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Evaluating Awareness of Umbilical Cord Blood Banking and its Ethical Aspects among Future Healthcare Providers

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Abstract

Umbilical cord blood banking is a rapidly growing field with significant medical potential, especially in regenerative medicine and hematopoietic stem cell transplantation. The first successful Umbilical cord blood transplant in 1988 marked a breakthrough, leading to the establishment of both public and private Umbilical cord blood banks worldwide. Pharmacy students, as future healthcare providers, play a pivotal role in patient education regarding Umbilical cord blood banking, but research on their knowledge levels remains sparse. This study was conducted at JKK Nattaraja College of Pharmacy over six months using a pre-post intervention design to assess the impact of education on students' knowledge and aptitude regarding umbilical cord blood banking. Initially, a structured questionnaire was administered to assess baseline knowledge. After an educational intervention comprising lectures and discussions, a post-survey assessed changes. Results indicated significant improvement in awareness and understanding of Umbilical cord blood banking applications, benefits, and collection methods. Before the intervention, most students lacked clarity on stem cell sources, Umbilical cord blood uses, and public vs. private banking differences. After the session, understanding improved markedly, with over 90% correctly identifying medical applications and banking types. The study concludes that educational programs are essential for enhancing pharmacy students' awareness and aptitude toward UCB banking, preparing them to counsel patients effectively.

Keywords: Umbilical Cord Blood Banking, Pharmacy Education, Educational Intervention.

INTRODUCTION

Umbilical cord blood banking has become a significant advancement in the field of regenerative medicine and hematopoietic stem cell transplantation. Once considered medical waste, umbilical cord blood is now recognized as a rich and easily accessible source of hematopoietic stem cells, which are crucial for the treatment of a variety of malignant and non-malignant diseases such as leukemia, lymphoma, thalassemia, sickle cell anemia, immunodeficiencies, and certain metabolic disorders. The first successful umbilical cord blood transplant was performed in 1988 in a child with Fanconi anemia, marking a breakthrough that led to the establishment of public and private umbilical cord blood banks across the world [1].

Public umbilical cord blood banks are designed to collect, process, and store donated umbilical cord blood units for unrelated recipients, thereby offering an invaluable resource for individuals lacking matched donors. Private umbilical cord blood banks, in contrast, offer storage services for personal or family use, usually at a significant financial cost. This division in banking systems raises ethical debates, as private storage is often marketed on the premise of "biological insurance" despite a low likelihood of personal use, whereas public banking promotes equitable, allogeneic usage that benefits a wider patient population.

The medical potential of umbilical cord blood is expanding beyond traditional hematopoietic stem cell transplantation to include regenerative medicine applications such as treatment for neurological disorders, cardiovascular diseases, diabetes, and autoimmune conditions. Emerging research on mesenchymal stem cells derived from umbilical cord blood demonstrates promise in tissue engineering and immune modulation.

Technological advancements,[2] including optimized cryopreservation and *ex-vivo* expansion methods, have enhanced the storage viability and therapeutic potential of umbilical cord blood-derived cells for prolonged durations.

Despite the growth in clinical applications, public awareness of umbilical cord blood banking remains suboptimal globally, particularly in developing countries like India. The first public umbilical cord blood repository in India was established in the early 2000s; however, socio-economic constraints, lack of education, cultural beliefs, and inadequate governmental support have restricted its widespread adoption. Additionally, the concept of umbilical cord blood banking is still relatively new among healthcare professionals and students across many health-related disciplines [3].

Pharmacists play an essential role in patient counseling and health education. As accessible healthcare providers, pharmacists are well positioned to offer guidance to expecting parents and families regarding the options, benefits, risks, and ethical implications of umbilical cord blood banking. Their involvement is critical not only in promoting umbilical cord blood donation and utilization but also in dispelling misconceptions and addressing concerns related to the safety, cost, and ethical aspects of cord blood storage. However, studies reveal that pharmacy curricula, especially in India, do not adequately cover topics related to umbilical cord blood banking, resulting in knowledge gaps among students who are future pharmacists.

Previous research has predominantly focused on medical students and practicing clinicians, revealing a relatively higher awareness and understanding of umbilical cord blood banking within these groups. Comparatively, there is a lack of data regarding the awareness levels and perceptions among pharmacy students [4]. This shortage of information is concerning because pharmacists, along with physicians and nurses, form the triad of patient education in clinical and community healthcare settings. Addressing this knowledge deficit among pharmacy students is imperative to ensure that they are capable of informing and guiding patients on critical healthcare decisions such as umbilical cord blood storage and donation.

Another important aspect relates to the ethical and socio-economic discourse surrounding umbilical cord blood banking. Private umbilical cord blood banks promote personal storage despite limited scientific evidence supporting its necessity for personal use, raising concerns over commercialization and potential exploitation of public fears. On the other hand, public umbilical cord blood banks face challenges such as inadequate funding, donor recruitment difficulties, and limited public engagement. These ethical dilemmas underscore the need for pharmacy students to receive structured education that balances scientific facts with socio-ethical perspectives, thereby preparing them to counsel patients responsibly and ethically [5].

Standardization of collection, processing, and storage protocols is critical to ensuring the quality and viability of stored umbilical cord blood units. Advances in collection methods (*in utero versus ex utero*), cryopreservation, and cell expansion technologies are continuously evolving to improve engraftment success and therapeutic outcomes. Knowledge of these technical developments is essential for pharmacy students, as they must stay abreast of innovations that could impact their future roles in clinical and industrial pharmacy practice.

Global trends also indicate that countries with established national public umbilical cord blood banking networks, such as the United States, Japan, and several European nations, have witnessed greater success in umbilical cord blood transplantation programs [6]. These models offer valuable lessons for developing countries like India, where infrastructural and policy-level improvements could enhance public banking efforts. Moreover, cross-border collaborations and international donor registries are expanding the reach of umbilical cord blood therapies, necessitating globally competent healthcare professionals, including pharmacists, to navigate these evolving landscapes effectively [7].

MATERIAL AND METHODS

Study Design

A pre-post interventional study design was employed to evaluate the impact of an educational program on the knowledge and aptitude regarding Umbilical Cord Blood (UCB) banking among pharmacy students. This design enabled assessment of changes in knowledge levels before and after a targeted educational intervention [8].

Study Setting and Duration

The study was conducted over a period of six months (January 2024 to June 2024) at J.K.K. Nattaraja College of Pharmacy, Tamil Nadu, India.

Study Population

The study population comprised undergraduate (B.Pharm) and postgraduate (Pharm.D) students enrolled at the institution.

Inclusion Criteria

- Students pursuing B.Pharm and Pharm.D courses.
- Age 18 years and above.
- Willingness to participate and provide informed consent.
- Availability for both pre- and post-intervention assessments.

Exclusion Criteria

- Students who had undergone prior formal training or workshops specifically related to UCB banking.
- Students who declined consent.
- Participants who provided incomplete or inconsistent responses in either survey [9].

Sample Size Determination

Using the RAOSOFT software with a confidence level of 95% and a 5% margin of error, the sample size was calculated to be 300 participants.

Sampling Technique

A convenience sampling technique was employed for recruiting eligible students.

Research Tool

A structured, validated questionnaire was designed for data collection. It comprised three sections:

- **Demographics:** Age, gender, academic year, course enrolled.
- **Knowledge Assessment:** 10 multiple-choice questions on UCB banking, its benefits, collection process, applications, and ethical concerns.
- **Aptitude and Perception:** 5 statements rated on a Likert scale to gauge students' attitudes and willingness to recommend UCB banking.

Educational Intervention

An educational module was developed, including:

- Lecture sessions covering UCB banking concepts, medical applications, ethical issues, and global trends.
- Group discussions to clarify doubts.
- Distribution of educational materials summarizing key points.

Data Collection Procedure

- **Pre-intervention Survey:** Participants completed the structured questionnaire to assess baseline knowledge and aptitude.
- **Intervention:** Students underwent the educational program.
- **Post-intervention Survey:** The same questionnaire (with minor variations to avoid memorization bias) was administered immediately after the intervention to evaluate knowledge gain [10].

Data Management

Responses were collected digitally via Google Forms, exported to Microsoft Excel, and checked for completeness and consistency. Duplicates and incomplete responses were excluded.

Ethical Considerations

The study was approved by the Institutional Ethics Committee (IEC) of J.K.K. Nattaraja College of Pharmacy. Written informed consent was obtained from all participants. Confidentiality of responses was strictly maintained, and participants retained the right to withdraw at any stage without any consequences.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics (Version 26). Descriptive statistics such as frequency, percentage, mean, and standard deviation were calculated. Paired t-tests were applied to compare pre- and post-intervention knowledge scores. A p-value of <0.05 was considered statistically significant [11,12].

RESULTS

Demographic Profile of Participants

A total of 303 pharmacy students participated in this study. Among them, 206 (68.0%) were B.Pharm students and 97 (32.0%) were Pharm.D students. The gender distribution revealed 206 male students (68.0%) and 97 female students (32.0%). Age distribution ranged between 18 and 24 years, with a majority of students aged 22 years.

Pre- and Post-Intervention Knowledge Assessment Understanding of Stem Cells

Before the educational intervention, only 49.8% of students could correctly identify the role of stem cells. After the intervention, this increased significantly to 83.2%, indicating improved understanding of stem cell characteristics and differentiation potential.

Table 1: Students Understanding of Stem Cells and Their Importance in Medicine

Response	No. of Students
Specialized cells that perform only one function	48
Cells that can develop into different types of cells in the body	252
Cells that are found only in the brain	1
None of the above	13

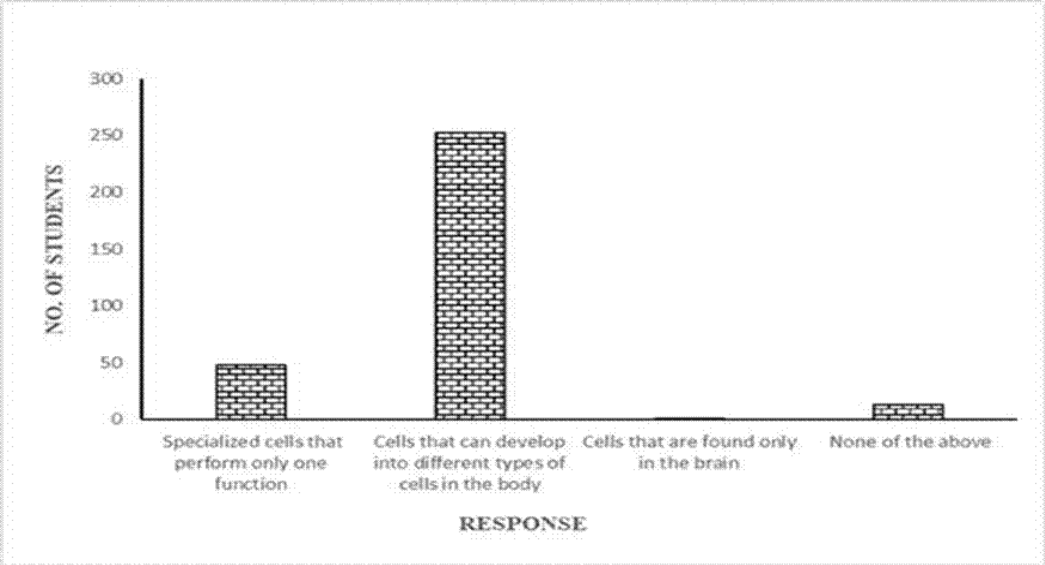

Figure 1: Students' Understanding of Stem Cells and Their Importance in Medicine

Awareness of Treatable Diseases

The proportion of students who were unaware of diseases treatable by UCB stem cells (62.7% responded "Don't know") decreased considerably post-intervention, with students correctly identifying leukemia, thalassemia, and sickle cell anemia as treatable conditions.

Table 2: Students' Knowledge of Diseases Treatable with UCB Stem Cells

Response	No. of Students (n=303)
Leukemia	18
Sickle cell anemia	6
Thalassemia	6
All of the above	284

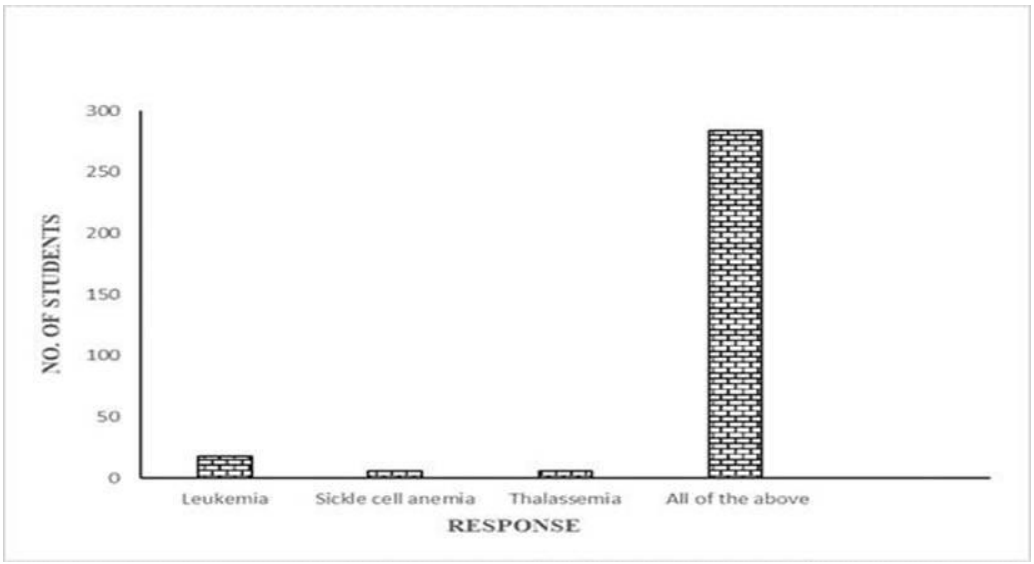

Figure 2: Students' Knowledge of Diseases Treatable with UCB Stem Cells

Knowledge of UCB Advantages

Awareness of the benefits of UCB stem cells—such as their easy and risk-free collection—rose from 23.1% to 95.7% after the session.

Knowledge on Storage and Banking Types UCB Storage Duration

Post-education, 88.1% of students correctly identified that UCB can be stored indefinitely under proper cryopreservation, an aspect previously

misunderstood or unknown by the majority of participants.

Types of UCB Banking

Initially, only 14.5% of students could distinguish between public and private UCB banking. After the intervention, this figure rose sharply to 94.4%, reflecting enhanced comprehension of banking options and their implications.

Perceptions and Attitudes Public UCB Banking Awareness

Prior to education, 69.6% of students selected "Don't know" when asked about public UCB banking. After the intervention, 88.8% correctly identified that public UCB banking allows for donation and use by anyone in need.

Opinion on Private UCB Banking

Support for private banking as an essential healthcare resource grew from 19.1% pre-intervention to 93.4% post-intervention, reflecting a major positive shift in perception.

Pharmacists Role in UCB Education

Initially, only 39.9% of students felt that pharmacists should play an active role in public education regarding UCB banking. Post-education, 92.7% endorsed this role, showing significant improvement in attitude towards professional responsibilities.

Willingness to Educate Others

A remarkable 96.0% of students expressed willingness to educate others about UCB banking following the intervention—a factor not previously assessed.

Overall Impact of Educational Intervention

After attending the educational session and reviewing the pamphlet, 97.4% of students reported a positive change in perception towards UCB banking compared to 58.1% uncertainty prior to the intervention. This demonstrates the intervention's effectiveness in enhancing both knowledge and aptitude

Table 3: Impact of Explanation and Pamphlet on Students' Perception of UCB Banking

Response	No. of Students (n=303)
Yes, I now understand its importance	306
No, my opinion remains the same	8

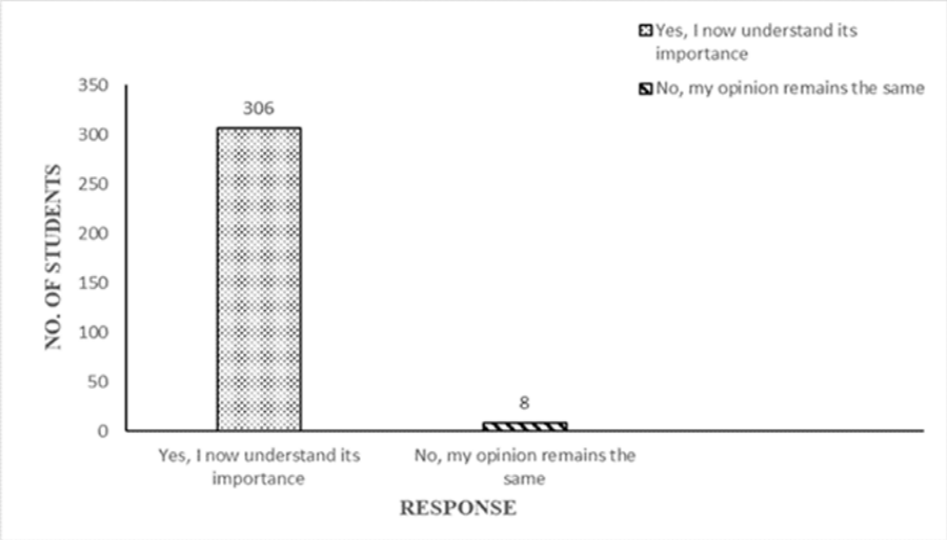

Figure 3: Impact of Explanation and Pamphlet on Students' Perception of UCB Banking

DISCUSSION

Umbilical cord blood (UCB) banking has emerged as an essential component in the field of regenerative medicine and hematopoietic stem cell transplantation. Despite its growing significance, awareness about its benefits, storage options, and applications remains insufficient, particularly among healthcare students who are potential future educators of the public on this topic. This study aimed to address this gap by evaluating the impact of an educational intervention on the knowledge and aptitude of pharmacy students regarding UCB banking.

Before the educational session, the majority of students demonstrated limited knowledge across various key areas of UCB banking. For instance, most students were unaware of the differences between public and private UCB banking options, the diseases treatable using UCB stem cells, and the correct methods of collection and storage. This lack of awareness could hinder their future ability to counsel patients and

contribute to informed decision-making regarding UCB banking.

Following the intervention, there was a notable improvement in students' knowledge and perceptions. Post-intervention responses showed that most students could correctly identify the types of UCB banking, its advantages, and the diseases it can treat. Their understanding of the long-term storage potential of UCB significantly improved, along with greater clarity regarding the ethical and practical considerations associated with both public and private banking options.

A major positive outcome of the intervention was the change in attitude towards the role of pharmacists in promoting UCB banking awareness. Initially, many students did not view this as part of the pharmacist's role. However, after the educational session, the majority acknowledged that pharmacists should actively participate in educating the public about UCB banking. This shift indicates that well-structured educational efforts can enhance the sense of responsibility among future pharmacists regarding their role in community health education.

Additionally, students' willingness to educate others about UCB banking increased significantly after the intervention. This demonstrates the potential of such educational programs to not only enhance knowledge but also to inspire proactive behavior among pharmacy students towards community awareness and patient counseling.

While the study showed promising results, certain limitations must be considered. The study was confined to a single institution, which may limit the generalizability of the findings to pharmacy students in other regions or countries. Moreover, the evaluation of knowledge was done immediately after the educational intervention; hence, the long-term retention of this knowledge remains unknown. There is also a possibility of response bias, as students might have chosen answers they perceived as correct during the post-survey rather than based on complete understanding.

For future research, studies could involve multiple institutions to provide broader insights and incorporate follow-up assessments to measure knowledge retention over time. Different educational strategies such as workshops, online modules, and practical demonstrations could be compared to identify the most effective teaching methods. Expanding such interventions to practicing pharmacists and other healthcare professionals may further improve public awareness and acceptance of UCB banking.

CONCLUSION

The present study demonstrated that a structured educational intervention effectively enhanced the knowledge and awareness of pharmacy students regarding umbilical cord blood banking. Initially, students exhibited limited understanding of its medical significance, storage options, collection procedures, and the pharmacist's role in patient guidance.

Following the intervention, there was a marked improvement in their ability to identify therapeutic applications, differentiate between public and private banking systems, and appreciate the long-term storage potential of umbilical cord blood units. Additionally, the session fostered a greater sense of professional responsibility among students, encouraging them to educate others on this subject. These findings highlight the importance of integrating such educational components into pharmacy curricula to equip future pharmacists with the necessary knowledge and skills for effective patient counseling, ultimately supporting broader public awareness and participation in umbilical cord blood banking.

Conflict of Interest: The authors declare that there are no conflicts of interest for this work.

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ABBREVIATIONS
UCB: Umbilical Cord Blood;
UCB Banking: Umbilical Cord Blood Banking;
HSC: Hematopoietic Stem Cells;
HSCT: Hematopoietic Stem Cell Transplantation;
MSC: Mesenchymal Stem Cells;
B.Pharm: Bachelor of Pharmacy;
Pharm.D: Doctor of Pharmacy;
IEC: Institutional Ethics Committee;
IBM SPSS: International Business Machines Statistical Package for the Social Sciences;
FDA: Food and Drug Administration;
RBC: Red Blood Cell
DNA: Deoxyribonucleic Acid;
RNA: Ribonucleic Acid;
WHO: World Health Organization;
cGMP: Current Good Manufacturing Practice;
QC: Quality Control;
QA: Quality Assurance;
CD34+: Cluster of Differentiation 34 Positive (Stem Cell Marker);
GMP: Good Manufacturing Practice;
SE: Standard Error;
SD: Standard Deviation.

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