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Selection of Gamete Donor Profiles Using Priority Method

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Abstract: Gamete donation is a part of assisted reproductive technology (ART) with third party reproduction used to conceive. Using donor gamete sample provides medically infertile woman to increase her chance of conceiving and delivering a child. In couple seeking IVF treatment, especially female partner is distressed with pressure from the family, relatives and society. And hence the couples expect to have the gamete donor who may have physical resemblance with the women partner. The gamete bank collects the recipient attributes and matches with the donor profiles that closely resemble recipient partner, including ethnicity, height, body-build, complexion, eye color, hair color and texture. Once a possible match is found, the recipient is given information about the gamete donor and decides whether to proceed or wait for another donor. The practice followed by ART specialist for selecting the gamete donor demands that the profiles are very popularly selected based on attribute priority. The couple expects that the gamete donor should have certain physical resemblance with couple partners. Many a times couple gives preferences for certain attribute for resemblance. By understanding this problem we have designed an attribute priority algorithm that selects the donor profile based on the attributes set with priority. We have selected total 543 records collected from gamete banks. This technique is useful when the couples prioritize the attributes while selecting the gamete donor profiles.

Keywords: Gamete Donor Profiles Assisted Reproductive Technology.

1. Introduction

In 1984 first pregnancy through gamete donation was reported which led to the birth of the first American child born from gamete donation on February 3, 1984.This research became the medical revolution of the modern age that developed an opportunity for those who were unable to conceive due to infertility or were at high risk for passing on genetic disorders. Donor oocytes and embryo transfer has given women a mechanism to conceive and give birth to a child that will be their biological child, but not their genetic child. Oocyte and embryo donation as practiced today, accounts for approximately 5% of in vitro fertilization recorded births [1]. Before this innovation, thousands of women not conceiving due to infertility had adoption as the only path to parenthood. This scientific innovation opened the doors for gamete donation and embryos which later turned into a common practice. Back in 1984, the birth of the first gamete-donation-produced child buzzed a major news carriers and exploded healthy debates on this practice which squeezed the future of reproductive medicine by creating a platform for further

improvements in women's health. The problem arises when the parents are not able to conceive through conventional process. When infertility occurs in male partner then the couple(s) used third party donated sperms from donor. And when it is detected in female partner then they conceive using artificial insemination where gametes are collected or shared from gamete donor. Gamete donation is a part of assisted reproductive technology (ART) with third party reproduction used to conceive. Using donor gametes provides a woman with an almost 50% chance of becoming pregnant and delivering a child, a possibility that had been previously unknown even using the most highly developed technique [1].

Gamete donation is done when gametes from a donor are fertilized with partner's sperm in a laboratory dish. The resulting embryos are then transferred to female partner's womb. A woman who have undergone premature menopause and in the peri-menopausal age group who do not show proper collection of follicles with other existing causes of infertility, entails the option of gamete donor (gamete and embryos). Women with genetic disorders, those who have undergone radiation therapy, and those with ovaries that are not accessible by ultrasound due to severe adhesions, can also avail donor gamete [2]. The couples seeking IVF (In Vitro Fertilization) expect to have the gamete donor who may have physical resemblance with the women partner. The attributes selected for searching the sperm donor profiles are almost common with the attributes selected for the gamete / embryo donor. During the course of ART treatment couples that use "anonymous" donors, the staff collects the recipient attributes and matches with the gamete donor profiles that closely resembles her, including ethnicity, height, body-build, complexion, eye color, and hair color and texture. Once a possible match is found, the recipient is given information about the gamete donor and decides whether to proceed or wait for another donor. In some cases, recipients are given information about several possible donors and select the match as per the given attributes [3]. The mechanism of selecting the gamete / embryo donor profile is similar to sperm donor profile. The same techniques can be used for gamete donor profile selection. But the practiced followed by ART specialist for selecting the gamete donor demands that the profiles are selected based on attribute priority. The couple demands that the gamete donor should have certain physical resemblance with couple partner preferably female. We have designed an attribute priority algorithm that selects the donor profile based on the attributes set with priority.

2. Related Work

We studied various literatures that derived different facts related to gamete donor process and system. First we discuss about the gamete donors, gamete donors are the female who poses the fertility and help the other infertile females to conceive. There exist pure professional agreement between the gamete donor and the recipient female. The donors are paid by the gamete banks as per the agreement signed between them. Women undergoing through in-vitro fertilization may be willing to donate unused gametes to such a programme, where the gamete recipients together help paying the cost of the ART treatment. It is very cost-effective compared to other alternatives.

The pregnancy rate with use of shared oocytes is similar to that with altruistic donors [3]. Next is the selection of donor gamete donor selected by recipient couples. Generally the couples preferred to have similar physical features to them in the donor. So they expect their donor with similar physical resemblance matched with recipient female. Since the male partner is fertile so his characteristics may resemble through his sperm. For matching the attributes of donor there exists 'Matchmaker model' as discussed by Kristin Holster in his dissertation titled "The business of Internet Egg Donation: An exploration of Donor and recipient experiences". There exists a professional matchmaker who his hired by gamete / sperm bank. He interviews the recipient and then screens the possible donors. The matchmaker assists the recipient in creating a prioritized list of selection criteria, helping her to understand what criteria are realistic and which are less. The matchmaker can also help the recipient to adjust her requests according to the matchmaker's knowledge of available donors and thereby expediting the process [4]. During the interview the coordinator will observe the recipient and her partner, and will then work with the recipient to draw up a general list of the characteristics desired in the donor. When a matching donor is found, the coordinator will present the donor to the recipient for approval. This process may also take place over the phone; women may fill the details on a coordinator's list or clinic's website. The key to success of this model is a coordinator who is able to accurately listen to and observe the donor and recipient, to make matches that have a high probability of being successful. This model is positive in that it allows the third party to make an objective match, objective here meaning only that she is not personally emotionally invested in the child, possibly introducing criteria to the recipient that she herself had not thought of. The negative aspect of this coordinator is that the

coordinator may not accurately analyze the donor and recipient and may make a poor match. The other model is 'Medical Model', where gametes are treated as interchangeable. Recipients are allowed to have limited, if any, demands as matches are made chronologically. The recipient on the clinic's list is matched with the next donor on the list with little regard for the intellectual or physical compatibility of the recipient and donor. This form often takes less time, allowing the recipient to make her attempts to conceive, perhaps the matches are not nearly as carefully made, and the donor and recipient may not share all of the characteristics that the recipient would prefer. Paradoxically, though perhaps not preferred by recipients, this model is far more equitable, as it relies on chronology and not status characteristics to make matches.

3. ICMR Guidelines

Indian council for medical research has prescribed the guidelines for ART clinics, gamete banks.

i. Identify a donor that will possess similar characteristics with the couples seeking the treatment.
ii. Look for a donor who has the qualities you want to be in your child; to give child a genetic edge.
iii. To avoid genetic diseases, review the donor's medical history closely.
iv. Read the personal statements of the donor for future reference. So that a couple will have knowledge about the donor describing his habits, profession, education, physical characteristics, medical history and a short essay about him.

3.1 General Attributes prescribed by ICMR

The ICMR guidelines are precisely followed for selecting the parameters to be used in gamete donor profile selection process. The process of selecting the gamete donor contains matching of physical, medical and other genetic characteristics. For this experimental study we focused on 16 attributes of gamete donor profile that were used for generating the donor profiles. All these attributes are standard attributes prescribed by ICMR [3]. The gamete donor database contains total 543 records as mentioned in table 1. The records are collected from Advanced Fertility Center[1], Chicago and Uma Fertility center[2], India.

Table 1: Gamete Donor Database from Gamete Banks

Gamete Bank	Gamete Donor Records
Uma Fertility Center	492
Advanced Fertility Center	51
Total Records	543

The list of selected attributes is shown in table 2 listed along with their abbreviations. The proposed algorithm is implemented using R programming language[3], an open source tool. Table 2 represents the ICMR attributes abbreviation for all the selected 16 attributes of the dataset used in the experiment.

Table 2: Attribute Abbreviation Table

Abbrv.	**Attrib.**	**Abbrv.**	**Attrib.**
BG	Blood Group	EDU	Education
ST	Skin Tone	HC	Hair Color
ETH	Ethnicity	BT	Body Tone
HT	Hair Texture	NS	Nose Shape
HGH	Height	PF	Profession
FS	Face Shape	REL	Religion
EC	Eye Color	WGH	Weight
MS	Marital Status	AGE	Age

4. Need of Method

The general practice followed for selecting the gamete donor is to match the physical attributes of couple partner with donor. Authors have proposed and implemented few techniques / algorithms such as binary variable method and nominal variable method for selecting the gamete donor profile in their previous work [5]. In all these techniques profiles are selected by computing the statistical match score based on each pair of the donor profile attribute. These techniques suggest the profiles list based on dissimilarity score. Later the couples / fertility specialists refer the matched attributes and the average similarity values between the couple. The above techniques work very efficiently for searching the donor profiles. The proposed methods give statistical score that assist the searchers for selecting the suitable donor profile. This method gives exact match as well as nearby match values for donor profiles. But with the existing proposed techniques there may be listed profiles where a particular listed profile may have highest similarity score but the match may not exist with hair texture or skin color, so in such scenario the couple's priority features may be found missing [9]. Also, the limitation for the proposed technique is that, a couple cannot provide the priority list

[1] www.advancedfertility.com

[2] Dr. Sairaj Bairaagi , Fertility Specialist and Director, Uma Fertility Center, India

[3] https://www.r-project.org/

of attributes for selecting the profile in the sequence of preferable attributes. For e.g., when a couple provides some attributes there may be few attributes like ethnicity, hair texture, skin color as one of their priority. Sometimes the couples are very inclined towards certain characteristics that should resemble or they may want the donor to have the those characteristics. With reference to this we propose a technique called *'Priority'*, based on which an algorithm is designed that designates the profiles based on priority list of attributes [10][11]. So, the limitation discussed for existing techniques can be overcome. This technique will be useful when there exists high volume of donor profiles in the donor database.

4.1 Data Encoding

The database used for experiment is shown in (table 3). The dataset is presented in encoded form where the value of each attribute is described with some numerical value. For this experiment we used value based records such as for blood group we use encoded value 2 instead of B+.

Table 3: Record Set of Gamete Donor with Encoded Values

Attrib. Type	Donor Attributes															
R.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	BG	ST	HT	FS	EC	NS	HC	BT	HGH	ETH	WGH	AGE	EDU	PROF	REL	MS
1	3	2	3	5	4	3	1	8	2	1	2	4	4	5	8	2
2	1	3	2	4	1	4	1	3	1	2	2	1	4	6	4	2
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
543	2	2	3	4	1	3	3	3	1	5	3	4	3	5	2	5

4.2 Proposed Method

Priority Algorithm:

Given: *Priority_List[]* is an array of attribute set preferred by recipient couple. *Set_Priority()* method is used to assign the priority weightage using an array *Attrib_List []*. The method generate_profile () is used to generate the list of gamete donors based on attributes set in *Priority_List[]*. D is the Donor dataset that contains the tuples of all donors with ICMR defined attributes.

Algorithm: Priority

Step 1: [Set Preference List]

Priority_List[] = call Set_Priority(Attrib_List [])

Step 2: [Set profile list with respect to Priority]

D' = Call generate profile (Priority_List [])

Step 3: [Display the list]

For each gd in d

Display(gd)

End For

Step 4: [end]

Here each, a_i ∈Attrib_List[]

Procedure : Set_Priority (Attrib_List [])

Begin :

Integer Priority_Value ;

For each a_i in Attrib_List []

Set a_i = Priority_Value ;

End For

Return Attrib_List []

End

Procedure : Generate_Profile(Priority_List [])

Begin :

Do

For Each(Attrib in Priority_List)

$\sigma^{di}_{value(Priority\_List)}$ = Value(Attrib_List [])

IF(d_i == 0)

exit ;
else
$\sigma^{di+1}_{Value(Priority\_List\ +1)}$ = Value(Attrib_List i+1) ;

ElseIf (d_{i+1} ==0)

Return d_{i+1} ;
exit ;
Else
Continue ;
while(Priority_List [i] != Priority_List[n]);
End For
Return d;

End

(σ = an operator for selection)

In step 1 an attribute priority is set using Set_Priority() method. For example the attribute are added in the Attrib_List[] array an accordingly the preference is assigned for each attribute.

In step 2 D' contains the list of donors based on the sequence of attributes assigned in Priority_List[]. The method Generate_Profile() passed the list of attributes through Priority_List[] array. In this method each attribute is selected and match with attribute value Donor database D.

In step 3 the list of gamete donor profile is displayed for each selected donor profile gd selected based on matched value of Donor with Recipient attributes.

4.3 Results:

The results are discussed with respect to analogy of the attributes that are prioritized by the recipients. In the first section of results presented in table 1 only two attributes i.e. blood group as B+ and Ethnicity as North Indian are selected by the recipient couple. The results displayed through algorithm are shown in table 4.

Type-1:- When Selected Two Attributes: Blood Group:- B+, **Ethinicity**:- North Indian

Table 4: Result for Selected Attributes

DID	BG	ETH	ST	FS	HT	HGH	BT	EC	HC	NS	WGH
1	B+	North Indian	Light	Round	Straight	5.3	Healthy	Black	Brown	Straight	50
3	B+	North Indian	Fair	Round	Silky	5.8	Healthy	Black	Black	Pointed	63
11	B+	North Indian	Wheatish	Oval	Wavy	6.0	Low Obesity	Brown	Brown	Short	71
64	B+	North Indian	Light	Oblong	Silky	5.1	Weak	Brown	Black	Long	44
220	B+	North Indian	Brown	Heart	Shiny	6.8	Low Obesity	Black	Black	Concave	91
360	B+	North Indian	Wheatish	Oblong	Curly	6.5	Obesity High	Brown	Brown	Straight	90
361	B+	North Indian	Light	Round	Wavy	5.52	Weak	Black	Black	Short	50
363	B+	North Indian	Wheatish	Diagonal	Shiny	5.9	Obesity High	Black	Black	Long	72
465	B+	North Indian	Light	Heart	Silky	6.2	Healthy	Brown	Brown	Pointed	73
475	B+	North Indian	Fair	Round	Wavy	6.4	Healthy	Brown	Black	Straight	78
528	B+	North Indian	Fair	Oblong	Silky	5.2	Average	Brown	Brown	Short	46
530	B+	North Indian	Light	Round	Straight	6.51	Healthy	Black	Black	Concave	90
533	B+	North Indian	Wheatish	Heart	Smooth	5.9	Low Obesity	Brown	Black	Pointed	66
543	B+	North Indian	Light	Round	Straight	5.46	Healthy	Brown	Brown	Straight	53

The input features are further processed through an algorithm and compared with attributes of donor stored in the donor's database. The result shown in (table 4) 14 records is listed, where records of two attributes i.e. blood group and ethnicity are constant and the values for other attributes are varying. For example, the values for attribute body type can be found as weak, healthy, low obesity, average, obesity high for each listed donor profile. For attribute eye color and hair color values are: black and brown. For attribute Nose shape values are: straight, pointed, concave, long and short. Attributes Height and Weight vary with each record. So, with respect to proposed Priority method first two columns contains same values as specified by user. The above results are based on only two attributes.

Type-2:- When Selected Three Attributes -Blood Group:- B+, **Ethinicity**:- North Indian **Skin Tone:** Light in this phase as a third priority skin tone attribute is selected and the value is set to light colour.So based on the input three priorities the following result set is generated.

Table 5: Result for Selected Attributes

DID	BG	ETH	ST	FS	HT	HGH	BT	EC	HC	NS	WGH
1	B+	North Indian	Light	Round	Straight	5.3	Healthy	Black	Brown	Straight	50
64	B+	North Indian	Light	Oblong	Silky	5.1	Weak	Brown	Black	Long	44
361	B+	North Indian	Light	Round	Wavy	5.52	Weak	Black	Black	Short	50
465	B+	North Indian	Light	Heart	Silky	6.2	Healthy	Brown	Brown	Pointed	73
530	B+	North Indian	Light	Round	Straight	6.51	Healthy	Black	Black	Concave	90
543	B+	North Indian	Light	Round	Straight	5.46	Healthy	Brown	Brown	Straight	53

To make matching results more adept we added one more attribute to the search criteria i.e. Skin Tone: - Light. Because we increase the factor for search criteria, most of the records from the type 1 result set are eliminated and only six records of the donor profiles are listed as output. The records of attributes blood group, ethnicity and skin tone remains constant while other attribute values are varying. Out of 14 records from previous table of type -1, only 6 records are listed for the current input attribute set given in table 5. The remaining 8 records are eliminated only because the attribute value of skin tone is not light.

Type-3:- When Selected Four Attributes

Blood Group:- B+, **Ethinicity**:- North Indian **Skin tone:** Light **Face Shape:** Round

Table 6: Result for Selected Attributes

DID	BG	ETH	ST	FS	HT	HGH	BT	EC	HC	NS	WGH
1	B+	North Indian	Light	Round	Straight	5.3	Healthy	Black	Brown	Straight	50
361	B+	North Indian	Light	Round	Wavy	5.52	Weak	Black	Black	Short	50
530	B+	North Indian	Light	Round	Straight	6.51	Healthy	Black	Black	Concave	90
543	B+	North Indian	Light	Round	Straight	5.46	Healthy	Brown	Brown	Straight	53

To obtain more priority base donor profiles we add one more attribute as next level of priority i.e. face shape as *round*. Since we have increased the factor for search criteria, two records from the type 2 table are eliminated and only four records of the donor profiles are listed as output as shown in table 6. The records of attributes *blood group, ethnicity, skin tone and face shape* remain constant while other attribute records are varying. As listed in the above table attribute *body type* contains values as *healthy* and *weak*. For attribute *eye color* and *hair color* values are black and brown. For attribute nose shape values are *straight, concave and short*. Attributes *height* and *weight* varies with each record.

Type-4:- When Selected Five Attributes

Blood Group:- B+, **Ethinicity**:- North Indian **Skin tone:** Light **Face Shape:** Round **Hair Texture:** Straight

Table 7: Result for Selected Attributes

DID	BG	ETH	ST	FS	HT	HGH	BT	EC	HC	NS	WGH
1	B+	North Indian	Light	Round	Straight	5.3	Healthy	Black	Brown	Straight	50
530	B+	North Indian	Light	Round	Straight	6.51	Healthy	Black	Black	Concave	90
543	B+	North Indian	Light	Round	Straight	5.46	Healthy	Brown	Brown	Straight	53

To improve efficiency of search criteria listed in the type 3, we added one more attribute to search i.e. *hair texture* as *straight*. Based on additional search attribute one record from the type 3 tables is eliminated and only three records of the donor profiles are listed as output shown in table 7. The records for attributes *blood group, ethnicity, skin tone, face shape and hair texture* remain constant while other attribute records are varying. As listed in the above table attribute *body type* contains values as *healthy*. For attribute *eye color* and *hair color* values are black and brown and respectively. For attribute *nose shape* values are *straight and concave*. Attributes *height and weight* varies with each record. So, compared to result set of type 1 finally user gets three options with total 5 priorities based values. These three records may fulfil the main priorities of users. The user can further select the donor profile based on the fulfilment of his priority list.

5. Conclusion

The priority method proposed by author is useful when the recipient couple expects the prospective donor based on their priority attribute set. This method may fulfil the main demand of the recipient couples i.e. the set of important attributes that couple wish to resemble them in their offspring. Simultaneously for priority method only limited number of features can be given as input. Due to less population of gamete donors at gamete banks recipient couples find limited results. Also, all features cannot exactly match with any of the donor, so this limits the recipient couple for more input set of priority list. As the recipient couple increases the input set in their priority list, parallelly the list of donor profiles is filtered. This method gives the result first based on the match attribute of donor profile with priority attributes provided by recipient couple and then remaining attribute values varies. Compared to the nominal, binary and distance methods, the proposed priority method gives matched values as well as 'near-by' values.

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