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The Concept of Stem Cells Transplantation: Identifying the Acceptance and Refusal Rates among Saudi Population

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ABSTRACT

Background: *Despite the fact Stem Cell-based Therapy (SCT) has attracted increasing attention and shown considerable progress, its clinical application is limited. The major obstacle is finding a matching family donor. In Saudi Arabia, 60% of paediatrics and 30% of adult patients cannot find a matching donor in their family. To our knowledge, little evidence has been published worldwide to assess the general public's awareness and attitudes regarding SCT. The current study aims to evaluate the public's knowledge and its acceptance and refusal rate of SCT and stem-cell donation in Saudi Arabia.* ***Methods:*** *A cross-sectional study was conducted to involve the public of Saudi Arabia of both genders. Voluntary questionnaires of 22 multiple-choice questions consisting of demographics, knowledge, and acceptance and refusal rate toward SCT and stem cell donation were distributed randomly.* ***Results:*** *A total of 502 participants completed the questionnaire. Most participants were female (94.4%, n=474), between 18 and 26 years of age (65.7%, n=330), and 56.2% (n=283) were at high school level and below. Participants showed low levels of basic knowledge regarding SCT: only 19.5% (n=98) gave the correct answer for stem cell sources, 26.9% (n=135) were aware of SCT centres and 38.2% (n=192) were aware of the possible factors affecting the success of SCT. A low percentage (1.8%) of respondents was registered at the Saudi Stem Cell Donor Registry (SSCDR). The internet and social media were the major sources of knowledge for half the participants. Interestingly, even though some participants expressed concerns, three-quarters of them stated their acceptance towards SCT and donation, especially if there were a need.* ***Conclusion:*** *The public's lack of knowledge about SCT and its concerns toward stem cell donation contributes to the shortage of donor availability, suggesting a need to increase the level of awareness and motivation. This study highly recommends implementing comprehensive educational campaigns, counselling programs, and clarifying the place and role of SCT centres.*

Keywords: Stem Cell Transplantation (SCT), Saudi Stem Cell Donor Registry (SSCDR), Hematopoietic Stem Cells (HSCs), Bone Marrow (BM), Peripheral Blood (PB), Umbilical Cord (UC)

INTRODUCTION

Stem Cells (SCs) are immature cells characterized by their capacity to self-renew and differentiate into different mature cell types. Hematopoietic Stem Cells (HSCs), one of the most recognized types of SCs, have a powerful ability to enhance the function of damaged tissues or organs [1]. There are three sources for HSCs: Bone Marrow (BM), Peripheral Blood (PB), and Umbilical Cord (UC). BM is the primary site of hematopoiesis and the main source of HSCs. PB is the most commonly used source for stem cells. HSCs are mobilized from BM into PB after stimulation

with hematopoietic growth factors and then harvested from donors [2]. UCB is a valuable and rich source of HSCs and nowadays is widely accepted and serves as an alternative source to PB and BM HSCs [3].

Recently, Hematopoietic Stem Cell Transplantation (HSCT) has been considered a lifesaving treatment and curative therapy for many disorders, including haematological disorders such as aplastic anaemia, severe thalassemia, sickle-cell disease leukaemias, and lymphomas, inherited metabolic disorders, and a range of immunological disorders [4-6]. However, HSCT remains associated with many complications and significant treatment-related mortality.

Transplant-related mortality is significantly influenced by many factors such as age, disease stage, health condition, HLA matching, and the transplantation process [7]. It has been reported that donations from the younger generation produce more successful transplants and lower complications [8]. Fully matched HLA siblings are the best donors and result in effective transplantation. In Saudi Arabia, adult patients have a greater chance of finding an HLA-matching sibling because most families have a large number of children [9,10]. However, this chance is reduced for pediatric patients [9,10]. Consequently, finding a large number of donors is recommended because an unrelated donor can be an alternative volunteer for patients who have not matched family members [11].

In that regard, several international and national organizations have been established to meet the demand for SCT. United States bone marrow donor organizations are international organizations that assist in increasing the number of transplants for blood cancer patients by 100% annually [12]. In Saudi Arabia, the Saudi Stem Cell Donor Registry (SSCDR) is a recognized local agency that was established in 2010 to provide a rich database of possible unrelated volunteers [13].

Among Middle Eastern countries, Saudi Arabia was the first Arab country to achieve HSCT, which took place in 1984. Currently, an estimated total of 500 allogeneic transplants are done each year. There are four main HSCT units distributed in different provinces of Saudi Arabia. These centres are King Faisal Specialist Hospital and Research Centre (KFSH&RC) and Prince Sultan Military Medical City (PSMMC) in Riyadh; King Faisal Specialist Hospital and Research Centre (KFSH&RC) in Jeddah; and King Fahad Specialist Hospital in Dammam (KFSH) [14]. Before 2016, a total of 6,184 HSCTs were performed in these centres [14]. Nowadays, the number of HSCT centres is rapidly increasing, which should contribute to making HSCT more accessible shortly.

However, stem cell transplantation is still a public health concern in Saudi Arabia, and its application is still a controversial therapeutic procedure for patients and donors. Many studies have evaluated medical students' knowledge and attitudes towards SCT worldwide [15-18]. However, few studies have been conducted among the general population [19,20].

Therefore, this research aims to analyze public awareness of the concept of SCT and the acceptance and refusal rate of stem cell donation. It also presents an analytical study based on extrapolating the most important reasons for accepting or rejecting this kind of therapy.

MATERIALS AND METHODS

This study is cross-sectional that was conducted between January and April 2021. It includes randomly selected members of the general public of both genders living in Saudi Arabia.

Data was collected using a self-administered questionnaire. The questionnaire was generated on Google forms and distributed online in February 2021 through social media applications. The questionnaire contained three sections with 21 total questions. The first section consisted of six questions about the demographic characteristics of participants (nationality, gender, age, educational level, city, and registration status in SSCDR). The second section consisted of seven questions to assess participants' basic knowledge regarding the concept of stem cells in terms of definition, sources, SCT centres in Saudi Arabia, the best age for donation, how to prepare patients for transplantation, the possible factors that affect the success of SCT and the major source of SCT knowledge.

The last section was made up of eight variables. These variables aimed to discover any history of stem cell donation among participants, measure the acceptance and rejection rate towards SCT and stem cell donation, and identify reasons that motivate subjects to become donors or prevent them from becoming donors.

Excel software was used for data entry and statistical analysis. A total of 577 participants responded to the online questionnaire. Before the statistical analysis, raw data was checked to detect any incompleteness or inaccuracies.

Thus, 75 participants' responses were omitted because they were incomplete, and only 502 responses were used for analysis. All study variables were analyzed using frequency tests and the results were presented as numbers and percentages.

Ethical Consideration

The study was approved by the research committee at Taif University in Saudi Arabia with the number (42-115).

RESULTS

Socio-demographic Characteristics of Study Population

Socio-demographic characteristics of the study sample include participants' nationality, gender, age, city, educational level, and registration status in SSCDR (Table 1). As previously noted, a total of 502 participants completed the questionnaire. The majority of participants were Saudi (92.8% (n=466)), female (94.4% (n=474)), and between 18 and 26 years of age (65.7% (n=330)). Further, 71.3% of participants (n=358) were from the Mecca region and (56.2% (n=283)) were at high school level and below. Almost all the participants (98.2% (n=493)) were unregistered with the Saudi stem cell donor registry.

Table 1 Demographic characteristics of the participants (N=502)

Participants' characteristic	Percentage (N)
Nationality	
Saudi	92.8% (n=466)
Non-Saudi	7.2% (n=36)
Gender	
Male	5.6% (n=28)
Female	94.4% (n=474)
Age	
18-26 year	65.7% (n=330)
27-39 year	12% (60)
40-49 year	15.9% (80)
>50 year	6.4% (32)
City	
Mecca region	71.3% (n=358)
Outside Mecca region	28.7% (n=144)
Educational level	
Medical university level	11.4% (n=57)
Non-medical university level	32.4% (n=162)
High school and below	56.2% (n=283)
Registration in Saudi Stem Cell Donor Registry	
Registered	1.8% (n=9)
Not registered	98.2% (n=493)

Level of Basic Knowledge about Stem Cells and SCT

To get an objective idea of the basic knowledge that the public has regarding stem cells and SCT, subjects were asked 7 questions (Table 2 and Figure 1).

Findings showed that approximately three-quarters of the subjects (74.7%, n=375) answered the stem cell definition correctly, but when asked about the sources from which stem cells are collected, the majority (61.2%, n=307) gave the wrong answer, 19.5% (n=98) gave the correct answer, and 19.3% (n=97) did not know the answer (Table 2).

In addition, it found that only 26.9 % (n=135) of the subjects who took the survey were familiar with SCT centres in Saudi Arabia, whereas the rest, 73.1% (n=367), were not aware of them. The study also found that more than half of respondents, 66.3% (n=333), knew the best age for donation, and around half, 45.8% (n=230), were aware of how to prepare patients for receiving stem cell transplants. However, when subjects were asked about the possible factors affecting the success of SCT, only 38.2% (n=192) of participants answered correctly (Table 2).

Table 2 Participants' knowledge about SCT (N=502)

Questions	Response (% and n)
What is the most appropriate definition of stem cells?	
Correct answer (Undifferentiated cells that can produce most of the body's specialized cells)*	74.7% (n=375)
Wrong answer (Harmful cancer cells)	3.2% (n=16)
I don't know	22.1% (n=111)
What do you think is the source of stem cells?	
Correct answer (All of the bone marrow, peripheral blood, and umbilical cord)	19.5% (n=98)
Wrong answer (Choose only one source)	61.2% (n=307)
I don't know	19.3% (n=97)
Have you heard of SCT centres in the Kingdom of Saudi Arabia?	
Yes	26.9% (n=135)
No	73.1% (n=367)
What is the best age for stem cells donation?	
Correct answer (18-49 years)	66.3% (n=333)
Wrong answer (50 years or older)	3.2% (n=16)
I don't know	30.5% (n=153)
What is the best way to prepare the patient for receiving stem cells?	
Correct answer(The patient receives high doses of chemotherapy and immunosuppressive medications)	45.8% (n=230)
Wrong answer (Direct injection with stem cells)	9.2% (n=46)
I don't know	45% (n=226)
What are the factors affecting the success of stem cell transplantation?	
Correct answer (All of the patient's age, health, and type of disease, donor's age general health, and relative relation.)	38.2% (n=192)
Wrong answer (Choose only one answer)	39.8% (n=200)
I don't know	22% (n=110)

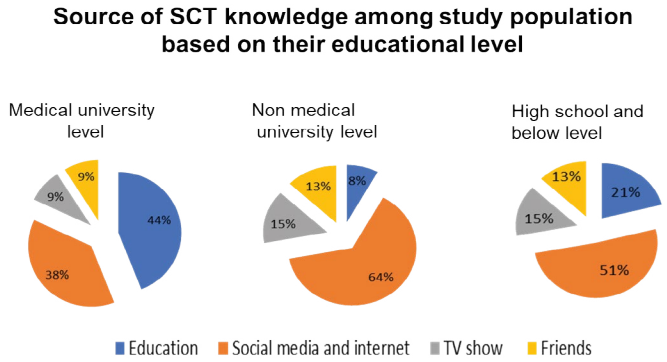

Figure 1 Sources of knowledge about SCT among the study population

When we compared the answers of participants based on their educational level, we found that half or more of the subjects who were at the medical university level gave correct answers to 4 out of 6 knowledge assessment questions (Table 2), while only 2 questions were answered correctly by ≥ 50% of participants at the non-medical university level or high school level and below (data not shown). This indicates that people at the medical university educational level had more basic knowledge of stem cell transplantation than others. When participants were asked about their major source of knowledge, the response was social media and the internet for most of the responders (54%, n=270), followed by education (19%, n=97), TV shows (14%, n=72), and finally friends (13%, n=63). When these data were analyzed based on the study population's educational level, the analysis showed that the majority of subjects at the non-medical university level (64%, n=104 out of 162), and at the high school level and below (51%, n=144 out of 283) rely mostly on social media and the internet as the major source of their information (Figure 1). Consequently, they have little knowledge of the subject because these sources are unreliable.

Experience with Donation and Attitude toward SCT

After assessing participants' knowledge, the study asked about donation experience and estimated the rate of SCT acceptance and refusal among participants using several questions in the last section of the questionnaire (Table 3).

The results showed that the majority of participants (89.2%, n=448) agreed that SCT is a lifesaving therapy. Moreover, 2.6% of subjects (n=13) had a history of donation with variable reflections and reasons. Interestingly, out of those who had donated stem cells, 1.8% (n=9) reported that their experience with donation was good or well while only 0.8% (n=4) had a bad experience. Finally, 0.8% (n=4) of participants had donated stem cells to recipients related to them, 1% (n=5) had donated to unrelated recipients, and 0.8% (n=4) had donated stem cells to be saved for their future possible use.

Regarding the general level of SCT acceptance or rejection among responders, the results found that the majority of the participants (92.2%, n=463) had accepted the topic. In addition, results showed that 94.8% (n=476) were willing to accept treatment with stem cells if they required it, and 96% (n=482) were also willing to donate stem cells if a member of their family were to need them.

This section also intended to investigate factors that contribute to motivating or declining stem cell donation. It revealed that helping patients and saving their lives was the main motivator for stem cell donation (71.1%, n=357) followed by an awareness of the importance of SCT (16.9%, n=85).

Despite the high rate of donation and SCT acceptance among most participants, some factors could contribute to decreasing their willingness to donate. These obstacles were investigated, and the results determined that fear of pain and complications associated with the donation process were the main factors that could influence 32.3% (n=162) of participants not to donate, and 12.5% (n=63) of respondents reported that their unawareness of SCT centres was the cause that prevented them from donating. Additionally, lack of staff competence, unawareness of the importance of SCT, and financial costs were the reasons for declining to donate for 11.8% (n=59), 9.8% (n=49), and 7.8% (n=39) of subjects, respectively. Finally, 3.8% (n=19) considered religious issues that could be associated with this kind of therapy as a reason for rejecting donation. However, 22% (n=111) of participants said no reason could impact their desire to donate stem cells.

Table 3 Participants' history and attitude towards SCT

Questions	Response (% and n)
Is Stem Cells Transplantation a lifesaving therapy?	
Yes	89.2% (n=448)
No	10.8% (n=54)
If you have been donated any kind of stem cells, How was your experience with the donation process?	
Very good	1.2% (n=6)
Well	0.6% (n=3)
Bad	0.8% (n=4)
I have not been donated before	97.4% (n=489)

What was the reason for the donation?	
Help a known patient	0.8% (n =4)
Help an unknown patient	1% (n=5)
For myself	0.8% (n =4)
I have not been donated before	97.4% (n=489)
Do you accept or reject SCT?	
Accept	92.2% (n=463)
Refuse	7.8% (n=39)
Will you accept SCT if you needed the treatment?	
Accept	94.8% (n=476)
Refuse	5.2% (n=26)
If there is a need to donate stem cells to save the life of a family member, will you accept the donation?	
Accept	96% (n=482)
Refuse	4% (n=20)
What is the reason behind your acceptance of stem cell donation?	
Helping patients	71.1% (n=357)
Knowing about its importance	16.9% (n=85)
I reject donation	12% (n=60)
What is the reason to decline stem cell donation?	
I have no reason	22% (n=111)
Fears of pain and complications	32.3% (n=162)
unaware of SCT centers	12.5%(n=63)
unaware of SCT importance	9.8% (n=49)
Lack of staff competence	11.8% (n=59)
Financial costs	7.8% (n=39)
Religious issue	3.8% (n=19)

DISCUSSION

Stem cell transplantation is a promising strategy for treating several types of life-threatening illnesses. Despite the fact stem cell-based therapy has attracted increasing attention and shown considerable progress, its clinical application is still limited. The major obstacle is finding a matching family donor. There is increasing demand for voluntary donors and long waiting lists for SCT worldwide. In Saudi Arabia, 60% of paediatrics and 30% of adult patients cannot find a matching donor in their family [21]. Lack of knowledge among the public and their concerns about donations contributes to the shortage of donor availability. To our knowledge, little evidence has been published worldwide to assess the general public's awareness and attitudes regarding SCT.

The current study aimed to evaluate the public's knowledge and its acceptance and refusal rate toward SCT and stem cell donation in Saudi Arabia. In general, it found that despite the fact more than two-thirds of respondents were familiar with the concept of stem cells (they had inadequate information about SCT and stem cell donation, especially in terms of the sources of stem cells, since only 19.5% answered correctly), factors affecting the success of transplants (only 38.2% gave the right answer), and SCT centres (73.1% of participants had never heard of them).

Similar to our finding, a case-control study conducted at SC donor registration campaigns at King Faisal Hospital, Riyadh, to emphasize the awareness and attitudes of the Saudi population regarding SCT, found that although 41.7% of participants were aware of SCs, 93% had a bad academic knowledge score [20].

Additionally, Bawazir, Al Kabli reported that the level of SCT and stem cell donation among the Saudi population in

Riyadh is considered to be low [19]. Another study evaluated the level of awareness of Cord Blood (CB) banking in the Saudi public and indicated a high lack of knowledge and unawareness of CB donation and its uses [22].

A recent integrative review was conducted to assess parents' knowledge and attitudes toward umbilical cord blood donation and banking using several electronic databases. This review revealed that parents' awareness of cord banking and/or donation was identified as low, but they had positive attitudes towards donation with CB. In addition, the review reported that parents' information sources were found to be inconsistent, varied, and fragmented. Hence, it identified health professionals as the preferred source of information for parents [23].

Therefore, it is important to highlight that reliable sources are crucial in providing the public with correct information and increasing its awareness of SCT. In agreement with this, our finding showed that generally, participants with a medical background had a greater amount of knowledge than others (data not shown). This can be justified by the fact that, as presented in Figure 1, subjects with a medical background rely on education as a major source of information, whereas respondents with non-medical backgrounds depend mostly on social media and the internet.

Furthermore, this study showed a low percentage (1.8%) of participants who are registered at SSCDR (Table 1), which could be attributed to educational background, since 88.6% (n=445) of the respondents were at non-medical university level or secondary school level or below.

People within medical fields are expected to have reasonable knowledge regarding stem cell transplants and the Saudi stem cell donor registry. A previous study was conducted among medical school students in Rhode Island to assess attitudes about joining the Bone Marrow Registry. The results of this study indicated that 50% of the students favoured being registered [15].

More recently, it has been confirmed that healthcare sciences students at Jouf University exhibited medium to high levels of awareness about stem cells and the significance of their medical application [18]. It also found that half of the medical students were aware of SSCDR, and it was significantly related to their knowledge score [18].

Similarly, one of the studies conducted in Jazan, Saudi Arabia, revealed that 9% of medical students were registered at SSCDR and were more likely to express better knowledge and attitudes than the unregistered [17]. In addition, the evidence established that nursing students possessed moderate to good knowledge scores and positive attitudes about stem cell therapy [16].

Alongside knowledge assessment, acceptance and refusal rates were measured among our participants. It has been shown that three-quarters of respondents accepted stem cell transplantation and donation, especially if there is a need. It also found that helping patients and saving their lives was the main subject motivator for donation (71.1%). Similarly, AlMojel, Ibrahim established that even the academic knowledge of Riyadh's population was insufficient, the majority accepted the idea of stem cell donation, and relieving patients' pain was the main encouraging attitude [20].

Despite the high rate of accepting stem cell donations and SCT among the majority of our participants, there are many concerns regarding registering as a donor.

Similar to other studies, pain and complications associated with the donation process are frequent reasons that prevent participation in SC donation. This indicates the need to improve medical care that would lead to fewer complications and faster recovery, thus encouraging more members of the population to be future donors [16,17,24-26].

CONCLUSION

Commonly, the lack of correct information about SCT and the value of stem cell donation contributes to the public's negative attitude towards the donation. Similar concerns have been raised worldwide, indicating a need to increase levels of awareness and motivation by providing comprehensive educational campaigns, counselling programs, and clarifying the place and role of SCT centres.

DECLARATIONS

Author Contributions

Amani A. Alrehaili, and Hind A. Alzahrani designed the study. Sarah Alshihri, Rahaf Althobaiti, and Nojoud

Alazizi collected the data and performed the analysis. Hind A. Alzahrani wrote the manuscript. Final data analysis and interpretation assembled by authors Hayaa M. Alhuthali, and Amani A. Alrehaili. Amal F. Gharib, Maha M. Bakhuraysah, and Hind A. Alzahrani revised the manuscript.

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Institutional Review Board Statement

The study was conducted following the Declaration of Helsinki. The study was approved by the research committee at Taif University in Saudi Arabia with the number (42-115).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

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Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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