Bloody infrastructures!: Exploring challenges in cord blood collection maintenance

Abstract

The collection of umbilical cord blood, a source of stem cells for cancer treatment, has become a highly strategised process. STS scholarship has explored the moral/economic tensions of this case but focuses less on questions of infrastructure. This paper aims to flesh out our understanding of how stem cell collections maintain usefulness whilst clinical requirements change. It borrows from literature on studying 'infrastructure' to analyse qualitative data on the UK context, exploring how it might help to think of these collections not simply as banks, but as infrastructures. It attends to how maintenance relies on alertness to the shifting standards of 'users', and demonstrates that infrastructural thinking offers the heuristic richness needed to explore these important aspects of maintaining collections of biological material and sustaining them into the future. It thus provides a contribution to the STS literature on tissue banking and the growing interdisciplinary corpus on issues of infrastructure.

Introduction

Umbilical cord blood (UCB) was first suggested as a source of hematopoietic stem cells (HSCs) in 1984, when a scientist working in the field of bone marrow transplantation science posited that cells with regenerative properties similar to bone marrow might be retrievable from placental tissue. By 1988, this discovery had led to the first therapeutic intervention with cord blood (Gluckman et al. 1989), which eventually precipitated a number of initiatives to collect UCB into repositories. The first of these, the New York Cord Blood Bank, is now one of around 160 internationally networked UCB banks that, alongside bone marrow registries, operate to provide transplant clinicians around the globe with HSCs for patients with a variety of illnesses for which HSC transplant is an element of treatment (Petersdorf 2010). It is, I argue in this paper, important to examine UCB banks as socio-technical infrastructures. How do public and private interests noted above play out in the more everyday banking processes, structures, and in particular in regard to clinical need? With this paper, I propose that our analyses of such tissue collections stand to be made more robust from an overt engagement with Science and Technology Studies (STS) and cultural theory work on the important notions of 'infrastructures' and 'archives', notions valuable to our understanding of the relationship between us and the technologies we variously use.

This point of departure moves away from existing social science commentaries on UCB. Though I cannot rehearse the full breadth of interventions here, it is worth briefly recounting two critiques of note: these relate first to a binary between private and public banks in the UCB market, and secondly, how within this context, categories of race and ethnicity are enacted by banks to secure specific UCB samples. The first of these interlinking critiques coalesce around so-called different 'models' of banking (public versus private UCB banks), with attention drawn to the commodification of the body through private banks, and the oppositional altruism engendered by the public banks. Companies offer exclusive banking services to pregnant women and their families. Known as 'private', or 'family banks', such initiatives require families to pay

upfront costs between £1000-3500 depending on whether they pay in a lump sum or an annual payment option (e.g., Cells4Life (2016)).

Though questions of propriety and the exploitation of the female body are brought to bear on the private banking model (Dickenson 2007, Waldby and Cooper 2010), a key concern with private banks is that they operate on a 'regime of hope' (Martin et al. 2008) through which the product of commercial UCB sequestration and storage is sold on the myriad future (and therefore unproven) treatments made possible to a child (or their family) by prudentially banking their tissue. To this extent, argues feminist philosopher Dickenson, private banking 'partakes of the myth of the infinitely regenerative body' (2007:84). As Martin et al. (2008) point out, though, the public bank – through which the donor neither pays nor is remunerated – operates as a 'regime of truth'. This regime, according to Brown serves as 'the legitimatory basis' of the public model, focusing 'almost exclusively on the present-day use of [UCB] HSCs in treating very rare blood and immunological disorders' (2005:342). Such accounts clearly recognise the importance of temporal orientation in these public collections of UCB, but are limited to the extent that their concern is in mapping out how the altruistic, and communitarian 'public model' masks the proprietorial, commercial interests of the private market.

More recently, social science analyses have engaged with how race and ethnicity categories are enacted in the public banking context. As a shared heredity between donor and recipient is understood to maximize the chances of better tissue matching between unrelated pairings, one of the most significant concerns of STS scholarship to date has been to focus on the enrolment of racial and ethnic categories in how public UCB banks are being populated and framed. For example, research on the policy that encourages Black and Minority Ethnicity (BAME) women to donate UCB through the rhetorical device of invoking an 'unmet need' for stem cells from BAME donors, and through the strategic selection of the physical sites from which UCB might be donated (Williams 2015). These sites are often situated in urban spaces with higher population concentrations of BAME people, thus increasing the likelihood that local births will be those of BAME women. What comes into relief in this account is the limitations placed upon those working within the system of British UCB banks to operate within the limited resources of a public health system. Such practices also ensure that transplant clinicians operating within the UK will have an immunologically comprehensive selection of stem cells which avoids the need to import more expensive stem cells from foreign banks (Brown and Williams 2015) which speaks to the proposal that we must think in terms of a global immunitary bioeconomy, through which the unevenness of access to UCB units requires that we think – if not in terms of the commercialisation of life - then in terms of its economization (Brown et al. 2011).

Whilst these analyses are vital in understanding the complexity of UCB banking today, I argue in favour of a different angle of analytic engagement. An analysis that develops strands of STS and cultural theory concerned with conceptual development of the notions of infrastructures and archives offer a novel lens through which to consider UCB banking. Andrew Barry argues that 'it has been easy for social scientists to assume that infrastructures are static, while people, goods, culture, money, and information simply flow smoothly around or through them' (2015). To that end, this paper suggests that people's cells and money are imbricated in systems that are far from static. These

infrastructures are actually in a contingent, 'eternal process of becoming' (Waterton 2010:654). Before focusing on the empirical context of the UK's public UCB banking infrastructure, I offer some conceptual foregrounding, drawing on STS, archival studies and social theory.

Archives and infrastructures

In her account of how to study infrastructure, Star (1999) argues that it is central to societal organization and can be defined by an array of elements. Amongst these are infrastructure's *embeddedness*; it is often nested within other social arrangements/structures which in turn fosters its *transparency*: infrastructures act as aids for doing things. Insofar as they are a conduit for this, they are often invisible as entities in themselves. Infrastructure's *temporal scope* is equally important in terms of its near and long term rhythms of process and practice. So too is the *incorporation of standards* – the classificatory schemas, for example, that order it, and make it intelligible to users and other systems.

Infrastructure is a highly useful way of thinking about many different empirical sites of investigation. It need not be physical, but might be data-based, or its physicality might not sprawl beneath a town like a sewerage system, but may instead be confined to a room of shelving units (an archive of Black British history), or of freezers (a clinical tissue bank). Infrastructure can then be seen as signifying 'the lists, codes, technical specifications, and other hidden mechanisms and standards that make the database work, both for those constructing the database and for those potential ''users'' that will one day want to retrieve information from it' (Waterton 2010:651).

What is shared by these different informational forms that constitute infrastructures , as Star and Bowker note, is that an infrastructure 'never stands apart from the people who design, maintain, and use it' (Star and Bowker 2006:230, Star 1999). The UK's electric power transmission network, the National Grid, cannot for this reason be understood without an appreciation of its infrastructural relationality. The network infrastructure is the locus of those who did, and currently do, design it. It is the locus of the many maintenance jobs that go into sustaining the network. It is the locus of the smaller and larger uses British users make of the National Grid. Microwaved meals and flashing Wi-Fi routers would be inconceivable without the Grid.

Another important aspect of infrastructure is brought to life in Jacques Derrida's work. In *Archive Fever* (1996), he sets out to explore what exactly constitutes an 'archive'. His etymological journey into the meaning of the word, and its consequent applications to psychoanalysis, implicate all collections – selectively derived, and intended for use – to qualify in some sense as archives. From Derrida's Freudian psychoanalytic archive, to cultural theorists' construction of the cityscape-as-archive (Featherstone 2000), to the biodiversity databases that STS scholars have framed fruitfully within Derrida's archival paradigm (Waterton 2010), the archival turn has taken a significant prominence in how contemporary social scientists are thinking about collections of both matter and of data. The most fecund element of Derrida's archive in the scheme of this paper is the importance that the French philosopher confers to tense. 'One associates the archive, as naturally one is always tempted to do… with the past. But it is the future that is at issue here, and the archive as an irreducible experience of the future' (1996:68).

Archives as infrastructural entities are primarily there that they may – at some point – be made use of. They may house an old pamphlet here, a datum there, 'a scrap of paper, or some other little piece of flotsam' (Steedman 2002:81) nestled away often many years ago. Their preservation has a purpose in that the archive might one day be used. As Elisabeth Kaplan puts it, those in charge of archives 'do what they do so that others…now or in the distant future, can do what they do' (2002:217). Similarly, Arjun Appadurai argues that an archive's design and intention are based upon 'the uses we make of the archive, not from the archive itself' (2003:14). The future is therefore an important element in how archives are managed and even why they exist. Because of this centrality on *potential* use, the archive stands as 'an irreducible experience of the future' (Derrida 1996:68). It *awaits* the use of its material, and is designed to maximise the likelihood of this use, be it imminent or latent. As Hilary Jenkinson (the archivist credited with professionalising archival practice in England) explained in 1938, archiving is a career of service, 'to make other people's work possible, unknown people for the most part and working very possibly on lines equally unknown to [the archivist], some of them in the quite distant future and upon lines as yet unpredictable' (cited in Evans 1975:153).

Jenkinson was highlighting then that the futurity of infrastructural orientation carried with it a central problematic. That the 'unknown people' that constitute the archive's users-to-be, who are working along 'lines equally unknown', are central to the archive. He was to be making a very similar point to Ribes and Finholt in their paper some seventy years later, *The Long Now of Technology Infrastructure*. They make clear that constituting the user of an infrastructure is no mean feat. '[W]e should not take the communities of infrastructure as a given,' they argue. 'Participants regularly debate the questions: "What is the community?" and "What does the community want?" Answers to these questions shift substantially over time' (2009:385). It is here that another key element of thinking with infrastructures comes into relief: the need to stave off obsolescence through the maintenance of usefulness.

An anecdote from my landlord regarding the unexpected sinkhole that recently appeared near my home serves us well here. In April 2016, a hole opened up between the Sheffield city suburbs of Woodseats and Millhouses. Our landlord was very excited, driving to Hutcliffe Wood Road to peer into the sinkhole the next day. He lamented that he couldn't find the sinkhole, only to discover he had been driving over it in his vain search. Within 24 hours, then, local council workmen had drilled down into the 20ft-deep former mine shaft, filled it up, and readied the local transport infrastructure that people might drive over it oblivious to the hole hours previous. It was rendered transparent again. Star reminds us that we only really notice infrastructure when it is broken – it 'becomes visible upon break down' (1999:382) - and indeed, a sinkhole is a more dramatic example of this. This is not surprising, given that mature systems 'reside in a naturalized background, as ordinary and unremarkable to us as trees, daylight, and dirt' (Edwards 2002:187). But we are also reminded – by Graham and Thrift – that it is the very 'processes of maintenance and repair…by which the constant decay of the world is held off' (2007:1). And yet, infrastructural maintenance and development 'takes time and negotiation' given the often multiple layers of technical consideration that make them both useful and highly complex (Star 1999:382).

To bring these infrastructural features into relief, the paper now engages with empirical data collected through semi-structured interviews with 19 individuals involved in UK parliamentary discussions on cord blood, in international conferences regarding HSC transplant, and the development of professional standards for UCB. I first look to bring into relief the importance of temporality – the need to think in Derridean terms of infrastructures as 'irreducible experiences of the future'. I do this through highlighting how UCB banks are understood by some as being of different generations that, building on past iterations of practice. I next move to unpick just one element of the individual UCB unit – its cell count. This acts as a vignette of the multiple scientific shifts that must be absorbed in the changing practices of infrastructural maintenance to keep the system useful. The paper then suggests that, given the need for continual strategic adaptation in how UCB collections are managed, we must move toward recognizing the inherently emergent nature of public UCB banking.

Learning from the past
Temporality, I have suggested above, is a central analytic component in studying infrastructure. A salient example of this in the empirical context of the UK's public UCB banking infrastructure is participants' conceptions of the space and attendant practices as generational. This conceptualization, exemplified below in the words of a scientist working for a charity-run HSC bank, can be seen to highlight the recognition within the UCB banking world of a need to respond to the shifting questions of how infrastructure constituencies and their requirements are temporally constituted.

> [The second UCB bank] started in 2006 … the [first] cord blood bank was already in existence. [A Spanish] cord blood bank was also in existence … created in 1995. We said second-generation because at that time, all the learning curves of the first banks were already there. We knew at that time that the cell dose was more important than [we thought] at the beginning...

The notion that the later UCB bank opening in 2006 could be 'second-generation' suggests that practices of collection management today were essentially borne of the discoveries made in the course of managing such infrastructures in the past. In establishing their second-generation bank, those managing the collection were equipped with the knowledge that had emerged since 'the beginning'. In particular, the shifting cell dose (also referred to as total nucleated cell count, or TNC), an important factor amongst the 'community of users' (Ribes and Finholt 2009). To be a second-generation bank obviously infers that there would have been a first generation preceding it.

> _RW:_ *OK, so what would a first generation cord blood bank be?*
> _Participant:_ *They were doing very low units with very low number of TNCs from their units. They were not testing all the virology panel diseases that they need to do as we are doing.*

In this exchange, another charity-run UCB bank scientist describes how the practices of first-generation banks were incomplete. The manner in which this participant places first-generation practices in the past ('they were not'), as compared to the second-generation being placed in the present ('we are doing'), speaks to the idea that practices in the field are indeed changeable.

We are what you would call a second-generation cord blood bank. We have learned how to process, how to test the samples, and have high quality units. ... in [a Spanish bank] I think they have 17,000 cord blood units, but they are working with four- or five thousand, because the others are so old that they are totally obsolete. And if someone requests ... these obsolete units, they're going to need to re-do tests on everything because they don't meet the current standing. We've started as a second generation cord blood bank, knowing what they were doing wrong in the past and learning the lesson and thinking ok, "if we do this, if we do that..."

The same scientist's choice of words is telling of their view that there is a need to enroll, and build upon, the knowledge of the past. The scientist explains that 'we have learned how to process' units, as compared to 'in the past.' Similarly, they suggest that second-generation bank workers are 'learning the lesson' from what has previously been done 'wrong'. Waterton describes database infrastructures as epistemic time machines, not because the matter derived at one point is suspended from the ravages of time, but in the sense that such spaces are 'built on some kind of guesswork, some faith, that we are doing this right, that we are entrusting and laying things and meanings that will be interpretable and meaningful in times to come' (2010:649). Waterton's point comes into relief in the account above. For instance, the scientist implies that 'if we do this, if we do that' then these collections can almost stave off making the errors of the past – of avoiding 'lock-in' (Garud and Karnøe 2001). This speaks more broadly to Garud and Karnøe's point about the criteria that establish a technological artefact's value. In this case, the quality criteria of UCB 'do not lie in a marker that is an overall arbiter of what is good and bad, but instead, become endogenized as a pattern of stabilized relationships within an emerging technological field' (2001:8). Relevance, put simply, is emergent – produced *alongside* the technology.

In the quote above, the scientist offers an example from Spain. Less than a third of this bank's inventory (this bank had been referred to by a participant earlier as a first-generation bank) is useful. The remainder is 'totally obsolete' but their age is not an intrinsically unattractive element. Rather it is the initially collected data that is insufficient. The bank would need to 're-do' tests, because though they may once have met a previous version of viability, they do not meet the 'current' one. The temporal dimension (the 'old' versus the 'current') is of course central to the usability of all technologies. In Rip's words, 'what were rational decisions in the context of the time may become historically irrational' (1995:419) and the continuing relevance of a technology can hinge on its developers' capacity to move past these temporally contingent irrationalities (that is, to avoid irrational path dependence). Spain demonstrates the importance of responsiveness on the part of those in charge of infrastructures. Even by ensuring the transition of practice, there is no guarantee that matter saved at one point will be relevant within the shifting landscape of the technology. As Edwards et al. write, we 'always imagine [infrastructures] as "future-proof" and universal, yet real-world systems are always future-vulnerable' (2009:371). To bring this more clearly into relief in the empirical context of UCB banking, the paper now moves to explore TNC in more detail. This is the value which determines the number of HSCs derived from a single UCB unit donation (many of the cells in the unit are not stem cells). The TNC represents those cells with the regenerative capacities understood to be able to repopulate the ailing body of the transplant recipient.

Towards a useful infrastructure

As Featherstone (2006) notes, those in charge of developing and managing collections operate with a *discriminating gaze* because of their mandate to find and preserve only things of use to their users. The UCB collection exists to be of use to the practitioners trying to provide healthcare to patients. In the sense that infrastructure is transparent (Star 1999), when a practitioner does a tissue search and gets back the results, they see only what the bank workers made available to them. They are not privy to knowledge of which units were regarded as irrelevant, just as all users of collections and archives are never privy to 'what archivists saw *before* the appraisal decisions were made to give researchers what they get' (Cook 2001:35 original italics).

As in all archives, a decision must be made over what is worth archiving. This decision is present throughout the various practices that lead up to a unit becoming part of the UCB bank. Importantly, however, this process is far from static, but an ongoing negotiation in which the parameters of acceptability are subject to change. The quote below comes from an interview with a charity-run UCB bank collection coordinator. I had asked if they recalled any change in the acceptable unit weight threshold (how heavy a bag of UCB blood must be for it to be worth sending to the laboratory to test for TNC) since beginning their job in 2010.

> *Oh gosh, yes. Several times. When we first started, I have a feeling… it was anything over 70 or 75g was considered to be clinical. Then it changed to anything over 90g was considered to be clinical. Or 100, I can't remember. Then it went up to 125. So, yes. Absolutely… It's always changing.*

In this account, the collection coordinator describes a scene in which collectors must be ready to transition their practice in accordance with collection criteria that are 'always changing' (read, always increasing). As the threshold for a UCB unit changes, collection practices must respond. There is an implication of increased selectivity in the account. They note that early on in the operation, 'it was anything'. The bank was far less discriminating. This is similar to the earlier account from the scientist who describes a scenario where 'everything was banked.' In what might be seen as a move away from an anything/everything mentality, infrastructural practice demands that archivists quite literally *weigh up* their decisions. The threshold of weight, as the above account demonstrates, has changed so many times that it was a struggle for the interviewee to actually remember what the thresholds have previously been. Why, then, has the threshold of TNC risen so much on the part of those managing the infrastructure? In the exchange below, I had been discussing the TNC threshold with a scientist who authors standards for HSC transplantation.

> *Participant: One of the things that is becoming clear is you need a really large TNC content….*
> *RW: You've raised it to 140?*
> *Participant: Yep.*
> *RW: That decision, how was it made?*
> *Participant: It was made on the basis of what people are actually selecting. Transplanters want large units.*

As the quote suggests, the managers of the collection make their decision on what to incorporate based on what clinicians 'are actually selecting.' As such, if the transplant clinicians want higher TNCs, it is incumbent on those managing the collection to provide that. They must build the collection around user requirement or their units will not be selected. The quote below comes from another scientist working with the non-clinical units sent to a charity-run public UCB bank.

> ...now there is an incentive to go higher and higher. So for example... the threshold was... 120... then it changed for 150... because now we know that you've got a better chance with that cell number for the cord blood unit to be picked for transplant.

The scientist's reflection reveals their understanding not only that user requirements will change, but that it stands to become more fine-grained. The filter of selectivity will permit less and less entry, because the weight threshold is increasing. As such, those managing the collection of UCB are following practitioner preference (i.e. recognising what is more likely to be 'picked'). In this account, the scientist shapes this in terms of an 'incentive', perhaps suggestive of a compulsion to move forward, to spur on the project of collection, perhaps because those in charge of building infrastructures 'dream that they will cater not only to... users, and uses in the present, but also to future communities, users and uses not yet anticipated' (Edwards et al. 2009:371). This resonates with archival theorist Kaplan's assertion to the profession, 'respond we must, or face irrelevance' (2002:218). Perhaps unsurprisingly, then, the increased centrality of TNC as a point of utilisation can be noted in the comparison of the initial Stem Cell Strategic Forum report (2010) and its refresh in the 2015 Stem Cell Oversight Committee report (2015).

In the 2015 parliamentary 'refresh' of the UK inventory's strategy, units in the inventory are 'graded' in terms of their cell dose. These grades, *A, B, C* and *R&D* (research and development), denote the borders of the quality of a unit as laid out below.

- Grade A donations: post-processing cell dose >19 x 10^8 TNC

- Grade B donations: post-processing cell dose 14-19 x 10^8 TNC

- Grade C donations: post-processing cell dose 9-14 x 10^8 TNC

- R&D donations: post-processing cell dose <9 x 10^8 TNC

  (UK Stem Cell Oversight Committee 2015:46)

Quite explicitly in the report these 'grades' are linked to their 'annual utilisation' (2015:25). More use is made of Grade A (3% of this section is used) as compared to Grade B or C (1% and 0.2% respectively). The table also notes that particular potential units (those below certain TNCs) 'ceased' being collected between 2010 and 2013, which serves to exemplify how the discriminatory gaze of collection practices has transformed since 2010. Notice too that there are more of the less desirable units (R&D and Grade C), and fewer of the more desirable ones (Grade B and Grade A). As the criteria of quality increase, a unit is less likely to meet them. It is particularly

interesting, in this respect, to compare the TNC boundaries between the two reports, compiled in a table below.

[INSERT TABLE 1]

Revealing the inherent politics of design and use in collection classifications (Beer 2013), the classificatory borders of TNC have shifted considerably since 2010. The two extremes here are particularly telling. The *top* selection of cords must now meet or exceed the threshold of 19, whilst in 2010 this included anything from 15 and over. The *lowest* grade in 2015 would not include any units equaling or below 9. Excluded here are many of the units that *would* have made the cut in 2010 (4-6.5, and 6.5-9). The comparison of these documents thus demonstrates the shift in inclusion to accommodate 'utilisation' by the constituency of clinicians that make up the user group. The shift is so key here because it signifies precisely the issue of infrastructure designers and managers to keep apace with the needs of users, which Ribes and Finholt aptly describe as 'a moving target' (2009:389).

'Growing' an infrastructure
Examples such as TNC are demonstrative of the argument put forward by Edwards et al. that infrastructures are less 'built' than they are 'grown'. The metaphor is intended to 'capture the sense of an organic unfolding within an existing (and changing) environment' (2009:369). Indeed, this very feeling of change – present in the accounts above – might be seen to constitute the UCB bank as it exists today. Change must take place in all collections. In any useful archive, note archival theorists Cook and Schwartz, without the ability to prepare for and incorporate the unfolding environment within which an archive exists, 'archival credibility will suffer ... Irrelevance will loom' (Cook and Schwartz 2002:179). As Graham and Thrift point out – the 'decay of the world' awaits the infrastructure that is not properly maintained within this landscape. In short, all infrastructures must have the latitude to absorb change. Recognition of this need is evident in the account below:

> ...it seems like every six months something new comes along which almost makes you... redefine your strategy on how you're going to proceed forwards. And because it's quite a rapidly changing landscape it requires you to be on your toes... and a lot of assumptions that maybe we had just five years ago have been a little bit blown out of the water.

In this reflection from a participant involved in a parliamentary group on stem cell transplantation, the field of UCB technology is described as a 'rapidly changing landscape'. This maps onto Edwards et al.'s argument that infrastructures are negotiated 'in the sense of the constitution of an evolving landscape around which actors must negotiate' (2009:371). But this is not a rare occurrence; it is regular, 'enmeshed with the routines and practical work of [an infrastructure's] use, upkeep, and repair' (Ribes and Finholt 2009:378). New findings can, in the words of the interviewee, blow assumptions 'out of the water,' suggesting not small changes, but potentially seismic recalibrations in the way things have to be done. Indeed, in the account, these new discoveries force those overseeing the banks to 'almost redefine' their strategy, as they move into the future. There is, as Borup et al. note, no 'neat slope of enlightenment' over time (2006:291). Given the likelihood that change will come

rapidly, workers in these archives must remain 'on their toes', ready to move at any point. There can be no prescribed path for a technology, as this would not capture the unpredictability of users' and developers' expectations.

What is asked of those working in these collections is that they make their collection ever relevant to the present, a reflection that Bowker makes more generally of contemporary collations of data: 'What is being demanded of the dataset is precisely something which over twenty years of science studies have shown cannot be asked of the scientific paper - to stand outside of time' (2005:177). The requirement of heavy maintenance is like a regular rewriting of an old journal article to keep it up-to-date. The growing metaphor suggests, too, a continuation beyond the finitude of building something toward completion. As Bowker notes, 'You never complete an infrastructure in the way you complete a novel; it is always and ever in the making' (2015). The complete and static UCB bank, through which the sociologically relevant cells of female/BAME bodies circulate, does not exist. The UCB bank, contingent already by way of a discovery, a successful initial transplant, and the sporadic opening of banks over the last two decades, is not – and cannot be – complete.

The collection management strategy, which guides the workers' goals and actions must itself be open to change lest it fall into obsolescence like a UCB unit collected in the 1990s and then left in a freezer for two decades without mediation in reference to shifting clinical demand. In this sense, the strategy must have an inherent latitude to absorb the changes the future might bring. The future is unknowable, and so to an extent the strategy's purpose is also unknowable, because purpose and use are *in the future*. It must be speculative. The exchange below comes from an interview with a scientist involved in an international association for stem cell transplantation. I had asked them about the shifting nature of strategies in stem cell donation and banking.

> *RW: Is there any way you could –*
> *Participant: have an eternal strategy?*
> *RW: Impossible?*
> *Participant: I would say so! If you had an eternal strategy then you would know how the illness actually works. And basically then you would be in the position to say this is not the right treatment, or this is the correct treatment… [research] advances every year… and as a consequence you have to readapt your strategy.*

A strategy that determined a route worth taking has to be 'readapted', an evocative word which speaks to the idea that archival strategies have to be malleable with the upcoming changes to the circumstances of their existence. The archive, then, is defined by the temporal dimensions that sustain it. The participant above speaks to the eternality of becoming, explaining the impossibility of 'an eternal strategy'. Indeed, as 'an irreducible experience of the future' (Derrida 1996:68), the informational form that constitutes the UCB bank infrastructure is 'in an eternal process of becoming' (Waterton 2010:654).

Conclusion
Technological stasis is not on the table in the accounts above, which resonate clearly with a point made by Selin that 'technology can only be understood as becoming, as neither solely constructed, nor determined, but amid the conceptual territory of the two

perspectives' (2006:125). The continued existence of UCB banking infrastructure through a continuing attractiveness to current and future clinical users, relies on the collection managers' willingness to reflect on its current state, to prepare for what Deuten and Rip term an innovation journey's 'contingencies' (2000:70).

What I hope to have shown here is that, like those working within many databases, archives, and other infrastructural forms, UCB banks operate on a shifting landscape. The requirements of the community of users stands to change, impelling change on the part of those who want their collections of matter or data to remain relevant to that community. The frustrated expletive 'bloody infrastructures!' is intended to convey how infrastructures frustrate. It is intended to evoke the recalcitrance of managing a collection of human tissue – suspending that tissue in a freezer whilst trying to negotiate its continued relevance on a shifting landscape of user needs. I hope here to have shown the complex and ongoing negotiation of an infrastructure subject to the demands of a scientific community whose expectations are ever in flux. This, perhaps, is why Star (1999:382) warns the optimistic infrastructure manager that there is 'no magic wand to be waved over the development effort' of growing an infrastructure.

A lack of recognition of this within the public blood stem cell banking debate is perhaps surprising given similar assertions in related empirical areas like more research-focused human embryonic stem cell (HESC) banks. As Webster and Eriksson (2008) demonstrate, scientists in this context undertake local research on a variety of issues in an attempt to anticipate users' future demands, but also to manage the speed with which they must respond to such pressure. Indeed, it makes sense that collections of matter – HESC and UCB banks alike – would hope to secure a stable and durable regime that might accommodate changes wherever possible. In this sense, this paper has traced how maintenance practices are intended to produce some kind of a 'doable future' for the UCB bank (Eriksson and Webster 2008).

Infrastructural thinking brings to the fore the innately temporal orientation of informational forms. Without acknowledging the contingencies of those structures that permit the procurement of cells, we risk not asking some of the key questions that portend the need for critical analyses of how value stands to be derived from (particularly female and BAME) bodies. Questions such as "which countries can afford to develop and maintain a UCB infrastructure?", "which patients' needs will be met by this UCB bank? Whose will not?". We should highlight the importance of considering the kinds of resources made available to public banks to be built and– importantly– maintained. The national context and the healthcare funding governance structures therein will certainly have their roles to play. Edwards et al generalize these political questions of social justice across infrastructural forms when they ask the following: "How can claims on, through, and against infrastructure be formulated, organized, and heard? What constitutes adequate representation or participation in the process of infrastructural change and development?" (2009:372). The public UCB bank brings these concerns sharply into relief, and offers a window to recognise these collections not simply as the static systems around which information flows but as collections of matter procured sometime past, being maintained in the present, with the hope that it can somehow be of use in the future.

References

Appadurai, A. 2003. "Archive and Aspiration." In *Information is Alive: Art and Theory on Archiving and Retrieving Data*, edited by J. Brouwer and A. Mulder, 8-14. Rotterdam: V2_Publishing.

Barry, A. *Discussion: Infrastructural Times*, September 24 2015. Available: http://www.culanth.org/fieldsights/724-discussion-infrastructural-times.

Beer, D. 2013. *Popular Culture and New Media: The Politics of Circulation*. London:Palgrave Macmillan.

Borup, M., N. Brown, K. Konrad, and H. Van Lente. 2006. "The Sociology of Expectations in Science and Technology." *Technology Analysis & Strategic Management* 18(3-4):285-298.

Bowker, G.C. 2005. *Memory Practices in the Sciences*. Cambridge, MA:MIT Press.

Bowker, G.C. *Temporality*, September 24 2015. Available: http://www.culanth.org/fieldsights/723-temporality.

Brown, N. 2005. "Shifting Tenses: Reconnecting Regimes of Truth and Hope." *Configurations* 13(3):331-355.

Brown, N., L. Machin, and D. McLeod. 2011. "Immunitary Bioeconomy: The Economisation of Life in the International Cord Blood Market." *Social Science & Medicine* 72(7):1115-1122.

Brown, N., and R. Williams. 2015. "Cord Blood Banking: Bio-objects on the Borderlands Between Community and Immunity." *Life Sciences, Society and Policy* 11(1):1-18.

Cells4Life. *Cord blood pricing: Low cost cord blood banking with Cells4Life* 2016 [cited 13/06/2016. Available: http://cells4life.com/cord-blood-pricing/.

Cook, T. 2001. "Fashionable Nonsense or Professional Rebirth: Postmodernism and the Practice of Archives." *Archivaria* 51:14-35.

Cook, T., and J.M. Schwartz. 2002. "Archives, Records, and Power: From (Postmodern) Theory to (Archival) Performance." *Archival Science* 2(3-4):171-185.

Derrida, J. 1996. *Archive Fever: A Freudian Impression*. Chicago, IL:University of Chicago Press.

Deuten, J., and A. Rip. 2000. "Narrative Infrastructure in Product Creation Processes." *Organization* 7(1):69-93.

Dickenson, D. 2007. *Property in the Body: Feminist Perspectives*. Cambridge:Cambridge University Press.

Edwards, P.N. 2002. "Infrastructure and Modernity: Scales of Force, Time, and Social Organization in the History of Sociotechnical Systems." In *Modernity and Technology*, edited by T. J. Misa, P. Brey and A. Feenberg, 185-225. Cambridge, MA: MIT Press.

Edwards, P.N., G.C. Bowker, S.J. Jackson, and R. Williams. 2009. "Introduction: an agenda for infrastructure studies." *Journal of the Association for Information Systems* 10(5):364-374.

Eriksson, L., and A. Webster. 2008. "Standardizing the Unknown: Practicable Pluripotency as Doable Futures." *Science as Culture* 17(1):57-69.

Evans, F. 1975. "The Second Generation: The Teachers and the Taught." *The American Archivist* 38(2):151-155.

Featherstone, M. 2000. "Archiving Cultures." *The British Journal of Sociology* 51(1):161-184.

Featherstone, M. 2006. "Archive." *Theory, Culture & Society* 23(2-3):591-596.

Garud, R., and P. Karnøe. 2001. "Path Creation as a Process of Mindful Deviation." In *Path Dependence and Creation*, edited by R. Garud and P. Karnøe, 1-40. Hillsdale, NJ: Lawrence Erlbaum and Associates.

Gluckman, E., H. Broxmeyer, A. Auerbach, H. Friedman, G. Douglas, A. Devergie, H. Esperou, D. Thierry, G. Socie, and P. Lehn. 1989. "Hematopoietic Reconstitution in a Patient with Fanconi's Anemia by Means of Umbilical-Cord Blood from an HLA-Identical Sibling." *New England Journal of Medicine* 321(17):1174-8.

Graham, S., and N. Thrift. 2007. "Out of Order: Understanding Repair and Maintenance." *Theory, Culture & Society* 24(3):1-25.

Ketelaar, E. 2002. "Archival temples, archival prisons: Modes of power and protection." *Archival Science* 2(3-4):221-238.

Martin, P., N. Brown, and A. Turner. 2008. "Capitalizing Hope: The Commercial Development of Umbilical Cord Blood Stem Cell Banking." *New Genetics and Society* 27(2):127-143.

Petersdorf, E.W. 2010. "The World Marrow Donor Association: 20 Years of International Collaboration for the Support of Unrelated Donor and Cord Blood Hematopoietic Cell Transplantation." *Bone Marrow Transplantation* 45(5):807-810.

Ribes, D., and T.A. Finholt. 2009. "The Long Now of Technology Infrastructure: Articulating Tensions in Development*." *Journal of the Association for Information Systems* 10(5):375.

Rip, A. 1995. "Introduction of New Technology: Making Use of Recent Insights from Sociology and Economics of Technology." *Technology Analysis & Strategic Management* 7(4):417-432.

Selin, C. 2006. "Time Matters: Temporal Harmony and Dissonance in Nanotechnology Networks." *Time & Society* 15(1):121-139.

Star, S.L. 1999. "The ethnography of infrastructure." *American behavioral scientist* 43(3):377-391.

Star, S.L., and G.C. Bowker. 2006. "How to infrastructure." In *Handbook of new media: Social shaping and social consequences of ICTs*, 230-245. London: Sage.

Steedman, C. 2002. *Dust: the archive and cultural history*:Rutgers University Press.

UK Stem Cell Oversight Committee. 2015. Unrelated Donor Stem Cell Transplantation in the UK: Effective Affordable Sustainable. London: Department of Health.

UK Stem Cell Strategic Forum. 2010. The Future of Unrelated Donor Stem Cell Transplantation in the UK: Part 2, Annexes. London: Department of Health.

Waldby, C., and M. Cooper. 2010. "From Reproductive Work to Regenerative Labour: The Female Body and the Stem Cell Industries." *Feminist Theory* 11(1):3-22.

Waterton, C. 2010. "Experimenting with the Archive: STS-ers as Analysts and Co-Constructors of Databases and other Archival Forms." *Science, Technology & Human Values* 35(5):645-676.

Williams, R. 2015. "Cords of Collaboration: Interests and Ethnicity in the UK's Public Stem Cell Inventory." *New Genetics and Society* 34(3):319-337.