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Human Embryology Science: Which Theoretical Information do Clinical Embryologists Need to Know More About? A Survey

Ciencia de la Embriología Humana: ¿Qué Información Teórica Necesitan Saber más los Embriólogos Clínicos? Una Encuesta

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SUMMARY: For the past decades, it has been apparent that assisted reproductive technologies along with clinical embryology have both propounded themselves triumphantly in the field of medicine. Although high-tech equipment and staff skills are crucial to the success of these breakthrough implementations, the pivot of these practices is updated, knowledgeable and competent technicians who excel in the field of human embryology. Crucially, the advancement of clinical embryology and its related fields depends on the meticulous training of clinical embryologists in practical skills as well as theoretical knowledge. Unfortunately, most aspects of reproductive medicine have no obligatory assembled curriculum. A lot more emphasis has been put on the clinical aspect of these sciences and training than its theoretical counterpart. Consequently, clinical embryologists continue to face difficulty in unifying the needed theoretical knowledge in these fields. Not only that, but they also struggle to shed a light on the advanced knowledge required to stand out as professionals. This study aimed to explore which theoretical information in the science of human embryology that embryologists need to know thoroughly about. The survey was conducted online (July 2021).

KEY WORDS: Embryology; Genetics; Reproduction.

INTRODUCTION

Clinical embryology has emerged as a new concept in the past few decades from the older well-known sciences; medical embryology and developmental biology (Kovacic *et al*., 2020). In the beginning, this science was primitive with no complex procedures, however, due to the rapid development of this field, clinical embryologists currently need to be updated on the scientific literature and obtain the skills needed to interpret and explain reported data (Kovacˇicˇ *et al*., 2015). Described as the 'artisan of life', clinical embryologists should be subject to wide training and continuous auditing and appraisal to be able to meticulously handle procedures where there is zero-tolerance for error (Rienzi & Fauser, 2021). Multiple reputable international figures have worked to define the work of an embryologist including the Society for Assisted Reproductive Technologies (SART), the European Society of Human Reproduction and Embryology (ESHRE), the Joint Commission on Accreditation of Healthcare (JCAHO), the Centers for Disease Control and Prevention (CDC), The American Society of Reproductive Medicine (ASRM) and the College of American Pathologists (CAP). The role of the embryologist has been divided into three aspects according to these figures: technical, administrative, and laboratory support and development and compliance with regulatory authorities. Therefore, the portfolio of the embryologist includes the following: oversight and maintenance of a laboratory and its instruments, equipment and supplies; preparation and quality control of culture media and all labware used for assisted reproduction techniques; processing of sperm for insemination or intracytoplasmic sperm injection (ICSI) and sperm cryopreservation (freezing); egg retrieval; conventional insemination; ICSI; assessment of eggs for fertilization; culture of embryos to cleavage stage or blastocyst; embryo selection and transfer; embryo cryopreservation and thawing; assisted hatching; biopsy of cleavage stage embryos (blastomere biopsy) or of

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blastocysts (trophectoderm biopsy); preparation of biopsies for shipping to and analysis by the genetics laboratory for preimplantation genetic screening and preimplantation genetic diagnosis (PGD); oocyte cryopreservation; maintenance of the cryopreserved inventory of sperm, eggs and embryos; ensurance that the laboratory is in compliance with regulations from local, national and federal authorities for licensure and accreditation; training in new techniques and training of new embryologists; recording and documentation of all events relevant to patient care and the laboratory's operation; participation in continuing education to always be knowledgeable about emerging technologies and concepts in the treatment of infertility; and active and effective membership on the clinical team for delivery of optimal patient care through excellent communication and collaboration. With such a huge array of duties there comes a need for extensive knowledge of multiple aspects of theoretical embryology. In this survey, we highlight areas of strength and those of weakness in the currently available training pro forma of clinical embryology and we try to evaluate the current educational level among clinical embryologists. Additionally, we shed a light on the need for continuous development of its curriculum to keep in line with the sophistication termed artificial intelligence that will dramatically change the embryologist's role in the upcoming years (Choucair *et al.*, 2021).

MATERIAL AND METHOD

We conducted an online questionnaire-based descriptive study of theoretical Information embryologists in Jordan need to know more about using Google forms. We designed a questionnaire consisting of 24 questions that sought to address the study aims using a mixture of scale items and free text boxes. An email invitation to participate was sent to the embryologists requesting them to forward the invitation to all other embryologists in their catchment area. Although there were 51 responses, it was not possible to estimate a response rate, as it was not possible to determine how many people viewed the invitation link and whether all respondents effectively cascaded the invitation.

Questionnaire data were exported into Google sheet for analysis. Quantitative data were presented as proportions. Thematic analysis was used for the qualitative results.

RESULTS

There were 51 responses, of whom 78.4 % have a bachelor's degree and 21.6 % have a master's degree. The age distribution of survey respondents is shown in the figure below (Fig. 1). The age range of the respondents was 25-50 years of age. Responses were received from embryologists at all career stages (Fig. 2) ranging from laboratory managers (49 %), Senior embryologists (33.3 %), embryologists (15.7 %), Assistants (2 %). Years of experience ranged from 3-25 years. Nearly 22 of survey respondents had 1-10 years of experience, 23 had 11-20y, and only 6 had more than 20 years of experience. Many respondents (84.3) work in governmental institutions. However, 13.7 % work in private institutions, with a further 2 % who work in academic institutions.

Out of 51 surveyed, 35 respondents reported taking courses related to embryology. Areas where respondents reported that they had good knowledge at, for example: Basic understanding of human reproduction, Ovulation, Spermatogenesis, Infertility, Cryopreservation of gametes, Embryos, Blastocysts, and Reproductive tissues, Intracytoplasmic Sperm Injection, Fertilization, Division of embryos and Semen fluid parameters according to the World Health Organization (WHO) manual. In contrast, respondents reported facing more difficulties in the basic understanding of genetics, the theoretical aspects of both clinical andrology and embryology, and the theoretical aspects of Pre-implantation genetic diagnosis, as well as sperm DNA fragmentation.

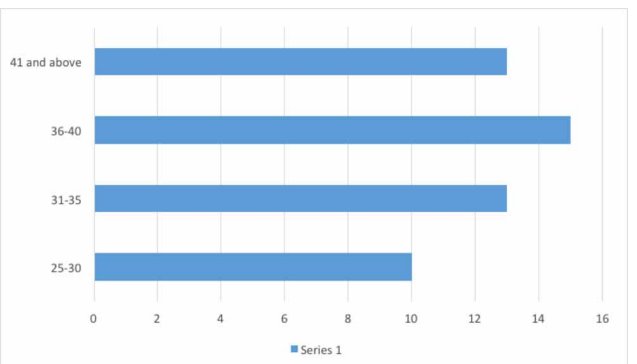

Fig. 1. Age Distribution of survey respondents.

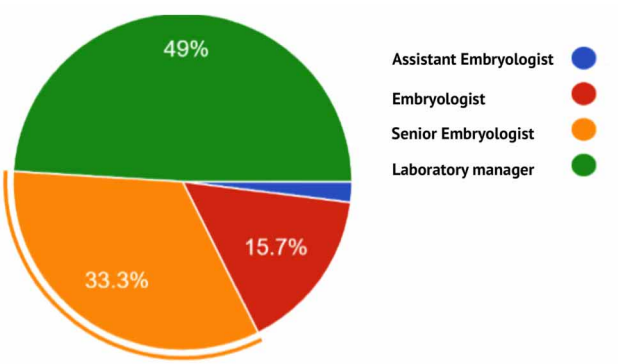

Fig .2. Embryologists career level.

Respondents reported many topics that need to be discussed during conferences and training courses such as quality control; new technologies in IVF; the Latest scientific researches worldwide regarding IVF; PGD or NGS. Other topics that were mentioned were implantation; time of ICSI; oocyte quality and embryo self-repair mechanisms; as well as stem cells in training azoospermia; embryo transfer tricks; or DNA fragmentation. Respondents mentioned topics that they think there's not enough available data about or usually not covered properly in their training. The top three reported topics were PGD, genetics, and quality control. Overall, PGD was most commonly reported.

A higher proportion of respondents (47.1 %) reported preferring visual methods to learn. Some respondents (31.4 %) reported reading as their favorite way to enlighten their minds. In contrast, a few respondents (11.8 %) commented that auditory learning is helpful for them. The remainder of the participants (9.7 %) voted for practical learning. More or less, all of them are priceless resources to gain further knowledge.

DISCUSSION

In his state-of-the-art successful first live birth through an IVF cycle, Professor Robert Edwards with the help of Patrick Steptoe instituted a novel profession, clinical embryology. Afterward, clinical embryology has evolved technically, with the advancements in the field including ICSI, assisted hatching, and the availability and widespread use of preimplantation genetic testing of embryos. With the huge number of couples battling subfertility and requesting assisted reproduction comes extraordinary scientific and technological headways (Péloquin *et al*., 2021).

Although IVF is often portrayed primarily as a technical procedure, of retrieval and transfer, ICSI and biopsy, a piece of solid knowledge in the fields of culture medium design and biochemistry of metabolism, reproductive cell physiology, and events of early reproduction grant distinctiveness to any embryologist (Go, 2015).

Clinical embryology comprises two components: science and art (Choucair *et al*., 2021). Both work in harmony to keep up with the daily advances in this science maintained by the increased demands on such technology. As a result, many authorities and international associations have set the standards to include the skills and knowledge needed to climb up the ladder of this specialty (Alpha Scientists in Reproductive Medicine, 2015), however, the core theoretical competencies of the modern embryologist have not been standardized. This point is pivotal for recruitment and quality assurance and thus periodic practice gaps assessments in line with new technologies are crucial elements in ensuring both.

The establishment of clinical embryology as a professional status and standard on an international basis has thus become imperative as stated by the ESHRE. Years later, the establishment of the ESHRE subcommittee (EmCC, Clinical Embryologists' Certification Committee) took place aiming to certify the competence of clinical embryologists working in IVF and to develop a formal recognition for clinical embryologists. The system provides two levels of certification: one for senior-level clinical embryologists and one for clinical embryologists.

Clinical embryologists are therefore expected to comply and incorporate all the new advances in their practice whilst maintaining their knowledge and skills needed to warrant evidence-based elite care for their patients. A qualitative study conducted by the ESHRE pointed out that such professionals are challenged with the heavy workload, rapidly evolving knowledge, and burnout. Embryologists' knowledge has widely been assessed through licensure. To apply for licensure, basic academic qualifications along with previous recognized operative experience must be submitted (Choucair *et al*., 2021). Maintaining this licensure, however, should come through continuous audit and ongoingeducation ESHRE conducted an a10-year analysis of the two-tiered exam used for their certification program in clinical embryology. The results showed mean scores of 68 % and 59 % for the clinical embryologist and senior clinical embryologist exams, respectively (Kovacic *et al*., 2020). Mean scores were 76 % and 73 % among the 60 % and 50 % of applicants who passed the exam, and no significant difference was found between the topics included (Kovacic *et al*., 2020). Such research on fertility has helped spot some challenges faced by embryologists that stand in the way of establishing best practices and patient care.

A study by Sophie *et al*., was conducted among embryologists to assess gaps in practice. 38 % of surveyed reported sub-optimal knowledge of treatments and instruction protocols for ovarian stimulation (Péloquin *et al*., 2021). Qualitative and quantitative data from embryologists in the same study showed that only 86 % agreed that the optimization of embryo culture conditions is more important than assessing embryo morpho. However, 34 % reported a lack of knowledge of these environmental factors (Péloquin *et al*., 2021). Embryo assessment was also reported as an important challenge by laboratory specialists as 82 % of them agreed that the selection of the embryo to transfer remains subjective. These results go in line with ours and emphasize the need for more comprehensive worldwide data.

Unfortunately, a system incorporating licensing and continuous evaluation is not the standard and the application of the proposed guidelines is neither being tracked nor evaluated. Thus, clinical embryologists currently employed in the field play a pivotal role in highlighting areas of deficiencies in their training and pointing out pitfalls in their curriculum. Realistically speaking, the current most driven route to obtaining a career in embryology is to join the staff of an infertility clinic as an embryologist and incorporate into the array of technical and administrative tasks that comprise this specialty. In short, learning through apprenticeship.

To the best of our knowledge, this is the first study that explored the theoretical information in the science of human embryology that Jordanian embryologists need to know thoroughly about; basic understanding of genetics, theoretical aspects of both clinical andrology and embryology, and theoretical aspects of Pre-implantation genetic diagnosis(PGS) are the most needed ones. We hope to shed light on the need for continuous development of the currently available training curriculum of clinical embryology to meet the standards of structured programs in the universal academic institutes and fertility centers.

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RESUMEN: Durante las últimas décadas, ha sido evidente que las tecnologías de reproducción asistida junto con la embriología clínica han demostrado un éxito importante en el area de la medicina. Si bien los equipos de alta tecnología y las habilidades del personal son cruciales para el éxito de estas implementaciones, el eje de estas prácticas son los técnicos actualizados, competentes y expertos en el campo de la embriología humana. Fundamentalmente, el avance de la embriología clínica y sus campos relacionados dependen de la formación meticulosa de los embriólogos clínicos en las habilidades prácticas y los conocimientos teóricos. Desafortunadamente, la mayoría de los aspectos de la medicina reproductiva no cuenta con un plan de estudios obligatorio. El énfasis se ha concentrado en el aspecto clínico y en el entrenamiento de estas ciencias más que en la contraparte teórica. En consecuencia, los embriólogos clínicos continúan enfrentando dificultades para unificar el conocimiento teórico necesario en estos campos. Este estudio tuvo como objetivo explorar qué información teórica importante en la ciencia de la embriología humana requieren los embriólogos. La encuesta de este trabajo se realizó en línea (julio de 2021).

PALABRAS CLAVE: Embriología; Genética; Reproducción.

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