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Impact of a Teaching Program on Knowledge and Attitudes Regarding Umbilical Cord Blood Banking Among Maternity Nurses: A Narrative Review

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Abstract: **Background: Umbilical cord blood banking (UCBB) has become an important component of regenerative medicine due to its therapeutic potential in treating various hematological and genetic disorders. Maternity nurses play a vital role in patient education and the promotion of cord blood donation and storage practices. Aim: This narrative review aims to evaluate the impact of a teaching program on knowledge and attitudes toward umbilical cord blood banking among maternity nurses. Methods: A literature search was conducted in PubMed, CINAHL, Scopus, and Google Scholar for English-language, identified 30 relevant studies published between 2020 and 2025. Eligible studies focused on nursing populations and relevant outcomes, with additional sources identified through manual reference screening. Findings: The findings revealed that maternity nurses demonstrate varying levels of knowledge, ranging from inadequate to moderate, while generally exhibiting positive attitudes toward UCBB. Educational programs were consistently associated with significant improvements in both knowledge and attitudes. Despite these improvements, gaps remain in the application of evidence-based practices and awareness of standardized guidelines. Conclusion: Educational interventions play a crucial role in enhancing maternity nurses' knowledge and attitudes toward UCBB. Implementing structured and continuous educational programs is recommended to improve clinical practice and support informed decision-making regarding cord blood banking.**

Keywords: **Maternity nurses, umbilical cord blood banking, education, teaching program, knowledge, and attitudes.**

1. INTRODUCTION

Umbilical cord blood banking (UCBB) describes the idea of the collection and additional processing and freeze preservation of the umbilical cord and placental blood right after delivery, with the possibility of its future use as a treatment (Laue et al., 2024; Waller, 2022). Umbilical cord blood is highly potent in hematopoietic stem cells that can restore blood and immune systems and is, therefore, clinically applicable in the treatment of malignant, genetic, hematologic, and immunologic diseases (Hare et al., 2021; Mayani et al., 2020). Within the past few decades, UCBB has ceased to be an innovative scientific idea and has become an established part of transplantation medicine and regenerative studies (Allan, 2020; Mayani et al., 2020). Regardless of such a development, its use is not widespread due to the lack of awareness, poor knowledge of healthcare providers and the population, and ethical and practical issues still influence perceptions and decision-making (Laue et al., 2024; Manchanayake et al., 2024).

The modern history of cord blood banking is closely connected to the process of the emergence of hematopoietic stem cell transplantation and the development of the national and international banking systems. In 1988, the first successful cord blood transplant marked a turning point in the regenerative and transplantation medicine field. It sparked the development of banking systems and regulation in the majority of settings (Narayanan and Phadke, 2019). The ongoing scientific study established the scientific value of cord blood as an alternative graft seed, and in a more targeted way, in patients who do not

have a well-matched bone marrow donor (Keller & Ballen, 2020). The developments have added pressure on the healthcare workers who have to be able to perceive the existing evidence and relate it to useful advice to the expectant families.

There has also been a growing transcendence of scientific interest in UCBB beyond the traditional hematopoietic transplantation. Current research has already addressed the uses of cord blood-derived cell therapies in neurological disease, immune-mediated disease, and new uses of cellular immunotherapy (Shi et al., 2022; Zhu et al., 2021). Further ex vivo growth, graft engineering, and long-term cryopreservation have contributed to the feasibility and increased clinical access of stored units (Mayani et al., 2020; Zhang et al., 2022). Meanwhile, ongoing inequality in access to, institutional preparedness, and awareness of the public (Laue et al., 2024; Manchanayake et al., 2024) still affects the uptake per country and health system. This makes UCBB dependent not merely on the advancements in the field of science, but also on the skills of frontline professionals who must clarify the indications, constraints, and ethical aspects of the UCBB.

Maternity nurses take a special place among such professionals. They deal directly with pregnant parents, both in the prenatal and intrapartum care and immediate postpartum, as well, and are frequently requested to explain the options available on cord blood donation or storage. It is through their knowledge, attitudes, and communication practices that they can shape informed decision-making in the process of increasing the overall implementation of cord blood services. Educational interventions are well known as potent tools to enhance knowledge in the profession, enhance confidence in the clinical setting, and encouragement of evidence-based behaviors in the healthcare setting that rapidly develop (Mansour et al., 2020; Shi et al., 2022). In line with it, the review will analyze the literature available on the consequences of teaching programs on the knowledge and perception of maternity nurses regarding umbilical cord blood banking.

2. SEARCH STRATEGIES

A literature search was conducted using PubMed, CINAHL, Scopus, and Google Scholar to identify studies relevant to maternity nurses and umbilical cord blood banking. Search terms were set together with Boolean operators and contained the terms maternity nurses, umbilical cord blood banking, education, teaching program, knowledge, and attitudes. Only English-language research published within the range of 2020-2025 was considered to ensure that the present study highlights the recent evidence and provides sufficient coverage of the concepts. First, the studies had to be eligible based on their interest in nursing or maternity population and the information about knowledge, attitudes, perception, or educational intervention about UCBB. Peer-reviewed studies that had no direct response to the topic were eliminated, as well as those that did not report any measurable outcomes. To enhance the levels of comprehensiveness, reference lists of the articles included were screened manually to identify more relevant sources.

3. REVIEW OF THE LITERATURE

3.1. Overview of Umbilical Cord Blood Banking

The practice of collecting, processing, testing, and storing the umbilical cord and placental blood left following delivery and storing it to be used as a therapeutic agent in the future (Laue et al., 2024; Mayani et al., 2020). It is a clinically-relevant biologic resource because this blood has the ability to differentiate into various lineages of blood and immune cells, which are hematopoietic stem cells (Devi et al., 2023). Since such cells have many functional parallels with the bone marrow - derived stem cells, they have been involved in the treatment of leukemia, lymphoma, aplastic anemia, inherited metabolic diseases, and some immunodeficiency syndromes (Allan, 2020; Mayani et al., 2020). The experiential body of the last thirty years has elevated the cord blood to become a stable object of hematopoietic stem cell transplantation and not a subject of research.

Evidence demonstrated by the registry has reiterated the utility of cord blood transplantation in suitable settings that have been selected. Massive studies have found better survival rates and decreased severe graft-versus-host disease in cases where adequate graft-versus-host disease matching is carried out (Mayani et al., 2020). Cord blood has been especially useful in transplantation among children or even ethnically diverse populations where some may not find a perfect adult donor match (Keller & Ballen, 2020). The observations have assisted in the justification of further development of public banking systems and standardization of processes of collection, release, and storage. At the same time, the reliability and clinical practicability of stored units have been increased because of advanced protocols, technologies, and transplant conditioning regimes, which improved the reliability of every preserved organ (Mayani et al., 2020; Shi et al., 2022; Zhu et al., 2021).

There are usually public and private systems used by cord blood banking. Public cord blood banks are owned by donated units, which can be listed on registries and made accessible to any possible recipient; the family is usually free to donate, and the units could also be utilized to support approved research in cases when the donation is not performed as a transplantation (Laue et al., 2024). The units are deposited at private or family banks with the aim of eventual use by the family that donated them, typically by paying collection, processing, and storage fees annually (Murdoch et al., 2020). Biologic insurance is frequently marketed as an instance of private banking. In contrast, the likelihood of autologous application has been characterized as minimal, which casts continuing doubt on clinical utility, cost-equity, and evidence-based counseling (Keller and Ballen, 2020). In order to alleviate these strains, it has been proposed to implement hybrid models to combine attributes of public donation and family-directed storage in a less biased regulatory paradigm (Laue et al., 2024).

Procedurally, the collection of cord blood as a practice is generally safe, painless, and noninvasive for both the mother and the infant, provided the procedures are done in line with the accepted procedures. The umbilical vein is shortly postpartum and opened after delivery and cord clamped, and blood is then collected through a sterile system and put into a sterile laboratory to process (Mayani et al., 2020). Infection screening, cell count, viability testing, HLA typing, reduction of volume, and controlled-rate freezing are some of the standard measures used in the laboratory before long-term storage in ultra-low temperatures. It is suggested that under established cryogenic conditions, biologic integrity has been established over years of storage in units, and experiments have shown continued viability, proliferative activity, and differentiation ability of stored units in years of storage (Hare et al., 2021; Zhang et al., 2022). Such results reinforce the belief in the science of long-term banking practices.

The curative benefits of cord blood are usually debated against other hematopoietic stem cell sources. Cord blood procurement is less problematic, has lower rates of chronic graft-verified-host disease, and is more tolerant to HLA mismatch in comparison to numerous adult sources of donor (Mayani et al., 2020; Shi et al., 2022). These advantages, however, have to be counterbalanced with the established limitations. It has a slower pace of engraftment due to a decrease in cell dose, and the supply of units is still limited to support larger adult recipients (Allan, 2020; Mayani et al., 2020). Cord blood biologic promise must then be clinically balanced, especially reports that families are making decisions that could be subject to commercial marketing, or they could have been influenced by emotional vulnerability.

The debates surrounding cord blood banking are still tied to ethic and regulatory concerns. The ownership rights, informed consent, quality assurance, access to transplantation, and commercialization of the services of a private bank still cause some debate between clinicians, policymakers, and ethicists (Murdoch et al., 2020). Issues with exaggeration of probable future utilization or lack of transparent communication on limitations increase concerns when the advertisements of private banking are concerned. It has thus been stressed that, through international standards, traceability, screening of donors, laboratory validation, accreditation, and alignment with transplant registries are essential protective measures to safe and ethically justified banking business conduct (Hare et al., 2021; Keller and Ballen, 2020). Such governance issues are especially crucial since the sustainability of cord blood services in the long run depends on the trust of the citizens.

In addition to its role in the field of hematology, cord blood has gained more and more interest in the area of regenerative and immunotherapeutic purposes. Its capability has been studied in cerebral palsy, autoimmune disorders, type 1 diabetes, and spinal cord injuries, and has engineered cellular therapies like CAR-T cells made out of cord blood (Caël et al., 2022; Shi et al., 2022; Zhu et al., 2021). Most of these uses are investigational, although they have increased the scientific and clinical justification of keeping high-quality cord blood units. Meanwhile, not all people have equal access to such benefits. Public banks that have accreditation are centralized in high-income areas, and low-resource locations are frequently associated with financial, infrastructural, and laboratory constraints that restrict donation, processing, and storage capacity (Narayanan and Phadke, 2019). Such discrepancies demonstrate that the system must resolve these discrepancies with appropriate policies, an effective educational system, and a labor force that can identify informed and situation-specific decisions.

Another working problem of modern literature is the correlation between the cord blood collection and other evidence-based birth practices, specifically delayed cord clamping. Although delayed clamping has several advantages for babies, it can minimize the amount of cord blood that could be banked, unless the time when the former is conducted is properly coordinated with the subsequent one (Laue et al., 2024; Manchanayake et al., 2024). This has significant practice

implications in that counseling can not be simplified as being one intervention option rather than another. Rather, professional medical workers need to clarify the dynamics of timing, obstetric conditions, logistics of collection, and institutional policy in actual clinical situations. Explanations like these are very relevant to maternity services since parents could receive inconsistent information and can seem that everything can be optimized to the full extent.

The social worth of cord blood banking is also greater when considered at a higher level than that of individual family decision-making. Public banking widens the pools of stem cell grafts that may be available, helps to increase the equal accessibility of patients without complementary family donors, and adds additional capacity in transplantation and regenerative medicine research (Keller and Ballen, 2020; Mayani et al., 2020). This is why in literature; the topic of public donation is frequently introduced not as the option of the individuals but as the resource of the population. But what determines whether the public systems can play that role is dependability through donor recruitment, awareness by the people, continued funding, quality of laboratory, and accessibility of trained professionals to teach the donors the aspects of donation properly. In an inappropriate environment in which such requirements are not strong, the theoretic advantage of public banking may not be converted to practical availability, as a strengthening force to the necessity of maternity-ready employees.

Ethical discussion of UCBB further raises the question of responsibility, openness, and proper communication. The idea of storing privately can be thought of by families whose lives are filled with hope, uncertainty, and worries about the future health of their child, which can make them especially prone to persuasive marketing (Murdoch et al., 2020). The ethical practice, further, requires obtaining a signature on a consent form. It requires the medical practitioners to state the real possibility of the utilization, make a distinction between the current application of the therapeutic indication and the imagined future applications, and make decisions without any false premises. The latter concerns take special importance in healthcare environments where the policy is still developing or where the information that is personally banked is more manifest than the information that is publicly funded.

Collectively, the literature creates an impression of a field of good scientific potential, wide therapeutic potential, and enduring ethical ambiguity. UCBB cannot be characterized only as an option in storage anymore, but as a multi-faceted clinical service, which borders on transplantation science, maternal-child health, bioethics, human health policy, and health communication. This is a more general perspective that is required because it can be utilized to comprehend the significance of knowledge among maternity nurses. Their labor is brought to the border of the scientific facts, parental values, institutions, and the in-time birth practices.

3.2. Knowledge of Nurses and their Attitudes to UCBB

Maternity nurses are strategically part of umbilical cord blood banking, as they are one of the medical professionals most regularly interacting with pregnant and giving birth mothers (Waller, 2022; Yadav et al., 2022). The quality of their attitudes toward the practice and the depth of their knowledge about UCBB are important in determining their capacity to articulate the clinical applications, practical procedures, and ethics of this practice. In situations where knowledge is a limitation or perception is unfavorable, nurses might not initiate discussions, give partial explanations, or put off counseling altogether. On the contrary, informed and confident nurses are more likely to help with evidence-based parental decision-making and become more effective at the processes of collection and referral (Ahmed et al., 2022; Mohammed et al., 2022).

The literature examined suggests repeatedly that the knowledge of maternity nurses in terms of their baselines is inadequate. Nurses have a generic concept of cord blood, yet have a lower depth to comprehend its collection process, storage options, contraindications, ethical considerations, indications of treatment, and cost (Elshourbagy et al., 2023; Esmail et al., 2022; Mousa et al., 2024). This trend is significant in that families usually need the services of maternity staff to encode and decode the complex information into practical advice. The end outcome of nurses being in doubt is potentially missed chances to donate to the general population, poor and uninformed consent, and greater vulnerability of parents to commercial prototyping instead of obtaining professional help (Debiazi et al., 2021; Waller, 2022).

In a study of knowledge and knowledge gaps among maternity nurses on cord blood stem cell collection and banking, Esmail et al. (2022) registered the level of this knowledge gap. Though they were correct in defining the general meaning of umbilical cord blood, 90 percent of the participants, 71.6 percent lacked the general overall knowledge, 93.3 percent responded with the wrong answer when it came to the process of preserving them, and 91.7 percent were unaware of the

cost liability of storing them. The awareness of key therapeutic indications was confined to just one quarter, and a majority displayed a negative attitude towards cord blood banking. Notably, knowledge levels were much dependent on age, the level of education, and experience, indicating knowledge deficits are not only predetermined by professional background but also by exposure to continual education.

Similar results were noted by Ibrahim et al. (2022), who estimated that 63.2 percent of maternity nurses possessed incorrect knowledge on cord blood collection by the nurses, and only 45.6 percent felt positive about the practice. The authors also stated that there were high correlations between knowledge scores and age, qualification, and research on stem cell training. Moreover, knowledge and attitude were closely connected with each other, which means that the better the understanding, the more positive the perceptions of the profession can be. Mousa et al. (2024) also recorded that over fifty percent of the involved nurses were not satisfied with their knowledge. In the study, 67.1% gave wrong responses on contraindications, 63.0 was the principal obstacle to the use of cord blood banks, and 65.8 had negative attitudes towards the use of cord blood banks. A combination of these results can imply that professional knowledge constraints are usually interwoven with practical issues of viability and availability.

Elshourbagy et al. (2023) also established that despite the familiarity of nurses with the basic terminology, gaps could still be present in such clinically significant areas. In their research, the percentage of nurses who defined cord blood collection correctly was 75.5. Still, only 41.5 of them possessed low general knowledge, 60.4 of them responded incorrectly to questions connected with the ethical issues, and the information about the methods of collection was wrong in 69.8. The vast majority of the interviewees also demonstrated their weak knowledge of the possible applications and importance of stem cells and cord blood as a source of therapeutic tools. The trend among the studies thus suggests that the notion of superficial awareness cannot be perceived to represent professional preparedness. Recognition of the concept is not found, but combined knowledge of the scientific, procedural, legal, and counseling aspects of UCBB is required.

The data is also pointing to the fact that the perception of UCBB by nurses is not determined solely by the strength of factual knowledge. Among these are the perceptions affected by confidence, institutional culture, prior educational exposure, and the degree to which nurses consider cord blood banking as a clinically significant and ethically authoritative activity (Ahmed et al., 2022; Elemam et al., 2021; Mousa et al., 2024). Positive attitudes are linked with increased readiness to talk about cord blood options, support parents in the process of making decisions, and use banking-related practices. By comparison, negative or doubtful attitudes can also diminish initiative and make counseling less useful. Since nurses can be the closest translators of health information to the parents, their personal confidence and professional position can have a significant influence on uptake.

A number of factors that influence the knowledge and attitudes of nurses are repeated in the literature. One of the most commonly reported factors is age. Some younger nurses, especially in the age bracket of 20 to 30 years, are commonly reported to experience greater changes following education interventions, which may be due to their exposure to modern curriculums as well as remaining familiar with the current emerging technologies (Mohammed et al., 2022). Educational level is also significant. Baccalaureate education nurses tend to have a higher level of baseline proficiency in stem cell science and responsiveness to educational interventions compared to diploma-prepared nurses (Ahmed et al., 2022). This implies that a prior academic preparation would be instrumental in determining how successfully complicated clinical concepts may be absorbed and utilized.

The positive predictor of knowledge is, however, not always work experience. Ahmed et al. (2021) concluded that there was no direct correlation between longer professional experience and greater knowledge or more positive attitudes, which is a reflection of the fact that years of practice do not necessarily translate into knowledge updated on current topics such as UCBB. Experience in the field of great change actually can be anticipated to broaden the gap between standard practice and current evidence. This conclusion strengthens the need to have deliberate knowledge renewal and not passive dependence on the length of service days.

Another important determinant is training exposure. Nurses who had already participated in a session regarding the importance of stem cells or cord blood banking are more likely to score higher at baseline and memorize more information post-intervention compared to those who had no prior exposure to educational material (Mansour et al., 2020). The context of institutions is also important. The hospitals that implement a structured in-service education system, leader support, and clear direction on counseling and collection also report a higher level of confidence in the staff and a stronger post-

intervention performance (Ahmed et al., 2022; Mousa et al., 2024). To a greater extent, more recently, digital and blended learning methods demonstrated possibilities in sustaining the knowledge and attitudinal change (Debbarma, 2024; Patali et al., 2023). The results all indicate that to enhance knowledge and attitudes of nurses towards UCBB, a personal investment in further education and organizational insistence on the process of continuous development are necessary.

The other common conclusion is that the knowledge gaps among nurses tend to reflect the general informational gaps observed among pregnant women and the general populace. Debiazi et al. (2021) demonstrated that the lack of access to credible information increases the lack of donations and poor awareness levels among expectant mothers. Under these conditions, maternity nurses will not be merely deliverers of the standard guidelines. They act as an interpretation of evidence that has the ability to reduce or increase the distance between scientific and parental knowledge. When nurses are knowledgeable enough, they can disarm misinformation, refute over-the-top statements, and refer parents to sensible decisions. In the absence of them, uncertainty is merely passed to the patient by the provider.

It is also evident in the literature that knowledge and attitude are reinforcing and not independent variables. The nurses, who are aware of scientific foundations, the procedure of collection, and the valid clinical use of cord blood, tend to consider UCBB as a significant part of the work with a mother and baby. On the other hand, nurses who regard the topic as commercially motivated, morally ambiguous, or not part of their job are less likely to desire further knowledge and start the dialogue. This mutual connection allows us to understand why the educational interventions often positively change attitudes, while simultaneously explaining how they change knowledge. Ideally, the more the knowledge, the more confidence, and the more confidence, the more proactive clinical participation.

The preparation given to the curriculum is one of the least studied areas in this discussion. Some of the studies suggest that education at the undergraduate nursing level does not offer sufficient exposure to stem cell science, cord blood collection, and ethical concerns, and thus after graduation, new nurses rely on on on-the-job education after being hired (Madhura, 2022; Patali et al., 2023). This design leads to unnecessarily differentiated variability in that the quality of post-employment education varies considerably across facilities. Implementation of UCBB into formal nursing education would provide a more consistent base, less institutional teaching would be ad hoc, and the nursing education would better address the current advances in regenerative medicine and transplantation care.

Organizational culture also influences the process by which the knowledge is converted into practice. On one hand, in the healthcare environments where ongoing learning occurs, leaders promote evidence-based discourse, and procedures are explained in a straightforward manner (Ahmed et al., 2022; Mansour et al., 2020). On the other hand, nurses do not seem reluctant to provide parents with advice and seem more apt to retain knowledge after some time (Ahmed et al., 2022; Mansour et al.). In comparison, the facilities that do not emphasize in-service learning can leave the nurses at the mercy of disjointed knowledge or unofficial explanations by their peers. This difference is important because without the presence of this environment, knowledge is not enough but must enable nurses to implement it with consistency and without fear in the normal maternity practice.

3.3. Impact of Educational Intervention on Umbilical Cord Blood Banking Knowledge

One of the most constant reasons that can be identified among the literature reviewed is that, although maternity nurses often lack the knowledge about UCBB, their perception of it perceives significant improvement once under a form of organized education intervention. The design has been reported in quasi-experimental, pre-experimental, and pilot designs with lectures, structured teaching, self-instructional modules, and video-assisted learning packages (Ahmed et al., 2022; Debbarma, 2024; Madhura, 2022; Mansour et al., 2020; Mohammed et al., 2022; Patal The direction of effect, although numerous setting, sample size, and education format differences exist, is highly similar. Knowledge in relation to the definition of cord blood, clinical uses, collection methods, preservation, contraindications, and the role of a professional is enhanced with educational interventions.

Mohammed et al. (2022) offered great arguments to support the validity of a program organized to train maternity nurses. Through quasi experimental design of pre- and post-test, the sample used was 89 participants; the study reported that only 11.2% of the nurses had good knowledge prior to the intervention, and that 86.5% had good knowledge after the intervention. The attitude also improved as a result of the program, indicating that the same happened to learn and perception. The importance of these findings lies in the fact that they demonstrate not just a slight change in the awareness

level, but a significant change in the professional knowledge following a dedicated teaching plan. This research thus upholds the argument that topic-specific, systematic instruction could be used to correct high levels of baseline differences in maternity facilities.

Similar high findings have been reported in a quasi-experimental study conducted by Ahmed et al. (2022) on 100 maternity nurses. Prior to the educational program, the good knowledge about cord blood banking and barriers was only 2% among the participants. Immediately after the program, 85% attained a satisfactory level of knowledge, and the follow-up evaluation indicated that there were scores well above the baseline, though the degree of decrease is marginally high with time. The greatest improvements were noted in terms of relation to the source of cord blood, collection techniques, preservation process, and therapeutic implications. The findings are especially helpful, as these indicate short-term efficacy and partial stays, in addition to being attracted to the general tendency of minor drop-off at follow-up.

A study that reported significant improvement in 128 nurses also found significant improvements after intervention by Mansour et al. (2020). Mean of the participants at pre-intervention was 6.59 ± 2.36, which indicated poor knowledge at baseline. The average score rose to 22.55 with a standard deviation of 2.30, with statistically significant improvement on most of the core areas of the assessments, including anatomy, definition, benefits, collection, and preservation of umbilical cord blood after the educational program. This gain scale implies that more than solitary deficiencies can be addressed; focused education can create integrated conceptual knowledge. Since the intervention involved both scientific and clinical procedures, the research allows confirming the opinion that a proper education must combine both theoretical and practical material instead of concentrating on one aspect of practice.

Small or pre-experimental studies have evidence supporting this. In a research involving 40 staff nurses, Debbarma (2024) rated a self-instructional module and identified that the mean knowledge scores increased from 11.52 (SD = 3.04) at baseline to 15.92 (SD = 2.11) at the end of the study, with a paired t value of 9.35 under the level of 0. Even though the intervention became self-directed instead of classroom-based, it brought about a substantial improvement, which means that even accessible educational instruments can be used efficiently, provided that they are designed in a clear manner. Likewise, Sahoo (2021) studied a video-assisted teaching module amongst 30 staff nurses and discovered that the percentage of nurses with poor knowledge decreased significantly after intervention, and the percentage of nurses with good knowledge rose to 70 percent. Post-test score was significantly greater than pre-test score; that means that knowledge acquisition is also possible with the help of multimedia strategies.

Follow-up studies can give valuable information on knowledge retention. According to Madhura (2022), 86 percent of nurses had low knowledge levels prior to the educational intervention, and 92 percent had excellent knowledge levels right after the educational intervention, and 86 percent of them had excellent knowledge levels three months later. The same pattern was reported by Patali et al. (2023). The study showed that 88.7 percent of nurses were poor in knowledge at baseline, 90.6 percent were good at skill level at the end of the intervention, and 81.2 percent were at an adequate skill level in three months of the follow-up. These researches demonstrate that the benefits of education do not always last long but also indicate at least some loss during the years. Therefore, there is a likelihood of inadequacy of one-time training where the objective is sustained clinical competence.

One of the main strengths in the evidence base is the consistency in terms of core knowledge domains, better after intervention. In various studies, an improvement in knowledge of cord blood origin, its anatomy and physiology, collection procedure, preservation protocols, treatment uses, and contraindications is observed once the nurses have undergone structured teaching (Madhura, 2022; Mansour et al., 2020; Patali et al., 2023). This matter is important since such areas correlate well with the knowledge that nurses are supposed to share in practice. Improved knowledge would not only be impactful in terms of concerns pertaining to test scores, but also the quality of counseling, documentation, procedural support and interdisciplinary coordination.

Meanwhile, the literature implies that the way of education is important. It appears that interactive simulation, discussion, guided explanation, and reinforcement by use of multimedia are far more promising in achieving learning than learning by mere exposure (Madhura, 2022; Sahoo, 2021). It does not stand alone in educational theory since it is thought that an active involvement will improve retention and implementation. The studies reviewed do not necessarily formally report the effect sizes, but the change in the pre- to post-intervention effect is often large enough to suggest practical relevance. These findings, together with follow-up assessment, provide a strong argument to incorporate cord blood banking education into

continuing nursing education as well as to include it in a regular in-service development instead of considering it as an optional or isolated issue.

All in all, the literature proves that educational intervention is one of the strongest means that could be used to enhance the knowledge of UCBB in maternity nurses. The key constraint is not the uncertainty of whether or not education works, but rather how to best maintain benefits over time and align interventions with varying resource contexts. The upcoming educational concept(s) must thus involve reinforcers, regular training refresh-ups, and local content to ensure that the efficacy of knowledge acquisition can be retained and translated into the relative uniformity of clinical practice.

Most of the intervention studies were conducted methodologically, following the pre- and post-test designs, and thus are convenient in the measurement of change over a certain period. However, they are usually not randomized or control-group based. Regardless of those design constraints, finding consistency in various samples and educational forms is a strong indicator of confidence in the overall finding that education is knowledge-enhancing. The intervention could be in the form of structured classroom instructions, self-study materials, or video instruction. Still, regardless of which form the intervention took, the nurses tended to change poor and unsatisfactory levels of knowledge into satisfactory or good levels of knowledge. This intersectionality of approaches implies that the main concern is not the ability of nurses to learn the content, but the possibility of institutions to facilitate them in doing so systematically.

The functional significance of such profits cannot be overestimated. Better results on the knowledge tests are of relevance since they relate to the information that nurses need to apply during the actual engagements with patients and other staff. Further knowledge of the timing of collection, who is to be avoided, the methods of banking, and other indications of therapy will result in greater therapeutic precision, less reluctance to talk the subject, and more dependable involvement in the collection process. The educational intervention, in this regard, is not simply an academic activity. It is a process of enhancing clinical preparedness in ordinary clinical contexts (maternity environments) where the decisions regarding cord blood have to be taken in the context of restricted time agendas and predetermined, emotionally colored circumstances.

Meanwhile, literature identifies the role of reinforcement. Three-month follow-up studies have shown that despite having much of the knowledge learnt, degradation is normal after the cessation of active teaching (Madhura, 2022; Patali et al., 2023). This can be concluded that one-off programs could work well to initiate change but not well to maintain change forever. Refresher courses, provision of reference material and inclusion of UCBB content in regular continuing professional development programs should therefore be done as part of the planning of education. These approaches would assist in transforming the learning of the short-term to long term competence in the profession.

3.4. Impact of Educational Intervention on the Umbilical Cord Blood Banking Attitudes

The analyzed evidence shows that the intervention at the educational level can optimally improve not only knowledge but also attitudes to UCBB by nurses. The significance of this relationship lies in the fact that the attitude determines how well the nurse's express confidence when discussing the cord blood options, how valuable the practice seems to the nurses and whether the practice should be implemented in their institutions. Initial attitudes in most of the studied works were neutral, and in severe cases, negative. Attitudes, however, improved significantly after structured education, indicating that uncertainty and skepticism may be due to poor information at least partially.

Mohammed et al. (2022) described one of the most obvious examples of this trend. Prior to the structured teaching program, merely 20% of the nurses were positively attitudinal toward UCBB. The percentage of positive attitudes increased to 89.9% after the intervention, and the improvement of this change was significantly greater. The research also established a significant association between knowledge and attitude, and the more the nurses were informed, the more they were in support of the practice. Similar results obtained by Ahmed et al. (2022) showed that only 8 percent of the participants had a positive attitude prior to intervention, and 92 percent of them expressed it after the educational sessions. The significant results of the chi-square of that study prove that the correctly designed teaching means can make a certain change in the way professionals see things.

Mansour et al. (2020) had also improved attitudinal change following educational intervention. Even though the attitude description of the same in the case study did not match with certain others, the post-intervention results were still found to be more lucid and positive in gaining a professional perspective about cord blood preservation, with a statistically significant improvement taking place. Collectively, these studies show that educational intervention can help nurses perceive UCBB

as a practice that is clinically legitimate and ethically debatable and not a bewildering or marginal innovation. This attitudinal change is particularly useful, as the community of positive perception is likely to affect the quality of communication, the desire to take part in the process and activities connected with the collection, and the further support of the program's viability.

The significance of these findings is due to the close relationship between attitude and behavior in the clinical setting. The perceptions of UCBB as a beneficial, ethically and professionally useful tool bring a nurse closer to the proactive discussions of the topic, patient answers, and compliance with the procedural aspects of the donation or storage. On the other hand, any lack of positive attitude (or negative attitude) may result in avoidance, partial explanations, or a lack of consistency when supporting the institutional policies. The attitudinal changes exhibited in the literature, hence, are applicable in interpersonal care and service implementation, particularly in units where nurses are the primary point of communication with families.

3.5. Nursing Role in the Umbilical Cord Blood Banking

Maternity nurses play a diverse and clinically important role in umbilical cord blood banking, which is closely linked with the quality of maternal-newborn care. Nurses perform parental education, informed consent, collection support, documentation, quality assurance, and interprofessional coordination as well as leading a program in certain settings (Laue et al., 2024; Waller, 2022). Due to the proximity as well as recurrent exposure of expectant parents to the nurses, nurses are often the first line of professionals who can effectively and efficiently present the subject of UCBB in a manner that can be familiar, timely, and address the parental concerns. They do not just provide technical assistance but can also go further to interpret, advocate, and facilitate at the system level.

Some of the most observable nursing roles in the region are education and counseling. It is possible that in the course of both an antenatal care and intrapartum care; nurses are called upon to talk about the nature of cord blood, what it composed of, how it is gathered, what diseases it might be useful in treating, as well as the differences between a cord blood bank that is publicly donated versus a cord blood bank that is privately preserved. Successful counseling should also include a conversation about the time of collection, storage methods, their cost, ownership, possible usage in the future, and the scope of existing evidence (Laue et al., 2024; Waller, 2022). Nurses play crucial roles as evidence-based information mediators since many families turn to UCBB first because of marketing or by word-of-mouth. Properly tailored counseling helps parents evaluate themselves among possible therapeutic solutions and exaggerated information, and makes informed decisions.

The knowledge and communication skills are essential in the quality of this counseling role. The benefits and limitations of balanced counseling must be made in tandem, the uncertainties identified where they are, and should at all times be open to parental values, culture, and emotional condition. Studies have indicated that the recommendations of medical workers can have a significant effect on the willingness of the parents to accept the free health care system, commercial banking, or no banking (Aboushady et al., 2021; Waller, 2022). In this respect, nurses should be capable not only of endorsing a conversation without any form of coercion but also of eliminating the falsehoods and addressing the frequently encountered misunderstandings. It is of great significance in the sphere of promotion of private banking when commercial messages might exaggerate the possibility of using the product or suggest a stronger fact than it could be at the moment (Murdoch et al., 2020).

The protection of the integrity of the decision-making process is also an ethical role of nursing professionals. They assist in assuring that the consent is informed, voluntary, and at the right time prior to delivery. This is to explain who can access the stored unit, the rights the family has, and the restrictions that may be imposed on subsequent therapeutic use (Murdoch et al., 2020). Due to this reason, nurses are not only instructors, but they also serve as moral mentors. The latter promote patient autonomy and reduce the likelihood that the consent was provided because the patient was not informed or coerced into it, which can be attributed to business considerations, because they offer impartial information, and ensure the parents understand what they are consenting to. This stand would make people surer of the institution and the whole cord blood banking system.

In addition to the role of counseling, the nurses also engage in the collection and administration process directly. Though the actual blood draw can be carried out by physicians or specially trained staff, maternity nurses are usually responsible for the preparation of sterile equipment, support of patients during labor and giving birth, instant observation of the baby,

labeling, documentation, and organization of transportation (Esmail et al., 2022). They should be vigilant with regard to specimen integrity and contamination or procedural error reduction. Recent practice suggestions point to the necessity to guarantee the timely nature and the authorization of the donor eligibility, appropriate labeling, and strong association with the services of the lab to optimize yielding and the viability of the cells (Hare et al., 2021; Manchanayake et al., 2024). These areas directly influence nursing competence in the quality and utility of gathered units.

Nurses also play a role in quality assurance as well as regulatory compliance. ARC cord blood programs must have standard documentation, traceability of blood, donor screening and institutional and national policies. Nurses are the interlink in the chain of information that can act as safety and accountability because much of the bedside documentation tends to be completed or verified by nurses (Hare et al., 2021). Policy, legal knowledge, and institutional practice, consequently, are an important component of professional competence. Where nurses are not conversant with this, chances are high that procedures may be executed erroneously and communication gaps may be experienced. Compliance and system reliability are reinforced when they are well prepared.

Another aspect of the nursing profession is continuous improvement and participation in research. Due to the constantly developing nature of stem cell science and transplantation practice, nurses need to acquire new knowledge by means of continuing education and evidence-based training (Shi et al., 2022; Zhu et al., 2021). Audits, data gathering, practice improvement efforts, and education analysis are some of the factors that can be used to improve UCBB services and identify the gaps in implementation. The literature also indicates that incorporating cord blood materials into the undergraduate and postgraduate nursing education would minimize the reliance on subsequent in-service training and would serve to equip the nurses with their duties of counseling and clinical services earlier in life.

Mature maternity nurses can take leadership roles in cord blood programs at the organizational level. Such functions involve the staff mentoring, the development of the protocols, the interdepartmental communications, the training coordination, and the compliance with collection prescriptions and accreditation requirements (Ahmed et al., 2022; Mousa et al., 2024). These leadership products point to the fact that nursing influence is not limited to bedside care. It is nurses who facilitate the institutional environment in which cord blood programs have been either declared successful or failed. That is why the empowerment of the nursing role in UCBB can be considered not only as a personal study, but as an investment into the quality, ethics, and sustainability of services related to the maternal and transplant services.

Another significant issue of the nursing role is interdisciplinary coordination. Banking of the Cords of blood involves interaction between obstetric services, the laboratory team, the transplant side, and even the third-party banking organizations. The roles of nurses can be regarded as linking these groups with each other by making sure that maternal eligibility information is accessible, documentation is formed, timing is properly communicated, and collection materials are transferred or prepared properly. Childbirth is a hectic clinical setting where one element of coordination failure can easily lead to lapses in the collection opportunities or the quality of collection specimens. Safety and efficiency can therefore be facilitated by effective nursing communication.

There is also a more extensive advocacy aspect of the nursing role. At times, nurses become the ones who realize that such families have not been provided with sufficient information about the balance, or that policy and practice fail to coincide with informed choice. They should be able to recommend earlier counseling, easier-to-understand patient education materials, and institutionalized access to avenues of donating their blood publicly or privately discussing their banking issues with a financial institution. This advocacy role plays a significant role, particularly in environments where cord blood banking is available, though not firmly established in maternity care. Nurses can create a difference in patient access and service design by recognizing viable crippling factors and reporting them to their superiors.

Lastly, the role of nurses in UCBB can and must be perceived as something dynamic, as opposed to something fixed. Due to the development of applications of science and the sophistication of banking systems, it is predicted that the organization of nursing roles will be extended instead of subtracted. It implies that being adept at UCBB is not to be regarded as a luxury specialized information in the possession of a few people Instead, it must be considered as a part of the larger trend, i.e., the move towards evidence-based and future-oriented maternity care where the nurses help to make the families make sense of the ever-proliferating treatment options in a clear, well-balanced, and professionally-oriented manner.

4. RESEARCH GAPS IN THE LITERATURE

The analyzed literature offers substantial evidence concerning the effectiveness of the educational intervention to enhance the knowledge and attitude of the maternity nurses toward UCBB. However, significant gaps still exist. To begin with, the majority of studies consider immediate or short-term outcomes. In contrast, only a few of them involve follow-up periods long enough to assess long-term knowledge remembrance or attitudinal change. Further evidence should be provided on the sustainability of educational benefits, and the likelihood of converting educational payments into counseling behavioral changes, collection practice, and patient-focused results in clinical practice.

Second, the articles present a low presence of comparative assessment of various instructional methods within various healthcare and cultural settings. An effective educational strategy in one institution or country does not necessarily translate into a feasibility in another one, especially in cases where the staffing, technology, and laboratory facilities largely vary in addition to the access of the population to banking facilities. Sanity regarding economic sustainability is also under-researched, particularly in low-and middle-income environments where the cost, infrastructure, and policy constraints can encapsulate the availability of banking, services (Keller and Ballen, 2020; Narayanan and Phadke, 2019). Further investigation on the long-term efficacy, contextual adjustment, and implementation viability is thus required to enable the designing of educational programs in accordance with the local demand without compromising the level of scientific and ethical practices.

Another gap is related to methodology. Convenience sample, one-site design, and self-reported measures of knowledge or attitude are dependent in many studies, so that generalizability could be restricted, and it can hardly be concluded whether the improvements mentioned in such studies are sustained in larger and more heterogeneous nursing populations. In the literature, a small number of studies address the question of whether an increase in knowledge results in actual counseling improvement in quality, documentation findings, successful rates of collection, or parental satisfaction. Likewise, only limited evidence exists that can relate educational interventions to outcome rates that relate to a transplant or other indicators of service use. By sealing these gaps, the evidence base could be reinforced by going beyond educational effectiveness as measured by test performance to effectiveness as measured by the clinical practice and impact on the health system.

5. CONCLUSION

This review shows that educational interventions are decisive to enhance knowledge and attitudes of maternity nurses about umbilical cord blood banking. In the reviewed studies, nurses often started with poor knowledge and doubtful or negative attitudes. Still, systematic instruction, self-directed educational courses and multimedia interventions always resulted in a substantial change. This repeated climb in various situations shows that knowledge gaps in UCBB can be changed significantly when schools are funded in systematic learning. These returns are significant in that the maternity nurses take the paramount role of baby sitting the parents through counseling, knowledge consent, procedural encouragement and program delivery.

As a result of the increase in clinical/investigative applications of cord blood, the improved pre-service training of maternity nurses has become more of a concern. Their competence will become greater, which will result in greater competence of the information they are providing to the expecting families, assist them in making better decisions, and more efficiently and more ethically utilize cord blood services. At the same time, in the literature, the requirement of the long-term presence of professional development, program support, and program planning according to the context is stated. Empirical training of maternity nurses as a streamlining of UCBB in the modern healthcare process is a readily available and accessible field of modality.

Extending these findings, strengthening maternity nurses' competencies in umbilical cord blood banking requires a shift beyond mere knowledge acquisition toward the enhancement of higher-order cognitive skills, including critical thinking and effective communication. Equipping nurses with up-to-date evidence-based information and structured practical training enables them to engage more confidently and professionally with expectant parents, address misconceptions with clarity, and facilitate informed and ethically sound decision-making. Furthermore, the integration of continuous, context-sensitive educational strategies within healthcare systems is essential to ensure the durability of learning outcomes and to maintain alignment with evolving clinical evidence and best practices. Collectively, these measures are fundamental to reinforcing the professional role of maternity nurses and improving the overall quality, safety, and ethical integrity of care within umbilical cord blood banking services.

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