

Chapter 14

Preparing an Interdisciplinary Workforce in Oncofertility: A Suggested Educational and Research Training Program

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Introduction

The significant threat posed by various cancer treatments on the reproductive potential of women and men—as well as on the future reproductive potential of children—requires the well-orchestrated development of a physician-scientist global workforce that can implement a research and clinical agenda. Ultimately, this workforce will be the nexus for the expansion and development of the interdisciplinary field of oncofertility. It is imperative that, in parallel to research and treatment advances, we train and educate the first and subsequent generations of specialists in oncofertility. This education and training provides the foundation of this discipline, which lies at the intersection of oncology, pediatrics, reproductive science and medicine, biomechanics, material science, mathematics, social science, bioethics, religion, policy research, reproductive health law, and cognitive and learning science.

This ambitious goal fits well with the general research agenda of the National Institutes Health, which depends upon the continued supply of creative scientists properly trained in interdisciplinary approaches to basic science research and the practice of medicine in the twenty-first century. It is critical that at least some of these scientists come from the ranks of properly trained *physician* investigators in the field of reproductive medicine. A successful oncofertility training program should be structured to meet the needs of these physician investigators and open a pipeline for the continued development of academic specialists within this interdisciplinary field. The ultimate goal is to prepare talented academic clinicians—reproductive endocrinologists, pediatric and adult oncologists, and surgeons—for investigative careers that focus on the reproductive, endocrine, and fertility needs of cancer patients and survivors. Research based on molecular and cell biology

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approaches should be emphasized, as well as the translation of basic research findings to human reproductive biology and clinical applications. These physician-scientists will be at the forefront of interdisciplinary translational medicine, working on developing novel techniques for the preservation and/or transplantation of gonadal tissue and the *in vitro* development of ovarian follicles to generate competent gametes for fertilization, normal embryonic development, successful pregnancy, and birth of healthy children to cancer survivors.

The Reproductive Endocrinologist and Oncofertility Specialist

Reproductive endocrinology and infertility (REI) is one of four subspecialties that requires advanced training after completion of residency in obstetrics and gynecology. In the USA, formal certification for advanced training in reproductive medicine lies under the aegis of the Division of Reproductive Endocrinology and Infertility of the American Board of Obstetrics and Gynecology, Inc. (ABOG) [1]. This board awards certificates of special competence for the practice of REI to individuals after completion of an accredited training program and subsequent passing of written and oral examinations. At present, there are over 1,000 REI board-certified specialists in the USA. The rationale for pursuing even further training in oncofertility is the need to focus the efforts of selected REI specialists in the context of the cancer patient through a rigorous educational, laboratory, and research curriculum. It is envisioned that the first generation of oncofertility specialists would be fellowship-trained, board-certified reproductive endocrinologists. However, it is anticipated that other physicians who develop an interest in oncofertility, such as medical and pediatric oncologists or medical endocrinologists, should be able to participate in oncofertility training programs. Specifically, these programs would involve training on the topics listed in Table 14.1. It should also be mentioned that, to date, there

Table 14.1 Key components of specialty training in oncofertility

Education	Laboratory technique	Research
Effects of radiation and chemotherapy on cells and reproductive tissues	<i>In vivo</i> or <i>in vitro</i> growth and maturation of ovarian follicles	Basic research program development relevant to the generation of competent oocytes and maturation of spermatogonium
Cryopreservation of oocytes, ovarian follicles, and ovarian tissue	<i>In vivo</i> or <i>in vitro</i> cryopreservation of male and female gametes	Clinical research program evaluating the outcomes and safety of fertility preservation laboratory methods
Cancer genetics and cancer pharmacology		
Biopsychosocial impact of a cancer diagnosis		
Reproductive bioethics and reproductive health policy		

has been limited interest by urologists in actively participating in oncofertility teams. This may be due to the fact that procurement of ejaculated sperm for cryopreservation is easy and has been in routine practice for many decades. Nevertheless, alternative sperm/testicular tissue procurement methods or approaches to the prepubertal male with cancer require special training and certainly development of research programs to optimize both the viability of cryopreserved tissue and the in vitro or ex vivo generation of mature male gametes.

Person-Power Needs

Critical to meeting oncofertility specialist person-power goals for the future is a good understanding of the past and present trends in the training of new reproductive endocrinologists, as evidenced by the number of fellowship positions and by analyzing the actual, as well as projected, person-power demands. To this end, data provided by the National Fellowship Matching Program, as well as the American Society for Reproductive Medicine (ASRM), provide a reasonably accurate representation of the present status of the specialty. In addition, in a publication in *Obstetrics and Gynecology*, Dr. Warren Pearse set out supply projections of reproductive endocrinologists nationally, which is expected to increase through the year 2014 and then plateau thereafter [2]. Although the clinical needs of the US population for medical services by reproductive endocrinologists are likely being met by this number of specialists, research development is probably insufficient. Most importantly, and in the context of the establishment of the discipline of oncofertility, a worldwide, concerted effort is needed to develop physician-scientists in this new field. At the present time, there is the unique opportunity to establish guidelines for the research training and education of these individuals and provide the academic foundation on which the future success of oncofertility as a field of academic study and medical practice will depend.

Existing Research Training and Career Development Programs

During the past 10–15 years, the NIH has established institutional career development awards (K12 awards) in obstetrics and gynecology. This has contributed to a reversal in the dearth of academic faculty positions for appropriately research-oriented individuals in the specialty. A series of Clinical Research Training Programs have also been funded to help replenish the virtually empty pipeline of clinician scientists. In addition, interdisciplinary career development awards in Women's Health Building Interdisciplinary Research Careers in Women's Health (BIRCWH) have now gone through multiple cycles of funding. These laudable efforts have contributed to the building of a critical bridge between academia and women's

health. It should be noted that the majority of the existing targeted federally funded programs (such as Women's Reproductive Health Research (WRHR), Reproductive Scientist Development Program (RSDP), and BIRCWH) are aimed toward the academic development of junior faculty rather than fellows. In order to fill newly created academic positions, it is therefore imperative to examine the fellowship ranks and create the appropriate environment, training, and funding opportunities that will expose fellows to the highest level of research in reproduction. To this end, 10 years ago, a consortium of reproductive endocrinology and infertility fellowship programs was formed and successfully applied for an NIH T32 training grant in order to properly train promising physician-scientists to enter the pipeline. To date, the program has proven very successful, with the majority of the trainees entering academic positions as RSDP, WRHR, BIRCWH, or Robert Wood Johnson Foundation (Harold Amos) scholars. Using this approach as a template, a similar program for both US and foreign physicians and scientists interested in the field of oncofertility was developed and is now completing its fifth year of funding.

History and Description of Board-Approved Training Programs in REI

Training in REI has experienced an impressive evolution during the past four decades. Prior to the introduction of American Board of Obstetrics and Gynecology (ABOG)-approved training programs in 1974, REI training had been fairly unstructured. The American Board of Obstetrics and Gynecology, Inc. is responsible for administration and oversight of these fellowship programs [1]. There are currently more than 40 approved 3-year fellowship programs in REI nationally, with over 100 fellows in training. The majority of the programs support one fellow per year with some programs having one fellow every other year and a few programs approved for two fellows per year.

Initially, the REI subspecialty was oriented toward attaining clinical competency in the field of reproductive medicine. However, research competency has always been a feature of REI training, and a formal thesis requirement was instituted in 1974, concurrent with the first oral examination. The thesis requirement enforces the need for exposure to scientific methods of inquiry. Fellows are required to perform a study that demonstrates adequate hypothesis testing and to further defend a thesis at the time of oral examination to attain certification in the subspecialty. The publication of this research work in peer-reviewed journals is closely monitored by the Division of Reproductive Endocrinology of ABOG, as it considers each fellowship program for continued accreditation. Formal progress reports and reviews of each program take place yearly, and formal reaccreditation reviews, which include site visits, occur at 3 to 5-year intervals.

When fellowship programs began to proliferate in the late 1970s, 2 years was deemed adequate to expose fellows to state-of-the-art clinical management principles

<p>Year 1</p>	<ul style="list-style-type: none"> ➤ Clinical Reproductive Endocrinology and Infertility (60%) ➤ Training in Assisted Reproductive Technologies (35%) ➤ Course Work (5%) 	<p>Formal Educational Activities</p>	
<p>Year 2</p>	<ul style="list-style-type: none"> ➤ Research training and course work (100%) 	<p><u>Weekly conferences:</u></p> <ul style="list-style-type: none"> ➤ Grand Rounds ➤ Seminar Series in Reproductive Biology ➤ Didactic Series in Reproductive Endocrinology (ABOG Learning Objectives) ➤ Journal Club 	<p><u>Required formal coursework:</u></p> <ul style="list-style-type: none"> ➤ Graduate course in Epidemiology and Biostatistics ➤ Graduate course in Genetics <p><u>Elective rotations:</u></p> <ul style="list-style-type: none"> ➤ Medical Endocrinology ➤ Pediatric Endocrinology ➤ Adolescent Gynecology ➤ Andrology
<p>Year 3</p>	<p style="text-align: center;">↓</p>		

Fig. 14.1 Blueprint of a typical 3-year fellowship training program in REI [1]. Note the time dedicated to research in years 2 and 3. This time is only interrupted by academic exercises, such as didactic seminars and journal clubs, thus allowing fellows to completely immerse themselves in their research training. The leadership of the subspecialty considers this time critical for the development of the next generation of academicians in reproductive medicine

in infertility and endocrinology. The successful *in vitro* conception resulting in the birth of Louise Brown in 1978 forever changed the field. An explosion in technology followed, and while the clinical applicability of *in vitro* fertilization and embryo transfer expanded, it remained largely within the province of the reproductive endocrinologist. Sophisticated technical advances in assisted reproductive technologies (ARTs) are now acquired during fellowship. The increase in required clinical competencies and the explosion in knowledge and scientific advances in molecular biology and genetics prompted ABOG to extend the required fellowship training period from 2 to 3 years, effective as of 1998, by expanding the length of required research training from a minimum of 6 months to a minimum of 18 months. This additional requirement for research training by ABOG emphasized the need and commitment for clinically trained individuals to experience an immersion in the laboratory, be exposed to cutting-edge basic research using molecular and cellular biology techniques, and complete successfully the thesis requirement. The increase in research time has also presented the opportunity to identify and engage those fellows who are interested in reproductive research as a lifelong pursuit. Although there are minor variations as to the distribution of time spent in various activities during an approved fellowship, the requirements by ABOG are fairly rigid [1]. A representative training program, which includes a 2-year research commitment, is outlined in Fig. 14.1. With regard to oncofertility training, it is suggested that additional and complementary training in oncofertility should be incorporated within the context of the current REI fellowship requirements to further train interested individuals in this new field.

Oncofertility Training Program Planning

Program Administration-Executive Steering Committee

It is suggested that a program for research training in oncofertility should be coordinated by a program director and administered through a university-based Division of Reproductive Endocrinology and Infertility or Department of Obstetrics and Gynecology. Responsibility for administration of such program should lie with an Executive Steering Committee, chaired by the program director and composed of clinical and laboratory specialists with documented strengths in clinical human reproduction and reproductive biology, oncology, genetics, and bioethics.

In addition to being responsible for the overall direction of the program, the members of the Executive Steering Committee should fulfill the following tasks:

- Review applications
- Review and follow-up on progress reports
- Conduct interviews of selected fellows at the beginning and end of the funding period
- Evaluate long-term strategy of oncofertility training and educational programs
- Shape the direction of the program as necessary to accommodate changes in training and focus
- Collect and review program change suggestions communicated by participating mentors
- Inform participating/sponsoring mentors of changes in program development
- Report to an Advisory Board and an Evaluation Committee

To fulfill these requirements, the members of the Executive Steering Committee should communicate regularly through face-to-face meetings and teleconferences.

Advisory Board

The Executive Steering Committee should be aided in shaping and modifying the oncofertility training program by an Advisory Board assembled for the oversight of the oncofertility program. The composition of the Advisory Board should include senior members of the academic community and preferably include at least one member from each of the following fields: (1) reproductive endocrinology, (2) oncology, (3) material sciences, (4) social sciences, and (5) bioethics. The vision, collective wisdom, and oversight of such a Board are invaluable in shaping the direction of an oncofertility training program and would be modified over time as needed. The Advisory Board should have scheduled meetings with the Executive Steering Committee to discuss the progress of the program, identify areas of excellence and needed improvement, and determine program expectations. These face-to-face meetings could be scheduled to coincide with major society meetings, such

as those for the Society for Gynecologic Investigation (SGI), Society for the Study of Reproduction (SSR), American Society for Reproductive Medicine (ASRM), or The Endocrine Society. Similarly, programs outside of the USA can plan their Advisory Board meetings during their respective reproductive and endocrine society meetings.

Program Faculty

Collectively, the clinical and research expertise of investigators participating in an oncofertility training program should not only represent the breadth and depth of reproductive biology and endocrinology but also encompass other research areas such as biopsychosocial science, bioethics and religion, and reproductive health policy and law. Oncofertility trainees would be paired with mentors who are leaders in their respective fields both in and outside of medicine. Each oncofertility training program should provide opportunities for training in areas directly related to or associated with issues facing patients with a new cancer diagnosis as well as their families. The training experience should include participation in adult and pediatric oncology clinics and exposure to cancer genetics and pharmacology.

It is also recommended that each oncofertility training program identifies a cadre of mentors outside the direct medical field who will guide both the Executive Steering Committee and the fellows in the interdisciplinary educational program, which is so critical for the development of the oncofertility specialist.

Comprehensive, Multidisciplinary Training

The fellowship/research program directors of oncofertility training programs should be responsible for ensuring that fellows gain training and exposure to areas that span the entire spectrum of oncofertility, including, but not limited to, adult and pediatric oncology clinics, cancer genetics, and cancer pharmacology (see educational program description below). In addition, each fellow should be expected to receive instruction in biopsychosocial science, bioethics and religion, and reproductive health policy and law. Therefore, it should be stressed that each oncofertility training program encompasses comprehensive medical and pediatric oncology programs, which provide the fellows with the opportunity for clinical interactions during training.

The primary focus of research projects for oncofertility fellows should be the human oocyte, which is so fundamental to the reproductive capacity of women across a comprehensive spectrum of normal and altered physiological conditions. This cell is arguably the most interesting and important cell in all of biology. On one hand, the oocyte harbors the ability to start new life and to bring happiness to infertile or childless people. On the other hand, it has the inherent capacity to reprogram our genetic material so that it can generate any stem cell or other cell type in

the human body. The spectrum of oocyte function encompasses a continuum of stage-specific physiological processes: germ cell growth, differentiation, and regulation; primordial follicle formation and demise and the role of granulosa cell support; antral follicle development, growth, and final maturation; and, finally, ovulation, corpus luteum formation, and luteal function. Each of these considerations is intimately involved in the generation of a healthy oocyte, and physiological alterations of these processes may lead to clinical disorders, such as premature ovarian failure, anovulatory dysfunction, polycystic ovary syndrome, infertility, and premature menopause.

A similar approach may be used for the study of male fertility preservation techniques. While sperm cryopreservation is standard of care in postpubertal males, no viable fertility preservation option(s) exist for prepubertal males. Maturation of testicular spermatogonial germ cells from testicular tissue is an area of active investigation. Hence, oncofertility fellows should also be educated in sperm and testicular physiology. Training of interested urologists not only in sperm and testicular tissue procurement techniques but also in research methodologies involving the *in vitro* or *in vivo* sperm maturation and in techniques of sperm and tissue cryopreservation is imperative.

In addition to the above, a training program for the oncofertility fellows should encompass the fundamentals of tissue engineering and biomaterial design principles. Fellows should receive training in the manipulation and handling of ovarian follicles and spermatogonial germ cells, learn how tissue engineering can be applied to biomedical science, and understand the various types of biomaterials, how they can be used, and what properties are important to consider when developing a research project. Fellows should be trained to follow standard operating procedures, learn to think in a hypothesis-based manner, and ultimately develop an independent project to be conducted during the research fellowship.

A major goal of an oncofertility research program should be the development of improved methods to cryopreserve gametes and reproductive tissues based upon sound, fundamental cryobiological principles. To achieve this goal, the research should focus on developing and testing optimized methods for the cryopreservation of *in vitro* matured oocytes, immature follicles, and ovarian tissue. The fellows participating in an oncofertility training program should receive state-of-the-art instruction on the physics and biomechanics of cell/tissue cryopreservation and should have the opportunity to test the competence of the freeze/thawed gametes to undergo fertilization and early development using animal models such as rodents and nonhuman primates.

The use of ART to treat human infertility has gained widespread use, and it is estimated that 1 out of 70 children born in the USA will have been conceived by ART. Disconcerting to many in the research community is that the clinical procedures used in ART are rapidly outpacing the underlying science—an example of ART before science. Recent retrospective studies have unmasked an increased incidence of certain genetic syndromes that may be the result of loss of imprinting. Even though the prevalence of these syndromes is extremely low, it is conceivable

that these observations may represent the “tip of the iceberg” and that perturbed silencing of other (imprinted) genes may cause effects that appear later in life. These observations and theoretical concerns have prompted several groups of investigators and their collaborators who represent diverse areas of expertise—toxicology, behavioral science, genetics, pharmacology, and clinical reproductive medicine—to address these issues. Thus, studies of the effects of *in vitro* conditions on gene expression in general and specifically on the epigenetic regulation of imprinted and other genes critical in development should be part of the research and training agenda of an oncofertility program. Such studies are critical prior to clinical application of ART. It can be easily seen how the oncofertility trainee would greatly benefit from such an experience.

Research Training

The goal of an oncofertility training program is to prepare talented MD, PhD, or MD-PhD reproductive endocrinologists in training for investigative careers in the interdisciplinary field (supra-speciality) of oncofertility through intensive research training under the guidance of experienced mentors. Research based on molecular and cell biology approaches should be emphasized, stressing whenever possible the translation of research findings to human biology and/or clinical application. These apprenticeships have a clear vector, which is progression to independence.

The research training and educational program should be designed to train fellows in cellular and molecular approaches to research in reproductive biology relevant to oncofertility. The following model of training is suggested:

- *Each* selected fellow spends the first month of oncofertility training to familiarize themselves with follicle culture systems. Such an experience provides the fellow with the opportunity for education in the physics of biomaterials. For fellows interested in research involving male fertility preservation, focused training in *in vitro* and *ex vivo* systems for the maturation of the male gamete should be considered.
- Each oncofertility fellow should be assigned a faculty research mentor involved in basic research within the areas of interest outlined in the previous section. All the mentors should have pledged support for the planned research training, have adequate space to accommodate the trainee and, most importantly, have sufficient time to work directly with the trainee in establishing and conducting the research project. The research project and an individualized curriculum should be developed in consultation with the mentor and a member of the Executive Steering Committee.
- A *second* mentor outside the field of reproduction should also be assigned to each trainee. This is meant to monitor, guide, and encourage the fellow on the interdisciplinary aspects of their professional development. Given the focus of the oncofertility specialty, this is deemed as extremely critical. To stress this, the

Executive Steering Committee should require periodic written reports by these mentors about the activities and progress of the fellow with respect to their interdisciplinary educational experience.

- All oncofertility fellows should be required to take courses to supplement their laboratory research experience. The following are examples of courses with relevance to the developing academic career of an oncofertility specialist:
 - *Cancer Genetics and Biology*: The course involves lectures and readings of important papers on cancer genetics, cancer cell growth, metastasis, angiogenesis, and experimental therapeutics.
 - *Topics in Cancer Pharmacology*: Reviews current literature on topics such as cancer genetics, hormonal carcinogenesis, environmental carcinogens, chemotherapy and gene therapy for cancer, cancer epidemiology, and prevention. New hypotheses in cancer etiology, prevention, and treatment are discussed as they appear in the literature. The aim of the course is to introduce the students to the latest developments in the above areas related to cancer pharmacology.
 - *Frontiers in Cancer Pharmacology*: This course combines didactic lectures from faculty with oral presentations and oral assignments from the students. The faculty present overviews of current and emerging topics in cancer pharmacology. Emphasis of the presentations is on the translation of basic science discoveries into therapeutic agents. Students choose related topics to explore in more detail.
- All oncofertility fellows should be required to have clinical exposure to adult and pediatric oncology patients who face the prospect of fertility loss or compromise. This can be done in conjunction with reproductive endocrinology and medical/pediatric oncology faculty who consult on these cases.
- All oncofertility fellows should be required to receive formal instruction in the responsible conduct of research (see below).
- All oncofertility fellows should be required to attend seminars, journal clubs, and lecture series at their institution. These educational programs exemplify the interdisciplinary nature of the training experience. A typical academic enrichment program includes attendance at weekly Grand Rounds in obstetrics and gynecology, the Cancer Center, and endocrinology; weekly Basic Science Lecture Series in reproductive biology; twice monthly journal clubs in reproductive medicine and oncology; monthly departmental and Cancer Center morbidity and mortality conferences; and other seminars of relevance in the departments of pharmacology, bioethics, and cell and molecular biology.
- All oncofertility fellows should be encouraged to attend courses and lectures that will increase their comprehensive awareness of oncofertility including, but not limited to, biopsychosocial science, bioethics and religion, and reproductive health policy and law.

Program Evaluation

Measures

An ongoing process for monitoring the success of any oncofertility training program should be established. Fellows should be required to submit written yearly progress reports, and these should be reviewed by the Executive Steering Committee. In addition, face-to-face meetings of fellows with members of the Executive Steering Committee should be arranged during annual meetings of the relevant societies such as SGI, ASRM, SSR, the European Society of Human Reproduction and Embryology (ESHRE), or The Endocrine Society. As the oncofertility specialty evolves and the training program matures, larger “oncofertility workforce meetings” can be held at which all fellows, mentors, and members of the Executive Steering Committee and Advisory Board attend. All fellows should be required to submit, in addition to written progress reports, a list of all publications and presentations at scientific meetings in which they have participated. It is the Executive Steering Committee’s intent to encourage fellows to present their research findings at national meetings that reflect the interdisciplinary nature of this program, not only at medical/pediatric oncology meetings but also at biophysiology and bioengineering, psychology, sociology, or nursing meetings. The above information should form the basis for a database of fellow progress and achievement, which can be updated annually.

Fellows should be asked to continue submitting information for 10 years following graduation from the oncofertility training program. The following “end points” for each oncofertility fellow can be monitored as evidence of program success:

- Entrance into academic positions
- Application and successful competition for mentored research positions such as RSDP, WRHR, or BIRCWH positions in the USA or other similar programs in other countries
- Application and award for individual mentored grants (such as K08 in the USA)
- Application and award as principal investigator of subprojects in major program project-type grants
- Applications and awards of individual pilot or major grants (R03 or R01 grants in the USA)
- Publication record in peer-reviewed journals
- Evidence of interdisciplinary and collaborative research by evaluating coauthors and participating departments in publications
- Promotion record
- Attrition record from academic ranks

Data should be compiled annually and shared with the Advisory Board in order to obtain guidance as to the direction and focus the program should take.

It may be advisable that a separate Program Evaluation Committee be assembled to evaluate and monitor (a) the long-term success of the program, (b) the Executive Steering Committee, and (c) the selection process. Since entry and success in academic medicine and establishment of oncofertility programs are the primary goals of the described training initiative, the Committee should be composed of one dean, two department chairs, and two program directors of major research programs. The program director and an additional member of the Executive Steering Committee can be ex-officio, nonvoting members of this Program Evaluation Committee.

Networking

A critical component in the development of future leaders in academic oncofertility involves the establishment of appropriate networking at the national *and international* levels. Program directors should take advantage of existing fellow retreats and plan to advocate for their oncofertility fellows to attend. These retreat programs not only facilitate networking between active fellows but also, and most importantly, encourage interactions in an informal setting between fellows in training, various leaders in academic medicine, and fellows in other fields, thus promoting interdisciplinary interactions and collaboration. These retreats can greatly enhance the level of camaraderie and help formulate the professional aspirations, both academic and clinical, of many budding oncofertility specialists. It should be recognized that these individuals are the future of the discipline and will one day fill the ranks of the various programs. Inclusion of oncofertility fellows in such retreats should foster their success as interdisciplinary, collaborative academicians.

Dissemination Plan

It is particularly critical to insure that there is appropriate dissemination of training program information in order to cast a wide net for recruitment of the “best and the brightest” into the oncofertility field. An oncofertility training program should integrate the following strategies for accomplishment of this goal:

- Include a section within each institution’s Web site that describes the field of oncofertility and the oncofertility training program and provides links to other established fertility preservation research and clinical programs’ Web sites.
- Send *yearly* letters to department chairs and program directors announcing the program and describing the application process and deadlines.
- Send *yearly* letters to deans and department chairs at institutions around the world describing the program and announcing opportunities in oncofertility training.
- Include an announcement for the oncofertility program with appropriate URL links and e-mail addresses in the ASRM Newsletter “ASRM News.” Do the

same with the affiliated societies' quarterly e-newsletters (Society for Reproductive Endocrinology and Infertility [SREI] and the Society for Assisted Reproductive Technologies [SART]) and with the newsletters of The Endocrine Society, ESHRE, and other international societies.

- Distribute oncofertility program and application information to all REI fellowship program directors.
- Distribute oncofertility program and application information to all REI fellows during their annual retreat.

Instruction in the Responsible Conduct of Research

All oncofertility trainees should participate in an institution-wide program on the responsible conduct of research, which in most institutions is coordinated by the office of the Vice Dean for Research and Training and the Center for Bioethics. All postdoctoral trainees should be required to attend an annual colloquium in which relevant issues (e.g., conflict of interest, assigning authorship) are discussed by a panel of investigators and administrators. During the course of their training, they must also attend discussion groups in which specific "cases" are discussed. Most major research institutions have established such programs, and oncofertility fellows should join other fellows in attending these programs as part of their training.

Significance and Interactions

With improved methods of cancer detection, advances in cancer therapy, and greater rates of cancer survivorship, the "supra-speciality" of oncofertility must be considered an integral component of comprehensive cancer care. Oncofertility training programs must convey the current concepts regarding the interdisciplinary relationship between basic and clinical science, as well as nonmedical fields, and how they impact the delivery of healthcare in our society. Indeed, the growing knowledge of ovarian reproductive physiology and follicle health and development, together with the willingness of several diverse disciplines to interact and achieve common goals in cancer patient care, has led to the development of a far-reaching new field of inquiry and its corresponding program of training that has global implications.

The current method of coordination and implementation of fertility care in patients with cancer consists of a series of communications between a cancer specialist with essentially no knowledge of reproductive biology and a reproductive specialist who has little understanding of how cancer treatment impacts reproductive health. In addition, there has been little consideration for comprehensive approaches to providing patients and their families with a full overview of fertility potential for young cancer patients. Moreover, it is recognized that there is no single specialty in physiology or medicine and no single institution that can provide all the

elements needed to provide such comprehensive care. The described oncofertility training program directly addresses this gap by providing reproductive specialists with the necessary knowledge and skills to bridge disciplines and receive training in both basic and clinical research. The success of an oncofertility training program requires the combined efforts of many individuals in diverse disciplines who are committed to the overarching goals of oncofertility. To that end, the curriculum is broad but also highly focused in certain required areas. In particular, a heavy emphasis on research is warranted to increase knowledge of the impact of cancer treatment on follicle and oocyte health and technologies that are being developed to provide new options for fertility preservation. The budding oncofertility specialist is given an opportunity to become familiar with the emerging technology for follicular growth in vitro and for cryopreservation of ovarian tissue, follicles, and oocytes. Moreover, this research experience provides a springboard for fellows to pursue an academic career within the oncofertility specialty. The comprehensive nature of the training also introduces biopsychosocial, ethical, and policy considerations that arise in the emotionally difficult time right after a new cancer diagnosis and can improve the ability of healthcare providers to counsel patients and their families about their fertility preservation options.

The described oncofertility training program should serve as a template for similar situations in healthcare where multiple disciplines must come together to create the opportunity to achieve the best outcome for patients. Having a dedicated specialist in oncofertility certainly improves the fertility options and lives of those who survive the ordeal of cancer and its treatment.

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