she explained that she had first heard about NIPT from a midwife friend, and had then sought out information (she had '*researched the test'*) via the Internet:

> It was a friend of mine, an NHS midwife- she had heard about it, and funnily enough she's fallen pregnant now and is going for the Nifty test. I do think there is a very large percentage of people out there that don't know about it. I think if you do your homework, and you Google it, and you are on the internet though... And obviously knowledge is wonderful nowadays, and everything is at your fingertips. There is nothing that isn't readily available to you, you just have to look and find it. With the internet, with books and everything, there is everything to learn really, isn't there?
>
> (Jamie, private NIPT patient)

Jamie very clearly models the role of an informed, autonomous, responsibilised patient (and mother), responding positively to the significant volume of information that had been made available to her regarding NIPT, prior to the testing taking place. Elsewhere, however, as I asked Jamie about why she had sought out NIPT, and what kind of understanding she had regarding the diseases and conditions that the test may have reported back on[68], she placed far less emphasis on the value of being 'informed', and was much more passive in her acceptance of testing:

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[68] When Jamie used the Nifty test, the conditions tested for were Down's syndrome (Trisomy 21), Edwards syndrome (trisomy 18) and Patau's syndrome (trisomy 13). Fetal sex was also reported if requested. The range of conditions that may be tested for through Nifty has since expended – see appendix two for further detail.

> *-And did you know much about the specific conditions they were testing for?*
>
> Not really. I mean there were three, you may even need to remind me on that. They are not sort of common to me, if you were to mention what they were I would probably go yeah, that's right, that's what it was. But they don't spring to mind, if you like. It was more- the issue for me was Down's, Down's syndrome. Not the other illnesses, not the other things involved… They gave me literature, there was lots of information, lots of hand-outs, which I felt was really reassuring.
>
> (Jamie, private NIPT patient)

Although Jamie had been quite clearly enrolled into the clinic then, as an '*informed and knowledgeable consumer*' (Latimer 2013, p.14), having clearly emphasised the large volume of information that had both been made directly available to her through the clinic, and had been sought out independently, the translation of knowledge regarding significant aspects of NIPT testing – the conditions that her pregnancy had been tested for - had been only selectively achieved. Whereas much emphasis was placed on *'knowing about'* the test and *'getting information'*, the specific diseases and disorders tested for were positioned very much in the background and made '*symbolically invisible'* (Thomas 2014, p.176). For Jamie then, although she presents as a motivated, autonomous, and informed consumer of NIPT, and although she seemed to receive a high standard of information in the form of 'pre-test counselling' in the clinic (elsewhere she told me how both the midwife and consultant had spent much time with her going through the details of testing: '*the lovely thing was it was all explained to me very, very clearly. So I knew exactly what was going on and what the outcome was going to be'*), the degree to which she became genuinely 'informed' was limited. Jamie's lack of clarity regarding the test did not seem to be guided by any failing on the part of the provider to obtain 'informed consent' – the value of knowledge regarding the specificities of disease and disorder is marginalised here, with Jamie placing a greater emphasis on the technology, practice and experience of testing itself. The choices that Jamie made regarding NIPT were not greatly informed, it seems, by a rational and autonomous process of decision making – rather, they were built around a vague and unspecific understanding of, disease and disorder that remained even after 'pre-test counselling' had taken place. The persistent presentation of women as autonomous, individual consumers and 'choice-makers' becomes quite clearly insufficient then, as we see that the very process of receiving information (however 'nondirective' it may be) - the process of becoming informed - entails some kind of local translation within relational, complex experiences of pregnancy, which are guided and shaped by both personal inclinations and established cultural norms:

> This positivism instantiates Euro-Americans' commitment to the idea that expert knowledge, derived from the application of technological and scientific approaches to uncovering and revealing provides people with

> objective knowledge as a firm foundation for making decisions. In addition, a relation between being 'informed' is being put into play alongside the stress on autonomy and freedom of choice. This emphasis de-socialises 'decision,' and decouples information as merely means to ends: as if choices can simply be informed yet autonomous.
>
> (Latimer 2007a, p.15)

Strathern's suggestion that '*choice might cease to be enablement'* speaks very clearly to the way in which Martha, a mum who had refused all offers of prenatal testing during pregnancy (and who had no direct experience of NIPD or NIPT), speaks of 'choice' in connection with testing. Reflected on what she felt were the limitations of NIPT, as it functioned within the context of the 'therapeutic gap', she pointed towards the emptiness of the choices that NIPT testing might present:

> I think for me, with that test, it's the same choice. That I don't want to make, I just don't want to make. I'll just deal with whatever comes and then, that's the child we have and that's it, I think. But there is an element of naivety in that thinking you know, if we have a Down's child we will manage. But you don't know if you will manage and you don't know if you will cope. But it's the same. It's a test that allows you either to have [an abortion, or not[69]]
>
> (Martha, mother with experience of routine prenatal testing)

For Martha then, NIPT remains significantly limited because it allows for only one kind of choice to be made: '*with that test, it's the same choice. That I don't want to make, I just don't want to make… It's a test that allows you either to have* [an abortion, or not]'. Not only does she illustrate the lack of real options that testing presents, she also points towards the inadequacy of genetic diagnosis as a form of information that might help guide testing (and abortion) decisions as they are experienced within the complex context of family life. Explaining here how she would remain at a loss as to understand exactly how any future child diagnosed with Down's syndrome may become part of her family – *'you don't know if you will manage and you don't know if you will cope'* – she echoes the explanations of the difficulties of screening for Down's syndrome that were provided by experts elsewhere. Rachel, a genetic counsellor, explained that, despite Down's syndrome being one of the most tested-for and publically 'visible' congenital diseases, when a diagnosis is made it is very often approached with the kind of uncertainty that Martha envisages it might:

> It is really surprising for the public, if they come and see us and they've got a little baby with Down's syndrome and you know, this is a condition that

[69] Once again, as the topic of abortion was approached, any kind of clear articulation became difficult (see chapter five for further discussion). Although Martha avoided direct talk of 'abortion' and cut herself off mid-sentence, it was made clear within the broader context of the conversation here that she was referring to abortion.

> has been well understood form a genetics point of view, as far as its diagnosis goes, you know, for decades. And they, they will come through the door and say- on the spectrum, where is my baby going to be? And we say, well I don't know. So I think that is a huge surprise.
>
> (Martha, mother with experience of routine prenatal testing)

Because Down's syndrome '*occupies a difficult position since it is enacted as 'compatible with life' yet can be offered as a legal reason for termination'* (Thomas 2014, p.219), the kinds of choices that routine prenatal screening tests present, once they are understood as being exercised and navigated within the context of a broader set of cultural understandings, and the complexities of family life, are problematic, and far from straightforward. This re-casting of 'choice' – as complex, situated, and problematic – makes it ever more difficult to envisage the narrow framing of choice as 'informed', and the persistent responsibilisation of individual women, as being appropriate and sufficient within the ongoing (and, through the possible application of NIPT, intensified) discussion of prenatal screening.

Decisions, choices and responsibilities in context

It was within accounts provided by mothers who had used NIPD within pregnancies 'at risk' of serious genetic disease where the difficulties involved in decisions regarding prenatal testing were most clearly articulated, and where a picture of 'choice' as complex, situated and contextualised (and not rational, autonomous or individualised) most clearly emerged. All of the mothers that I interviewed after using NIPT for Down's syndrome had received a 'screen negative' results, and so had only imagined, and not experienced the more difficult decisions and choices that testing might bring to pregnancy. NIPD patients, in contrast, confronted reproductive 'choice' directly, and although their experiences were (primarily) approached from within the context of specialist prenatal care (and not routine screening), as they illuminated the problems implicated in the task of navigating testing within the context of family life, they presented accounts which were highly relevant to an understanding of how people (not populations) experience and understand prenatal testing.

Joan had used NIPD in her most recent pregnancy, because her son (who was in his early twenties) had been diagnosed with a severe form of haemophilia, and she had been diagnosed as a 'carrier'. Reflecting back upon the difficulties she and her son had faced during his early years (he had been diagnosed '*out of the blue'* after having repeatedly suffered from major haematomas and prolonged bleeding, over the course of a number of

years), Joan explained how she had felt her reproductive choices in subsequent years had been limited by this difficult family experience:

> I was relieved, not that I wasn't having a boy but that I wasn't going to have a boy with haemophilia. Because having seen, um, my son go through what he had been through in his early years and how hard things were for him. It was hard. And even though now he is healthy, and well, his early years were pretty miserable.... So it was quite- it was really traumatic for him, and for me. But obviously more for him, he was a baby. So when we got back it did- it affected our decision to have more children really. And that's why we waited so long- what six, seven years? It's not that we didn't want to have more, we did. But I guess he took up all the, not the time. But it seemed like a really big decision to have another baby. Because if it was a boy, was it going to be a haemophiliac? How were we going to cope with that?
>
> (Joan, NHS NIPD patient)

Discreet experiences of pregnancy, and prenatal testing then, were informed by events (and knowledges acquired through these) that had occurred decades beforehand. Elsewhere, Cara, who had used NIPD for fetal sex (and had experienced abortion after fetal abnormality) explained how the broader context of her life impacted significantly on the kinds of reproductive decisions and choices she felt that she was able to make. Both her brother and her young child had been suddenly, and within a short time frame, diagnosed with serious disease – her brother with a rare genetic disease (which is what led to the offer of NIPD testing during pregnancy) and her daughter with a rare form of cancer.

> So I did all of her- you know she's never had a jar of anything, it was all home cooked blended organic stuff, which is why it was such a shock when she was diagnosed. Up to her first birthday she was absolutely fine no issues, and um- I think just after her first birthday I was really, ridiculously broody, much more than I had been before having her really, and I sort of said yeah I really wanted to have a second one. And I dunno, it all just kind of [long pause] all went a bit wrong really, with my brother- but I guess that you know, it's very difficult because there have been so many things. There is a bit of a story behind each of them.
>
> (Cara, NHS NIPD patient)

The experiences of both her brother and her daughter – the *'story behind each of them'* – contributed very directly to the shaping of Cara's later decision making regarding abortion: '*you know in my situation I had a brother on a timescale, a daughter that had just come out of chemotherapy, and not knowing- and just, there's a point at which it's just overload*'. Again, it was the presence of broader contextual factors, and not simply a rational, individualised understanding of the consequences that a difficult pregnancy might bring, that guided Cara's decision making here. Acting less as an autonomous individual, and more perhaps as a mother and a sister, the interconnectedness of family

life was positioned centrally within Cara's approach to the choices presented to her through prenatal testing.

Finally, Jodie presented an account of 'risky' pregnancy that also spoke very directly to questions concerning the routinisation of prenatal screening, and the expectation that women will make 'informed' and 'rational' choices. Jodie had a son with severe haemophilia, had been identified as a carrier, and had used NIPD within a subsequent pregnancy in order to identify fetal sex. The baby had been identified as male through NIPD, and so Jodie planned on having an amniocentesis to identify whether the baby had haemophilia – if the baby was diagnosed then arrangements could be made in advance for the birth to be managed at a specialist care centre (Jodie lived several hundred miles away from the nearest specialist clinic):

> With the pregnancy with him, the obstetrician kept pushing me to have my amnio early. And I said I'm having my amnio to see where I'm having my baby, and she went but, what if he has got down's Syndrome? I said I don't care, but she kept pushing and pushing and pushing me to have this amnio at 12 weeks in case it had Down's syndrome, and I said no, because- I said you wouldn't test me until my 20 week one anyway for Down's Syndrome, I'm not going to make a decision now just because you are now saying it's available to me because I have another child with another condition. I said I'll get what I'm given, if he's got Down Syndrome and Haemophilia I'll get on with it. You know I'm not- but then obviously not everyone is like that and they wouldn't would they.
>
> *Do you think you would feel differently if there was an early test?*
>
> I think if I had like that obstetrician- her attitude was to terminate, if it was. And I think, for me I wouldn't do it, but I could see a lot of people would start to over-analyse, so I think maybe it's not a good thing. Especially if you have already got three or four kids or if you are a single teenage mum, you can see why maybe, yeah.
>
> (Jodie, NHS NIPD patient)

Whereas Jodie's obstetrician approached the testing rationally – identifying it as a potential opportunity to provide (cost and time-effective) diagnostic testing for Down's syndrome as well as haemophilia, Jodie approached testing from a position that emphasised the value of minimising the risk to her pregnancy (an earlier amniocentesis would have brought with it a risk of miscarriage, a later one would have brought the lesser risk of early labour). The reported actions of her physician, being quite clearly directive (even coercive), stand in great contrast to the mainstream approach that is adopted towards both screening and diagnostic testing, which emphasises the value of autonomous choice and informed consent – and as much as a framing of choice as informed, rational and individualised may be insufficiently adequate to capture the full, lived complexity of women and parent's decisions regarding prenatal testing, this account clearly shows that

even this minimal, narrow emphasis on individual choice and informed consent is of value (being sufficient, perhaps to guard against this kind of coercive treatment). This example also highlights the power that the dominant framing of disease and disorder, as enacted through prenatal testing, holds: pregnancies/fetuses/babies diagnosed with disease or disorder are figured very clearly by Martha's physician as outcomes to be avoided – made potentially, (almost inevitably here), disposable. When broader social, cultural and personal perspectives on testing are taken into account then, and when the way in which certain knowledges are foregrounded and others are marginalised is examined, it becomes clear that 'choices' and decisions are not made rationally and independently, but come situated within far richer, and far more complex contexts: '*viewing needs and demands as cultural creations within a social context leads to doubts that assumptions of "free choice" with respect to the actual use of prenatal diagnosis are appropriate* (Lippman 1991, p.32).

Summary

Within this chapter I show how, as NIPD and NIPT move ever-closer to the field of prenatal screening, explicit entanglement with biopolitical concerns – inherent to the field of public health – becomes unavoidable. I explain how the biopolitical site of reproductive screening has been subject to much criticism, with the repeated mobilisation of 'informed choice' emerging as a phenomenon of significant problematisation within the literature (and within accounts generated here). With their professional identities being shaped by this difficult and contested context, I show how public health professionals face significant challenges as they administer and govern prenatal screening programmes particularly.

Analysing the media reporting of NIPT, I show how talk of riskiness is foregrounded – with the effect that the technology becomes a legitimate object for population surveillance, and its biopolitical extension is achieved. I show how underlying discourses – concerning the selective shaping of populations – are also present within such accounts. And moving on to analyse participant accounts, I show how public health professionals respond to the problematic 'mainstreaming' of NIPT by seeking distance, emphasising the test's lack of utility, and – responsiblising others through the rhetoric of 'informed choice' – distancing themselves from professional entanglement with contentious issues and concerns.

Finally, I show how NIPD emerges as a biopolitical tool – holding the power to contribute to the practice of population-wide screening, and the corresponding shaping of populations. I problematise the framing of women as autonomous, individual, rational (and responsible) choice-makers, showing how a cultural framing of choice – which

recognises the power of governing bodies and institutions – allows for a more nuanced understanding of how the technology may be approached. I highlight the significance of the relational over the rational within mothers' lived accounts of pregnancy and testing particularly, and I point towards the profound difficulty with which the needs of (abstracted) whole populations and the (situated and contextualised) perspectives of multiple persons may come to be integrated.

Chapter Eight. Discussion

This chapter provides an overview of the thesis, tracing the critical points raised within each chapter, identifying issues that may be of concern within the future discussion of NIPD, and addressing some of the more critical questions that this work raises.

Summary of the thesis

Within the preceding chapters I draw upon Foucauldian concepts of 'problematisation', 'dividing practices' and 'biopolitics', and I approach the examination of NIPD - as it comes to be discussed within and across participant accounts, as well as differently-situated textual and visual data – analytically and critically, identifying specific and repeated moments of problematisation, objectification and ordering. Drawing from Douglas, I attend to marginalised and dissenting accounts particularly, and drawing from Latour and Latimer, I make use of the concepts of 'enrolment', 'translation' and 'alignment' to examine the way in which the trajectory of NIPD technology is being shaped, divided and categorised. Finally, drawing from Strathern, I approach the discussion from a critical perspective that recognises and problematises the persistent foregrounding of the rational over the relational, and the cultural dominance of an approach to personhood that values individuality and autonomy over social and cultural relations.

Within chapter two I track the trajectory of NIPD from the earliest stages of its development to the present, identifying the locations within which the technology has come to be enrolled and translated – a variety of routine, established programmes of prenatal screening and diagnosis - and exploring the way in which testing has begun to sediment in the clinic. Reviewing the relevant literature from within (primarily) the fields of medical sociology and anthropology, bioethics and science and technology studies, I show how prenatal testing generally, and NIPD specifically, arise as sources of significant problematisation, and I trace the contours of debate, pointing towards gaps in the literature. Approaching the history and trajectory of NIPD technology critically, and examining its emergence and translation within both the clinic *and* the market, I show how NIPD's on-going development is being guided by a particular (and powerful) alignment of healthcare, bioscience and capital. Within chapter three I explain how the study was designed and conducted, reflecting on some of the practical and ethical challenges raised during fieldwork, and explicating the process of data analysis in detail: showing particularly how data situated across different registers were brought together,

and how they were analysed utilising a 'grounded' approach that gives rise to the 'thick' descriptions presented and examined within chapters four to seven

Within chapter four I show how NIPD, as it is enrolled within a number of clinical spaces, and as it is translated within a range of different contexts, becomes subject to substantive dividing practices (Foucault 1982): examining the technology at a 'pre-naturalisation' stage, participants actively sort, categorise and classify (Bowker and Star 1999) emergent NIPD tests and associated practices. Reflecting on the 'splitting' of NIPD into two major streams – NIPD/diagnosis and NIPT/testing – I show how participants account for the reasons that lie behind such processes, exploring how NIPD 'troubles' existing boundaries between practices of screening and practices of diagnosis – classifications which are central to the stability of 'routine' and 'normal' approaches towards prenatal testing. As the contingency of established boundaries is explored, dissenting participants 'dispose' of the emergent (and disruptive) technology by drawing upon discourses of accuracy, and by mobilising talk of numbers - appearing here as potent political and cultural agents (Verran 2013) - in order to deny the usefulness of this new technology and maintain space for clinical judgment (Latimer 2013). In contrast, participants more closely aligned with the technology highlight the power of emergent NIPD tests, denying the need for complete accuracy and - drawing parallels between NIPD and established, trusted technologies of diagnosis - reinterpreting the category of 'diagnosis' to further allow for NIPD's successful enrolment and translation within the clinic. I show how clinicians and patients alike respond to the promise of NIPD's accuracy and clarity – with clinicians emphasising the test's capacity to provide almost-complete 'reassurance', and private NIPT patients responding similarly – with the end result that the emergence of non-invasive testing represents a significant moment in the development of prenatal testing, as powerful near-diagnostic testing becomes applicable (and available) for use in 'low risk' populations for the first time.

In chapter five I show how the theme of abortion appeared and re-appeared as an issue of concern within much of the data gathered here – with talk of abortion being present within almost every fieldwork interview conducted. I show how discourse around abortion and prenatal testing, although ubiquitous here, is experienced as fundamentally problematic: the majority of participants struggled to approach the issue directly, failing to find the language with which to describe their experiences with or understandings of abortion, and highlighting the politicised and stigmatised character of the contemporary abortion debate. Recognising that this 'problematic' issue nevertheless lies at the heart of the discussion of NIPD (and other prenatal testing technologies) – as emergent non-

invasive tests and those who encounter them are charged with the task of operating within the 'therapeutic gap' – I draw from Taussig's concept of the 'public secret', showing how abortion functions here, and within the discussion at large, as something that *'is widely known but can not be articulated'.* I show how the secrecy and 'silencing' of the abortion experience brings with it a sense of stigma, which extends out into the lives of both patients and professionals, and which contributes to the construction and re-construction of abortion as 'public secret', leaving those who encounter abortion directly in a position where they feel unable to discuss their thoughts, feelings and concerns openly, and without judgment.

In chapter six I explain how, in response to the blurring and destabilisation of established boundaries, problematic issues of significant 'ethical' and 'social' concern – 'hot' entanglements such as disability rights and the systematic application of 'selective' or 'therapeutic' abortion - are identified as being as central to the discussion of NIPD, within both the data here, as well as the more 'public' and 'mainstream' discussion of the technology at large. I show how mainstream bioethical discourse has dominated the public discussion of prenatal testing and NIPD, as public debates have been guided by a highly professionalised and institutionalised approach towards the examination of 'ethical and social issues', which makes concerted effort to contain and defuse the more difficult and contentious issues raised. I proceed to highlight, however, how the majority of participants approached the technology critically, problematising the tests and actively debating the emergence and translation of NIPD and NIPT within the field of prenatal testing.

I move on to explain how dominant, institutionalised forms of bioethical discourse are mobilised by 'insiders' particularly – those most closely aligned with NIPD – in order to contain and defuse 'hot' issues, and I point towards the relative 'thinness' of such strategies, that depend on the circulation and re-circulation of institutionalised concepts such as autonomy, informed consent and individual choice. Proceeding then to highlight accounts provided by 'critical users' – those with experience of the technology, but who are less closely aligned - I show how significant ambiguity regarding the ethical and social issues raised by NIPD remains, with participants pointing critically towards; the marginalisation of voices outside the mainstream, the profound (and inappropriate) influence that commercial testing providers and developers possess, the responsibilisation of women rather than more powerful administrative and political agents, the limitation of reproductive 'choice' and the shaping of screening programmes to satisfy economic and political ends.

Concluding chapter six, I show how 'outsiders' - those furthest from the mainstream discussion and who are least closely aligned with the technology - present highly critical and dissenting accounts, not only of NIPD and NIPT, but of prenatal testing more generally. These 'outsiders' are able to extend their criticism out, drawing on alternative discourses and identifying the re-emergence and intensification of highly contentious, 'hot' issues such as the stigmatisation and discrimination of those with disease or disability, the stratification of society along medically and genetically defined lines, the profound and pervasive routinisation and normalisation of screening, and the exercise of significant (bio)political power through prenatal screening, selective abortion, and the resulting shaping of populations.

Within chapter seven I explore accounts provided by those most directly implicated in the politics of prenatal testing. I show how, as NIPT screening tests have not only proliferated within the commercial sphere, but have increasingly entered into the discussion (and conduct) of established, routine systems and practices of prenatal screening in the UK, non-invasive prenatal testing technologies have become a matter for discussion not only within specialist locations such as clinical genetics and fetal medicine, but also now within the broader field of public health. The bringing together of public health and NIPT, both of which have been identified as locations for critical discussion and debate, raises significant anxieties and concerns, most clearly within the public health profession itself – the space within which responsibility for the more contentious and difficult aspects of screening is likely to be most publically located. Responding to this, public health experts firstly establish a sense of distance between their professional responsibilities and the disruptive and problematic arrival of NIPT (which threatens significant 'fallout'), and secondly they begin to responsibilise others – 'society', 'clinicians', 'people' and most centrally 'women'. The specific way in which women come to be responsibilised is through their framing as individual, autonomous, rational consumers, their personhood constituted through their capacity for 'choice'. Critical understandings of choice, however, are employed here to show how inadequate a framing this is – particularly within the complex, lived, situated contexts women and parents approach testing from within. As prenatal testing is shown to be experienced and understood not in rational, individualised terms, but as a practice that is shaped by broader social, cultural and personal understandings of what testing means, and that is so thoroughly routinised and normalised that it comes to be 'distributed throughout the brains and bodies' of women and their families – technologies of testing emerge as not simply clinical tools, but biopolitical mechanisms of control.

Study limitations

Although this study addresses a clear gap in knowledge, providing insight into early professional and personal experiences of NIPD and NIPT in the UK, it is unable to comprehensively address *all* issues of interest and concern within the field at large. Here, I outline some of the limitations of the study, and point towards alternative approaches that may have been taken to the overall design and conduct. Firstly, my own positioning in relation to the field may have led to some degree of bias within the data produced. As explained within chapter three, as a female researcher speaking in the majority of cases with other women, I may have elicited particularly emotionally-engaged and 'open' accounts from research participants during the course of fieldwork interviews. Whilst this presented a valuable opportunity to produce and examine particularly rich and detailed accounts of experiences with NIPD and NIPT, the overall character of the final dataset may have been influenced by such considerations, and it ought to be recognised – particularly as I was the sole researcher engaged in data collection for the project – that if a different researcher were to have conducted the fieldwork, alternative accounts of NIPD and NIPT may have been produced. It ought also be recognised, however, that the fact that I was of the same gender (at least) as the majority of the research participants engaged in the project did not entail that I approached key questions and concerns from any kind of shared perspective. I have no direct personal experience of pregnancy, prenatal testing or parenthood, and as such my own personal experience is very clearly divergent to that of many participants interviewed here.

Secondly, although I engage in a practice of examining and cross checking textual material and relevant documentation alongside the analysis of interviewee accounts, the data gathered and examined here is not explicitly ethnographic in the traditional sense. Possible fieldwork locations that would enable the direct observation of NIPT testing (private prenatal clinics) became available only towards the end of the fieldwork phase, and subsequent to a large volume of fieldwork data having already been gathered: it was decided therefore that the conduct of observational fieldwork lay very clearly beyond the remit of the current study. I therefore present no observational data, and I am unable to examine and cross-check the themes raised according what was occurring within the clinic. Being unable to shed light on what might have been observed as NIPT entered into the daily life of the clinic, I can relate my findings only to participants' *reported* experiences, and not what occurred 'on the ground'. Because the development and implementation of the technology has been both rapid and sustained since the outset of this study however, the generation of such data would be a highly feasible option for future research. Studies which produce and examine observational and ethnographic data

addressing the use of NIPD and NIPT in the clinic would supplement the work presented here, and would be highly valuable within the on-going critical discussion of the technology, as well as the discussion of prenatal testing and diagnosis at large.

Finally, the particular approach taken within this thesis – which foregrounds the discussion of processes of problematisation, division, categorisation, and classification – does not represent the only possible path that may have been taken towards the examination of the data produced. A more explicitly feminist approach, foregrounding the work of feminist technoscience for example – *'inspired by social constructionist approaches to gender, sex, intersectionalities, society, science and technology'* (Åsberg and Lykke 2010, p.299) - could have been adopted, and this may have been particularly useful when teasing out the full implications of women's accounts of NIPD and NIPT technology as presented here. Alternatively, a strategy that employed a rigorous actor-network-theory approach (Latour 2005) could have been designed, to specifically enable the close and sustained tracking of NIPD and NIPT testing technologies, as they appear as very particular objects/actors. Such an approach may have enabled particularly close attention to be paid to the concept of 'agency' (Law 1992), helping to shed light on the ways in which various actors – such as commercial companies, women, health professionals, political bodies – were acting as 'drivers' and contributing to the shaping of this emergent technology. Again, such alternative approaches may be taken up within future examinations of NIPD and NIPT, leading to perspectives that may both challenge and complement the work presented here.

The future of critical discussion

A number of issues relevant to the possible future trajectory of NIPD and NIPT are not yet discussed at great length within the literature, and have not been placed centrally within this thesis (as they focus on recent developments, or issues that were of limited relevance to the data gathered here). Issues regarding the socio-economic background of patients and parents, and the impact of such factors on experiences with and understandings of these emergent tests – whilst not explored here - have been identified as relevant to the discussion of prenatal screening more generally, as well as the 'uptake' of screening and the subsequent rate of abortion:

> Socioeconomic inequalities exist in the antenatal detection of [Down's syndrome], and subsequent termination rates are much higher for [Down's syndrome] than other anomalies. Termination rates for all anomalies are lower in more deprived areas leading to wide socioeconomic inequalities in live born infants with a congenital anomaly, particularly [Down's syndrome], and subsequent neonatal mortality.

(Budd, Draper et al. 2015)

There is very little discussion within the literature of why these rates differ, and a critical examination of differing cultural conceptions of testing, disease and abortion, as they might appear across different socio-economic groups, would be valuable, as it has previously been shown that *'substantial social and cultural inequalities exist in knowledge about testing'* (Green, Hewison et al. 2004). Demographic information on participants was not systematically gathered here, but was informally noted as it arose – and whilst the socio-economic background of NHS NIPD patients and parents recruited through mother and baby groups varied widely, the small number of private NIPT patients that were interviewed had a number of features in common, with each of them being professionals in full-time work, and all of them having had previous experience of private healthcare services. A larger study of NIPT testing's emergence into the private clinic may more clearly identify and explain the emergence of such patterns.

Recent 'advances' in testing have led to the 'incidental' detection of maternal cancer diagnoses (Hughes 2015, Newson and Carter 2015, Romero and Mahoney 2015, Sample 2015, Bianchi, Chudova et al. 2015a), and although such occurrences are being discussed within the clinical and bioethical literature, little evidence on how women might respond to such information currently exists. With widespread increases in the average maternal age occurring within many countries worldwide (Loane, Morris et al. 2013), coupled with the fact that the risk of a cancer diagnosis increases with age (Office for National Statistics, 2015), the cultural relevance of such diagnoses may come to be increasingly acute: an examination of patient perspectives regarding questions of maternal diagnosis (as a result of fetal testing) may therefore be valuable. Other recent and successful advances in gene-editing technologies (CRISPR-Cas9[70]) promise to introduce a new era of genetic intervention. Such technologies have already been applied to human fetal tissue (acquired through IVF), and the ethical issues associated with such practices are being discussed (UNESCO International Bioethics Committee 2015). Given the historical centrality of the 'therapeutic gap' within prenatal testing, coupled with increasing experience of (genomic) diagnoses, it may be useful to align the discussion of emergent gene-editing technologies with the on-going debate and discussion of NIPD and practices of prenatal testing.

[70] CRS\ISPR-Cas9 is a new technique of genome editing using a bacterial system, offering the possibility of inserting, removing and correcting DNA with relative simplicity and efficiency (UNESCO International Bioethics Committee, 2015)

Problematisations, questions and concerns

This thesis demonstrates how NIPD, examined as an emergent prenatal testing technology that is being enrolled and translated within and across a broad range of spaces, comes to be understood not simply as a benign extension of everyday, routine and normal prenatal testing technologies and practices - but is deeply problematised – and it shows how it emerges (finally) as a powerful biopolitical tool. It explains how NIPD's emergence is examined and contested - even by those most closely 'aligned' with the technology's development - and it shows how issues and concerns of moral, political and cultural significance are consistently raised for discussion by a broad range of actors. The substantive dividing, sorting and classification practices identified and examined here not only lead to the sorting and selective 'disposal' of specific NIPD tests, they also lead to the containment, defusion and 'disposal' of the more disruptive and problematic discourses and conversations that are exercised, together with more openly critical accounts of the cultural construction (and meaning) of prenatal testing. Within the remainder of this chapter I identify and discuss how some of the more problematic and contentious aspects of the discussion at large are managed, contained and disposed within the mainstream and public discussion, and I suggest alternative discourses that may be employed in order to broaden the debate, and to allow for the inclusion of a wider range of voices, and the production of a richer account of NIPD's emergence and translation.

The disposal of abortion

Firstly, conversations around abortion – emerging here as fundamental to experiences with and understandings of NIPD and prenatal testing – are silenced and disposed. The division of NIPD and NIPT, the corresponding division of diagnosis and screening, and efforts made to maintain the separation of 'selective' or 'therapeutic' abortion practices away from the field of public health (as exercised through prenatal screening programmes) as it faces 'troubled' boundaries, each lead to the clear and persistent disengagement with conversations around abortion and NIPD. I have shown how abortion is approached and framed – by participants here and within the public discussion of NIPD technology (and other prenatal tests) at large - as a kind of 'public secret', something that lies beneath the surface of debate but which is not, or cannot, be openly spoken of. The consequences of this 'silencing' are multiple: firstly, NIPD may be less problematically aligned with the practice of screening (as it does not give rise to a problematic examination of the 'hot' abortion debate), and it may, therefore, continue to enrol within routinised, normalised testing spaces. Secondly, however, the clear practical and social advantages that NIPD could offer to (some of the most vulnerable) patients -

access to earlier, and therefore less 'public', and potentially less 'traumatic' experiences of abortion for the small number of women who receive a prenatal a diagnosis - are made marginal, as issues concerning test accuracy and cost effectiveness continue to be foregrounded within the discussion of NIPT's on-going implementation (Freeman et al. 2015 - forthcoming). Although evidence regarding the particular effects of abortion method - surgical or medical - on women's subsequent health and wellbeing is lacking (Statham 2002), the fact that *'women place a high value on the provision of choice of method of termination'* (Howie, Henshaw et al. 1997) has been very clearly identified. Although NIPD may present an opportunity to allow women access to earlier abortion services if they feel it presents a better option for themselves and their families – to provide a rare opportunity for *genuine* choice in relation to the conduct of prenatal testing – the issue of abortion continues to be disposed, with the result that:

> If NIPT is added to the current NHS screening test repertoire as a contingent test, this would, however, mean some women will undergo four prenatal testing procedures before receiving a definitive diagnosis: a nuchal fold scan and a blood test, a NIPT test if the result is higher than the cut-off risk, and a subsequent invasive test if they receive a positive NIPT result. For some women, termination of pregnancy may actually take place at a later stage in the pregnancy than with current screening protocols. Will women feel as favourably towards NIPT once it is situated within this proposed pathway? The psychological burden of these multiple tests for pregnant women and their partners is unknown.
>
> (Bryant 2014, p.2)

Many of the expert accounts presented here suggest too that the 'implementation' of NIPD would be managed in such a way that disturbance to current practice would be minimised, with the technology's trajectory being shaped around the demands of established clinical practices and structures, rather than the 'needs' of this small group of women. The consequences of such a move, coupled with the persistent silencing of abortion, may entail that issues relevant to the experiences of these most vulnerable women - the 'high risk' patients whose (disordered) pregnancies are in fact the focus of screening and diagnosis programmes – remain marginalised, and their interests unsupported.

If NIPT screening *were* to be introduced population-wide then not only will the screening service be improved to such an extent that a greater number of women will face decisions regarding abortion, but *all* pregnant women will be positioned far closer to (stigmatised and silenced) conversations around abortion as a result of the offer of screening alone. With such developments taking place within a broader cultural context where the strong connection between *diagnosis* and abortion is rarely made public, and where conversations around the connection between screening, public health and abortion are

exponentially more 'difficult', the social and cultural shaping of women's reproductive 'choice' is likely to remain undiscussed, and the corresponding responsibilisation of individual women is likely to continue. It has been suggested that the relational complexity of 'selective' or 'therapeutic' abortion experiences, combined with paucity of bioethical discourse and the silencing of debate, entails that a new kind of discourse is urgently required – one which *'requires an ethic of listening that is willing to bear witness to the chaos'*:

> The shift in clinical ethics towards a narrative based practice may initiate the opening of a cultural space where chaos narratives may be more fully appreciated and heard. Bioethics must not shy away from the silences and must continue to be aware of how the nature of its discourse sets certain agendas before its content is processed. Neat and tidy abstract conclusions often leave us ill equipped for moral engagement at the level of lived experience.
>
> (Thachuk 2007, p.514)

The accounts provided here by NIPD patients particularly show how central such 'chaos narratives' are to their lived experiences of abortion. The account of testing provided by Abi, who recalls the complexities of a particularly problematic and contested abortion experience, highlights the difficulty with which such experiences currently come to be managed both in the clinic and within the context of an on-going family life:

> So Dylan was put to sleep on the Wednesday, and then I hadn't listened or absorbed anything so didn't realise I would have to go back into the hospital on the Saturday to deliver him. So Friday I'm in the park with my daughter [*Abi becomes very upset*], just like, keeping things normal. And looking back, I don't know how I did it. I um- what happened next? Um, had the funeral, life carried on. I went onto antidepressants a little bit, didn't want to because I've got ME. And before I was diagnosed with that I spent 18 months on Prozac, and nobody did anything other than put me on them.
>
> *So you weren't given much information on what was going to happen with the termination?*
>
> It could be that I just shut it out, and that I just refused, you know I just handed the phone over and refused to listen. Because, you know, to me, she was being very blasé about killing my child. And you know, I know it's the whole procedure but having to get somebody to sign it off before it happens is just, it just felt wrong. And I know it's only to cover their own back, but to be fair what was I meant to do? I thought I was going to take a tablet and it would all be done. That's what I thought. I didn't realise we would see him on the monitor, the monitor would be turned away from us, I would be injected, and then turn up. I think the anti-D made it harder, because we had to bumble around the hospital waiting until my body was at a right time from having he procedure to checking my blood levels, that was a hard bit. But turning up at the hospital and everyone knew why you were there, and they were trying to talk to you. It was just.
>
> (Abi, NIPD NHS patient)

Abi's account renders the difficulties that may be involved in the contemporary 'selective' or 'therapeutic' abortion experience tangible – the vagueness with which the procedure was approached, the rationalisation and legalised framing of Abi's decision, the sense of stigma she felt had surrounded her experience, the sense of inevitability and lack of 'choice' that Abi reports – providing support for the claim that, as a result of silence and stigma, *'women are socially isolated, their experiences kept secret, their grief disenfranchised'* (Thachuk 2007, p.512). Although Abi's abortion experience occurred after amniocentesis and not NIPD, such accounts are essential to the understanding of how fundamentally problematic – especially if testing does *not* come to be positioned earlier in pregnancy – the 'selective' or 'therapeutic' abortion experience may be. Although such issues may be faced by a minority of women – with most experiencing 'reassurance' and not on-going 'risk' once their testing is complete - they are, nevertheless, a direct consequence of prenatal screening and diagnosis programmes:

> Prenatal care programmes, not an openness towards abortion, transform her body into a field of operations for technocratic and bureaucratic interventions. And it is of course not only the pregnant woman but also the fruit of her belly that is affected by being discussed in the context of probabilities and risks which, strictly speaking, make sense only for groups; her unborn is transformed into the crumb of a population.
>
> (Duden 1993, p.28)

The disposal of 'hot' entanglements

The topic of abortion is not the only one 'disposed' of within the discussion of NIPD. Within the public, 'mainstream' discussion of NIPD's development, and despite the presence of dissenting accounts, the more difficult and contentious issues that participants here, for instance, so clearly raise - the stigmatisation of those with disability, the shaping of populations though the systematic application of selective abortion, the stratification of society and its division into categories of 'normal' and 'abnormal, 'sick' and 'healthy' – are explicitly *not* foregrounded. Rather, it is talk of informed consent, reproductive choice and individual autonomy that is made central to the discussion of 'ethical' or 'social' concerns, and more directly critical perspectives remain marginalised. This thesis highlights a broad range of critical and dissenting voices which are relevant to the discussion of NIPD, and which may otherwise (typically) be positioned at the margins of debate, as those aligned with the technology and its associated practices are given the strongest voice. Drawing upon (powerful) mainstream bioethical discourse, the public debate on NIPD responsibilises 'individual' women and parents, and fails to reflect on the broader social

and cultural shaping of the technology, and its enrolment and translation within routine clinical practice:

> Without a doubt, prenatal diagnosis has (re)defined the grounds for abortion – who is justified in having a pregnancy terminated and why – and is a clear expression of social control… prenatal diagnosis is thus revealed as a biopolitical as well as a biomedical activity. an abortion may only become "legal" in some countries if the fetus has some recognized disorder, and the justifying disorder becomes "recognisable" because geneticists decide to screen for it
>
> (Lippman 1991, p. 34)

As Lucy (genetic counsellor) suggests - see page 131 - the rise of NIPD *could* function as an opportunity to reflect critically, not simply on the technology itself, but on the broader cultural construction of screening and diagnosis. Given the wealth and depth of the critical commentary that has been produced as reproductive technologies have been enrolled within the clinic and have been translated within the lives of pregnant patients the critical discussion of NIPD has a rich resource of debate and discussion to draw from.

More critical accounts of NIPD's development – which highlight the lack of public discussion concerning the more difficult and contentious issues identified by participants here - have started to appear, with Newson (Newson 2014) for instance questioning not only the practical implications of NIPD's emergence within prenatal screening and diagnosis, but critically examining the construction of such practices, suggesting for instance that '*we must not use screening as an excuse for withdrawing practical or psychological support for people who choose to continue a pregnancy that will lead to the birth of a child with a genetic or congenital condition',* and pointing towards the significance of the relational as well as the rational: '*we need to appreciate that although these decisions are made by women and couples based on their individual values, the social context in which they are made is also important'.* Critical perspectives on the project of prenatal screening have been described previously, with Clarke for instance examining the thinness of public debate around Down's syndrome screening particularly. Pointing towards the presence – and containment - of 'bold' and critical dissenting perspectives, Clarke explains how the examination of 'hot' entanglements has been purposively avoided, with the result that screening – operating within the context of the 'therapeutic gap' – leads inevitably towards the (uncritical) routinisation of abortion:

> [The critical examination of screening] has not happened – society has baulked at this discussion, and has never debated these issues openly… there is no consensus that terminating affected pregnancies is the most appropriate response to the challenge of Down's syndrome and that this view should be promoted publically through the National Health Service. The debate has scarcely even started, despite some bold attempts.

(Clarke 1997, p.128)

The unavoidable entanglement of screening, public health and selective abortion places great pressure on a system that (primarily) manages the ethical and social implications of testing via a framework that emphasises only the *individual* and not the political or cultural shaping of choice. As the '*structural directiveness*' (Clarke 1997) of prenatal screening programmes becomes increasingly clear, the responsibilisation of women, and not the institutions, individuals and broader political processes that direct and govern screening systems, appears as entirely at odds with any kind of critical understanding of the way in which choices and experiences come to be shaped:

> Given the way in which health professionals influence both public attitudes to genetic disease and the reproductive decisions of individual women, it is disingenuous of clinicians to claim they are simply making available services that the public manifestly wants to utilize. In fact, they are frequently generating the 'needs' that they claim to meet, and they are choosing to find a 'solution' to this 'need' rather than to other needs that might be just as urgent and rather more amenable to simple, benign interventions.
>
> (Clarke 1997)

Prenatal screening, as a practice that has come to be thoroughly routinised and normalised - '*distributed throughout the brains and the bodies of the citizens*' (Hardt and Negri 2013, p.216) - has been shown to be a key location for the exercise of biopower *'regulating social life from its interior, following it, interpreting it, absorbing it, and rearticulating it',* rather than any kind of explicitly political, transparent, accountable system of administration and governance. It has been suggested that the consistent promotion of '*informed choice'* as the chief purpose and benefit of prenatal screening is a key way in which the process at large, and the professional lives of those involved, may be distanced from entanglement with debates around 'hot' issues such as disability rights and eugenics (William, Alderson et al. 2002, as cited in, Wilkinson 2015, p.26). And it is perhaps for this reason – because of the clear presence of 'hot' entanglements such as '*the vexed question of new eugenic possibilities*' (Latimer 2013, p.153) – that those whose professional identities are so closely aligned with the politics of prenatal testing (understandably) seek to distance themselves from more critical questions regarding prenatal screening and the explicit shaping of populations (via a process of identification and 'disposal' before birth). Although the accounts provided by public health experts here presented, at times, as less than sympathetic towards the kinds of difficult experiences that were so richly illustrated by those who had used NIPD, the task of harmonising a population-wide public health perspective on NIPT and screening, with an understanding

of the contextualised, situated, complex and difficult experiences that people encountering NIPT testing may face, is unlikely to emerge as anything other than profoundly difficult.

Elsewhere, as they critically (and empirically) examine the provision of genetic counselling as practiced in connection with NIPD, presenting *'a challenge to the status quo'*, Farrelly and Cho (Farrelly, Cho et al. 2012) provide evidence to suggest that there is a persistent lack of conversation around disability within the emerging context of NIPD (and NIPT) counselling. Suggesting that these conversations too, become disposed, they point towards the problematic implications that such an approach entails, particularly as testing becomes more widespread, and more routine:

> Many genetic counselors are not engaging in comprehensive conversations about disability with their clients Soon, non-invasive prenatal diagnosis will be offered at an affordable cost early in pregnancy, making diagnostic results available to clients on a far broader basis, and making these issues salient for a larger population of clients. The noninvasive nature of such testing may mean that the informed consent process is reduced even beyond its current state.
>
> (Farrelly, Cho et al. 2012, p.823)

Conversations around abortion, disability, and the social and cultural shaping of selective reproduction are undeniably problematic. The issues and concerns raised however – the 'hot' entanglements – that are generated as a result of such conversations, may only become more acute as the scope of NIPD technology continues to expand:

> While [Down's syndrome] may be the first genetic condition that can be definitively diagnosed in the first trimester on a population basis, others will undoubtedly follow. Countries and their people will be challenged to answer: what forms of genetic variation are valuable?
>
> (Skotko 2009, p.825)

> Driven by profit and powerful technology, several biotech companies are expanding popular prenatal screening tests. In addition to looking for Down syndrome, they are starting to check for smaller breaks and errors along a baby's 23 sets of chromosomes that can also cause severe, if rare, birth defects. In brochures aimed at expectant mothers, Sequenom bills its expanded test as the "only prenatal blood test that analyzes every chromosome of your developing baby."… Bigger is sold as better. The companies are driving this, not patients and not providers.
>
> (Regaldo 2015)

Private NIPT tests now available for purchase within the UK offer to provide results on a wide range of conditions (see appendix two) that would otherwise have only been made available through specialist clinical genetics services, and only after patients had received

comprehensive pre-test counselling. The conditions that have come to be tested for vary widely in severity and phenotype: some of the conditions tested for through commercial NIPT tests, such as trisomy 16, are *'uniformly lethal'* (Petracchi, Igarzabal et al. 2009), whereas others, such as 'triple X', are far more benign, producing symptoms that would be difficult to recognise as being life-threatening: *'delayed language development... accelerated growth... IQ levels 20 points below that of controls... low self esteem'* (Otter, Schrander-Stumpel et al. 2009). Emerging private testing services such as Sequenom's MateriniT GENOME (see fig. four, page 25) test are marketed under the banner of providing as much information as possible - by analysing *'every chromosome'* - and with on-going and parallel advances in sequencing technologies taking place alongside, such testing is likely only to become lest costly, and the marketing more prolific. The breadth and depth of the genetic information that may be generated through the use of these 'advanced' NIPD tests holds the potential to bring significant practical, social and ethical challenges:

> Terminations may be triggered by uncertainties of interpretation of the genome sequence; we have already considered such [variants of unknown significance] and [incidental findings] but these may now influence practice in a way that would disturb many professionals, especially as society is only beginning to adjust to the uncertainties of interpretation of genomic information. Basing serious and irreversible decisions on such provisional interpretations, which are so liable to shift in significance, could lead patients to make decisions that they later bitterly regret.
>
> (Clarke 2014, p.27)

> Given that the sequencing of the genome in many cases only enables one to determine the probability of developing an illness, a difficulty arises: how to establish an accurate relation between the gravity of the foreseen illness and the probability of it appearing? Must a weak probability of developing an illness later be considered as a major or a minor risk? Access to such tests, especially if they are not correctly interpreted, is anxiogenic; how will parents live with the knowledge that the child has the probability of developing a serious illness that may never develop?
>
> (UNESCO International Bioethics Committee 2015)

Once again, the 'irreversible decisions' that such testing would impose are likely to be ascribed to women, as it is the individual 'consumers' and 'patients' who become charged with the task of navigating these complex and uncertain emerging technologies – which produce information that *'can often not be predicted in advance [and] can only be explained with hindsight that may not emerge for some years into the future'* (Clarke 2014, p.27). Significant increases in the range and number of diagnoses that are made through NIPD may lead to further divisions being made between the 'normal' and the 'abnormal, the 'sick' and the 'healthy'. Within her critical examination of the dysmorphology clinic,

Latimer shows that the category of 'normal' is becoming less and less inclusive in the wake of proliferating diagnoses, and is undeniably therefore, shrinking:

> We might think these syndromes may simply represent difference – difference in one set of children and their parents from another… What emerges however is how the genetics of normal human development relies on this mapping of deviations in growth and form, with the observation and description of congenital abnormality. So much so, that what seems to be evident is that it is the normal that is itself shrinking. So that, as one geneticist put it to me: from his perspective, we all have a syndrome.
>
> (Latimer 2013, p.xvi)

Within the context of the dysmorphology clinic parents are faced with the ongoing struggle to manage the emergence of diagnosis and disease – within a space where counselling *'acts as [the only] form of intervention'* (Latimer 2013, p.204) – and where clinical practices and processes of *'deferral and undecidability'* dominate. Within the context of non-invasive prenatal testing, parents and particularly mothers are faced with similar '*uncertainties in interpretation'* (Clarke 2014) around the meaning of genetic diagnosis, but they are, by contrast, offered a more problematic form of intervention: the 'choice' of whether to end the pregnancy through abortion, or to continue in the presence of diagnosis. Additionally, whereas the practice of dysmorphology occurs within specialist clinical spaces, and is guided by the expertise of clinical geneticists, the practice of non-invasive testing may not be confined to the practice of clinical specialties. Although private prenatal testing services for Down's syndrome may currently be accompanied by thorough pre-test counselling (the accounts provided by NIPT patients interviewed here suggested that the information received prior to testing was significantly more comprehensive than that which they received within the NHS), the future trajectory of testing is being very actively shaped by commercial companies and laboratories positioned at a great distance from the lived, relational experiences of pregnancy that their tests – their products - come to affect.

Operating within the context of the therapeutic gap, such 'enhanced' non-invasive testing opportunities, when examined critically, may be seen to provide very little hope of bringing real 'choice'. Strathern explains how the absurdity of the circular relationship between consumer demand and commercial manufacturing *'offers the real glimpse of a situation where choice might cease to be enablement'* (Strathern 1992b, p.36), showing how the proliferation of commercially-generated options, framed in terms of 'choice' and which ought therefore to imply some kind of freedom, in fact produces a world where genuine 'choice' is heavily restricted, as manufacturers pre-determine what kind of 'choices' are made available, according to *their* expectation of consumer demand. Within the context of

rapidly-expanding commercial NIPD testing, Strathern's suggestion that prolific commercialisation and marketisation leads to a *'a world full of persons embodying the choices of others'* - particularly when examined alongside Latimer's *'shrinking'* of the normal - hints towards the possibility that women's future reproductive 'choice' may come to be shaped, primarily, not by those with expertise in clinical genetics or genetic counselling, or by those whose bodies and lives are so closely bound to experiences of testing, but by those who hold (and wield) the (bio)power that is being generated here, through a strong alignment of healthcare, bioscience and capital, as exercised within the rapid and on-going development and translation of NIPD.

List of tables and figures

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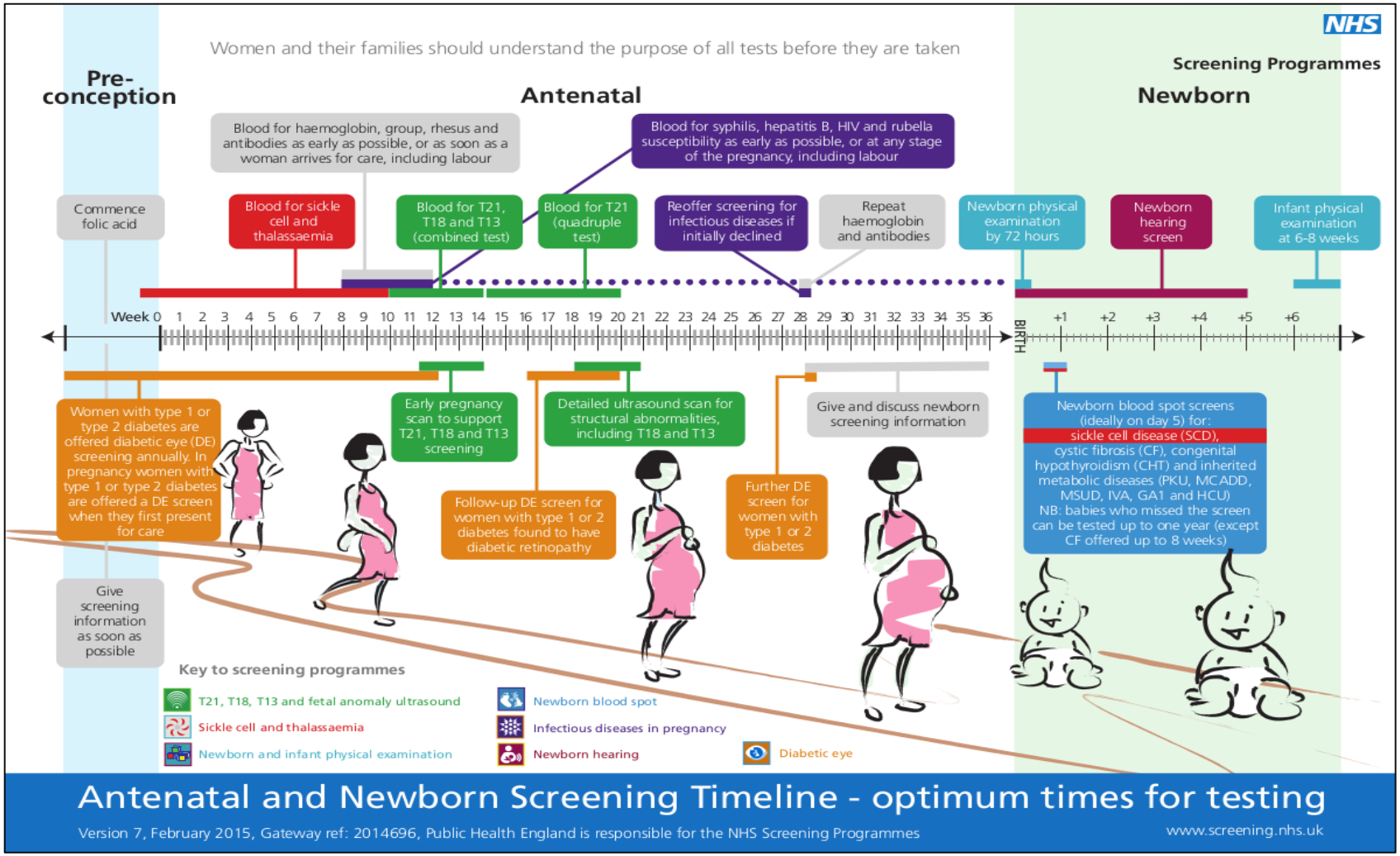
Appendix One. NHS Antenatal Care Timeline

FASP (2015). Antenatal and Newborn Screening Timeline - optimum times for testing. London, Crown Copyright. Available at: http://cpd.screening.nhs.uk/timeline



Appendix Two. Commercial NIPT Provision in the UK.

Table shows commercial NIPT tests currently known to be available to purchase in the UK. Conditions listed in grey are not currently tested for within the remit of the UK National Screening Committee's Fetal Anomaly Screening Programme (FASP).

Brand name of test	Conditions tested for (information correct as of 08/06/15)	Name of developer	Location of developer
Harmony™	Fetal sex Down's syndrome (Trisomy 21) Edwards' syndrome (Trisomy 18) Patau's syndrome (Trisomy 13)	Ariosa Diagnostics, Inc. (acquired by Roche/Hoffman-La Roche Inc., January 2015)	California, USA
Panorama™	Fetal sex Down's syndrome (Trisomy 21) Edwards' syndrome (Trisomy 18) Patau's syndrome (Trisomy 13) Triploidy Monosomy X (Turner syndrome) Karyotype XYY/Jacobs syndrome Klinefelter syndrome (47XXY) Trisomy X (triple X syndrome) 22q deletion syndrome (DiGeorge) 15q (Prader-Willi/Angelman syndromes) 1p36 deletion syndrome 5p deletion syndrome (Cri-du-chat syndrome)	Natera, Inc. (formerly gene security network)	California, USA
MaterniT21 Plus™	Fetal sex Down's syndrome (Trisomy 21) Edwards' syndrome (Trisomy 18) Patau's syndrome (Trisomy 13) Monosomy X (Turner syndrome)	Sequenom, Inc.	California, USA

	22q deletion syndrome (DiGeorge) 5p deletion syndrome (Cri-du-chat syndrome) 15q (Prader-Willi/Angelman syndromes) 1p36 deletion syndrome 4p (Wolf-Hirschhorn syndrome) 8q (Langer-Giedion syndrome) 11q (Jacobsen syndrome) Trisomy 16 Trisomy 22		
Verifi™	Fetal sex Down's syndrome (Trisomy 21) Edwards' syndrome (Trisomy 18) Patau's syndrome (Trisomy 13) Monosomy X (Turner syndrome) Trisomy X (triple X syndrome) Klinefelter syndrome (47XXY) Karyotype XYY/Jacobs syndrome	Verinata Health (acquired by Illumina Inc. in February 2013).	California, USA
NIFTY™	Fetal sex Down's syndrome (Trisomy 21) Edwards' syndrome (Trisomy 18) Patau's syndrome (Trisomy 13) Monosomy X (Turner syndrome) Klinefelter syndrome (47XXY) 5p deletion syndrome (Cri-du-chat syndrome) 1p36 deletion syndrome Trisomy X (triple X syndrome) Karyotype XYY/Jacobs syndrome 2q33.1 deletion syndrome (Glass syndrome)	BGI Diagnosis Co., Ltd.	Shenzhen, China
Genesis Serenity®	Fetal sex Down's syndrome (Trisomy 21)	Genesis Genetics	Nottingham, UK.

NIPT	Edwards' syndrome (Trisomy 18) Patau's syndrome (Trisomy 13) Monosomy X (Turner syndrome) XXX (Triple X) XXY (Klinefelter syndrome) XYY (Jacobs syndrome)		
The IONA® test	Fetal sex Down's syndrome (Trisomy 21) Edwards' syndrome (Trisomy 18) Patau's syndrome (Trisomy 13)	Premaitha Health, Plc.	Manchester, UK.

Appendix Three. NIPD Tests Currently Approved for Diagnostic use by the UK Genetic Testing Network (UKGTN).

Genetic condition or trait tested for	Further information on condition/trait (from the Online Mendelian Inheritance in Man®/OMIM database)	UK laboratories offering test	Date of UKGTN approval
Apert syndrome	Congenital disorder, resulting in malformations of the skull, hands and feet. Varying degrees of intellectual disability/developmental delay associated. Estimated to occur in 1 in 160,000 births.	London North East RGC GOSH	September 2014
Cystic Fibrosis	Condition of varying severity, disrupts function of the pancreas, intestinal glands, biliary tree, bronchial glands and sweat glands. Infertility occurs in males and females. Birth incidence varies greatly amongst different populations.	London North East RGC GOSH	September 2014
Fetal sexing for Congenital Adrenal Hyperplasia (CAH) and other X-linked conditions.	CAH: in female newborns external genitalia are masculinised, gonads and internal genitalia are normal. Untreated males and females may manifest rapid growth, penile or clitoral enlargement and short stature. Estimates of birth incidence vary significantly.	• Birmingham RGC Bristol RGC • Manchester RGC • Salisbury RGC • London North East RGC GOSH •	March 2011
FGFR3-Related Skeletal Dysplasias (Achondroplasia, Hypochondroplasia, Muenke Syndrome, Thanatophoric Dysplasia Type I and Thanatophoric Dysplasia type II)	• Achondroplasia: most frequent form of short-limb dwarfism. • Hypochondroplasia: form of short-limb dwarfism, milder than Achondroplasia. • Muenke syndrome: variable phenotype that can range from no detectable clinical manifestations to complex findings	London North East RGC GOSH	September 2013

	• Thanatophoric dysplasia I and II: severe short-limb dwarfism syndrome that is usually lethal, with patients dying in the first hours of life.		

Appendix Four. Participant Consent Form

CONSENT FORM VERSION 2.0. 15/02/13.
PARTICIPANT NUMBER FOR THIS STUDY:

Cardiff University School of Social Sciences

Consent Form

Title of Project: Women's reasoning on emerging non invasive prenatal diagnosis (NIPD) technologies. Name of Researcher: Heather Strange

Please initial the boxes on the right hand side.

1) I confirm that I have read and understand the information sheet dated..... (version.....) for the above study. ☐

2) I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. ☐

3) I agree to the interview being tape recorded but my name will not be used. ☐

4) I understand that what I say may be quoted in publications about this study, but my name would not be used and I agree that such quotations can be used. ☐

5) I agree to take part in the above study. ☐

_____	_____	_____
Name	Date	Signature

A WELSH LANGUAGE VERSION OF THIS DOCUMENT CAN BE MADE ON REQUEST

Appendix Five. Participant Information Sheet (Patients/Parents)

Letter of invitation

PhD project: Women's reasoning on non-invasive prenatal diagnosis technologies

Dear Madam/Sir

I would like to invite you to take part in a research study. Before you decide, you need to understand what research is being done, and what your participation would involve. I would be very grateful if you could take the time to carefully read the following information. This should take around 30 minutes.

Part 1 of the Participant Information Sheet tells you the purpose of this study and exactly what will happen if you take part. Part 2 gives you more detailed information about the conduct of the study.

Because this study involves talking about a new technology, I have also included a section that explains this called 'Introducing NIPD'. You do not have to read this information, but if you would like to take part in the study, you may find this interesting.

If you would like any further information, or if you have any questions, please do not hesitate to contact me. I will do my best to answer any questions or concerns.

A Welsh language version of this information sheet can be provided upon request.

Yours Sincerely,

Heather Strange

PhD Student

Tel: 07872927092

Email: strangehr1@cardiff.ac.uk

Participant Information Sheet Part one

What is the purpose of this study?

This study is interested in what a range of people think about new non invasive prenatal diagnosis (NIPD) technology. NIPD is a new kind of prenatal testing technology that is currently used for limited medical purposes. Scientists and clinicians are working on developing this technology further, so that it may become available a wider range of purposes, and many think that NIPD will change the routine care of pregnant women in the future. For this reason, I am interested in speaking to people who have experience of NIPD testing, as well as people who have experience of routine prenatal testing. These people might be patients, they might be parents, or they might be clinicians. If they are parents or patients they might have accepted and used prenatal testing, or they might have decided not to use prenatal testing. I would like to talk to all of these people about their experiences of prenatal testing, and their thoughts on what using NIPD testing might mean. I would like to speak to a wide range of people because many different people will be involved with using NIPD, in lots of different ways. I would like to explore these questions now, before NIPD is introduced widely, so a picture can be built up of what people think about NIPD tests.

Why have I been invited to take part?

You have been invited to take part because you have some experience of NIPD or routine prenatal testing during pregnancy. You may have had experience as a patient or a parent. You may have accepted and used prenatal testing, or you may have been offered testing during pregnancy and decided not to use it. I would like to talk to you about your experiences, and your thoughts on NIPD.

Do I have to take part?

It is up to you to decide whether you would like to take part in this study. I will not discuss what you say or whether or not you participate with anyone outside of the research team. If you decide to take part but change your mind at any time, even during the interview, you are free to leave the study without having to give any reason.

What will happen to me if I take part?

If you agree to take part I will contact you and ask you to agree to an interview, which will be arranged to take place at a time and place that is most convenient to you. The interview can take place in your own home, or it can take place somewhere else that you suggest. I can assist with making a space available for interview, if this helps. If you are happy to take part in an interview I will send you confirmation of the date, time and place

in the post, along with a 'consent form' which you can read before coming to the interview. Before the interview I will make sure you have understood the information that you have been given about the study, I will give you the opportunity to ask any questions, and I will ask you to sign the consent form. This form will record your understanding of the study, and your willingness to take part. The interview is expected to last for about an hour, and with your permission I would like to audio record what you say, so that I can make sure I have accurately captured all information.

Over the course of the interview I will ask you about your experiences of prenatal testing. I would also like to ask you about your thoughts on NIPD, whether you have experience of the technology or not. Before talking about NIPD, I will give you some information in the form of short written scenarios or 'vignettes'. The scenarios will give examples of how NIPD might be used in future. With your permission I will also collect some background information such as your age, gender, marital status, ethnicity, and previous employment.

I will also ask if you have a partner that you think may be interested in taking part in the project. This does not mean you have to discuss the project with your partner: it would be entirely up to you whether you speak to them about the research, or whether you ask them to think about taking part. If you would like to ask your partner about taking part, I will provide you with an additional copy of the information pack to for you to pass on to them. Partners who would like to take part will go through the same steps as you did, contacting the researcher if they would like to participate, arranging a date and time for interview, and signing a consent form. Like you, they would be free to leave the study at any time without giving any reason. All interviews will be carried out individually, and I will not discuss during interview anything that any you or any other previous participants have said.

I would like to reassure you that any information collected about you will be strictly confidential. Your name or any other information which could identify you will not be associated with anything you tell me. Once the interview is over I will type out what has been said word for word but your name will not be used and you will not be identifiable in any written report.

You do not have to answer any questions you do not wish to and you may stop the interview at any time without giving a reason.

My partner has just taken part in your study: why have they given me this information pack?

I would like to include the partners of women who have had experience of NIPD or routine testing in this study because, as parents or close family members, they will often be very involved in the discussion and use of prenatal tests. Because it is difficult for me to contact partners directly, I will be asking participants to speak to their partners about the project, if they think they might also be interested in taking part. This method of contacting people is used when the groups that researchers would like to speak to are very small or difficult to reach, and is sometimes called 'snowball sampling' (this is because the number of

people available to speak to slowly grows, like a snowball, as information on the study spreads by word-of-mouth). All interviews will be carried out individually, and I will not discuss during interview anything that any other previous participants, including your partner, have said.

What are the possible disadvantages and risks of taking part?

Taking part in the interview will take up about an hour of your time. During the interview, you will be sharing memories of past experiences, and you will be describing thoughts and feelings. Talking about pregnancy, and especially prenatal testing, could raise sensitive personal issues and you could feel distressed or upset by this.

What are the possible benefits of taking part?

Individual study participants will not directly benefit in any practical way from this research. It is hoped that this study will help benefit other people, who may have to make decisions about NIPD in the future. It will do this by painting a picture of the interests and concerns raised by the patients, parents and clinicians who participate.

What will happen if I don't want to carry on with the study?

If you do not want to participate in the study you do not need to contact me or read the additional information included in this pack, if you do not want to. During the interview, you do not have to answer any questions you do not wish to, and you may stop the interview at any time without giving a reason.

Participant Information Sheet Part two

Will my taking part in this study be kept confidential?

Yes, all information will be completely confidential. If you are an NHS patient, no-one involved in your care will be told that you have agreed to take part in the study and nothing that you say will be reported back to anyone involved in your care.

An important exception to this rule concerns cases where serious medical or legal information is disclosed by participants during the course of the research. If serious information is disclosed, the researcher has a legal and moral obligation to report this information.

Several practical steps will be taken to ensure that your privacy is maintained and the confidentiality of your information is protected:

- During the interview I will ask your permission to audio record what is said. I will not use your name during the interview. Once the interview is over, I will type out what has been said from the recording and the recording will then be erased. Your name, along with any other information which might identify you, will not be included in the typed information. What is said during the interview will be completely anonymous, and this is the only information that will be used in the study. There will be no way in which you will be able to identified.

- If you are not happy for me to audio record the interview, I will take written notes as the interview goes along, and I will type this information up when the interview is over. These notes will use the same system for protecting your anonymity: I will not use your name, and no information that might identify you will be included in the typed up information.

- When I have typed what you have told me, I will study this information and compare this with what other people tell me. I can then identify common areas of interest or concern. The typed information will then be kept in a locked filing cabinet accessible only to the researcher for a period of ten years. The computers on which the typed information is stored will be password protected and only accessible by the researcher.

- Your signed consent form, which contains your name will be kept in another locked filing cabinet which will only be accessible to the researcher.

- Direct quotations from you may be used as I write up the results of this research. Only your words will be used and no personal or identifiable information about you will be included in any written documents.

What will happen to the results of the research study?

The results of this study will be used to help prepare the researcher's PhD thesis. This will be examined by professional academics from Cardiff University and another UK University, before a decision is made about whether a PhD will awarded.

The results from the study will then be published in national and international academic and professional journals.

Who is organising and funding the research?

This study is funded by the Welsh Government's National Institute for Social Care and Health Research (NISCHR), who awarded a full time studentship to support this work, and it is sponsored by Cardiff University.

Who has reviewed the study?

This study received an independent scientific review from NISCHR before the studentship was awarded. In addition, all research that involves the NHS is looked at by an independent group of people, called a Research Ethics Committee (REC) who work to protect participants' safety, rights, wellbeing and dignity. This study has been reviewed and given favourable opinion by South East Wales Research Ethics Committee.

Further information and contact details

If you would like more information about the study or if there is anything that is not clear, please do not hesitate to contact the researcher, Heather Strange on 07872927092 (during working hours) or strangehr1@cardiff.ac.uk.

What if I have concerns during my participation?

If you are worried or unhappy about any aspect of this study or your participation at any time, you should speak to the researcher (Heather Strange) who will do her best to address your concerns, or answer your questions. If you remain unhappy and wish to complain formally you can do this by contacting the Cardiff University Research Governance team on 02920 879130 (Mr Chris Shaw, Research Governance Coordinator). If you participate in this study as an NHS patient you are also free to use the normal NHS complaints procedure (further details can be found on your hospital or trust's website).

What should I do now?

If you would like to take part please complete the details on the following page and return it to me in the stamp-addressed envelope. I will then contact you and arrange a suitable time and place for the interview to take place.

Reply slip

I am interested in taking part in this study and give permission for my contact details to be used by the researcher.

Signed:_____

Name
(printed):_____

Address:_____

_____

_____

_____

Telephone
number:_____

Email
address:_____

Introducing NIPD

What is prenatal testing?

Prenatal testing is an important part of the medical care that is offered to women during pregnancy. It is not compulsory to use prenatal testing during pregnancy, although all women are offered some tests if they are under NHS care. Prenatal tests can provide information about the health of the fetus (the baby developing inside the mother's womb). They do this by either looking at the mother's blood, or by looking more directly at the fetus itself.

Some prenatal tests are routinely offered to all pregnant women, and some are offered only to women who's pregnancies are at high risk of certain medical complications. The tests that are offered to all women are called **screening tests**: they do not give yes or no answers, but they do give women a result that tells them if they are at high or low risk of carrying a baby with certain health problems. These tests use technologies that are **non invasive** which means that they do not risk harming the fetus. The technologies used for screening are ultrasound scanning and blood testing. The groups of diseases or characteristics that are commonly tested for during prenatal screening are: Down's syndrome and other fetal anomalies; Sickle Cell and Thalassaemia; infectious diseases such as Syphilis, Hepatitis, HIV and Rubella.

The tests that are offered to women who's pregnancies are at high risk of certain medical complications are called **diagnostic tests**. The medical names of these tests are "Amniocentesis" and "Chorionic Villus Sampling" (CVS). These tests give very accurate answers about whether the fetus has certain health problems. Diagnostic results can be used to decide about the future of a pregnancy. If a result indicates that the fetus has health problems then, for serious diseases, termination of pregnancy is an option. These tests are **invasive**, meaning that by using them during pregnancy, there is some risk of harm to the fetus. There is a risk of between about 1% and 2% that a pregnancy will miscarry if these invasive tests are used. This is because these tests look at the fetus more directly. They involve using a needle to take samples of the fluid or tissue that surrounds the fetus as it develops. These samples contain genetic information (DNA) from the fetus. This genetic material can be tested to see whether the fetus has certain genetic diseases or characteristics. These tests are carried out at a later stage in pregnancy than screening tests.

What is NIPD?

NIPD is a new kind of prenatal test that is very accurate, non invasive and can be carried

out during the early stages of pregnancy (from seven weeks). NIPD testing involves taking a sample of the mother's blood and then looking at it for information about the health of the fetus. NIPD works because there is a small amount of DNA from the fetus that is present in the mother's blood during pregnancy. It is this DNA that can provide very accurate information about the health and development of the fetus. NIPD tests are at a very early stage of development and are not currently offered to all women as part of routine medical care.

By looking at this DNA we can tell if the fetus is male or female. It is expected that in the future we will be able to find out more information about the fetus using NIPD tests, finding out for instance whether the fetus has certain genetic diseases such as Down's syndrome.

Why is NIPD used?

Currently, NIPD is only offered to women who are at risk

of carrying certain "sex-linked" diseases. Some women know because of their family history that, if they are carrying a boy, there is a chance that the fetus may be affected by a sex-linked disease that is present in the family. These women are offered special care during their pregnancy by specialist clinics. By using NIPD testing these "at risk" women can find out whether the fetus they are carrying is a boy or a girl. NIPD is especially useful because it allows them to find this information out non-invasively (using only a blood test), at an early stage of pregnancy, and without risking the health of the fetus. If the fetus is found to be female it cannot be affected by the sex-linked disease and the pregnancy can be managed as any normal pregnancy would be. If the fetus is male then it could be affected by the sex-linked disease, and the pregnancy can continue to be managed by specialists with expert knowledge of how this might change the pregnancy, plans for birth, and the baby's future health.

NIPD is also routinely used to identify the blood type of the fetus, in women who are at risk of developing a disease called Haemolytic Disease of the Fetus and Newborn (HDFN), during their pregnancy. NIPD testing of the fetal blood type allows doctors to decide whether the pregnant woman will need to take certain drug treatments, which can prevent HDFN from occurring.

What is going to happen in future?

The development of NIPD technology is ongoing, and although it is impossible to say exactly what will happen, certain areas of development are likely to be important in the future.

Down's syndrome testing

The next stage of development in NIPD technology, that is likely to become part of NHS prenatal care services in future, involves testing for Down's syndrome. Currently, several different NIPD tests for Down's Syndrome are being tested in the UK. In the United States, several companies have already made NIPD tests for Down's Syndrome available. Current NIPD tests for Down's Syndrome are very accurate, but none are 100% accurate. For this reason, they can only currently be used as an "advanced screening test" that gives women a very good idea of whether their baby has Down's syndrome, but does not give a definite yes or no answer.

It is expected that NIPD tests for Down's syndrome will eventually be 100% accurate. If this happens then NIPD tests could replace current invasive tests that are used to give a definite diagnosis. This means that 'high risk' women would no longer have to risk their pregnancy to get a definite answer about whether their baby has Down's syndrome. Also, because NIPD is a simple blood test, it could be used to replace current screening tests too. This would mean that all women would get a definite yes or no answer about Down's syndrome, not just 'high risk' women.

Testing for other genetic diseases and non-medical traits

More developments in NIPD technology are expected to happen in the future, but scientists are more cautious about this, and most agree that it will take many years to develop advanced tests. It is thought that future developments could lead to a very wide range of NIPD tests being made available. Because NIPD involves the testing of genetic material (DNA) from the fetus, and because all of the fetus' genetic information (the "whole fetal genome") has been found in maternal blood, it is hoped that it will be possible for NIPD to give doctors and parents a lot of information about the fetus. It is hoped for instance that serious genetic diseases such as Huntington's Disease and Cystic Fibrosis could be tested for using NIPD. Tests for less serious diseases such as Haemophilia could also be made available, and some people think that tests could also be developed for a range of genetic "traits" that are not commonly linked to disease, such as height, eye colour, or hair colour.

Appendix Six. Participant Information Sheet (Experts/Professionals)

Letter of invitation

PhD project: Women's reasoning on non-invasive prenatal diagnosis technologies

Dear Madam/Sir

I would like to invite you to take part in a research study. This Participant Information Sheet explains what research is being done, and what your participation would involve. I would be very grateful if you could take the time to read the following information. This should take around 30 minutes.

Part 1 tells you the purpose of this study and exactly what will happen if you take part. Part 2 gives you more detailed information about the conduct of the study.

Because this study involves talking about a technology that you may not be familiar with, I have also included a section that explains this technology, 'Introducing NIPD'. You do not have to read this information, but if you would like to take part you may find this interesting.

If you would like any further information, or if you have any questions, please do not hesitate to contact me. I will do my best to answer any questions or concerns.

A Welsh language version of this information sheet can be provided upon request.

Yours Sincerely,

Heather Strange
PhD Student
Tel: 07872927092
Email: strangehr1@cardiff.ac.uk

Participant Information Sheet Part one

What is the purpose of this study?

This study is interested in what a range of people think about new non invasive prenatal diagnosis (NIPD) technology. NIPD is a new kind of prenatal testing technology that is currently used for limited medical purposes. A number of scientists and clinicians are working on developing this technology further, so that it may become available a wider range of purposes, and many think that NIPD will change the routine care of pregnant women in the future. I am interested in speaking to patients, parents and clinicians who have experience of NIPD testing, or who have experience of routine prenatal testing. I would like to speak to a wide range of people about their thoughts and experiences because it is likely that many different types of service users and service providers would be involved in using NIPD, if it were to become part of routine prenatal care. I would like to explore these questions now, before NIPD is introduced widely, so a picture can be built up of what these people think about NIPD tests.

Why have I been invited to take part?

You have been invited to take part because you have professional experience of NIPD or routine prenatal testing. I would like to talk to you about your professional experiences, and your thoughts on NIPD.

Do I have to take part?

It is up to you to decide whether you would like to take part in this study. I will not discuss what you say or whether or not you participate with anyone outside the research team. If you decide to take part but change your mind at any time, even during the interview, you are free to leave the study without having to give any reason.

What will happen to me if I take part?

If you agree to take part I will contact you and ask you to agree to an interview, which will be arranged to take place at a time and place that is most convenient to you. I can assist with making a space available for interview. If you are happy to take part in an interview I will send you confirmation of the date, time and place in the post, along with a consent form which you can read before coming to the interview. Before the interview I will make

sure you have understood the information that you have been given about the study, I will give you the opportunity to ask any questions, and I will ask you to sign the consent form. This form will record your understanding of the study, and your willingness to take part. The interview is expected to last for about an hour, and with your permission I would like to audio record what you say, so that I can make sure I have accurately captured all information.

Over the course of the interview I will ask you about your experiences of prenatal testing. I would also like to ask you about your thoughts on NIPD, whether you have experience of the technology or not. Before talking about NIPD, I will provide additional information in the form of short written scenarios or 'vignettes'. The scenarios will give examples of how NIPD might be used in future. With your permission I will also collect some background information such as your age, gender, marital status, ethnicity, and previous employment. Any information collected about you will be strictly confidential. Your name or any other information which could identify you will not be associated with anything you tell me. Once the interview is over I will transcribe the data, but your name will not be used, and you will not be identifiable in any written report.

You do not have to answer any questions you do not wish to and you may stop the interview at any time without giving a reason.

What are the possible disadvantages and risks of taking part?

The interview will take up about an hour of your time. During the interview, you will be sharing memories of past experiences, and you will be describing thoughts and feelings. This process could raise sensitive issues and you could feel distressed or upset by this.

What are the possible benefits of taking part?

Individual study participants will not directly benefit in any practical way from this research. It is hoped that it will help benefit other service users and service providers, who may have to make decisions about NIPD in the future. It will do this by painting a picture of the interests and concerns raised by the patients, parents and clinicians who participate.

What will happen if I don't want to carry on with the study?

If you do not want to participate in the study you do not need to contact me or read the additional information included in this pack, if you do not want to. During the interview, you do not have to answer any questions you do not wish to, and you may stop the interview at any time without giving a reason.

Participant Information Sheet Part two

Will my taking part in this study be kept confidential?

Yes, all information will be completely confidential. An important exception to this rule concerns cases where serious medical or legal information is disclosed by participants during the course of the research. If serious information is disclosed, the researcher has a legal and moral obligation to report this information.

Several practical steps will be taken to ensure that your privacy is maintained and the confidentiality of your information is protected:

- During the interview I will ask your permission to audio record what is said. I will not use your name during the interview. Once the interview is over, I will type out what has been said from the recording and the recording will then be erased. Your name, along with any other information which might identify you, will not be included in the typed information. What is said during the interview will be completely anonymous, and this is the only information that will be used in the study. There will be no way in which you will be able to identified.

- If you are not happy for me to audio record the interview, I will take written notes as the interview goes along, and I will type this information up when the interview is over. These notes will use the same system for protecting anonymity: I will not use your name, and no information that might identify you will be included in the typed up information.

- When I have typed what you have told me, I will study this information and compare this with what other people tell me. I can then identify common areas of interest or concern. The typed information will then be kept in a locked filing cabinet accessible only to the researcher for a period of ten years. The computers on which the typed information is stored will be password protected and only accessible by the researcher.

- Your signed consent form, which contains your name will be kept in another locked filing cabinet which will only be accessible to the researcher.

- Direct quotations from you may be used as I write up the results of this research. Only your words will be used and no personal or identifiable information about you will be included in any written documents.

What will happen to the results of the research study?

The results of this study will be used to help prepare the researcher's PhD thesis. This will be examined by professional academics from Cardiff University and another UK University, before a decision is made about whether a PhD will awarded.

The results from the study will then be published in national and international academic and professional journals.

Who is organising and funding the research?

This study is funded by the Welsh Government's National Institute for Social Care and Health Research (NISCHR), who awarded a full time studentship to support this work, and it is sponsored by Cardiff University.

Who has reviewed the study?

This study received an independent scientific review from NISCHR before the studentship was awarded. In addition, all research that involves the NHS is looked at by an independent group of people, called a Research Ethics Committee (REC) who work to protect participants' safety, rights, wellbeing and dignity. This study has been reviewed and given favourable opinion by South East Wales Research Ethics Committee.

Further information and contact details

If you would like more information about the study or if there is anything that is not clear, please do not hesitate to contact the researcher, Heather Strange on 07872927092 (during working hours) or strangehr1@cardiff.ac.uk.

What if I have concerns during my participation?

If you are worried or unhappy about any aspect of this study or your participation at any time, you should speak to the researcher (Heather Strange) who will do her best to

address your concerns, or answer your questions. If you remain unhappy and wish to complain formally you can do this by contacting the Cardiff University Research Governance team on 02920 879130 (Mr Chris Shaw, Research Governance Coordinator).

What should I do now?

If you would like to take part please complete the details on the following page and return it to me in the stamp-addressed envelope. I will then contact you and arrange a suitable time and place for the interview to take place.

Reply slip

I am interested in taking part in this study and give permission for my details to be given to the researcher.

Signed:_____

Name (printed):_____

Address:_____
_____
_____
_____

Telephone
number:_____

Email address:_____

Appendix Seven. Interview Schedule for Patients/Parents

Interview schedule for semi-structured interviews: service users

About the interviewee

ID for this study:
Number of children:
Ages of children:
Gender:
Occupation:
Martial status:
Highest educational level:
Date:
Time:

Introduction

Thank you for agreeing to take part in the study and for allowing me to interview you today. Before we speak about NIPD I would like to ask you a few questions about you and your family.

PART ONE

Q1 (SELF AND FAMILY)

- **Can you tell me a little bit about yourself and you family?**
- When did you first became a mum?
- When did you first think about having children?
- How many children do you have? How old are they?
- Who do you live with - who makes up your family?
- Do you go out to work? What is your occupation?

Q2 (EXPERIENCES OF PREGNANCY)

- When did you first find out that you were pregnant?

(Who did you speak to? How did family and friends feel?)

- How did you feel during your pregnancy?

(How did you feel physically? Did you have many ups and downs? Did your feelings change over time?)

- How did you feel after pregnancy?

Q3 (BEING OFFERED CURRENT TESTING)

- Were you offered only routine tests during pregnancy, or did you receive any special prenatal care?

- What do you remember about the tests that were offered to you during pregnancy?

(Who offered you the tests? How did they tell you about the tests - did they explain face to face or give you written information?)

- How did you feel about the tests at this point?

(Did you understand what was being offered? Did you have many questions?)

- How did you decide whether to use the tests?

(Who did you speak to? Were all of your questions answered? Did you look for additional information?)

Q4 (USING CURRENT TESTS)

- Which tests did you use?

- What was the testing process like?

(Who looked after you? Where did the testing take place?)

Q5 (AFTER CURRENT TESTS)

- Did your feelings about the tests stay the same throughout the pregnancy (or across different pregnancies)?

- How would you improve the tests if you could?

PART TWO

Did you read the NIPD info? Brief update.

Before we look at scenarios - any thoughts on NIPD?

I'd like us to look at some scenarios that we can use to think about how NIPD might be used.

Q4 (EXPLORING NIPD SCENARIOS). Look at scenarios two and three.

- Did you know anything about this kind of testing before today?

- Do you think you would use NIPD in any of these ways?

(Why? What is good about NIPD? What would you find difficult about using NIPD?)

- In what circumstances do you think NIPD should be used?

(What should be tested for? DS only, fetal sex, small number of diseases, large number of diseases?)

Look at scanario one.

• Do you think NIPD should be made available on the NHS?

(Why? What tests should be made available? Should people be allowed to buy the tests instead? Should people be allowed to use the tests at home?)

• Do you think most pregnant women will want to use NIPD?

(Why would women use NIPD? Who might not want to use it?)

• Do you think the media will be interested in NIPD?

Close of interview

Thanks again for taking part in the study. Do you have anything else you would like to add, that we haven't covered today?

Appendix Eight. Interview Schedule for Experts/Professionals

Interview schedule for semi-structured interviews: service providers

About the interviewee:

ID for this study:
Profession:
Date:
Time:

Introduction

Thank you for agreeing to take part in the study and for allowing me to interview you today. Before we speak about NIPD I would like to ask you about your professional background.

Q1 (CURRENT ROLE)

- Could you tell me about your work?

- Who else do you work with?

Q2 (CAREER PATH)

- How did you become a……?

Q3 (CURRENT NIPD PATHWAY)

- Could you explain how a patient would typically come to use NIPD?

- Where does the testing take place?

(Who else is involved in testing? Who takes the blood samples? Where is the lab? Who reports results back to you? Who reports results to patients?)

Q4 (EXPERIENCES OF NIPD)

- Do any particular patient experiences of NIPD stand out for you?

- Do any very good outcomes come to mind?

- Have you come across any when problems using NIPD?

Q5 (NIPD INTO CLINIC)

- When did you first come across NIPD?

- When was NIPD first used in your clinic?

Q6 (FUTURE NIPD)

- Will you continue to use NIPD?

- How could NIPD be improved for your work?
- Where else do you think NIPD could be used?

- How do you think NIPD will be used in future?

(Do you think the range of applications will expand? Do you think NIPD will be used outside the clinic? Do you think NIPD will be used for non-medical purposes?)

Close of interview

Thanks again for taking part in the study. Do you have anything else you would like to add, that we haven't covered today?

Appendix Nine. Vignettes

Scenario one: NIPD Down's Syndrome testing for high risk women only

If a woman is given a risk of carrying a baby with Down Syndrome of **1 in 1000 or higher** after using NHS screening tests, she will then be offered an NIPD test. This test is more than **99% accurate** and if it comes back "positive" then it is highly likely that the baby will have Down Syndrome. If the test comes back positive then the woman will be offered an invasive test to confirm the results.

- *The routine screening tests are given at around at 15 weeks*
- *The risk of miscarriage from an invasive test is around 1-2%*
- *In 3-5% of women NIPD may not work*
- *Currently, only women who are given a risk of 1 in 150 or higher are offered an invasive test*

Scenario two: NIPD Down's Syndrome testing for all women

In addition to all of the routine antenatal screening tests, **all pregnant women** will be offered an NIPD test for Down Syndrome. If they say yes, a blood sample would be taken during their 12-week appointment. This test is more than **99% accurate** and if it comes back "positive" then it is highly likely that the baby will have Down Syndrome. If the test comes back positive then the woman will be offered an invasive test to confirm the results.

- *Results from the NIPD test will be given after 5 working days*
- *Invasive tests can be used from 15 weeks*
- *The risk of miscarriage from an invasive test is around 1-2%*
- *In 3-5% of women NIPD may not work*

Scenario three: private testing for a range of conditions

NIPD tests are available to buy through private clinics and they cost around £500. These tests can be used from **10 weeks** of pregnancy and are **more than 99% accurate**. The tests will give information on Down Syndrome, as well as several other more serious trisomies that affect babies from birth. The tests will also give women three more options:

1. They can find out the sex of their baby

2. They can test whether the baby has one of the most commonly diagnosed single gene disorders (these include cystic fibrosis, Beta-thalassemia, sickle cell disease, spinal muscular atrophy and Huntington's disease)

3. They can find out whether the baby has a genetic mutation that will increase their risk of breast and ovarian cancer in later life (BRCA mutations).

- *They can choose as many of these options as they like at no extra cost.*
- *Women only need to provide one blood sample.*
- *For options 2 and 3, the baby's father will also have to give a blood sample.*

Appendix Ten. Poster Presentation.

Poster presentation, International Society of Prenatal Diagnosis 19th International Conference, Washington DC, USA, 2015: *Strange, H. (2015). "Patient and professional experiences with non invasive prenatal diagnosis (NIPD) and testing (NIPT): Social and ethical issues raised."* Prenatal Diagnosis ***35****: 27 - 109.*

Patient and professional experiences with non-invasive prenatal diagnosis (NIPD) and testing (NIPT): social and ethical issues raised

Heather Strange, Cardiff University,Centre for Ethical and Social Aspects of Genomics and Epigenetics (Cesagene)
strangehr1@cardiff.ac.uk

Objectives 01

This research aims to provide a rich understanding of patient and professional experiences with non-invasive prenatal diagnosis (NIPD) and non-invasive prenatal testing (NIPT) in the UK.

Method 02

This qualitative study is based on data gathered via interviews with patients and professionals in the UK. Twenty-one experts with professional experience of NIPD and/or NIPT (scientists, fetal medicine consultants, policy makers and genetic counsellors) were interviewed, along with nine patients with experience of NIPD/T, and nine parents with experience of routine prenatal screening and/or diagnosis. Clinicians working in both the NHS and private prenatal care participated in the study.

Findings 03

Theme one: hopes and anxieties

As an emerging medical (and genomic) technology, and as a location for rapid technological innovation, participant accounts of NIPD/T prompted much reflection on possible future developments.

Patients who used NIPD for fetal sexing approached the test from within the context of 'at risk' pregnancies and family lives affected by genetic disease. Here, NIPD was a significant but relatively small step within a complex experience. These patients were hopeful that the advantages of early, non-invasive testing would be extended, enabling direct diagnosis of disease (rather than fetal sex alone).

Elsewhere the possible expansion of non-invasive testing, particularly within the pregnant population at large, raised significant concerns. Fears that an accessible, broad range of tests would emerge were raised, and participants expressed concern regarding the possible impact of such developments:

"And how would you imagine the state of NIPD science in five years time?"

"It's a bit scary in some ways, like being able to sequence a whole genome, which they have shown that they are able to do. And then what do you, what do you tell someone about that? What do you actually use, and what is important? You know, do we really need to be investing so much in doing that? But I can easily see it going that way. When you speak to women about what is important to them, and they sort of say they want as much information about their baby as possible, and so, if you offer them a test and say well we can tell you everything, as if they are going to say no, you know? They will feel pushed into, to saying yes, I want to consume that- if it's available I want it."

Scientist involved in the development of NIPD

Theme two: test accuracy

Participants consistently explored test accuracy, and the division made between NIPD and NIPT, as a theme for discussion. Contrasting views on accuracy, particularly regarding how a 'diagnostic' test is defined, emerged across the dataset. Those who worked with diagnostic tests in the clinic stressed the need for accuracy, and they were certain that NIPT could not yet be classed as diagnostic: 'it's trying to be a diagnostic test, but it's not accurate enough'. Within this group a test was diagnostic only if it were 100% accurate:

"There's been a shift towards NIPT. What do you think that-"

"Because it's never going to be a diagnostic test. And I actually feel that it will probably never be a diagnostic, because of the cell type that you are looking at and- you know I think it's just with the cell type you are looking at, you are never going to be 100%."

"Um, no tests are 100% are they?"

"Yes, if you have an amniocentesis. It's a diagnostic test. A CVS is a diagnostic test as long as you look at the cultures as well. So they are diagnostic tests."

"And they are 100% reliable?"

"Yes."

Cytogeneticist

Those with experience of screening tests were more optimistic about the diagnostic power of NIPT, questioning the need for, or possibility of, 100% accuracy. NIPT patients perceived accuracy as particularly high: they felt confident in the results and experienced the testing process, and receipt of results, as highly reassuring:

"Yeah I mean frankly, you can't beat 99.9%. I think that in anyone's mind you would feel massively reassured by that. You and I both know you are never going to get 100% with anything, frankly. So as I found that out, that it was 99.9%, then absolutely that gave me the confidence in the results really. Because like I said, you know, it doesn't get much better than that."

Private NIPT patient

Theme three: NIPD/T and termination of pregnancy

Conversations around termination quickly followed on from discussions of accuracy. Professionals were aware that NIPD/T was emerging within a context where, in the majority of cases, diagnosis leads to decisions around termination, and not treatment. Given NIPD/T's capacity to provide early, risk-free information, concerns were raised:

"We spend quite a long time with people, talking through invasive prenatal testing... and of course if you take that risk away... There is a risk that people will have a test, get a result that says their baby is affected and terminate a pregnancy without a whole lot of thought, potentially. Because they've not had to weigh up their decision making in quite the same way."

Consultant clinical geneticist

Private providers described how women were arriving prepared for conversations around termination, aware that highly-accurate NIPT test results could bring them a step close to such decisions: They are now asking what happens if I get a high-risk result, what is the next step? Can you tell me about terminations? The centrality of termination to discussions of NIPD/T, as well as prenatal testing more generally, emerged as a very strong theme: despite being a difficult, emotional topic of discussion, talk of termination arose within almost every interview.

Conclusions 04

The rapid development of NIPD and NIPT has quickly given rise to a diverse range of experiences. The issues of interest and concern described within the patient and professional accounts shown here attest to a complex ethical, legal, political and social landscape. Knowledge of these early experiences may enable a better understanding of the advantages NIPD and NIPT can offer, as well as the practical and ethical problems that may arise in future, as these tests become further embedded in both specialist clinical practice and routine prenatal care.

Acknowledgments 05

This work has been carried out with support from the Welsh Government's National Institute for Social Care and Health Research (NISCHR). The author would also like to acknowledge the support of her supervisory team: Dr Andrea Edwards (All Wales Medical Genetics Service) and Professors Adam Hedgecoe and Joanna Latimer (Cardiff University).

Appendix Eleven. REC-approved Project Protocol (Version 2.1, 17/06/13)

Women's Situated Reasoning on Emerging Non-Invasive Prenatal Diagnosis Technologies (NIPD)

Student / Chief Investigator (CI)

Heather Strange
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Study Sponsor

Cardiff University

Funding

National Institute for Social Care and Health Research (NISCHR), Welsh Government.

Table of Contents

Acronyms

ART - Artificial Reproductive Technology

Cff-DNA - Cell Free Fetal DNA

CI - Chief Investigator (student)

CVS - Chorionic Villus Sampling

DTC - Direct To Consumer

ESRC - Economic and Social Research Council

HDFN - Haemolytic Disease of the Fetus or Newborn

HD - Huntington's Disease

IVF - In Vitro Fertilisation
MSS - Maternal Serum Screening
NHS - National Health Service
NIHR - National Institute for Health Research
NISCHR - National Institute for Social Care and Health Research (Welsh Government)
NIPD - Non Invasive Prenatal Diagnosis
NT - Nuchal Translucency
PGD - Preimplantation Genetic Diagnosis
PIS - Participant Information Sheet
PND - Prenatal Diagnosis
PNS - Prenatal Screening
RAPID - Reliable and Accurate Prenatal non Invasive Diagnosis
T21 - Trisomy 21 (Down Syndrome)

1. Project overview

Non invasive prenatal diagnosis (NIPD) is a new type of non-invasive, early, and highly accurate prenatal genetic testing technology. It is currently used within the NHS for a limited number of clinical applications, but developments are ongoing, and there is speculation over possible future applications.

Much of the current scientific and clinical research on NIPD focuses upon developing tests for certain chromosomal disorders, including Down's syndrome (Papageorgiou et al, 2012). The aim here is to produce robust tests that can either supplement or replace the prenatal testing technologies that are currently used within specialist prenatal diagnosis services provided to 'at risk' women, as well as those used within population-wide screening programmes that are offered to all pregnant women under NHS care (and also those cared for privately and publicly in many other countries worldwide) (Benn et al 2012).

Continued developments in NIPD technology could result in early, non-invasive, highly accurate prenatal genetic tests being made available as part of NHS prenatal screening and diagnosis programmes. Whilst it is likely that such tests will present significant clinical advantages over current testing technologies, they are also likely to simultaneously raise social, ethical and practical advantages, disadvantages, issues and concerns.

This qualitative study will explore in detail the social significance of NIPD, focusing centrally upon the meaning and value of NIPD as discussed by those service users and service providers who are, or who are likely to be, required to personally and professionally engage with this emerging technology. The discussion of this technology will be situated within the ongoing academic exploration of prenatal genetic testing, the emergence of new medical technologies, and their translation into clinical practice.

This study will gather data via analysis of semi-structured qualitative interviews with a broad range of service users and service providers, exploring in detail their experiences with, and situated responses to, NIPD testing technology. Recognising the value of lived experience, this study will focus on a number of issues of relevance to the needs and interests of service users and providers; exploring the value that NIPD holds for individuals in relation to their own lives, their role within their families, or their professional roles within clinical teams; highlighting the practical, social and ethical concerns that are raised by experiences with and responses to NIPD; examining the way in which personal and professional encounters with rapidly emerging and changing prenatal testing technologies are negotiated.

Recognising that new reproductive technologies such as NIPD simultaneously help to shape new social, clinical and scientific worlds, this study also aims to help map the broad impact of this emerging technology. Framed against the wider context of NHS prenatal care services, central to which are the routine clinical pathways for prenatal screening and diagnosis, this study will also produce data relevant to the critical examination of current clinical practice.

2. Lay Summary

What we know

Prenatal screening and diagnosis technologies are well-established objects of sociological research and a large body of literature has grown out of studies in this area. Women's experiences with and responses to technologies such as ultrasound or amniocentesis, which are routinely used in prenatal care, have been thoroughly explored. Relating to NIPD, a huge volume of clinical and scientific literature exists. We know that certain NIPD tests have been quickly and successfully translated into routine clinical practice. We also know that the scope of NIPD testing is likely to expand in the future, and that this may have a direct impact on both routine and specialist NHS prenatal care. A limited body of

social science and ethics literature on NIPD has been published, some of which explores service users' experiences of NIPD, and some of which prospectively addresses the social, practical and ethical concerns that may be raised by this technology.

What we don't know

Although some social science studies have examined NIPD testing, only a small number of studies have been conducted to date, and a very small body of directly related literature currently exists. Many questions remain around whether NIPD will raise social, ethical and practical issues and concerns, what these might be, and who might be most effected. Given the rapid development and success of NIPD technology to date, it is important to explore questions about both current and future uses of the technology, especially in relation to the perspectives of the people who work with or use NIPD.

What the researcher will do

The researcher will conduct interviews with a broad range of service users and service providers, who have different experiences of NIPD and prenatal testing. The researcher will ask participants about their experiences with NIPD, and/or their thoughts and opinions on NIPD. The researcher will use the data gathered from these interviews to identify and explore the social, ethical and practical issues relevant to the discussion of NIPD technologies, focusing centrally upon the interests of service users and providers.

How service users and service providers will benefit

Individual study participants will not directly benefit in any practical way from this research. Their participation will, however, help the researcher contribute to the discussion of the ethical, social and practical issues raised by NIPD. Recognising the particular value of each participants' lived experience, this project will highlight areas that are of particular interest and concern to those who are engaged personally and professionally with prenatal testing. Because issues around NIPD testing are being explored in this way, at a time when NIPD is at an early stage of technological development, it is hoped that service users and service providers who work with or use NIPD in the future will benefit from the results of this study.

3. Research Outline

3.1 Introduction and background to the study

Scientific background

The clinical practice of prenatal screening, (PNS) and prenatal diagnosis (PND) are central to modern prenatal care. Routine PNS programmes allow for the population-wide screening of a small number of common diseases, and PND testing allows for the targeted diagnosis of a wider range of serious diseases in certain 'at-risk' pregnancies.

Despite the successful routinisation of many prenatal technologies, it is recognised that improvements in efficiency and clinical utility could yet be made, and a drive toward technological innovation within PNS and PND has remained ever present. The ongoing search for improved technologies has led to the development of non invasive prenatal diagnosis (NIPD).

NIPD exploits the presence of cell free fetal DNA (Cff-DNA) in the maternal blood, the presence of which was first reported in 1997 (Lo et al, 1997). Cff-DNA is present in the maternal blood throughout pregnancy. It enters the maternal bloodstream via the placenta, and increases in amount along with gestation. It is also rapidly cleared from the maternal bloodstream after birth. The successful application of NIPD depends upon being able to distinguish, isolate and extract Cff-DNA from an overwhelming background of maternal cell free DNA, and subsequently being able to subject this fetal genetic material to analysis. Cff-DNA is reliably identifiable for NIPD testing purposes from around seven weeks gestation (Devaney et al, 2011).

NIPD tests offer some major practical benefits when compared with current routine prenatal testing technologies. Currently, NIPD is the only technology that promises to combine the benefits of being a diagnostic test, that is also clinically non-invasive (requiring only a small maternal blood sample), and is available to use within the early stages of pregnancy (the first trimester or first 12 weeks).

Currently, NIPD is routinely used within specialist prenatal care services, in order to identify fetal sex in pregnancies that are at high-risk of X-chromosome linked (sex linked) disorders (Hill et al, 2011). It has been made available in the UK through the NHS for these purposes since 2003. The integration of the technology into this particular area of clinical practice has been successful to such an extent that NIPD for fetal sex determination has become the most frequently requested molecular diagnostic test

currently used in prenatal medicine (Raymond et al, 2010). It has also been reported that NIPD is replacing rather than supplementing invasive testing for fetal sex in some cases: during a three-year audit of two NHS laboratories, when NIPD for fetal sex identification was used for clinical purposes, only 32.9% of women went on to have an invasive test (Hill et al, 2011). NIPD is also routinely used for identification of fetal rhesus status (blood group) status in certain at-risk pregnancies, and it has been very successful in improving the preventive treatment of haemolytic disease of the fetus and newborn (HDFN) (Scheffer et al, 2011).

NIPD Tests for Down Syndrome/Trisomy 21 (T21) remain at the clinical-trial stage within the UK, but the successful development and application of such tests is widely regarded as the next major step that will be taken within the ongoing development of NIPD (Lo et al, 2012). Within the US, Hong Kong and China several companies are competitively marketing NIPD tests for Down's syndrome and other aneuploidies. These tests are currently used as advanced screening tests only, with positive results requiring follow up with invasive testing, but excellent results detailing very high levels of sensitivity and specificity have recently been reported (Palomaki et al, 2012, Bianchi et al, 2012). These tests are currently distributed on a commercial basis via a number of prenatal clinics.

NIPD tests for single gene disorders, whilst not currently being used in routine clinical practice, are being trialled on a research basis for a handful of conditions such as sickle cell anaemia and Huntington's disease (HD) (Barrett et al, 2012, Bustamante-Aragones et al, 2008). It is expected that an increasing number of NIPD tests for single gene disorders will be available in the future, and it is similarly likely that tests for disease susceptibility variants (such as breast cancer genes - BRCA mutations) will also be made available. It is recognised that parallel developments in genome sequencing technologies may further expand the scope of prenatal genetic testing, and that 'the capacity to identify a broad spectrum of genetic traits and predispositions will be concomitant with the development of prenatal diagnosis' (Benn et al, 2009). Positive expectations have been further reinforced by the publication of data that confirms that DNA from the entire fetal genome can be found in the maternal blood (Lo et al, 2010). This has led to many claims that NIPD testing for conditions that are clinically less severe, late onset, or non-medical in nature may be an inevitable result of continued technological progress, and it has been suggested that such advances could result in a move towards 'personalized prenatal medicine' (Bianchi, 2012). NIPD testing is also rapidly gaining momentum outside of the clinical context: tests for both fetal sex and fetal paternity are currently available on a direct-to-consumer (DTC) basis from several online companies based in the US.

Support for the on-going development and use of NIPD is clearly evident within the UK: an influential expert working group report (Wright et al, 2009) described the clinical application of NIPD as 'desirable' and recommended that the development of the technology should be fully supported. The National Institute for Health Research (NIHR) provided funding for a five-year (2009-2014) national research programme on NIPD; Reliable Accurate Prenatal non-Invasive Diagnosis (RAPID 2015); which aims to 'improve the quality of NHS prenatal diagnostic services by evaluating early non-invasive prenatal diagnosis'. The RAPID project is broad in scope and has delivered a large volume of clinical data, as well as qualitative research on women's experiences of NIPD, and literature that addresses the ethics of NIPD.

It is important to recognise that NIPD is likely to enter widespread clinical use via one of two major paths. NIPD may come to replace or supplement the invasive testing that is used within specialist prenatal and clinical genetics services (PND only path), or it may take this role, whilst also replacing or supplementing tests that are used in routine population-wide prenatal screening programmes (PND plus PNS path). As explained above, NIPD is currently used within the UK for limited PND applications only. Given the degree of interest that exists around NIPD for Down Syndrome however, and given that Down Syndrome testing is a central component of routine NHS prenatal care pathways, questions about NIPD entering into both PNS and PND programmes remain equally as important here.

Prenatal screening and diagnosis: social science literature

Prenatal screening and diagnosis technologies are well established objects of sociological interest and research, and themes such as reproductive autonomy, medical paternalism, genetic determinism, abortion politics, eugenics, female embodiment, equity of access to healthcare and the rights of people with disabilities have emerged as being of central concern.

Although they are amongst the most successfully routinised applications of Artificial Reproductive Technology (ART), PNS and PND technologies continue to raise significant political, economic and ethical concerns (Rapp, 1999). The phenomena of routinisation is of central interest within the literature: it has been recognised, for instance, that the process of routinisation itself can serve to obscure many issues that are of central concern within prenatal care (Press et al, 1997). Screening and diagnosis technologies have been

characterised as cultural objects of enormous complexity and transformative power, and the concrete and embodied experiences of women, as reported within key empirical texts (Rapp, 1999; Rothman, 1994) have served to highlight the impacts of routinisation. Rapp has described how, as they negotiate various encounters with new prenatal technologies, women are transformed into 'moral pioneers'. She has also described how, as a result of routinisation, women's acceptance of testing becomes normalised, and opportunities to refuse testing are eroded, resulting in the broad social conceptualisation of prenatal testing as an appropriate and responsible parental action.

Rothman has described how the success of prenatal screening technologies is built upon a more general move towards an increasing commodification of life, a process which forces women to confront a redefinition of motherhood, and question the nature and origin of the modern mother-child bond (Rothman, 1987). Rothman has also introduced the concept of the 'tentative pregnancy' (Rothman, 1994), capturing the particular way in which women tend to delay or lessen the depth of social and and psychological engagement with pregnancy, responding to their experiences of prenatal testing, with the time spent waiting for results being particularly significant.

Prenatal testing has been recognised as being a socially and politically complex practice that simultaneously raises both eugenic and liberating agendas (Duster, 1990). These issues have been analysed in relation to critical discussions of disability rights and reproductive rights (Shakespeare, 1998). The 'disability rights critique' problematises prenatal testing, pointing to the presence of two major issues: it is claimed that, by preventing the birth of fetuses with particular genetic 'diseases' or 'disorders' prenatal screening programmes promote the eradication of certain social groups, and that the value judgments inherent within such practices also foster discrimination against those living with disease, disability and disorder. Rothman points to the fact that the provision of screening, in combination with genetic counselling, is a form of fetal 'quality control' (Rothman, 1994) in which presumptions about the meaning of genetic health are made. Rapp also highlights the explicitly selective nature of prenatal testing technologies (Rapp, 1998), and Lippman too points to the fact that the primary aim of testing is the separation of those fetuses we wish to allow to develop, from those we wish to discontinue (Lippman, 1991). The argument that genetic screening promotes social injustice has been, however, characterised as being particularly complex (Shakespeare, 2005), and it is recognised that screening can be viewed as being a practice that facilitates both the growth of individual reproductive freedom and large-scale social control.

The communication of information within prenatal testing is recognised as being a complex and socially significant process. Whilst the power inherent within the clinical portrayal of prenatal genetic test results has been highlighted, the subjective nature of clinical descriptions of genetic diseases and disorders has been highlighted: 'every description of a genetic disorder is a story that contains a message' (Lippman et al, 1992). Marteau et al. describe how women do not act as passive recipients of objective clinical information (Marteau et al, 1992), and, similarly, Lippman explains how during the decision making process women tend to alter the persuasiveness of the biomedical information on screening that is provided to them, weaving it with their own instincts and beliefs in order to create a particular kind of 'embodied knowledge' (Lippman, 1999). It also has been demonstrated that this style of moral reasoning that depends upon a complex process that involves the personalisation of risk information, the reshaping of statistics, the reinterpretation of the concept of health as well as a personal interpretation of counselling information on disease and disorder, tends to be shared by both women who accept and refuse testing (Rapp, 1998).

NIPD: social science literature

As clinical and bioethical interest around NIPD has steadily grown, the need for social science research has been explicitly recognised, and a small number of empirical studies have very recently begun to emerge. Susan Kelly and Hannah Farrimond have published two qualitative papers as a result of a recent project looking at lay reasoning around NIPD. This project set out to ask questions about how the public view emerging NIPD testing procedures, and what preferences regarding the clinical use of future NIPD tests might be. Four distinct public 'viewpoints' emerged from the data: NIPD was simultaneously viewed as: discrimination against the disabled; a positive clinical application; appropriate for severe disorders only; a personal choice. Many of the concerns raised within the data echo the critical discussion of NIPD within the bioethics literature, and participant responses that paralleled the disability rights critique were found to be particularly strong. The identification of this perspective as dominant was held to be particularly important, especially given that these kinds of critical voices 'are often marginalised or drowned out by more dominant clinical and medical discourses in debates about new genetic technologies' (Farrimond et al., 2011). A general 'consensus of concern' was also identified as being present throughout the data: every participant, for instance, rejected the idea of NIPD being made available outside traditional clinical pathways, on a commercial or direct-to consumer basis (it is worth noting here that the study was UK-based, and that this may have had an impact on findings - similar questions need to be

asked of the US public, for example, who experience prenatal testing from within a more commercially oriented system).

Zamerowski et al. published an early empirical study, asking how high-risk women perceive NIPD-type testing (Zamerowski et al., 2001). Responding to a survey, women who were currently experiencing high-risk pregnancies, and who planned to have an invasive test (amniocentesis or CVS), responded favourably to the technological promise of NIPD: 'only half of the women would seek invasive testing after a normal blood test'. In a similar study, conducted with women undergoing routine fetal anomaly scans, and female medical students, Kooij et al. produce more conflicted results: 'our respondents do not agree about making the test generally available: a majority of the pregnant women support a general availability of NIPD, whereas the students are far more reluctant' (Kooij et al, 2009). Some degree of consensus was reached regarding two issues here: participants were highly critical of testing for late onset disease, and the also 'clearly rejected' identification of fetal sex in order to facilitate non-medical sex selection. Describing the results of a survey of women in their third trimester of pregnancy, Tischler et al. report that most women show an interest in NIPD 'primarily because of increased safety for the fetus, although a significant minority are uninterested or ambivalent' (Tischler et al., 2011). Another survey-based study (Sayres et al. 2011), looking at attitudes toward the clinical implementation of NIPD as reported by obstetric healthcare providers in the US, also reported a widespread level of concern related to testing for single gene disorders and non-medical sex selection. Very few respondents reported a high level of knowledge of NIPD and a general level of uncertainty among obstetric providers about the details of implementing NIPD testing prevailed. The study also described how healthcare providers held the general perception that patients face strong social pressure to accept testing, and that they particularly valued the role of counselling within prenatal testing services.

As part of the NIHR funded RAPID project, Celine Lewis has conducted qualitative research on women's responses to NIPD for fetal sex (publications forthcoming). This research is particularly valuable as it presents information regarding women's lived experiences of NIPD. Broadly speaking, participants experiences of NIPD were reported to have been 'overwhelmingly positive with words including "brilliant", "exiting" and "incredibly lucky" being use to summarise the overall experience'. Analysis of data gathered via semi-structured interviews revealed that, regarding the possible advantages of NIPD, four major themes could be identified: safety; ease of testing; timing; enhanced decision making. Although the disadvantages of NIPD were felt to be 'minor in

comparison', four themes also emerged regarding these: miscarriage risk; increased anxiety; connection to a potentially 'unwanted' fetus; being robbed of surprise and misuse of technology. Some of the interview excerpts revealed the inherent tension that, at times, dominated women's reported encounters with NIPD: "having that blood test is just nothing, it's like any of your other visits to hospital when you're pregnant, it's just the results have such a big impact". Here, as an explicitly non-invasive test, NIPD is simultaneously experienced as being normal and routine ('just nothing') whilst also being a potential source of significant information ('such a big impact').

3.2 Study aim and objectives

The central aim of this qualitative research project is to explore experiences of and situated responses to current and emerging non invasive prenatal diagnosis (NIPD) technologies.

Specific objectives include:

- To examine the practical, ethical and social issues that are raised by experiences with current NIPD testing.

- To explore situated responses to emerging future applications of NIPD technology

- To gain an understanding of how service users and service providers negotiate the complexities of engaging with an emerging technology

3.3 Timetable

The project grant runs for 36 months and began on April 1st 2011. The timetable below provides detailed information on each of the planned research stages. Academic supervision meetings to be held regularly, throughout the project. It is envisaged that some time will be taken to attend relevant conferences and workshops.

Stage one: April 2011- March 2012

Literature review
Drafting of ethical approval/NHS governance documents

Confirmation of key clinical contacts

Stage two: April 2012 - September 2012

Ethical approval/NHS governance forms prepared and submitted
Honorary contract obtained
Participants recruited
Interviews planned and piloted

Stage three: October 2012 - March 2013

Interviews carried out
Data analysis (on-going)

Stage four: April 2013 - September 2013

Structured thematic analysis of all data

Stage five: October 2013 - March 2014

Preparation of thesis
Applications to follow-up grants (to support dissemination of study results)
Submission of thesis

3.4 Rationale for timetable

The literature review will be broad and ongoing throughout the project: it will cover relevant publications within the social sciences, the relevant clinical and scientific fields, as well as media outputs (print and electronic). Visits to key clinical contacts will be made in order to confirm and clarify plans for recruitment and research. Recruitment of participants will commence once relevant ethical approval and R&D approval is confirmed. Approximately thirty service users and ten service providers are to be recruited for participation in the study. A maximum of five service user partners will also be recruited. Interviews will be carried out at a time and place of the participants choosing, and are expected to last between thirty and sixty minutes. Data analysis will take place throughout the project, however an intense and concentrated period of analysis will follow the fieldwork stage. Writing and preparation of the thesis will also be ongoing

throughout the project, however an intense period of structuring and writing will take place during the final months.

3.5 Plan of investigation, site selection and Recruitment strategies

Participant Cohort and sample size

This study involves the recruitment of participants from a number of different groups:

Service users

- NHS patients with experience of NIPD testing
- NHS patients with experience of invasive prenatal testing (Amniocentesis or CVS)
- Members of the public with experience of routine prenatal screening tests
- Private patients with experience of NIPD testing

Service providers

- NHS professionals who work with NIPD testing
- NHS professionals who work with current prenatal testing (specialist/diagnostic or routine/screening)

NIPD developers

- Persons involved in the clinical and commercial development of NIPD testing

Partners

- Partners of service users, recruited through a process of "snowball sampling"

Approximately ten participants from each of the service user groups will be recruited, and approximately five participants from each of the service provider groups will be recruited. Following interviews with service users, a maximum of five participant partners will be recruited through a process of "snowball sampling".

The research practice of "snowball sampling" involves working with participants who are willing and able to further identify additional potential participants that the researcher

may otherwise not be able to reach. This particular recruitment process makes use of participants' own networks and is suitable for use in research where the target population is particularly small or difficult to reach (Atkinson, 2001). With regards this research study, those participants who agree to help the CI identify additional participants will be asked to pass on a copy of the appropriate Participant Information Sheet to individuals they think may be interested in taking part in the study. Any potential participants identified in this way will then go through the same recruitment pathway that has been designed for participants recruited through key clinical and non-clinical contacts. This process will be used only when necessary, i.e. when target populations are small (NIPD developers) or difficult to access (partners of service users).

A maximum of five NIPD developers will also be recruited, initially via the CI's professional networks, and subsequently via a process of snowball sampling. A maximum total of 50 interviews will therefore be conducted. Given that only the CI will be responsible for conducting, transcribing and analysing the content of the interviews, this is believed to be an appropriate and achievable sample. The study sample here is not intended to be representative; the central aim here is to generate rich and deeply contextualised data, using in-depth qualitative interviews.

Inclusion and exclusion criteria

Potential participants will be selected in accordance with certain inclusion and exclusion criteria. With regards the following criteria, it is important to be clear about a number of points: participants' 'direct personal experience' must relate to their own pregnancy; potential participants who have both accepted and refused testing will be eligible for inclusion in this study; relevant service providers are likely to include, but will not be limited to: genetic counsellors, fetal medicine consultants and nurses, haemophilia consultants and nurses, midwives. It may be difficult to recruit women who have refused testing in many cases, as the specific content of clinical databases varies, and contact details for women who have refused testing may not be available.

Participants will be included if they are:

- Women with direct personal experience of NIPD.
- Women with direct personal experience of current prenatal testing, either routine or specialist/invasive (Amniocentesis/CVS).
- Service providers with direct professional experience of NIPD

- Service providers with direct professional experience of current prenatal testing, either routine or specialist/invasive (Amniocentesis/CVS)
- Professionals with experience in the field of NIPD development
- Partners of women with personal experience of either NIPD or current prenatal testing

Participants will be excluded if they are:

- Persons unable to communicate fluently in written or spoken English.
- Persons unable to provide fully informed consent.
- Under the age of 18.

It is beyond the scope of this research project to provide comprehensive translation services for communication in languages other than English. Additionally, because of the in-depth nature of qualitative interviewing, it is felt that any use of verbal translation services would undermine participant confidentiality and reduce the quality of the data generated.

As an exception to the above, to ensure that this research complies with the Welsh Language Act, Welsh translations of the written information provided to potential participants and participants (patient information sheets, consent forms) will be made available upon request. The availability of this service to participants will be made clear within the Participant Information Sheets.

All participants will be asked to sign a consent form prior to their recruitment onto the study, and the CI will gain additional verbal consent immediately prior to each interview. The CI will remain sensitive to any participant dissent throughout the interview process, and if signs of distress or discomfort become evident at any time, the researcher will check that the participant is happy to continue. Participants will be given the opportunity to withdraw from the study at any point. If participants choose to withdraw from the study they will be given the option of having all data that has been collected up to the point of withdrawal disregarded and destroyed. The CI will also make available information about support groups and clinical services that are able to provide any additional support that may be needed.

Relating directly to the discussion of reproductive choices and decisions, as well as personal experiences of clinical encounters, all interviews may raise sensitive and

emotional issues. It is therefore felt to be appropriate those under the age of 18 are excluded from participation in this study.

Additional exclusion criteria for NHS patients with experience of NIPD or invasive testing, and their partners

- All participants must have completed pregnancy at the time of initial contact. These participants will be recruited through specialist care centres, such as haemophilia clinics or clinical genetics services. This group of women will be excluded in order to ensure that the particular content of this study will not disrupt the decision-making process with regards the possibility of diagnostic prenatal testing or any other specialist prenatal care.

Additional exclusion criteria for participants with experience of routine testing, and their partners (non NHS)

- All participants must be over 30 weeks gestation at the time of initial contact. Women at earlier stages of pregnancy are excluded from the study to ensure that the content of the interviews does not disrupt the decision-making process with regards routine prenatal testing.

Separate exclusion criteria for participants with experience of using NIPD tests for Down's Syndrome, and their partners (non NHS)

- All participants must be over 12 weeks gestation at the time of initial contact. All women must have completed the NIPD testing process and received the results of their NIPD test by the time of initial contact. At the time of writing, the NIPD test that is being used by private clinics in the UK (the Harmony test) provides results that are more than 99% accurate. These women are eligible for inclusion at an earlier stage of pregnancy than other participants. It is felt that this is appropriate because they have received results that are more accurate than the routine NHS tests which are used later in pregnancy. It is felt therefore that the content of interviews will not be disruptive to women or couples' decision making regarding routine prenatal testing.

Site selection and support from key contacts

This research will be conducted using participants recruited from several clinical and non-clinical sites located in Wales and England. Whilst participant selection is not intended to be representative, the demographic scope of this project is not intended to be narrowly focused, and recruitment from a multiple of sites in different geographical locations will help ensure that a broadly heterogenous sample is generated.

The specific selection of clinical/NHS sites will depend greatly on the assistance of key clinical contacts. To date, several key clinical contacts have been identified and they have each indicated their willingness to support the CI in the participant recruitment process. It is expected that the CI will also identify and approach clinical contacts in other centres. Key clinical contacts have agreed to provide support for gaining access to NHS patients/potential participants from the following clinical sites:

- All Wales Medical Genetics Service, University Hospital Wales, Cardiff and Vale University Health Board
- Arthur Bloom Haemophilia Centre, University Hospital Wales, Cardiff and Vale University Health Board
- Peninsula Clinical Genetics Service, Heavitree Hospital, Royal Devon and Exeter NHS Foundation Trust

In addition to this, contacts from the following sites have agreed to provide additional support if participant numbers from the sites above are low:

- Fetal Medicine Unit, St Michael's Hospital, University Hospitals Bristol NHS Foundation Trust

Contacts from the following non-NHS clinical site have also agreed to provide support for participant/patient recruitment:

- Innermost Secrets Clinic, Ash Tree Private Medical Clinic, Cardiff

As the level of NIPD and/or invasive diagnostic testing at each centre is limited, it is expected that the CI will continue to identify and approach clinical contacts in other centres, in order to ensure that sufficient numbers of participants are available for contact and recruitment.

The specific selection of non-clinical sites will again depend greatly upon the assistance of key contacts. These key contacts will be leaders/organisers of mother and baby/mother and toddler groups. To date the CI has made initial contact with a number of groups, and has started the process of identifying key contacts.

Most of the clinical and non-clinical sites identified to date have been located in Wales, as it is from within Cardiff University networks that the CI has approached key contacts. The lead NHS R&D office for ethical approval purposes will be located in Wales. SSI forms will be generated for each site, and amendments to the protocol will be made if and when additional sites are identified.

Recruitment strategies

The recruitment process for NHS service users, described in detail below, will serve as a template for recruitment of all participants in this study. Where changes are made to this process for the recruitment of other groups, these will be described in subsequent sections. The study 'information pack' will be identical in content for all potential participants.

Recruitment of NHS service users

Initial contact with potential participants will be made through a key clinical contact who has agreed with the CI in advance to act as a gatekeeper to the project. At least one clinical gatekeeper will be identified at each study site. The clinical gatekeeper will either already be directly known to potential participants, or they will be part of the clinical team that is directly known to potential participants.

The clinical gatekeeper will be responsible for selecting potential participants to contact, working with patient databases they routinely have access to as part of their clinical work, and in accordance with this study's inclusion and exclusion criteria. This ensures that the CI will not have access to any identifiable patient data without prior consent from the participant.

Initial contact will be made through written invitation from the clinical gatekeeper on behalf of the CI. A study 'information pack' containing an invitation letter, a participant information sheet (PIS), a reply slip and stamped addressed envelope, will be distributed to potential participants by the clinical gatekeeper. The clinical gatekeeper will either

distribute this information in person, or they will send the information to the participants' home address.

The invitation letter will briefly introduce the study, explain the contents of the information pack, explain who is contacting them and why, and will provide contact details (telephone, email and postal) for the CI. The participant information sheet (PIS) will outline in detail, using clear and comprehensible language: the aims and purpose of the study; why the potential participant had been selected for inclusion; explanations of exclusion criteria; practical details of what participation would entail; details of potential risks and benefits; details of the research funder and sponsor; information on confidentiality; details of the participant's right to withdraw from the study at any point. At the end of the invitation letter, the potential participant will be invited to contact the CI (by telephone, postal reply slip or email) if they are interested in taking part in the study. They will be invited to ask any questions they might have, or ask for clarification on any of the information covered in the documents they received. A stamped, addressed envelope will be included with the invitation letter and participants will be asked to return the reply slip, and completed consent form, if they are interested in taking part.

Potential participants will be asked to complete and return (in a stamped, addressed envelope) a reply slip if they are interested in taking part in the study. The reply slip will ask the participant to confirm their interest, and will ask for a phone number and/or email address with which the CI may contact the potential participant to make further arrangements.

Upon receipt of reply slips, the CI will make direct contact with potential participants via phone or email. They will offer to answer any questions that the potential participant may have, and make arrangements for interview time, date and location. The participant will be free to choose a time and place that is most suitable to them, however, the CI will ensure that a suitable interviewing space is available if required. The CI will finally explain that the next stage of contact involves the posting of a consent form to the potential participant.

The consent form will ask the potential participant to confirm in writing the following: that they have read and understood the information sheet, that they understand that their participation is voluntary and that they are under no obligation to the gatekeeper or CI, that they have the right to withdraw from the study at any time, that they agree to interviews being audio recorded, that they agree to their anonymised quotes being

published, and that they agree to take part in the study. It will again be made clear that, if potential participants have any questions about the consent form, or any other part of the interview process, they will be free to contact the CI. Participants will be encouraged to read the consent form prior to the interview taking place, and to bring it with them on the day of the interview. The CI will however ensure that additional copies of the form are available on the day of the interview, for those who choose not to complete the forms in advance. The final stage of recruitment will involve the potential participant and the CI running through the consent form together, and the gaining of additional verbal confirmation of consent just prior to the interview taking place.

In summary then, a number of discreet stages make up the overall recruitment process:

- Identification of potential participants by clinical gatekeeper
- Initial contact from clinical gatekeeper (information pack) on behalf of the CI
- Receipt of reply slips from those interested in participating
- First direct contact between CI and potential participant, by phone or email (interview arrangements made)
- Second direct contact between CI and potential participant (consent form posted, interview arrangements confirmed)
- Consent form reviewed by CI and potential participant prior to interview

Recruitment of women with experience of routine prenatal tests (non NHS)

Initial contact with potential participants will be made through a key contact who have agreed with the CI in advance to act as a gatekeeper to the project. These non-clinical gatekeepers will be leaders/coordinators of mother and baby groups, breastfeeding groups, and other groups that work directly with pregnant women and mothers. The gatekeepers will be directly known to the potential participants via these networks.

The gatekeeper will be responsible for the initial identification of potential participants. In order to identify potential participants the gatekeeper will use networks that they routinely access. These networks will take the form of parenting groups that meet regularly. These networks may also include online parenting groups who communicate primarily through social networks, but who also meet regularly in person.

Initial contact with potential participants will be made by the gatekeeper, who will informally introduce the study in person on a one-to-one or group basis, or via written

communication through routinely accessed online networks. The gatekeeper will explain that information packs will be made available, to be collected in person during or after group meetings, to those who are interested in finding out more about the study. The CI will provide the gatekeeper with multiple copies of information packs, and these will be distributed by the gatekeeper, after initial interest from potential participants is communicated. Information packs will not be posted out. This step is taken in order to minimise the potential for breach of confidentiality or privacy, and in order to protect potential participants' personal data (addresses and contact details). The recruitment strategy for this group will then continue as outlined previously.

An additional number of participants will be recruited via a process of "snowball sampling". This process will be initiated by asking participants, after the completion of their interview, whether they would be willing to communicate basic information about this study to persons known to them, who fit the same inclusion and exclusion criteria as themselves. If participants are willing to help identify additional potential participants in this way, the CI will ask them to pass on a copy of the appropriate Participant Information Sheet (via post or email, the CI will provide printed copies and postage when required) to those individuals they think may be interested in taking part in the study. These additional potential participants will then enter into the pathway for recruitment that has already been established and is outlined in detail above.

Recruitment of NHS professionals (groups working with NIPD and routine testing)

Identification of potential participants will be made by key clinical contacts who have agreed in advance to act as a gatekeeper to the project, and who will also be assisting with the recruitment of NHS patients/service users. The CI will also identify a number of potential participants already known to the CI through professional and academic networks, and in accordance with the study's inclusion and exclusion criteria. Gatekeepers will identify potential participants using their own professional networks, in accordance with the study's inclusion and exclusion criteria.

Initial contact with potential participants will be made either in person, or via email/phone contact. Potential participants will be briefly introduced to the aims, objectives and methods of the study by the gatekeeper or the CI as appropriate. If initial interest is expressed, full information packs will be sent to each potential participants' place of work. The recruitment strategy for this group will then continue as outlined previously.

Recruitment of NIPD developers

The CI will identify a small number of potential participants already known to the CI through professional and academic networks, in accordance with the study's exclusion and inclusion criteria.

Initial contact will be made either in person or via email/phone contact. Potential participants will be briefly introduced to the aims, objectives and methods of the study by the CI. If initial interest is expressed, full information packs will be sent to each potential participants' place of work. The recruitment strategy for this group will then continue as outlined previously.

An additional number of participants will be recruited via a process of "snowball sampling". This process will be initiated by asking participants, after the completion of their interview, whether they would be willing to communicate basic information about this study to persons known to them, who fit the same inclusion and exclusion criteria as themselves. If participants are willing to help identify additional potential participants in this way, the CI will ask them to pass on a copy of the appropriate Participant Information Sheet (via post or email, the CI will provide printed copies and postage when required) to those individuals they think may be interested in taking part in the study. These additional potential participants will then enter into the pathway for recruitment that has already been established and is outlined in detail above.

Recruitment of Partners

Partners of women with experience of NIPD or current prenatal testing will also be recruited through a process of snowball sampling. If participants indicate during the course of an interview that they are in a relationship with a person they have parented a child with, the CI will ask, at the close of the interview, whether the participant would consider introducing the study to their partner as a potential participant. The CI will have copies of information packs available for participants who are willing to approach their partners about the study. The CI will also make it clear that they can be contacted at a later date, and that information packs can be supplied by post, if this approach is preferable. The recruitment strategy for this group will then continue as outlined previously.

It is recognised here that any discussion of personal relationships, however minimal, holds the potential to raise sensitive issues. The recruitment method adopted here will therefore involve a significant level of sensitivity and discretion on the part of the CI, and a cautious approach to questions and discussions involving personal relationships will be adopted at all times. It is also recognised, however, that the partners of women making decisions about prenatal testing are an important group to attempt to include in this study, and their interests and concerns are regarded as highly relevant. This group may be 'hard to reach' using more traditional methods of recruitment, as they are likely to be less closely involved with prenatal care services and mainstream parenting groups (Steen et al, 2011, Lewis, 2000). As a method designed to 'provides a means of accessing vulnerable and more impenetrable social groupings' (Atkinson, 2001), snowball sampling has been selected as the most appropriate approach for targeting participation from this group.

3.6 Methods

Literature review

The literature review for this project will necessarily be broad, and on-going. Key papers of clinical and scientific relevance will be identified, and activity in this area of publication will be regularly monitored, as technological changes in this field are rapid and on-going. Literature relevant to examination of the social, ethical and practical implications of prenatal testing will be identified, and a particular focus on papers that discuss NIPD in relation to such matters will be maintained.

Interviews

All interviews conducted will be semi-structured, and will be broadly informed by a narrative approach. This type of interview design allows for the perspective of the participant/interviewee to be fully expressed, encouraging the use of his or her own spontaneous language in the narration of events (Jovchelovitch et al, 2000). The CI will prepare a list of question topics in advance of undertaking interviews, and this list will act as a rough guide to the broad areas of discussion to be covered within each interview. By adopting a broadly narrative interviewing style, the CI ensures that participants are able to direct the course of the interview as much as possible, with the CI having minimal input into the structuring of the interview, beyond the broad questions identified in advance. It is envisaged that interviews will last for approximately 45 minutes, although no upper

limit will be imposed. Basic demographic details for each participant will be noted during the introduction stage of each interview. All interviews will, with permission, be audio recorded, and subsequently transcribed by the CI.

Vignettes

Study participants will be made up of service users and service providers with a broad range of experiences, and with different levels of knowledge about NIPD. In order to address this gap in knowledge, short vignettes will be used to explain and contextualise current and possible future applications of NIPD where appropriate. It is envisaged that the CI will make use of this research tool during the majority of interviews, and that use of vignettes would not typically be required only with those service providers who have direct experience of NIPD. Recognising that vignettes can only provide a limited amount of information on a complex technology such as NIPD, the CI will make it clear that they are designed only to prompt discussion, and that participant can ask for clarification on any of the points raised.

Data analysis

Interview transcripts will be analysed thematically and the data will be grouped and categorised according to key themes. Data collection and analysis will be undertaken concurrently allowing one process to inform the other. Particular attention will be paid to the language and terms used by the participants themselves in order to maintain a focus on their perspective. A qualitative software analysis package such as NVivo8 will be used as a tool for organising the data more effectively. This analysis work will be informed by a reflexive approach which ensures that the researcher stays attuned to the ethics of their own research, taking account of how their presence and participation effects the co-construction of meaning within the interview process.

3.7 Ethical considerations

It is recognised that all participants may be physically, psychologically and emotionally vulnerable, and that much of the subject matter of this research is highly sensitive. In accordance with the research design outlined above, participants will be informed fully about the purpose, methods and intended possible uses of the research, well in advance of their participation. Participants will be fully informed about what their participation in this research entails, and what potential risks may be involved: avoidance of harm is a key

concern and the rights, safety and wellbeing of participants are of central import to every stage of the research design. Participants' right to anonymity and confidentiality will be respected throughout, and the CI will take steps to ensure that participation is voluntary and free from any coercion. Participants will be made fully aware from the outset that they have the right to withdraw from the research at any time. Any conflicts of interest or partiality on the part of the CI will be made explicit and formal ethical approval will be sought when and where necessary.

The CI has the support of academic supervisors from Cardiff University School of Social Sciences, who will ensure that the project continues to meet appropriate ethical and professional standards. This project is also supported by a clinical supervisor from the All Wales Medical Genetics Service, who will help to ensure that the research is appropriately designed to reflect the needs of service users and service providers. In addition to this, the CI has received advice on research design and management from a number of clinicians already known to the CI through various professional networks. The CI has also consulted the British Sociological Association's 'Statement of Ethical Practice for the British Sociological Association' (2002) in designing this research protocol.

As previously outlined, throughout the recruitment and interviewing stages of the research, the CI will remain sensitive to any signs of distress of dissent. If a participant were to become upset or distressed, they will be asked whether they would like to withdraw from participation. If they clearly indicate that they wish to continue the CI will ask whether there are any issue they feel uncomfortable with discussing as part of the research. If participants choose to withdraw from the study they will be given the option of having all data that has been collected up to the point of withdrawal disregarded and destroyed. If they withdraw during the interview process, then they will be asked whether they would like to withdraw from the study altogether, or whether they would like to rearrange the interview.

It is recognised that the study could have impact on the health and wellbeing of the CI. Regular meetings will be held with the project supervisors, which will allow for any problems or concerns the CI might have, to be fully discussed. The CI is also aware of Cardiff University's 'Lone Worker Guidance' and 'Health and Safety in Fieldwork' policies, and will work in accordance with these. A key step that will be taken to ensure the safety of the CI when working alone, will be the development of a clear communication strategy. Regular communication with a named contact (colleague or other responsible person) will

be carried out during the fieldwork stage, with this person being informed of all dates and times of each appointment.

Data management

The confidentiality of the data produced and the anonymity of all participants will remain of key concern throughout the research process. In order to protect confidentiality and privacy, certain practical cautionary steps will be taken. Each interview will, with each participants' permission, be audio-taped; it will not, however, contain the participant's personal details. Each participant will be allocated a unique identification number to protect their identity. This coding system will link the tape-recordings to the participants, and is necessary in case further participation or clarification is required of an individual participant. Only the CI will have access to this coding system information to ensure that the confidentiality of participants is safeguarded. This identification information, along with the transcripts of each interview, will be stored in a password protected folder in the CI's account on the Cardiff University shared drive. The CI will be the only person to have access to this data. Paper copies of consent forms will be stored securely on site at Cardiff University. All information will be stored for a period of ten years following the completion of this study, after which time it will be securely destroyed. All interview transcript data will be anonymised to ensure that it will not be possible to identify individual participant's from data contained within written documents produced from the study (PhD thesis and other publications).

3.8 Involvement of stakeholders

This study places service users, their experiencees, and their responses to an emerging technology of social significance as central: its primary aim is to highlight and give value to their voices. The study methods have been designed to enable as rich an account of each women's experiences and responses to be presented: the use of semi-structured, narrative interviewing techniques with minimal input from the researcher will allow participants to fundamentally direct the course of the data that is produced.

The voices of service providers will also be highlighted, and they will be closely involved in the dissemination stage of the project. It is hoped that this study may help facilitate the development of a clinical and regulatory approach to NIPD that is as informed by the experiences and responses of the service users and service providers most directly

involved, as it is by clinical and scientific data on the technology and its practical application.

3.9 Expertise of the research team

Whilst the research will be carried out by the student alone, the study will be monitored and informed by two academic supervisors, and one clinical supervisor. This team provides relevant expertise in clinical genetics, medical sociology, bioethics and philosophy, and qualitative methodology.

The centre for Economic and Social Aspects of Genomics (Cesagen) is a multidisciplinary research centre at Cardiff University's school of social sciences. The centre has a proven track record of research in medical sociology and clinical practice, with a particular focus in expertise on developments in new biotechnologies. The centre provides access to a wide range of professional and academic expertise.

The All Wales Medical Genetics Service (AWMGS) provides specialist genetic services to individuals and families with, or concerned about, rare genetic conditions. The service is made up of clinical and laboratory services which together provide medical genetics services to the population of Wales. Cardiff and Vale University Health Board hosts the AWMGS at the University Hospital of Wales (UHW), Heath, Cardiff. Specialist consultant geneticists, doctors and genetic counsellors provide genetic services in all the main hospitals throughout Wales.

3.10 Study outcome and dissemination

This study is being undertaken for the fulfilment of a PhD in social science, at Cardiff University. For this purpose, a written thesis will be produced based on the work undertaken here.

It is envisaged that the results of this study will also be published in peer-reviewed journals.

Information about the study will also be made available to participants, in the form of a short written summary of the results.

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