Original research

Providing recurrence risk counselling for parents after diagnosis of a serious genetic condition caused by an apparently de novo mutation in their child: a qualitative investigation of the PREGCARE strategy with UK clinical genetics practitioners

Alison C Kay, Jonathan Wells, Nina Hallowell, Anne Goriely

ABSTRACT

Background Diagnosis of a child with a genetic condition leads to parents asking whether there is a risk the condition could occur again with future pregnancies. If the cause is identified as an apparent de novo mutation (DNM), couples are currently given a generic, population average, recurrence risk of ~1%–2%, depending on the condition. Although DNMs usually arise as one-off events, they can also originate through the process of mosaicism in either parent; in this instance, the DNM is present in multiple germ cells and the actual recurrence risk could theoretically be as high as 50%.

Methods Our qualitative interview study examined the views and reflections on current practice provided by UK practitioners working in clinical genetics (n=20) regarding the potential impact of PREcision Genetic Counselling And REproduction (PREGCARE)—a new preconception personalised recurrence risk assessment strategy.

Results Those interviewed regarded PREGCARE as a very useful addition to risk management, especially for cases where it revised the risk downwards or clarified that a couple’s personalised recurrence risk meets National Health Service thresholds for non-invasive prenatal testing, otherwise inaccessible based on the generic DNM recurrence risk.

Conclusion Participants said it could release some couples requiring reassurance from undergoing unnecessary invasive testing in future pregnancies. However, they regarded mosaicism and PREGCARE as complex concepts to communicate, requiring further training and additional appointment time for pre-test genetic counselling to prepare couples for all the possible outcomes of a personalised risk assessment, including potentially identifying the parental origin of the DNM, and to ensure informed consent.

INTRODUCTION

The birth of a child with a serious clinical disorder (eg, with complex learning disabilities, severe physical impairment, shortened life span) to a healthy couple with no previous family history is a life-changing event. De novo mutations (DNMs) cause developmental disorders in ~1 in 295 live births1 and when a DNM is identified as the cause, in the majority of cases this is a one-off event, which occurred either in a single gamete from one of the parents (egg or sperm), or early in the child’s own embryonic life. In such cases, the recurrence in a future pregnancy is essentially negligible. However, if the DNM first arises at an early timepoint in the
Screening of embryonic development of one of the parents, it can be present in multiple gonadal cells (‘gonadal mosaicism’). In this situation, the recurrence risk can be theoretically as high as 50%.

Not knowing the specific circumstances of individual couples, practitioners currently rely on a population-average risk estimate of the DNM occurring in a future pregnancy of ~1%–2%. This generic recurrence risk does not separate those couples with negligible risk from those with a higher risk. As a result, couples are asked to make potentially life changing reproductive decisions with information that is almost always incorrect and potentially misleading.

The UK-led PREcision Genetic Counselling And REproduction (PREGCARE) study developed a systematic strategy for providing families with a personalised risk assessment following the birth of a child with a genetic condition caused by DNM. This relies on analysis of tissues (blood, saliva, buccal swabs, urine and sperm) from child-parent trios and stratifying each of the 60 families recruited into one of 7 categories associated with different recurrence risks (Figure 1). The experimental strategy involves ultra-deep sequencing of the tissues to identify cases of occult mosaicism, followed by haplotyping of the DNM for the mosaic-negative families to determine parent-of-origin. Individual clinical reports were returned to the referring clinicians who informed the families of their results. The PREGCARE study was able to provide a refined risk that, in all cases, differed from the 1% to 2% generic risk originally given to couples. In ~10% of recruited families, the ultra-deep sequencing identified evidence of mosaicism in one of the parents that had been missed on previous routine analysis—associated with an increased risk of recurrence—but for the other 90% of couples the risk was reduced.

Figure 1
Overview of the PREcision Genetic Counselling And REproduction (PREGCARE) strategy and stratification of de novo mutation (DNM) recurrence risk into seven different categories. By establishing the origin (paternal (blue), maternal (pink) or postzygotic (proband, green)) and the timing of the mutational events (purple colour indicates mutant cells), it is possible to stratify individual families into different categories that are associated with widely different recurrence risks (see ‘anticipated recurrence risk’ in the figure). The proportion of cases in each category can be estimated using data from the literature. Four of the seven categories (ie, categories B, C, F and G) involve mosaic presentations and can be identified by deep sequencing of the collected tissues from the family trio. Furthermore, analysis of a sperm sample for paternal cases allows direct quantification of the risk to another pregnancy (ie, variant allele frequency (VAF) of the DNM in the semen sample). By singling out these mosaic families, the remaining (mosaic-negative by deep sequencing) categories (A, D, E) have a reduced risk of recurrence estimated to be ~0.1% (~10-fold reduction over the generic 1%–2% risk) (see Bernkopf et al for details). The last row of the figure represents an overview of the refinement of risk generated during the PREGCARE strategy. Analysis of the DNM parental origin via long-read sequencing allows to further refine the risk for the mosaic-negative categories and reassure the majority of families, as category A (one-off paternal, 71% of cases) is associated with a negligible risk, estimated to be below 0.1% depending on the exact limit of detection for the specific custom assay; note that categories D and E cannot be distinguished from one another because it is not possible to access maternal oocytes and the risk for a DNM of proven maternal origin is estimated to be reduced modestly (~2×–8×) compared with the population with generic risk. Likewise, the risk associated with category F (mixed maternal mosaicism) cannot be quantified but is likely to be ‘high’ and can be estimated to be on average ~10% (for further details and references, see Bernkopf et al). Figure adapted from Bernkopf et al.
The PREGCARE strategy has the potential to transform genetic counselling practice by allowing couples to make future reproductive decisions based on personalised information. However, before the argument can be made that this should be implemented as part of routine clinical care, it is important to consider clinical genetics professional’s experiences of providing recurrence risk information to couples and their views on the current challenges and unmet needs as well as the potential impact of introducing a personalised approach for service provision and patient outcomes.

Existing literature shows a difference in lay and health professionals’ perspectives on how reproductive risks are perceived and received. Pregnant women’s perception of population-based risk is driven more by their interpretation of their subjective risk— influenced by experience, personality and beliefs—and feelings about the acceptability of the risk being considered, than the objective probability of an affected pregnancy. However, if the availability of personalised, evidence-based, risk information appears an attractive option to counselling practice, it may complicate this picture and create new challenges.

METHODS

Research participants (n=20) were recruited via advertisement to professional associations: (British Society of Genetic Medicine and the Association of Genetic Counsellors and Nurses). All had experience of counselling couples about prenatal options following diagnosis of conditions caused by a DNM in their child. Fourteen clinical geneticists (CG) and 6 registered genetic counsellors (GCr) were recruited, from 15 NHS Trusts across the UK. Twelve out of 20 participants had direct experience of referring couples into the original PREGCARE study. Fourteen out of 20 participants were women, including 1 male GCr, reflecting the gender composition of the profession.

Semi-structured interviews (duration ~60 min) were conducted remotely via Microsoft Teams between February and June 2022, beginning approximately 10 months after the PREGCARE research study enrolled the last family in March 2021. Interviews covered included: interviewee’s current practice in providing recurrence risk information; views on the usefulness of generic recurrence risk; views of, or experience with, PREGCARE and reflections on the practicalities of introducing PREGCARE into clinical practice. A qualitative data analysis software package, NVivo, was used to manage the data generated and Reflexive Thematic Analysis was used to analyse the data. The analysis revealed a number of themes reflecting practitioners’ experiences including: responsibility; the reassurance gap and the communication challenge for mosaicism and tools of reassurance. The latter two are reported below. The Standards for Reporting Qualitative Research reporting guidelines were used.

RESULTS

The analysis suggested there were few discernible differences between the responses of CG participant number and GCr participant number.

The reassurance gap and issues for risk communication

Clinical genetics professionals described a tension between the generic recurrence risk currently provided to couples and couples’ subjective perceptions of the risk of a recurrence in a future pregnancy. Thus, providing reassurance was described as challenging, especially for those couples wanting total reassurance. Practitioners thought it a very difficult situation for couples who do not feel reassured after receiving a generic recurrence risk, although small (19%–29%), acknowledging that they are left with underlying uncertainty. Practitioners were aware that the generic risk figure is not accurate for any given couple (and may vary depending on the specific condition) and that the potential consequences of recurrence—having an affected pregnancy—was not an abstract fear because these couples had already had a child with a life-changing genetic condition. As GCr19 said: “It’s still kind of leaving them I guess a bit in limbo because we’re saying, ‘It’s most likely low risk but there is a chance’…” (table 1, GCr07)

Practitioners said their limited experience of DNM recurrence bolstered their perception of the recurrence risk as ‘low’, often drawing comparisons with counselling about autosomal recessive inheritance in which unaffected ‘carrier’ parents have a 25% chance of having an affected child. They wondered whether they were lucky in not having a recurrence in their own patients yet, as CG16 reflected: “Sometimes, I think experience empowers you to feel maybe overconfident. You know, I’ve yet to be, touch wood, I’ve yet to be caught out in my career”. GCr20, whose patient had experienced a recurrence, recounted a very challenging experience for the team because, “it took us all by massive surprise and was quite traumatic as well”. It was
an experience for which they felt unprepared (table 1, GCr02, GCr20).

Although some participants said, based on the comparably low DNMs recurrence risk, that they were comfortable providing couples with a generic risk, others described generic risks as ‘judgement figures’ (CG08) and feared giving couples ‘wildly inaccurate risks’ (table 1, CG02). A general air of caution was expressed around the accuracy of the generic risk figure given, usually 1%–2%, with some reflecting that it was better not to focus on the numbers and that the practitioner should check the literature with each case for new information: “I try to avoid numbers because I think a lot of the numbers are a guess in the first place” (CG08) (table 1, GCr10).

In this context, PREGCARE was described as offering the possibility of more clarity, as GCr19 said, ‘certainty feels more comfortable’ (table 1). However, when asked to consider a PREGCARE outcome identifying the maternal origin of a DNMs (ie, maternal mosaicism, categories D, E, F) on figure 1), for which precise quantification is not yet scientifically possible due to the inaccessibility of the oocytes (see legend to figure 1), the practitioners interviewed were ambivalent as to whether this was a gain. Participants thought identifying maternal mosaicism could be helpful in terms of risk management and accessing interventions, but expressed concern about counselling parents, describing this outcome as harder to counsel, not least because the wider margins of risk in this situation could be seen as “...an increased amount of entropy, if anything. I would find that tough...tough to communicate” (CG15) (table 1, GCr17).

Despite the potential benefits of a personalised approach, the idea of changing the DNMs risk message currently given to couples was seen as challenging. Practitioners said they usually give mosaicism, especially somatic mosaicism, a brief and simplified explanation in clinic because it is complicated to understand (table 1, CG10, CG15, GCr19). The ‘out of the blue’ origin of DNMs and the associated ‘no one’s fault’ messaging they currently deliver was felt to provide relief to couples, who are usually aware of other potential genetic inheritance patterns (carrying higher standard recurrence risks): “So, they may feel some level of relief that it’s not something that’s inherited. It’s not something where they might be carriers and there’s a one in four recurrence” (GCr20) (table 1, GCr12). Subsequently, deconstructing this to explain mosaicism and PREGCARE, which explicitly outlines the parental origin of the causative mutation in their child, was seen by some participants as challenging, requiring “...more time and more appointments because you’re doing another round of testing with some lengthy explanations” (GCr07) with “too much background required to explain” (CG15).

Tools of reassurance and justification for prenatal procedures
Conveying thoroughness and being able to offer couples an action plan was seen as a valuable tool of reassurance. Interviewees said that in current National Health Service (NHS) practice actions are limited to informing couples regarding their ‘options’, which due to risk-specifed access thresholds for accessing non-invasive options on the NHS (non-invasive prenatal testing (NIPT); NIPD; PGT-M), consist of invasive prenatal testing (PNT) in the next pregnancy. In many cases, PNT was not seen as medically necessary by interviewees, instead the offer and undertaking of PNT was seen as primarily an anxiety-reducing or anxiety-reassuring exercise, as CG14 said: “...if it’s 1% or less, then I will arrange it for reassurance but personally I don’t think it’s necessary” (table 2, GCr19). If a couple did not return to clinic to discuss prenatal options in the next pregnancy, practitioners took an optimistic stance: “I take it that they’re therefore reassured” (CG10), although they added that with no follow-up it was unknown “if they just decided not to have any more” (table 2, CG18).

Although, the importance of patient-centred practice and being empathetic to parents’ need for reassurance were justifications for further testing, not all participants were entirely comfortable with providing invasive testing: “They’re going down an invasive testing route on a baby that looks normal on the scan...” (CG11), nor directing couples to expensive non-invasive testing outside the NHS, as CG06 put it: “...that’s the worry, that people go off and spend money they shouldn’t, they don’t need to spend [on private NIPT]” (table 2, GCr06).

Interviewers were also aware that even presenting PNT as an option, places an evaluative burden on a couple, especially as access to tests, particularly invasive tests, often requires an expressed intention to terminate that pregnancy if a recurrence is identified (table 2, GCr01, CG18, GCr20). In this light, PREGCARE was perceived as a way of addressing the reassurance gap, conveying thoroughness and providing an action plan without the couple having to risk a current pregnancy or grapple with the acceptability of negative outcomes: “I think it’s all about getting as much information as we can for people without putting a current or potential pregnancy at any risk” (CG09) (table 1, GCr10).

PREGCARE was regarded as particularly ‘beneficial’ (GCr07) in cases where the personalised recurrence risk was identified as 10% or higher, the current threshold for eligibility to funded PGT-M in the NHS. Participants hoped that in such circumstances, in meeting the threshold for accessing NIPT on the NHS, this would become available to couples with a DNMs risk. Where a personalised recurrence risk was lower than the generic recurrence risk, this was regarded as a ‘good news’ result and participants thought couples might feel less inclined to undergo PNT or to pay for a non-invasive test (table 2, GCr07, CG18). Furthermore, they wondered, if the PREGCARE assessment returned a personalised recurrence risk below the generic recurrence risk, this would be evidence to support the practitioner being more directive and not offering or dissuading the couple from PNT (table 2, CG08).

However, despite perceiving these benefits to risk management, some interviewees were uncertain as to whether couples would be sufficiently motivated to undergo the process of personalised risk assessment due to the number of samples required from the trio (including, blood and sperm samples) (table 2, CG13), whereas others who had recruited to PREGCARE did not report this as an issue, commenting that PREGCARE couples ‘were quite happy to provide anything that would help to work things through’ (GCr20).

Essentially, practitioners said that if PREGCARE could refine the recurrence risk downwards, this would offer most couples the reassurance they seek. It would add clarity and evidence-based information to clinic consultations, provide justification for risk management, and release couples from unnecessary invasive testing. When the personalised risk was raised to 10% or above, practitioners reflected that although not offering reassurance through a reduction in risk, the PREGCARE outcome could justifiably access to further interventions on the NHS. However, in cases where PREGCARE testing identified maternal mosaicism—in which case the recurrence risk would be unquantifiable due to the inaccessibility of the oocytes—practitioners were concerned that this would be unhelpful and add to couples’ uncertainty. As CG08 observed: “If it’s high risk but not quantifiable, then you’re
back into the fudge figure” (table 2, CG15). Practically, detection of maternal mixed mosaicism presents a challenging situation for counselling which should warrant extra-care in future pregnancies, even if the risk is not directly quantifiable, it is substantial. However, PGT-M is not suitable for these couples due to the presence of the DNMs at low levels in maternal plasma.

Finally, when considering implementation, participants raised the importance of timing; when to inform patients about PREGCARE. DNMs recurrence risk information is currently given in appointments focused on conveying a diagnosis for the affected child. Subsequent follow-up is often patient-led and triggered by a new pregnancy (table 2, CG14). Additionally, practitioners described how pregnancy brings time pressures for both practitioners and patients. As CG12 remarked: ‘The difficulty is people come back pregnant and then there’s no time to offer it’ (table 2, CG19). Practitioners reflected that for PREGCARE to be useful, it would need to be discussed with couples fairly soon after diagnosis and to do this, clinic time would need to be allocated for pre-test and post-test genetic counselling (table 2, CG10, CG11). Needing ‘careful handling and explanation’ (CG02) and a level of ‘genetic literacy’ (GCr07), interviewees in our study thought that a precision risk assessment like PREGCARE would be better delivered within clinical genetics, rather than being a mainstream offering, in order to ensure that couples’ consent was better informed.

**DISCUSSION**

Gathering views of health professionals is critical for considering how and when new genomic tests are introduced into clinical practice. Clinical genetics professionals play a central role in informing and facilitating patient understanding and decision-making and therefore, their views and experience are key to the development of policy and guidelines. The above results suggest that precision risk assessment is appealing to clinical genetics practitioners. Participants generally regarded PREGCARE as beneficial in terms of giving them the confidence to clarify a couple’s specific circumstances, whether the risk was low and in refining the risk to improve risk management options for those with an increased risk.

The finding of a reassurance gap for DNMs recurrence risk is consistent with the literature, which highlights the role of risk perception and risk acceptability when dealing with genetic risk information and uncertainty.4 5 10–16 Although effective reassurance is an essential medical task, not least because health anxiety impacts a patient’s understanding of information and can result in overuse of health services,17–19 in the context of genetic counselling low-risk results are not always reassuring.13 20–22 In this study, practitioners reported challenges in reassuring couples after a child is diagnosed with a genetic condition caused by a DNMs and some couples remain incredibly anxious about making future reproductive decisions. They described trying to convey the risk as ‘low’ but that some couples perceived their risk as higher than other people because an event that is rare to 50/50—either it will or will not happen again to them.15 16 23 Also, consistent with the study by Fumagalli et al,7 they told us that even when couples did perceive the risk to be small, their
acceptability of any risk was often very low due to already having an affected child. Practitioners found it challenging that in the current setting they could not provide the reassurance these couples needed. They reflected that this uncertainty was difficult for some couples and, mirroring other studies, the expected burden of a second affected child could act as a driver for seeking PNT or opting for voluntary sterility.

There was also a reassurance gap for the practitioners themselves. They were aware that risk management and the advice they provide about reproductive decisions occur without information specific to a couple’s circumstance and wondered if they, as practitioners, had just been lucky not to have a recurrence among their cases so far. Concerns about accuracy and misleading information are consistent with other studies of practitioner views on delivering risk information, such as those on the early introduction of NIPT, in which interviewees stressed the importance of accuracy and the implications of inaccurate or uncertain results.

The willingness to offer a next step—an invasive procedure such as chorionic villus sampling (CVS) or amniocentesis—to provide reassurance has also been observed in other studies. The study by Williams on fetal medicine practitioners’ perceptions of PNT reported they felt an imperative to ‘do something’ to help with the uncertainty driving patient anxiety. In the context of DNM recurrence, despite offering CVS/amniocentesis, the practitioners in our study did not regard it as medically necessary based on the objective (generic) risk. Mirroring other studies, they regarded NIPT/NIPD—relying on a blood sample from the pregnant woman for cell-free fetal DNA present during pregnancy—as better means of offering and obtaining reassurance and expressed frustration that these non-invasive options are not available to couples on the NHS based on the DNM generic recurrence risk. Of note, NIPD requires development of a custom assay for each DNM which can be challenging to design in a time-pressured situation of an ongoing pregnancy.

Taking place prior to a new pregnancy, practitioners thought that using PREGCARE during routine reproductive counselling following the diagnosis of a DNM would avoid leading couples unnecessarily into considerations of miscarriage risk and the distress of undergoing invasive procedures/termination of a wanted pregnancy for the purpose of reassurance.

The existing literature indicates that NIPD and other non-invasive options should be viewed critically. Likewise, our interviewees expressed concerns about anxiety driving some pregnant couples to take any test available, resulting in unnecessary and often expensive procedures. Some researchers have also taken issue with considerations of prenatal investigations such as ultrasound focusing only on the benefits while others have drawn attention to the decisional burden placed on patients with any prenatal risk management procedure because patients must consider the risks and benefits of the options offered, and they are drawn into considering new risk scenarios.

Burton-Jeangros et al referred to this as ‘manufactured uncertainty’. Furthermore, although the offer of an unsolicited test may not be an impediment for making an autonomous choice, the moral significance of the offer is inseparably bound by the social context in which it is offered and it may be difficult for women or couples to decline such ‘options’ once they have been put forward by a health practitioner.

The practitioners interviewed assumed the couples who did not return to clinic to discuss prenatal options were reassured by the generic recurrence risk provided. However, they also told us that there is no routine follow-up with these couples and their reproductive outcomes are unknown. Assuming reassurance for those who do not seek an ‘options’ discussion may be misleading. Perceived acceptability affects the interpretation of a given risk more than the objective probability of an event occurring—this also applies to risk management options such as non-invasive testing. For example, in an earlier US interview study of couples with children diagnosed with genetic conditions caused by DNMs (n=40), two-thirds of parents avoided choosing between troubling outcomes by not pursuing future childbearing (over two-thirds were still within childbearing age). This was due to low acceptability for the prenatal options at the time of the study (CVS or amniocentesis) and wanting to avoid the potential of being confronted with the choice of termination or continuation with an affected pregnancy. Interviewees in our study thought that PREGCARE, as a preconception tool, would avoid leading those couples stratified into categories with very low risk into unnecessary consideration of termination.

Further consistencies with the literature were found in the preparation of couples for undergoing assessment using a novel technique or technology. Here, the emphasis was on the importance of specialist handling. As in the research interviews with genetic counsellors regarding NIPD for sexing in relation to sex-linked conditions, the majority of participants in our study voiced a preference for PREGCARE to be delivered through clinical genetics. Similarly, a range of UK health practitioners in a qualitative study of NIPD also advocated for specialist providers, skilled in pre-test and post-test counselling. This interest in professional gatekeeping, also seen more broadly, represents a desire to uphold ethical standards and was accompanied by some anxiety about the capacity of other specialists to provide couples with sufficient pre-test counselling for informed consent. Mirroring studies on the introduction of NIPT/NIPD, our participants also appeared to have reservations about patient understandings of a novel test. Our data also suggest that discussing a range of possible test outcomes is an integral part of genetic counselling practice and offering PREGCARE in the context of reproductive decision-making would not pose a different sort of counselling challenge, although requiring additional explanatory training. The desire for clear guidelines and appropriate training is consistent with practitioners’ reactions to other new technologies.

Study limitations

Every effort was made to recruit both CGs and GCrS for this study. Although the former did outweigh the latter in the final sample (14:6), this likely reflects the starting point for discussing DNM recurrence risk with parents, which is a consultant-led diagnosis appointment for the family of the affected child. As a qualitative study, the results of this study are not generalisable and practitioners’ views on how couples would react to personalised information are hypothetical, although based on extensive clinical experience. Further qualitative research to elicit the perspective of couples themselves is planned.

Study implications

This study has produced some tentative recommendations. PREGCARE was generally regarded as more beneficial than relying on generic risk, for both practitioner and couples. Sufficient clinician time would be needed for pre-test genetic counselling to ensure informed consent, support understanding and prepare couples for the range of possible outcomes. Result-giving would also require clinician time, especially when mosaicism is identified. Due to the skills required, the participants interviewed felt that PREGCARE should be accessed via clinical genetics in the first
instance, or other services with embedded genetic counselling practitioners. Additionally, they regarded mosaicism as a complicated process for patients to understand and thought training and resources, such as the graphical representation of the seven scenarios presented in the PREGCARE study reports returned to referring consultants (see figure 1), would be beneficial. We note that the choice of 10% recurrence risk to qualify for NHS-funded PGT-M is biologically poorly defined and, in conjunction with our findings here and in the PREGCARE study, may need to be reconsidered in the light of our work.

Acknowledgements
The authors would like to thank Professor Andrew OM Wilkie for comments on the original interview script and all the participants who generously gave up their time for this study.

Contributors
Conceptualisation: AG, NH. Funding acquisition: AG, NH. Ethics: JW, NH, AG. Recruitment: ACK, JW. Data collection: ACK. Qualitative analysis: ACK, NH. Project administration: ACK, JW. Writing—original draft: ACK, NH. Writing—review and editing: NH, AG, ACK. Approval: NH, AG, ACK, JW. Guarantors: NH & AG.

Funding
This research was supported by a National Institute for Health Research (NIHR) Oxford Biomedical Research Centre Award (BRC 593413) and a Wellcome Investigator Award (219476/21/9/2) to AG. NH is a member of the Wellcome Centre for Ethics & Humanities, which is funded by the Wellcome Trust (203132/21/16/2).

Competing interests
None declared.

Patient consent for publication
Not applicable.

Ethics approval
This study was approved by Central University Research Ethics Committee (R77884/RE001) at the University of Oxford and also the Medical Sciences Interdivisional Research Ethics Committee (MS-IDREC). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review
Not commissioned; externally peer reviewed.

Data availability statement
Data are available on reasonable request.

Open access
This is an open access article distributed in accordance with the Creative Commons Attribution 4.0 Unported (CC BY 4.0) license, which permits others to copy, redistribute, remix, transform and build upon this work for any purpose, provided the original work is properly cited, a link to the licence is given, and indication of whether changes were made. See: https://creativecommons.org/licenses/by/4.0/.

ORCID iDs
Alison C Kay http://orcid.org/0000-0002-1432-2516
Anne Gorley http://orcid.org/0000-0001-9229-7216

REFERENCES