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ORIGINAL RESEARCH

"Suddenly Having two Positive People who are Carriers is a Whole New Thing"- Experiences of Couples Both Identified as Carriers of Cystic Fibrosis Through a Population-Based Carrier Screening Program in Australia

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Abstract A population-based CF carrier screening program was implemented in Victoria, Australia in 2006. This study explored the experiences of couples when both partners were identified as CF carriers. Between January 2006 and December 2010, 10 carrier couples were identified and invited to undertake a semi-structured interview. Nine interviews were conducted, seven couple interviews and two individual interviews. One couple declined to participate due to the recent termination of an affected pregnancy. Interviews were analyzed using inductive content analysis. All couples experienced surprise on learning their carrier couple result. The couples who were pregnant at the time of screening chose to have prenatal diagnosis, with the majority considering it to be the "next step." The two couples who had an affected pregnancy reported feelings of devastation and grief upon receiving their prenatal diagnosis result and terminated the pregnancy. All carrier couples were offered free genetic counseling, with only one couple declining the offer. Couples were unprepared for a positive carrier couple result. However, all the couples changed their reproductive behavior as a result of their carrier status. The results of this study have been used to inform the program and service offered to CF carrier couples particularly with respect to genetic counseling for reproductive decision making.

Keywords Genetic screening · Cystic fibrosis · Cystic fibrosis carrier screening · Attitudes · Genetic counseling

Abbreviations

CF	Cystic fibrosis
VCGS	Victorian Clinical Genetics Services
PND	Prenatal diagnosis
TOP	Termination of pregnancy
PGD	Preimplantation genetic diagnosis

Introduction

Reproductive genetic carrier screening is the screening of individuals or couples to determine if they are carriers of a disease-causing gene mutation that may result in disease in their offspring. The goal of reproductive genetic carrier screening is to provide individuals and couples with reproductive options so that they may avoid the birth of a child with the disease if they choose. Some people may use reproductive genetic screening to prepare themselves for the birth of an affected child. For couples who are already pregnant at the time of genetic carrier screening, reproductive options are limited to: no further testing with early diagnostic testing of the baby when born, or prenatal diagnosis to prepare for the

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birth of an affected child or to terminate an affected pregnancy. Subsequently, carrier couples may elect to continue with reproductive plans, have no further children, adopt, use donor gametes, use pre-implantation genetic diagnosis or become pregnant and use prenatal diagnosis.

Cystic fibrosis is the most common, autosomal recessive condition in those of Northern European descent, with a prevalence of 1 in 2500–3500 live births and a carrier frequency of 1 in 25 (Southern et al. 2007). Chronic suppurative lung disease is largely responsible for reduced life expectancy, which is currently a median of 37 years (Dodge et al. 2007). Other clinical manifestations of CF include pancreatic exocrine insufficiency, biliary cirrhosis, elevated sweat electrolytes and male infertility. Although there is no cure for CF, treatment has improved outcomes over the last 30 years. Treatments include daily chest physiotherapy, inhaled mucolytic agents, hospital admissions, antibiotics, pancreatic enzyme replacement and a specialized diet. In recent years the development of cystic fibrosis transmembrane conductance regulator (*CFTR*) specific medications, improved infection control measures, new devices to clear airways and improved nutritional support have been predicted to increase life expectancy of recently diagnosed newborns (Massie et al.2014). Lung transplantation is available for some patients, but does not cure CF (Rowe et al. 2005).

CF is caused by mutations in the *CFTR* gene. The discovery of the *CFTR* gene in 1989 made carrier screening for CF possible. Furthermore, more than 95 % of people with CF do not have a family history of CF, and even when a proband with CF is known in a family, the uptake of cascade family screening is low (Boulton et al. 1996a; McClaren et al 2011). For this reason, population-based carrier screening aims to offer testing to individuals regardless of family history. In countries with a high prevalence of CF, the well accepted screening criteria of Wilson and Jungner are met, as the condition is an important health problem, testing can be performed to determine carrier status with known test sensitivity and reproductive options are available to prevent the birth of a child with the disease (Wilson and Jungner 1968).

In the USA, the National Institute of Health, the American College of Medical Genetics and the American College of Obstetricians and Gynecologists have recommended that CF carrier screening be offered to all pregnant women and couples planning a pregnancy (ACOG 2011; Watson et al. 2004). Similar recommendations were made in Australia by the Human Genetic Society of Australasia (HGSA 2014).

In the state of Victoria, Australia, a population-based CF carrier screening program was implemented by Victorian Clinical Genetics Services (VCGS), in 2006. The program offers screening to women and couples before or during the early stages of pregnancy via private obstetricians and general practitioners. It is currently a fee-for-service program with each test costing AUD$220.

During the first 2 years of the program (2006–2008) 3200 individuals were screened, 106 carriers were identified, all partners of carriers were screened and nine carrier couples were found (Massie et al. 2009). Of the nine carrier couples, six were pregnant at the time of screening, all utilized prenatal diagnosis and two affected pregnancies were identified and terminated (Massie et al. 2009). Therefore, all the carrier couples identified through the program used the information obtained from screening to make reproductive decisions. This is supported by the findings from other studies, showing that approximately 70 % of couples planning a pregnancy in the UK, USA and the Netherlands stated that the results of screening for CF carrier status would influence their reproductive behavior (Botkin and Alemagno 1992; Henneman et al. 2003; Poppelaars et al. 2003; Watson et al. 1991).

The reproductive decisions and experiences of CF carrier couples have been well documented for those identified by the birth of an affected child, newborn screening and/or cascade testing (Boue et al. 1991; De Braekeleer et al. 2000; De Braekeleer et al. 2004; Dudding et al. 2000; Evers-Kiebooms et al. 1988; Henneman et al. 2001a; Henneman et al. 2002; Mischler et al. 1998; Myring et al. 2011; Sawyer et al. 2006; Wertz et al. 1991). These studies have shown that most couples changed their reproductive plans as a result of their carrier status, with the majority opting to have no further children or utilize prenatal diagnosis in subsequent pregnancies. However, little is known about the reproductive decisions and experiences of couples that are identified as carriers of CF through population-based screening programs. Population-based carrier screening for CF has been available in the U.K., U.S.A, Italy and Australia for a few years. While no research to date has specifically explored the reproductive decisions and experiences of carrier couples it has been shown that the majority of carrier couples utilize prenatal diagnosis and terminate an affected fetus (Brock 1996; Clausen et al. 1996; Massie et al. 2009; Schwartz et al. 1993).

In 2010 we conducted a study to evaluate the VCGS population-based CF carrier screening program and to assess the attitudes and outcomes of screening among carriers and non-carriers (Ioannou et al. 2010). The program was found to meet the needs of those who had screening with provision of pre and post-test information rated as being satisfactory, the process of testing considered simple, with relatively high knowledge retention and recall of carrier status. However, carrier couples were excluded from the study. Therefore, the aims of this current study were to explore the views and experiences of couples that were both identified as carriers of CF with regard to the process of screening, reproductive decision-making and psychosocial impact.

Materials and Methods

VCGS Population-based CF Carrier Screening Program

Pre-test information about CF and screening is provided by the offering doctor, information brochure and the program website (www.cfscreening.com.au/). Those interested in screening are provided with a screening pack containing a brochure on carrier testing for CF, a cheek brush, a three-step guide on how to collect a cheek brush sample, an invoice for payment for the test, a pathology request form which must be signed by a medical practitioner and a return pre-paid envelope.

Sequential testing is generally used, with one partner, almost always the woman, being tested first and, if found to be a carrier, their partner is tested. The sample collected using the cheek brush is returned to VCGS by post where it is tested for the 12 most common *CFTR* pathologic variants or pathologic mutations causing classic disease. This panel of mutations gives a test sensitivity of 83.5 % in the general population and 95 % in the Ashkenazi Jewish population in Victoria (Massie et al. 2009). The results of the test, available within seven working days from the receipt of the cheek brush sample at the laboratory, are sent directly to the referring doctor. Carriers are informed of their carrier status via a telephone call from either a genetic counselor associated with the program and/or their doctor.

If an individual is found to be a carrier of a *CFTR* mutation, they are offered free genetic counseling and testing to determine their partner's carrier status. If both partners are found to be carriers, genetic counseling is provided to discuss all available options and an appointment with a physician with expertise in the treatment of CF is offered. Carriers are informed of the relevance to family members of their carrier status and are provided with a letter which can be sent to family members informing them of their increased risk of being a carrier of CF.

Participants

From the implementation of the program in January 2006 to December 2012, 8872 individuals had been screened through the program, with 251 carriers and 12 carrier couples identified. Of the 12 carrier couples, 11 received genetic counseling with only one couple declining the offer. The two carrier couples identified after 2010 were not included in the current study, which commenced in June 2011, as it was thought that not enough time had elapsed since screening to allow them to come to terms with the potential outcomes or to have made decisions about future pregnancies.

Methodology

Qualitative methods were chosen to enable exploration of the experiences of couples when they were both identified as carriers of CF. Open-ended questions, informed by the literature and process of screening, were used in the semi-structured interview schedule. This methodology provided participants with the opportunity to freely take the discussion in any direction while keeping some focus on the topics under investigation.

Interviews

All interviews were conducted over a 12-month period beginning in June 2011. All interviews were conducted by the same author (LI), a PhD scholar who had audited the counseling course of a Masters of Genetic Counseling Degree and has had experience conducting interviews with pregnant women in public health sector. Interviews discussed the following: offer of screening, reasons for having screening, testing process, outcomes of testing, evaluation of the program, reproductive outcomes as a result of screening and cascade testing. Interviews were digitally recorded, transcribed verbatim and de-identified with each participant assigned a pseudonym.

Analysis

Transcripts were analyzed using inductive content analysis (Elo and Kyngas 2008). NVivo 10 was utilized to organize and store the data (QSR International Pty Ltd, Melbourne, Australia). This process involved coding and categorization of similarities and differences independently by LI and SL. Comparisons for coding reliability was a process of discussion and deliberation of themes and connections between themes.

Ethics Committee Approval

This study was approved by the Human Research Ethics Committee of the Department of Human Services, Victoria, Australia (HREC 15/05).

Results

Response

One of the ten eligible carrier couples declined to participate due to the recent termination of an affected pregnancy. The male partners from two couples declined to participate in the study. Therefore, a total of nine interviews were conducted, seven couple interviews and two individual interviews, resulting in 16 participants in the study (Table 1).

Table 1 Summary of screening outcomes for carrier couples identified through the GHSV program 2006–2010

Carrier couple	Year tested	Year interviewed	Previous children	Preg. Status	PND?	PND Result	TOP	Future outcomes
1. Helena	2007	2011	2	N	N/A		N/A	PND: Affected-TOP; Unaffected
2. Isobel	2006	2011	2	Y	CVS	Carrier	N	No further children
3. Aaron and Addison	2006	2012	1	Y	CVS	Carrier	N	No further children
4. Blake and Bella	2007	2012	–	Y	CVS	Non-Carrier	N	PND: Unaffected
5. Callan and Chanel	2008	2011	–	N	N/A		N/A	PGD: Currently in the process of PGD for second child
6. Daniel and Delta	2008	2011	–	Y[a]	CVS	Affected	Y	PGD: One child
7. Edward and Eva	2008	2012	–	N	N/A		N/A	PND: Unaffected (*x*2)
8. Fynn and Felicity	2009	2011	1	Y	CVS	Non-Carrier	N	No further children
9. Garrett and Gabrielle	2009	2012	–	Y	CVS	Affected	Y	PND: Unaffected

pseudonyms used for names

[a] In vitro fertilisation (*IVF*) pregnancy

The females from six of the nine couples were pregnant at the time of receiving an offer of screening, and one pregnancy occurred as the result of IVF. The remaining three females were not pregnant when screened, and one had recently had a miscarriage of pregnancy. In order to provide context for the quotes for which pseudonyms were used, codes are provided in brackets to signify if the participant: was pregnant (P) or not pregnant (NP) at the time of testing; had an unaffected (UA) or affected (A) pregnancy that was terminated (T) or not terminated (NT); or utilized Preimplantation genetic diagnosis (PGD).

The results presented in this paper outline the four major themes that emerged from the interviews about the offer of testing, the testing process itself and outcomes after testing (Fig. 1). The major themes are illustrated using quotes from transcripts as evidence. In some examples, quotes were truncated by the use of "…" for clarity, without changing the meaning.

Theme 1: Offer of Screening

Participants were asked to discuss the offer and acceptance of screening.

Receiving an Offer of Screening

Seven of the nine couples stated that they were offered CF screening by their obstetrician and one couple was offered screening by a genetic counselor following the birth of their first child who was diagnosed with a chromosomal abnormality. The remaining couple was offered screening by a gynecologist from whom they sought pre-pregnancy advice.

Health professional's Explanation with Regard to Screening

The majority of participants stated that they were satisfied with the pre-test explanation and information provided by their doctor.

> "Absolutely. She sort of outlined the main concerns, the health issues" Delta (P:A,T)

However, some participants reported that they did not receive much, if any, information on CF or screening.

> "Nope it was just, 'Here's cystic fibrosis, you go and do your own research and work it out,' so there was very little" Blake (P:UA)

Health Professional's Recommendation Towards Screening

Several participants felt that their health professional had provided a direct offer of screening.

> "He just sort of said that it was an important thing he thought." Isobel (P:UA)
> "'The bottom line is if you are pregnant and you were to find out this child has cystic fibrosis … would you still have it?' and I said no. And she said 'Then you should probably take the test'." Delta (P:A,T)

Other participants, however, reported that their doctor's approach in offering the test was more passive.

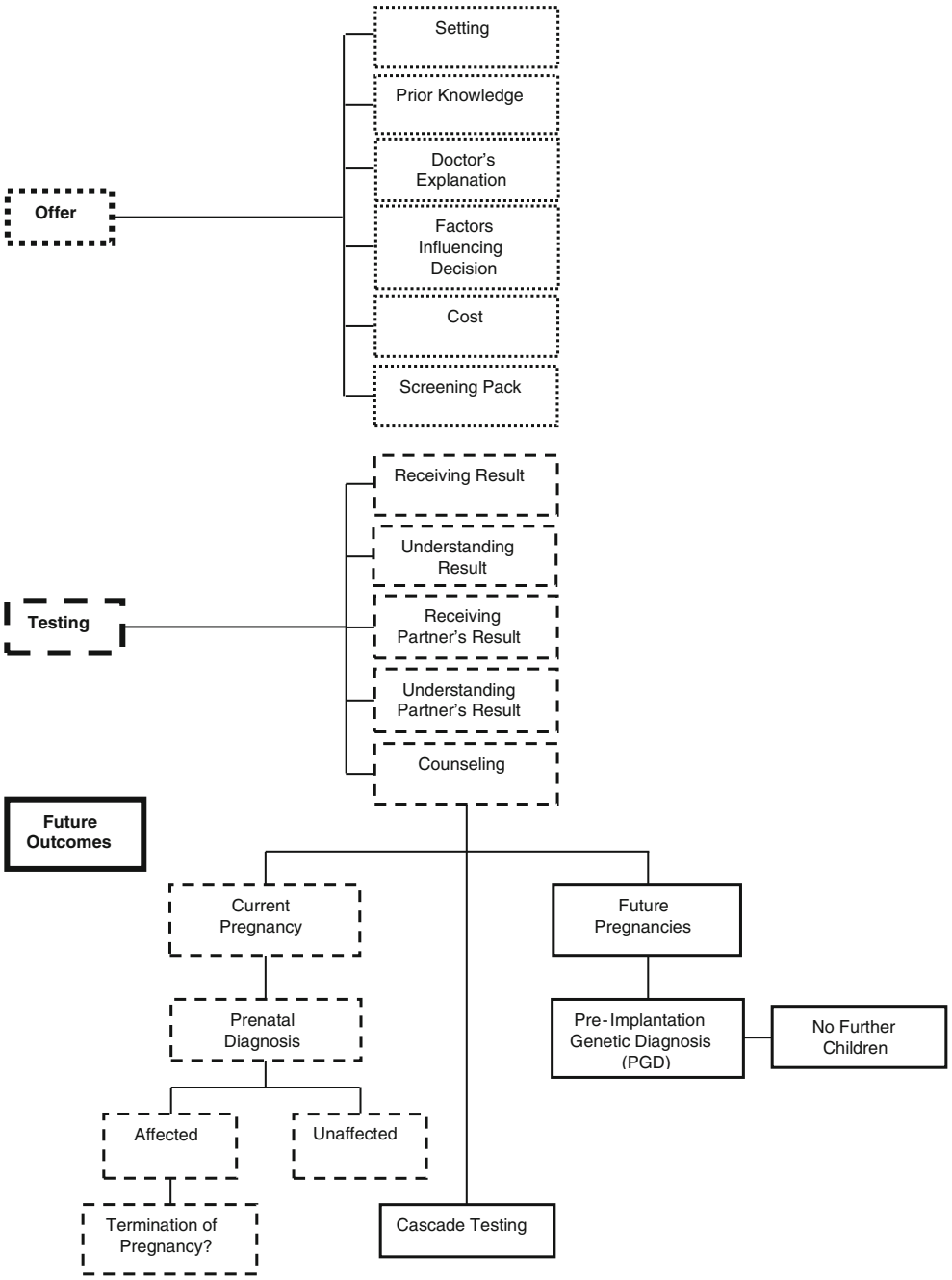

Fig. 1 Flow chart of themes arising from interviews with CF carrier couples

> "He just basically explained it and gave me the mouth swab and said if we want to do it just sort of fill in the form and send it off." Addison (P:UA)
> "It was, 'Here's the pack, go and look at it'." Blake (P:UA)

Lack of Knowledge of CF Prior to Screening

None of the participants had a family history of CF. Before having the test, most participants ($n=12$ individuals) had never heard of CF, or had heard of it but did not know anything about it. Some participants reported having heard about it due to fundraising events in the community, while others reported having known that it was genetic but not much else.

> "I knew of it, and I think that I knew it was a genetic disease but I don't think I would have known any more than that." Callan (NP; PGD)
> "I had heard the name but I didn't know what it was." Daniel (P:A,T)

Four individuals had prior knowledge of CF; two had known someone who had CF while the remaining two had worked with individuals who had CF.

Motivations for Having Screening

Many different reasons for deciding to have screening were evident.

One couple, of Ashkenazi Jewish descent, stated that they were aware of the increased risk of being a carrier for particular genetic diseases due to their ethnicity. That together with the fact that one of them had known someone with CF was the main reason that they accepted the offer of screening.

A female participant wished to avoid the birth of a child with CF, stating that she perceived the disease as severe.

> "Well no I don't want to have a child who has got that illness that is so serious, and so then I took [the screen]." Delta (P:A,T)

One participant also considered the disease to be severe and perceived that he and his partner would struggle to meet the needs of a child with CF due to their age.

> "I knew enough about it that I knew it was really serious but I thought it was because we were both 38, 39 and older sort of parents, so I thought it was really good to just have it if you could rule out a serious illness." Garrett (P:A,T)

Two females reported that their main reason for wanting to have screening was due to prior genetic issues or concerns, with one participant having given birth to a child with a chromosomal abnormality and the other having had a miscarriage.

> "At that point we had had such bad luck that I thought that I needed to know for the sake of being thorough." Helena (NP; A,T)
> "I was pregnant and I miscarried and they just decided to try to just eliminate why could a baby miscarry, and then this test came up and we did it…" Eva (NP; UA)

One participant stated that her reason for having screening was to assist with the piloting of the then "new" carrier screening program.

Influence of Cost on the Decision to Have Screening

Participants were asked if they recalled the cost associated with screening and if it was an influencing factor in their decision to have screening. Two of the participants stated that the cost of the test was an issue for them and/or their partner in terms of accepting the offer of screening.

> "The cost is an obstacle [be]cause we very much considered not getting it." Helena (NP; A.T)
> "Originally [partner Blake] didn't feel comfortable about being tested, just thought that it was such an expense associated with the entire process." Bella (P:UA)

The other participants ($n=14$) did not find the cost an influencing factor in the decision to have screening.

> "Not $200. I mean even now at $220 I mean if it is a lifetime of being in and out of hospital and most of them don't live past 30. You pay more for a pair of jeans." Isobel (P:UA)

However, some stated they could see how it could be a potential barrier to other couples.

> "I did think it was a bit expensive but you know, I guess you can't put a price on it really." Addison (P:UA):
> "I can imagine people would find it a lot." Chanel (NP; PGD)

Satisfaction with the Information Provided by the Program

All participants were asked if they were satisfied with the information provided and the ease of collecting and returning the cheek brush sample included in the screening pack. Some couples reported that they could not recall the screening pack in its entirety due to the time elapsed since screening. Nevertheless, all couples found the process of collecting and returning the cheek brush sample straightforward, and the cheek brush easy to use. Two participants remembered the brochure that was provided, and both found it informative.

Theme 2: Testing for CF Carrier Status

Participants were asked to discuss their experiences of being tested. The female partner was tested first in all but one couple, with that couple electing to test the male partner first stating that they perceived the female partner to be less likely to be a carrier of CF due to her Asian ethnicity.

The test results were generally received between 1 and 3 weeks later. Participants reported that they were not very anxious while waiting for their results and this period was perceived as fairly fast.

Surprise at Finding out Test Result

Participants who were tested first stated that they were surprised to learn of their carrier status but they were not overly concerned.

"I came back positive which was a bit of a shock but you know still not that severe…" Helena (NP; A,T)
"I just assumed I wouldn't be because I had no family history. So I don't remember being at all worried about it until we got the results." Callan (NP; PGD)

The surprise was much greater after learning of their partner's result and their carrier couple status.

"….it was a much bigger shock when then my [husband] was tested and [came] back positive. That was very significant." Helena (NP; A,T)
"It was all, you know, it will be rare that you both have it, that is what we were told pretty much all along, so when I got it I was like oh that's strange but it will be fine because [he] won't have it cause it's so rare. Then he got it and it's like ok so unlucky." Eva (NP; UA)

Understanding the Meaning of Being a Carrier Couple

Upon receiving their carrier couple test result most couples immediately understood the significance of their result. Some mentioned the genetic risk of having a child with CF due to being a carrier couple.

"There was a high possibility or a one in four chance that the baby I was carrying was positive or had cystic fibrosis." Isobel (P:UA)

Others described the severity of the situation they were in.

"It was absolutely terrifying at that point yep. Cause then we knew that this was the real deal." Delta (P:A,T)

All participants mentioned that they were informed of the possible outcomes and implications of screening by the genetic counselor when they received their first carrier result. When participants were contacted regarding their partner's result, the information was reiterated with an invitation for a face-to-face counseling session.

One couple reported that they did not instantly understand the meaning of being a carrier couple and credited the Internet and various health professionals for their increased understanding.

"We found out over the phone and we probably then jumped on the Internet to find out more and then we had these very, you know, helpful meetings with the counselor and physician, but I don't think I instantly understood what it meant." Callan (NP; PGD)

Role of Genetic Counseling

As part of the VCGS CF carrier screening program, carrier couples are offered face-to-face genetic counseling and an appointment with a CF specialist. Of the nine couples, only one, not pregnant at the time of screening, declined the offer of a counseling session. Another couple declined an appointment with the CF specialist, as the female of the couple is a registered nurse and they felt that they understood the implications of having a child with CF sufficiently.

The majority of participants were satisfied with the counseling session and information provided. One male, Callan, reported that the counseling session together with the meeting with the CF specialist gave him and his partner an understanding of cystic fibrosis and clearly outlined their reproductive options.

"… out of those two visits together I think we … understood our options and understood how strongly we were being recommended that we not just go out and get pregnant. Which, that was the most shocking confronting bit for me." Callan (NP; PGD)

Another participant added that the information gave her and her partner a realistic view of what life would be like with a child who has cystic fibrosis.

"It was very clearly explained, the care that is involved and because at that point we really needed to hear that because all we were thinking is maybe we can handle it because of course, you know, we were questioning, we didn't want to let go of this pregnancy." Delta (P:A,T)

Another person noted that the counselor was helpful in aiding her and her partner in making an informed decision.

"They really stepped us through it,…you kind of just want to rush to the bit where you say 'Ok what decision will we make?' but she was very good in holding us back and making us really understand it." Gabrielle (P:A,T)

Two participants expressed dissatisfaction with the information that was provided during the counseling session and the meeting with the CF specialist. One participant felt that the information provided during the counseling session encouraged couples to make the decision to terminate an affected pregnancy. She said:

"I think the information given to us was that it was a very severe condition, it was life threatening, it was a terrible ordeal to live with, all of which now in hindsight I think now was quite overstated … I think the genetic

counseling process is quite biased towards encouraging families to terminate and I think simplifying the decision or simplifying the information to encourage it to be a very simple decision." Helena (NP; A,T)

By contrast, another participant felt that the information provided during the counseling session and meeting with the CF specialist could have been more direct with regard to the impact CF has on the parents, the family unit and society.

"They probably weren't harsh enough actually. …I don't think … we got presented probably the, I call it the 'burden on society' or the 'burden on the parents' about what the actual impact is and how it will completely change, potentially completely change your life." Blake (P:UA)

Decision Making About Prenatal Diagnosis

Of the nine couples, six were pregnant at the time of screening, and accepted an offer of prenatal diagnosis to determine whether their fetus had CF. When talking about prenatal diagnosis (PND) most of the couples described the decision to have prenatal diagnosis as not being difficult, but rather the next step in the screening process. One female explained:

"Oh, it would have been the next step, that wasn't difficult to have [PND], it would have been more difficult to determine the next step [termination of pregnancy]" Addison (P:UA)

Another participant stated that the decision was not difficult as both she and her partner had already agreed on the outcomes of screening.

"I guess we were both testing for the same purpose, we weren't going to continue the pregnancy if it was a positive result, so we kind of knew the outcome." Gabrielle (P:A,T)

However, one female described her difficulty in making a decision with regard to prenatal diagnosis due to the risk of miscarriage associated with the test.

"Oh well, I suppose the next step was that I chose to have the amnio done, which was difficult because you don't know if it is going to terminate it or what's going to happen…" Isobel (P:UA)

Another couple reported that they went into the prenatal test appointment uninformed; therefore they did not make the decision to have prenatal diagnosis until they were at their appointment.

"We went in to actually get the test done and the doctor sort of said 'You know why you are here?' and we sort of said 'Well we are here cause we were told to turn up', and she actually spent an hour going through it all. We were going down a path already so it wasn't a major issue." Blake (P:UA)

All participants received their prenatal diagnostic test results between 1 and 2 weeks after testing. All were informed of their results via a telephone call from either a genetic counselor associated with the program or their obstetrician. Most participants were anxious or worried while waiting for their results and this period was perceived as very long.

"I was freaking out…" Isobel (P:UA)
"It was obviously a horrendous wait…" Addison (P:UA)

Grief Upon Learning Prenatal Diagnosis Result

Of the six pregnancies tested, two were affected with CF. These couples described their feelings of devastation and grief upon receiving their test result.

"…we were left with absolute grief." Delta (P:A,T)

The remaining four couples that received an unaffected test result expressed feelings of fortune and relief.

"Lucky…" Isobel (P:UA)
"Unbelievable relief." Eva (NP; UA)
"Like crying. Yeah that was fantastic." Felicity (P:UA)

Decision Making About Termination of an Affected Pregnancy

The two participants that were carrying a fetus affected with CF decided to terminate the pregnancy. One participant expressed the difficulty and uncertainty that she and her partner felt with regard to making this decision.

"Critical. It was tormenting, absolutely tormenting. … My husband was actually one of the ones who said 'How bad can it be? We can handle it; maybe it might not have a very severe case of it.' You know, as much of the medical facts that we had we were still questioning whether it was, whether aborting it or terminating it was really necessary." Delta (P:A,T)

While the other participant acknowledged the difficulty of terminating a pregnancy both she and her partner had already

decided upon their course of action when accepting the offer of testing.

> "I guess we were both testing for the same purpose; we weren't going to continue the pregnancy if it was a positive result, so we kind of knew the outcome. We weren't heading for something where there was going to be this great level of indecision, so it was just that we are going to do this, and so it was hard but easy in a way." Gabrielle (P:A,T)

Critical of Genetic Counseling

Two participants, who terminated an affected pregnancy, raised concerns with regard to the genetic counseling they received when deciding whether or not to terminate the pregnancy.

> "It is certainly not a neutral process. I mean though they don't in particular encourage you to terminate, cause I understand that… there would be ethical or moral reasons for them to directly say that, it is indirectly implied in everything that is said across the board. From nearly, from every specialist, every genetic counselor, the language that is used, the way the condition is described, the impact on the families, and it is constructed as being something that you would very much want to terminate, and I think that really, yeah it does then influence the way people behave in terms of terminating or not, and it certainly influenced me." Helena (NP; A,T)
>
> "The only thing I would have said that was a little disturbing I'll say was, they had this picture of a baby… I think it showed the statistic of cystic fibrosis and I remember the picture being like like this, it sounds terrible… like a burnt child or something. I would say that the probably the illustrations that went along with the counseling were a little concerning and probably a little unnecessary. I think maybe just outlining the statistics on paper in numbers would have been sufficient." Delta (P:A,T)

Theme 3: Future Outcomes of Screening

The participants were asked about the outcomes of screening, with regard to future reproductive plans as well as informing family members of their increased risk of being a carrier of CF.

Subsequent/Future Pregnancies

All participants were asked if they had any further pregnancies since having screening, and if so what reproductive decisions they made. Of the nine couples, three have had no further pregnancies since being identified as a carrier couple. Of the remaining couples, four utilized prenatal diagnosis for their subsequent pregnancies. Six pregnancies have occurred since screening, with one pregnancy affected, which was terminated. The participant who had the affected pregnancy regretted her decision to terminate, stating that the experience had been very traumatic for her.

> "I very much got that I killed a baby… it was quite a sort of shocking process to go through… We rushed the abortion through at a private clinic but I think if I had slowed down time I actually would have kept the baby. So I actually then experienced a lot of grief over that decision… it was incredibly traumatic." Helena (NP; A,T)

Therefore, upon conceiving her second [subsequent] child she sought further information from a CF specialist, and decided to keep the pregnancy regardless of the prenatal test result.

> "I think the day I got a positive pregnancy test result I saw a specialist at the (Hospital), a cystic fibrosis specialist, and I said 'I am pregnant. I think this baby could very much have cystic fibrosis. I want to keep the pregnancy. Can you tell me about cystic fibrosis?'" Helena (NP; A,T; UA)

One of the participants, who had previously terminated an affected fetus, expressed the difficulties she faced utilizing prenatal diagnosis for her subsequent pregnancy.

> "The first pregnancy of course you're pregnant and everything is going well, but the second pregnancy though, you know that things might end in 12 weeks' time. So it was very hard." Gabrielle (P:A,T; UA)

Three couples stated that they contemplated the use of preimplantation genetic diagnosis (PGD) for future pregnancies. One couple became pregnant naturally while the remaining two couples utilized PGD for subsequent pregnancies. One of these couples had already had an IVF pregnancy due to fertility issues, so they felt that PGD was a logical step for them. One couple that elected to use PGD reported that after discussing the various options this was the best option for them.

> "We went through the options of adopting … There was the option of getting pregnant and doing an amnio at 4 months and then aborting, and then there was the option of IVF, which just came out as such an obvious direction for us to go." Chanel (NP; PGD)

However, they expressed a number of concerns and difficulties with the PGD process, namely the cost and time associated with the process. The couple reflected that the information provided during genetic counseling did not prepare them for these issues.

Communicating Genetic Information to Family Members

When talking about the dissemination of genetic information to family members, all of the participants mentioned that they had informed at least one family member of their carrier status.

> "…we've told everyone… there is a side of my family that we are sort of estranged we don't really see them, but I made the effort to get in touch with them and tell them that 'cos it is relevant health information for them." Callan (NP; PGD)

Some participants raised issues with regard to informing family members and relatives. Lack of knowledge of family members appeared to be a barrier, with some participants stating that their family members believed they would not be carriers.

> "I think that there is a lot of misconception with them sort of saying 'Oh it couldn't possibly be me.'" Blake (P:UA)
> "I think I found when I was talking to relatives they get confused because they would say 'But no one's had cystic fibrosis,' and they get confused with the carrier bit and having it…" Felicity (P:UA)

Another issue that was raised by participants in terms of family communication was the relevance of life stage of family members, with some participant's not informing family members who had finished or were not having children.

> "Look, most of our brothers and sisters had already had kids, had sort of finished having kids, so it wasn't so important to them." Addison (P:UA)

One couple had found it difficult to decide whether to inform their siblings, who were both pregnant and too far along for PND.

> "It was hard for us because we had… we had siblings in literally the worst position because they were pregnant and it was too late to do anything about it. So that was particularly difficult in terms of being the bearer of bad news." Callan (NP; PGD)

Theme 4: Concerns with Regard to CF Carrier Screening Program

Lack of Awareness of CF

A concern mentioned by the participants was lack of awareness of CF and CF carrier screening in the population.

> "No one's aware and even to this day if I speak to people about it… I've got a girlfriend at the moment that's trying to fall pregnant, I said 'Make sure you do the CF'… no one knows. Even in the private sector they don't. She is through IVF, and they haven't spoken about it once." Isobel (P:UA)

Accessibility to Program

One participant voiced concerns about the accessibility of the current program, particularly concerning couples not being offered screening and later being identified as carriers after the birth of a child with CF.

> "So I'd hate to sort of think that the families that the first time they know about this is when you get the results back say 'Oh look we found this and by the way we had a service that can be offered which you didn't get access to.' You would be furious." Blake (P:UA)

Summary of Findings

In summary, findings presented here demonstrate that couples participated in CF screening for many different reasons. Prior to testing participants did not have a good understanding of the condition and were surprised to learn that they were carriers. The majority were satisfied by the counseling and support that they subsequently received. While a minority felt that CF was portrayed in an overly negative manner that may encourage termination of pregnancy, one participant considered that the information they had received was possibly too optimistic. Couples who were pregnant at the time of screening all had prenatal diagnosis, and those who received a diagnosis of CF terminated their pregnancy.

Subsequent reproductive choices were informed by the knowledge of their carrier status. Although all participants disseminated the genetic information to at least one family member they identified several challenges with this process and many perceived a lack of awareness about CF and CF carrier testing within the community.

Discussion

This qualitative study is the first to explore the experiences of couples who are both identified as carriers of CF through a population-based screening program in Australia. This study provides valuable information that can be used to assist with implementation and development of genetic carrier screening programs, specifically with regard to the provision of counseling and support.

Couples were most commonly offered screening by their obstetrician, with the majority being pregnant at the time of receiving the offer. It is generally agreed that the best time to offer screening is before pregnancy, as it provides the couple with the most reproductive options (Decruyenaere et al. 1992; Green 1992; Ioannou et al. 2010; Magnay et al. 1992). However, preconception carrier screening has been associated with various barriers including the absence of a preconception health care setting and lack of interest of individuals and/or couples at this life stage (Henneman et al. 2003; McClaren et al. 2008; Poppelaars et al. 2003). The three couples in our study that were offered screening before pregnancy perceived that they were at increased risk due to ethnicity and genetic concerns relating to miscarriage and chromosomal abnormalities.

Prior knowledge of CF was relatively poor amongst the study participants. Four of the participants had prior knowledge of CF, due to knowing someone with the condition or working in an area related to CF, but the remaining participants had no knowledge of CF other than having previously heard the name of the condition and knowing that it is inherited. Knowledge of CF and screening has been shown to be low prior to screening, when making the decision in regards to having screening, but improves once identified as a carrier and once further verbal information is received (Cobb et al. 1991; Durfy et al. 1994; Grody et al. 1997). Provision of post-test counseling is likely to also improve knowledge, with carriers usually receiving more follow-up than non-carriers (Ioannou et al. 2010).

Factors that influenced the couple's decisions to accept an offer of screening included a desire to avoid the birth of a child with CF, high perceived severity of the disease and/or a high-perceived susceptibility due to ethnicity and age. This is similar to findings from other studies (Delvaux et al. 2001; Henneman et al. 2001b; Henneman et al. 2003; Ioannou et al. 2010). Participants also mentioned "doctor's recommendation" as a factor that influenced their decision to have screening, and this is supported by a number of other studies (Hall et al. 2006; Ioannou et al. 2010; Loader et al. 1996; McClaren et al. 2008). Time of screening, prenatal or preconception, may also be an influencing factor in the decision to have screening, with studies showing a higher uptake in pregnant women as they perceive screening to be more relevant (McClaren et al. 2008; Poppelaars et al. 2003).

While all of the couples had screening despite the cost of the test, two couples described the cost as a significant issue in their decision to have screening and the remaining couples felt the cost could be a barrier to other couples. Previously, studies involving the VCGS CF carrier screening program have shown that cost was not identified as an influencing factor in the decision to accept or decline the offer (Ioannou et al. 2010; Ioannou et al. 2014). This is likely to reflect the private health setting in which the screening is offered in the VCGS program, where individuals tend to be better educated and have a high household income (Ioannou et al. 2013). In contrast, reports from other screening programs suggest that the cost of screening is a significant factor in the decision whether to have screening (Barlow-Stewart et al. 2003; Durfy et al. 1994).

Population-based screening tests generally involve individuals and/or couples who are not at increased risk of being a carrier due to a family history of the condition, and therefore screened individuals generally do not expect to receive a positive test result. All participants described their feeling of surprise and concern, first upon learning their own carrier status, and secondly, and more intensely, when the second member of the couple was found to be a carrier, as many had not believed their partner would also be found to be a carrier. Henneman and colleagues had similar findings (2002). This has also been shown in studies exploring the feelings of women who receive a high risk ultrasound screening result for chromosomal abnormalities, with the majority of women perceiving the scan as a social, non-medical event and are unprepared for abnormal findings (Baillie et al. 2000).

Prenatal diagnosis was considered to be the "next step" for the majority of couples, with only one stating that the decision was difficult. Six couples were pregnant at the time of screening and all had decided to have prenatal diagnosis. Two women were found to have a fetus affected by CF and expressed feelings of devastation and grief and terminated the pregnancy. From existing studies we know that the majority of carrier couples identified through population-based carrier screening for CF utilize prenatal diagnosis and terminate an affected fetus (Brock 1996; Clausen et al. 1996; Massie et al. 2009; Schwartz et al. 1993).

The reproductive behavior of parents of children with CF identified through newborn screening is altered by the birth of an affected child and knowledge that both parents are carriers. The majority of carrier couples either have no further children or use prenatal diagnosis for subsequent pregnancies (Dudding et al. 2000; Sawyer et al. 2006). This was similar in the current study, with three of the couples deciding to have no further children, four utilizing prenatal diagnosis and two undergoing preimplantation genetic diagnosis (PGD), for subsequent pregnancies. Of the two couples that utilized PGD, one of the couples had infertility problems and could not conceive naturally. One of the participants in the current study, who utilized prenatal diagnosis for two subsequent

pregnancies, changed her mind with regard to pregnancy termination after her first pregnancy stating she regretted terminating her affected pregnancy.

Genetic counseling is generally described as a neutral nondirective process that facilitates reproductive decision making taking into account personal, moral, social, religious and ethical considerations (Resta et al. 2006). All carrier couples were offered free genetic counseling, with only one couple declining the offer reporting a personality clash with the counselor. In order to aid reproductive decision making, a respiratory physician, who works with children with CF, was available to meet with the couples to provide insight into what having a child with CF would entail.

While all couples who met with the respiratory physician were satisfied, some participants raised several issues with regard to the genetic counseling process. Two couples who had terminated an affected pregnancy felt that the genetic counseling process subtly encouraged termination of an affected fetus through language and illustrations. Furthermore, one couple expressed surprise at their perception that the genetic counseling process actually discouraged them from continuing with their reproductive plans. A very early study of carrier couples, identified as a result of a family history of CF or having had an affected child, found that a majority of couples perceived genetic counseling left them with no other option than to refrain from having children (Frets et al. 1991). However, we do not know the style of counseling offered in our study. All of the genetic counsellors associated with the program are qualified, with a degree in genetic counselling, and have vast experience working within various VCGS screening programs including high school and newborn screening.

It is important to note that the majority of couples were satisfied with the genetic counseling provided. The grief experienced by the two couples who terminated an affected pregnancy may have negatively impacted their opinion of the counseling process. This is particularly evident as one of the participants stated that she and her partner made a rushed decision to terminate their pregnancy and she didn't want to hear the information that was being provided by the genetic counselor or respiratory physician as she felt that it might make her question their decision.

Cascade testing as a result of dissemination of information from carriers to family members is an important outcome of screening. The majority of carrier couples informed family members of their increased risk, with parents and siblings being the most likely to be informed. The main reason for not informing family members was if they were not having (further) children. There were some issues with regard to the dissemination of information to family members including lack of knowledge about CF of family members and current late gestation pregnancies. Dissemination of carrier risk has been shown to be high with the most frequently informed being parents and siblings (Boulton et al. 1996b; Delvaux et al. 2001; Ioannou et al. 2010; Watson et al. 1992). Nevertheless, a recent study showed that only about 11 % of close relatives of individuals with CF have carrier screening (McClaren et al. 2010).

A lack of awareness by the general population with regard to CF and screening was a common concern for study participants. Many participants compared the importance of screening for CF carrier status to Down syndrome screening and believe that CF carrier screening should be incorporated into routine practice to ensure all couples are offered testing.

Study Limitations

Since the implementation of the VCGS CF carrier screening program in 2006, only a small percentage of the population has been screened due to screening only being offered in the private health system and not all health professionals offering screening to their patients. The limited number of individuals who have been screened has resulted in only a small number of carrier couples being identified. Therefore a limitation of the study was the small sample size restricting the generalizability of these findings. In addition, two males declined to participate in the study, preventing their experiences from being heard. Lack of knowledge and variability with regard to the counseling style of the genetic counselors associated with the program is also a limitation of the study. Furthermore, this is a retrospective study meaning responses may have been influenced by cognitive biases, such as hindsight and attribution bias, current context and perspective as well as knowledge of outcome.

Practice Implications

The current program is inequitable, with pregnant women and couples in the public health system not receiving an offer of screening. In order to ensure equity of access, CF carrier screening needs to be offered to all pregnant women and couples planning a pregnancy, in both the public and private health systems. In an ideal situation, this would also be free of charge and offered to women and couples prior to pregnancy via family planning clinics and GPs. In order to increase awareness of CF and CF screening in the community screening should be routinely offered, brochures should be available in the waiting rooms of all GP, Obstetric and Family Planning clinics, and information on CF screening should be provided in all pre-pregnancy information packs.

The findings of this study highlighted several important implications for the practice of genetic counseling with regard to CF carrier screening. In particular, the need for genetic counselors to facilitate the reproductive decision making process while maintaining neutral language and presenting nondirective information. Furthermore, the requirement for the

same information about CF (inheritance, disease complications, survival and burden of care) to be shared with carrier couples regardless of the counseling situation, pre-pregnancy, during pregnancy or after the birth of a child with CF. There is likely to be personal approaches to delivery of the information about CF that vary between counselors, and similarly, differences amongst recipients of counseling in how they respond. The mixed response in our group of carrier couples highlights this point.

Research Recommendations

There is little research on the outcomes of screening for CF carrier couples identified through population-based screening programs. Individuals in the general population, who do not have a family history of CF, have a lower knowledge of CF and are unprepared for a positive carrier or carrier couple result. Since population-based screening for CF was recommended in the USA, several states have been offering screening to all pregnant women and couples planning a pregnancy, providing an opportunity to evaluate the outcomes of screening in the general population.

Conclusions

Carrier couples were generally satisfied with program and service provided, changed their reproductive behavior as a result of their carrier status and informed family members of their increased risk. None of the couples regretted their decision to have screening. Nevertheless, improvements to the program should include better pretest information and very clear information to carrier couples identified during pregnancy that not having prenatal diagnosis and not terminating an affected fetus are valid options.

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Human Studies and Informed Consent "All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study."

Animal Studies No animal studies were carried out by the authors for this article

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