

Our First Experience Implementing “Clinical Embryology and Reproductive Medicine” as a Curriculum Course of the Study Program General Medicine at the Faculty of Medicine in Bratislava, Slovakia

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Summary

There is no separate course in the medical curriculum summarizing all aspects of human reproduction in most medical school curricula. At the same time, such a course would logically connect knowledge from clinical embryology and assisted reproduction, encompassing the issue of female and male infertility, mechanisms of birth defect formation, their prenatal diagnosis and subsequent specialized neonatal care. The aim of a wide team of university teachers comprising embryologists, gynecologists, neonatologists, endocrinologists, geneticists and others was to create and implement a new course entitled "Clinical Embryology and Reproductive Medicine" into the fourth-year curriculum of the study program General Medicine at the Faculty of Medicine, Comenius University in Bratislava. There has been a great interest in the course, as evidenced by the number of medical students enrolled. The lecture syllabuses have been divided into several thematic areas: 1) Clinical embryology including a laboratory part of assisted reproduction, 2) Cause and treatment options of female and male infertility, 3) A comprehensive view of the issue of birth defects, 4) The issue of preconception education, prenatal and childbirth training, family planning, 5) Reproductive immunology and endocrinology. Despite the complexity of human reproduction being a mainstay of gynecology and obstetrics, it is

underemphasized in the medical school curricula worldwide. It is often reflected in shorter hospital / practical trainings during undergraduate studies and lower requirements at the final exam. Therefore, as students almost unanimously valued, this new course is extremely helpful in preparing for the final state exam.

Key words

Assisted reproduction • Clinical embryology • Congenital malformations • Infertility • Prenatal diagnosis • Reproductive immunology and endocrinology

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Introduction

Human reproduction is covered in a variety of courses undergraduate medical students of study program General Medicine will encounter within their six-year study. The different aspects of human reproduction form an integral part of the begging of undergraduate studies

whether it is anatomy, embryology, biology or physiology. At a more senior stage of medical education, students get in contact with human reproduction again, now in a more clinically aligned fashion focused on issues of reproduction when trained in hospital in gynecology and obstetrics. Not only that, reproduction is briefly covered during hospital trainings in internal medicine (selected endocrinopathies), pediatrics and pediatric surgery (the issue of birth defects), surgery (male infertility within urology), or pharmacology (hormone therapy, pharmacodynamics of hormonal contraceptives). All these topics are highly complex that there is little time nor space to cover human reproduction at an appropriate detail and complexity.

When searching for papers on innovations of undergraduate training in gynecology and obstetrics, the majority deals with the simulation of spontaneous delivery [1,2], the simulation of breast palpation [3,4], innovations for the refinement of surgical techniques in gynecology [5,6], or simulation of laparoscopic surgery [7]. Upon closer inspection of “traditional” curricula of medical faculties, courses dealing with all the complex intricacies of human reproduction and reproductive medicine is highly uncommon, yet such course would logically interconnect the knowledge of clinical embryology and assisted reproduction, encompassing male and female infertility, mechanisms of birth defects, their prenatal diagnostics, and subsequent specialized neonatal care. Such course would include the whole continuum ranging from basic science knowledge to the latest clinical applications and would also comprise the knowledge of the most up-to-date reproduction-related subspecialties of various medical fields like reproductive immunology, reproductive endocrinology, or oncology-related issues like the problem of fertility maintenance in oncological patients within reproductive age.

Considering all the aforementioned, a multi-disciplinary team of university lecturers and clinical experts has been established at the Faculty of Medicine, Comenius University in Bratislava with the main goal of creating and implementing a brand-new curriculum-based elective course “Clinical embryology and reproductive medicine” into the fourth-year curriculum of the study program General Medicine. The authors presume that those students who will take the course will appreciate the interdisciplinary approach of the course and will acquire a complex understanding of all the aspects of human reproduction. On top of that, it was intended for the students taking the course to also gain deeper knowledge

and a more positive attitude towards further study of gynecology, obstetrics, or neonatology.

Methods

The first step was the creation of a broad team experts assembled from the human resources of the Faculty of Medicine, Comenius University in Bratislava, Slovakia as well as invited clinical specialists, who agreed on the need to introduce a new course focusing on reproductive medicine into the study program of General Medicine. Based on the general recommendations of the Slovak Accreditation Agency for Higher Education, undergraduate students were also included in this creative process. The team of teachers subsequently obtained financial support from the Ministry of Education, Science, Research and Sport of the Slovak Republic in the form of grant entitled: “Creation of study materials for the newly created course Clinical Embryology and Reproductive Medicine”.

Results

A new curriculum-based elective course entitled “Clinical Embryology and Reproductive Medicine” has been implemented and taught within the fourth year of the six-year curriculum of the study program General Medicine since the academic year 2019/2020. The course consisted of two-hour seminars during the summer semester (14 weeks). There has been a great interest in the course among students, as evidenced by the number of students enrolled in spite of the voluntary nature of this course (Table 1). Unfortunately, except for the first two seminars in February 2020, all the other seminars were held only in the form of online classes due to the

Table 1. The number of students who chose the new curriculum-based elective course “Clinical embryology and reproductive medicine”

Academic year	Number of students
2019/ 2020	43
2020/ 2021	46
2021/ 2022	50

* Currently, more than 300 students are enrolled in the fourth-year of the study program General Medicine, with 38 curriculum-based elective courses.

Table 2. Lecture syllabus of the curriculum-based elective course "Clinical embryology and reproductive medicine" at the Faculty of Medicine, Comenius University in Bratislava

1.	Introduction to clinical embryology. A recent view on the functional morphology of the female and male reproductive organs
2.	Fertilization and early embryogenesis from the point of view of clinical embryology. Recent view on the functional morphology of placenta
3.	Female infertility, diagnostics, and treatment possibilities. Polycystic ovary syndrome (Stein-Leventhal syndrome)
4.	Male infertility, diagnostics, and treatment possibilities
5.	Overview of laboratory methods of assisted reproduction. Spermology, methods of micromanipulation and intracytoplasmic sperm injection into the oocyte, <i>in vitro</i> cultivation of early embryo, and evaluation of its development
6.	Teratology. Overview of the most common birth defects and causes of their formation
7.	Prenatal screening and diagnostics of birth defects. Current possibilities of fetal therapy
8.	Selected aspects of care for newborns with birth defects
9.	Reproductive endocrinology. The relationship between <i>diabetes mellitus</i> and infertility
10.	Reproductive immunology
11.	Contraceptive methods and Pearl's index
12.	Preconception education, prenatal training, and childbirth. Childbirth from the perspective of evolutionary biology
13.	Options of fertility preservation and cryopreservation in reproductive medicine. Pre-implantation genetic diagnosis
14.	Ethical aspects of reproductive medicine

COVID-19 pandemic. Therefore, the implementation of innovative teaching methods will only be covered in the Discussion.

Lecture syllabi can be divided into several thematic areas (the list of all topics is listed in Table 2):

1) *Clinical embryology and laboratory part of assisted reproduction*. The content of this topic is focused on covering the latest knowledge on spermiogenesis and oogenesis, fertilization, and embryo implantation, as well as the key events during the development of an early embryo and extraembryonic structures, focusing on placenta. It also contains a description of in-vitro fertilization techniques, the principle of time-lapse monitoring of early embryos, and the information on possibilities of gametes and embryo cryopreservation. Lecturers leading this thematic area have extensive experience as clinical embryologists working in the centers of reproductive medicine.

2) *Causes and treatment options of female and male infertility*. The most common causes of female and male infertility and their treatment options are covered. Therefore, the course is held by two academic staff: one

lecturer is a trained gynecologist specializing in reproductive medicine, the other one is a urologist dealing with male infertility. Since the Slovak Research and Development Agency project entitled "Histomorphological basis of idiopathic tubal infertility" is in progress at the lecturers' workplaces, students receive the latest information from translational research their course conveners are directly involved in.

3) *A comprehensive view of the issue of birth defects*. This part includes a seminar with a biologist-geneticist who will introduce students to the basic principles of teratogenesis. This is followed by a seminar with a gynecologist specializing in fetomaternal medicine, which focuses on the possibilities of prenatal diagnosis. In the lecture dedicated to prenatal diagnostics, students become familiar with the main purpose of prenatal diagnostics, which is the early detection of birth defects and subsequent management. Two basic methods of prenatal diagnosis – both non-invasive and invasive – are presented in detail. Within the non-invasive methods, emphasis is placed on ultrasound screening of birth defects and the state-of-the-art method – detection of free fetal

DNA in the mother's blood (NIPT, non-invasive prenatal testing). From the invasive methods, students become familiar with the collection of chorionic villi, amniocentesis and cordocentesis. The accompanying lectures cover the current legislative framework for solving those pregnancies in which the fetus is confirmed to be affected by a birth defect was met with a positive response and the liveliest discussion among students. The last in this area is a seminar with a pediatrician - neonatologist, on postnatal care of newborns and children with birth defects.

4) *Issue of preconception education, prenatal and childbirth training, family planning.* The issue of preconception education and pregnancy planning concerns all fields of medicine, so this topic should be a part of undergraduate education. It is an indisputable fact that chronically ill women who are under the outpatient care of an individual specialist should not become pregnant without previous planning, as this increases the risk of adverse pregnancy outcomes, including miscarriages and birth defects. The risk of maternal morbidity and mortality is also higher. Therefore, an expert in the outpatient setting should always actively search for any hint of reproductive plans and instruct the patient about the means of protection against unplanned pregnancy, and in cooperation with a gynecologist, also recommend effective and safe contraceptive methods. Part of the lecture is also an overview of the latest knowledge about the effectiveness of individual types of contraception and their suitability for selected diseases.

5) *Reproductive immunology and endocrinology.* The thorough understanding of these two dynamically developing areas of medicine is crucial for a successful treatment of infertility. Therefore, the teaching staff also includes experts in immunology and endocrinology. Thanks to this multidisciplinary approach, students will better understand the relationship between some endocrinopathies (such as diabetes mellitus) and the issue of infertility, as well as the importance of local suppression of immune response during implantation and formation of the placenta within the uterine mucosa (the role of uterine NK cells).

Discussion and future plans

Gynecology and obstetrics are highly diverse medical disciplines that integrate preventive medicine, complex problem solving, and surgical intervention. Despite the complexity of the field, the curricula of a

majority of medical schools worldwide inadequately emphasize its importance. The result is that decreasing the duration of the obstetrics and gynecology medical student clerkship resulted in lower course examination scores [8]. This fact makes it more challenging to plan both the hospital trainings and theoretical seminars because these educational activities have to cover a considerable amount of diverse knowledge in a short period of time [9].

At a first glance, it may seem that some parts of our new syllabi present merely a repetition of knowledge already covered in earlier years of study, for example, the seminars discussing clinical embryology. However, it is well known that students in the 2nd year of study are yet to acquire basic knowledge from pathology and pathological physiology, so it would be futile to discuss new trends in clinical embryology in detail.

Unfortunately, clinical embryology is generally underemphasized in the Slovak (and not only Slovak) medical education system. Officially, this medical field in the Slovak Republic does not exist, and currently, there is no possibility to gain "clinical embryologist" certification from any institution due to the absence of any formal training in the specialty. Compared with the neighboring Czech Republic, the medical field clinical embryology was established by the government decree in 2010, after 30 years of informal existence. The overall length of this specialized education is at least 48 months [10]. In other countries, the embryologists are educated at universities within special master's degree programs and they can take internationally recognized certified exams at the European society of human reproduction and embryology (so called ESHRE Certification for Clinical Embryologists) [11]. In the future, we will follow the accreditation process of this specialized program under Slovak conditions carefully and will make an effort to implement the specialty Clinical embryology in Slovakia. This seems important as clinical embryologists have many duties, including the examination and processing of ejaculate, *in-vitro* fertilization control (e.g., by micromanipulation techniques), evaluation of adequate early embryo development, cryopreservation of gametes and embryos, harvesting of blastomeres from morula for the purpose of preimplantation genetic screening. Most importantly, clinical embryologists play an essential role in overall fertilization success thanks to the complexity of his/her knowledge, reinforced by a mutual discussion with a gynecologist about the best way to implement given procedure. Therefore, in our opinion, the graduates of general medicine performing assisted reproduction should

also be comprehensively informed about the laboratory methods during the procedures. Moreover, according to the study of Dutch researchers [12], repeating the theoretical knowledge from anatomy, embryology, and physiology when studying clinical courses is inevitable. Results of the aforementioned study revealed that graduates enrolled in obstetrics and gynecology residency programs often have insufficient theoretical knowledge. The problem is also that the curriculum of most of medical faculties is very busy so embryology gets easily overlooked. Hamilton and Carachi [13] put together a questionnaire and gave it to 146 medical students. Most of the students were critical of the teaching depth, pace and retention of knowledge. The most problematic part was the ability to apply the knowledge on relevant clinical scenarios. Scott et al. [14] used the same questionnaire and methods. These authors concluded that embryology was highly valued among students and that a clinically oriented embryology course would be highly beneficial especially in the second half of their studies thanks to a solid theoretical basis obtained during previous years. Fakoya et al. [15] highlighted the importance of creating core syllabi for the teaching of embryology and teratology with the main emphasis on international cooperation, leading to

guidelines that would make it easier for universities to develop the courses.

One of our goals was to implement a team-based learning, where the students would discuss the concrete medical problem regarding reproduction (or case studies) in small, diverse groups and search its possible solutions under the guidance of experienced teachers. There are several universities which have already implemented such an active way of teaching with the use of critical thinking. It is becoming common and very popular among students and teachers alike [9,16].

Conflict of Interest

There is no conflict of interest.

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