

# Evaluation of an embryology and genetic testing patient counseling education intervention for reproductive endocrinology nurses

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**Objective:** To study the impact of an educational program on the knowledge base of reproductive endocrinology nurses on embryology and genetics topics to determine both improvement in knowledge and confidence in the nurses' ability to counsel patients on such topics.

**Design:** Interventional study.

**Setting:** Clinics.

**Patient(s):** None; subjects were reproductive endocrinology nurses.

**Intervention(s):** Preintervention knowledge self-efficacy test, educational exposure, and 2-week follow-up testing.

**Main Outcome Measure(s):** Knowledge test scores, self-efficacy scores.

**Result(s):** Nurses, regardless of educational attainment, demonstrated statistically significant increases in knowledge of both embryology and genetics, which was retained at least 2 weeks after the educational intervention. Furthermore, nurse self-efficacy increased after intervention, and qualitative data support the desire for increased educational opportunities.

**Conclusion(s):** Nurses benefit from focused educational efforts, resulting in improved knowledge in embryology and genetics. This improved knowledge base resulted in improved nurse confidence in patient education. (*Fertil Steril*® 2019;112:275–82. ©2019 by American Society for Reproductive Medicine.)

**El resumen está disponible en Español al final del artículo.**

**Key Words:** Reproductive endocrinology nurses, embryology, genetic testing, self-efficacy, education

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**A**lthough reproduction and family-building is a fundamental human plan, multiple biologic and social barriers can limit or prevent many from achieving such goals. One in eight U.S. couples have

difficulty conceiving (1). The contemporary definition of infertility is the inability to conceive, and intervention is recommended after 1 year of unprotected regular sexual intercourse with no conception if the female partner is

under 35 years of age, which is reduced to 6 months if the woman is 35 years of age or older (1). For these women, successful pregnancy often requires clinical evaluation and treatment. For ~85%–90% of couples experiencing difficulty with conception, low-technology medical intervention can aid in the facilitation of a pregnancy (2). For the remaining 10%–15%, in vitro fertilization (IVF), with or without genetic testing, is often their sole option to achieve reproductive success (2). Also of note, infertility diagnoses affect men and women equally (2).

Patients are motivated to achieve pregnancy and expect information regarding the quality of their embryos

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and the results of preimplantation genetic testing; often, physicians counsel patients about the benefits and risks of genetic testing, but physicians do not have as much time with patients as the nurses who more regularly interact with these patients. Mitchell et al. state that, over time, the responsibility of the physician has shifted to nurses, increasing and changing the nurse's workload, and has blurred the boundaries of clinical practice (3). Reproductive endocrinology nurses play a vital role in the success of IVF but are unfortunately often unfamiliar with complex embryo morphology and genetic testing results, limiting their ability to counsel effectively (4).

There are no published studies on nurse training in embryology and genetics relative to the biologic tenets of cellular division nor the impact of such training on patient counseling and nurse confidence. Furthermore, formal nursing education for embryology and genetic testing is limited (5). The majority of the novice fertility nurse education comes as informal mentoring from a more experienced nurse (3, 4, 6). The morphologic and genetic data of embryos are often not discussed in detail with the nurses and consequently the information is not effectively passed on to patients through the nurses. Such knowledge would be beneficial in patient discussions benefiting the parents and future children, because nurses are often asked to clarify or elaborate on discussions held with the physician (4).

To address the current gap in nursing education, an educational intervention was implemented to increase knowledge in reproductive endocrinology nurses about the laboratory science of IVF. The educational intervention provides nurses with a clear understanding about the methods and impact of embryology and genetics on patient outcome. The objective of the educational intervention was to characterize the effect of medical education on the ability of nurses to effectively counsel patients on embryology and genetic testing. Furthermore, we assessed the self-efficacy of nurses and how nurses used the provided training of morphologic embryo quality and genetic testing of embryos in counseling patients. We hypothesized that after completion of the intervention, nurses would have an improved understanding of embryology and genetic testing and improved confidence in counseling patients. The knowledge gained would empower nurses as invested participants in the conversation about improving outcomes for couples.

## MATERIALS AND METHODS

### Sample

The educational assessment was delivered in different clinics during a "lunch and learn"-type forum until the sample size of 60 nurses was reached (see the Independent Variable Analysis section for power analysis). The intervention was a Powerpoint presentation, ~25 minutes per topic with the use of slides, pictures, embedded videos, and photographs explaining the basics of embryology and cellular and nuclear division (meiosis and mitosis). The presentation was recorded and voiceover was used to reduce variation. Because questions would have skewed the results between presentations, no questions were allowed. Each nurse was asked to put a personal four-character alphanumeric code of their choice to

assure anonymity during the testing process and to link the preintervention surveys with the postintervention surveys. The investigators were unaware of the specific four-character identification number chosen by each subject, and no personal identification information was provided on the testing material.

### Instrumentation

Four tools were developed for the research study, including: 1) the Reproductive Endocrinology Nurses Demographic and Descriptive Data Collection Instrument; 2) Level of Knowledge of Laboratory Science and Reproductive Genetics Preassessment (given before and 2 weeks after intervention); 3) Nurses Self-Efficacy and Confidence Scale (given before and 2 weeks after intervention); and 4) open-ended question instrument to gather qualitative data to triangulate with quantitative data.

Two medical doctors and two embryologists validated the assessment and the self-efficacy tools for content. If the questions or answers were determined to be unclear, unnecessary, or unreliable, the questions were discarded or corrected until the validators reached consensus. In addition, Cronbach alpha was performed for postintervention validation.

**First instrument: reproductive endocrinology nurse demographic and descriptive data collection instrument.** The reproductive endocrinology nurse demographic tool was used to capture relevant demographic data and individual nurse characteristics, such as educational degree level achieved, years of nursing experience, years of fertility nursing experience, job title and previous job title, and type of tasks done in the clinic on a percentage basis over a week's time. Based on the research done on nurses' work in IVF centers and their varying job responsibilities, it was important to capture the percentage of time doing a particular task as well as the demographic data that most affected the nurses' learning.

**Second instrument: pre-lecture and post-lecture assessment of embryology laboratory and reproductive genetic knowledge.** The level of knowledge of embryology laboratory and reproductive genetics test had been developed to determine the level of baseline knowledge (before) and knowledge gained (after) about the embryology laboratory and reproductive genetic testing. The questions were from the four lecture domains, including embryology laboratory terms and definitions, embryology laboratory processes, reproductive genetic terms and definitions, and reproductive genetic processes. The questions were written so that the nurse would have to apply knowledge rather than memorize terms. Topics in the 20-question test were based on components identified as important components for nurses in laboratory science and reproductive genetics. The items were in a four-choice multiple-choice format with a fifth choice of "I don't know" to eliminate the possibility of answering questions correctly by chance.

**Third instrument: pre-lecture and post-lecture Nursing Self-Efficacy and Confidence Scale.** The pre-lecture and post-lecture Nursing Self-Efficacy and Confidence Scale

(NSECS) ascertained on a Likert-type scale the comfort level of the nurse with the information and how it was useful in a patient-facing role. The NSECS research tool was used to assess preintervention and preintervention self-efficacy of nurses in terms of laboratory science and reproductive genetics. The self-efficacy scale consisted of five terms. The 11-item NSECS determined self-efficacy and self-confidence before the nurse heard the lecture on embryology laboratory and reproductive genetics. The researcher included one statement as a “not” question to increase validity. The preintervention self-efficacy assessment was used to determine the baseline confidence and the postintervention efficacy assessment was used to determine if the educational intervention was helpful in increasing the confidence of the nurses to discuss embryology laboratory and reproductive genetics with patients.

**Fourth instrument: qualitative assessment.** A qualitative assessment was given to the participating nurses to determine if the knowledge conferred during the lecture had helped in conversations with patients regarding their laboratory and reproductive genetic testing. The four questions were written to assess their opinion on the utility of such a program and the comfort level of the nurses while discussing these topics with patients, and to allow for unscripted replies to get feedback from the individual nurse. The qualitative questions were open-ended and asked the participant to describe in detail any changes to their comfort level in counseling patients about the embryology laboratory and reproductive genetics.

The instructions for the post-surveys and qualitative questions were sent to the participating nurses 2 weeks after the intervention. The nurse had the opportunity to reply via an anonymous link in an e-mail sent by the data manager (W.H.C.) to keep the researcher blinded throughout the process. The link sent the nurse to Survey Monkey, where the same knowledge assessment, confidence scale, and qualitative questions were hosted.

### Research Questions Analysis

Normality testing was performed. When the data were normally distributed, a paired *t* test was used to compare the pre- and post-NSECS to determine if statistically significant differences existed. A *t* test was also used to compare the pre- and post-knowledge assessment test score. In addition, test item difficulty analysis and a Kuder-Richardson 21 analysis was used to validate the knowledge test. The significance level was set at *P* = .05 and the confidence level at 95%.

### Independent Variable Analysis: Research Questions

The independent variables that were measured were years of experience, job title, previous job title, degree achieved, percentage of time in front of patients in a counseling or teaching role, and whether the nurse has had any embryology or genetics course before the intervention. The dependent variables were the scores on the pre- and post-educational intervention knowledge assessment and the self-efficacy scale both before and after the educational intervention. A power calculation

was performed and with a standard deviation of 0.25 and statistical significance of 0.05, the number of nurses needed to participate was determined to be 58. The completion of the pre-assessments of 61 participants constituted the sample group for this study.

### Institutional Review Board Approval and Ethical Considerations

Research approval and permission granted to perform the study was obtained through the A.T. Still University Institutional Review Board. It was determined that the educational intervention was exempt, requiring only informed consent to participate in the research study, because it was an educational intervention with surveys and knowledge assessments.

## RESULTS

### Descriptive Statistics

The nurses were 100% female. Of the 61 nurses who participated, 41 nurses completed the pre- and post-tests. The educational breakdown of the group who completed both the pre- and post-tests was as follows. Nine participants had less than a Bachelor degree and described their degrees as Associate, Licensed Practical Nurse, Medical Assistant, or high school diploma; and 26 held a Bachelor degree (Table 1). Ninety-three percent had a nursing degree and the 7% had a bachelor degree but were not nurses. Four participants earned a Master degree in nursing, and one participant was a Medical Doctor.

### Knowledge Assessment Validation

A test item difficulty index was conducted on all test questions. For the assessment of test difficulty, the researcher can use a combination of test question difficulty indices as indicated by education theorists. A mix of question difficulties is optimal; in the case of the knowledge test, most

TABLE 1

Demographics of reproductive endocrinology nurses (n = 41).

|                     |    |                       |       |
|---------------------|----|-----------------------|-------|
| Years of experience |    | Year of degree        |       |
| 0–5                 | 15 | 2010+                 | 13    |
| 6–10                | 4  | 2000–09               | 13    |
| 11–15               | 7  | 1990–99               | 8     |
| 16–20               | 7  | 1980–89               | 5     |
| 21–25               | 3  | 1970–79               | 1     |
| 26–30               | 2  | 1960–69               | 1     |
| ≥31                 | 3  |                       |       |
| Degree              |    | Previous course       |       |
| < than B.S.         | 11 | Embryology            | 8     |
| B.S.                | 25 | Genetics              | 11    |
| > than B.S.         | 5  | Average time (%)      |       |
|                     |    | Counseling medication | 24.20 |
|                     |    | Counseling treatment  | 21.20 |
| Job title           |    | Administration        | 21.00 |
| Donor coordinator   | 5  | Teaching internal     | 16.00 |
| IVF coordinator     | 8  | Other                 | 12.40 |
| Nurse               | 26 | Procedure based       | 3.00  |
| Supervisor          | 4  | OR                    | 1.20  |
|                     |    | Recovery              | 1.00  |

Catherino. Fertility nurses' knowledge and confidence. *Fertil Steril* 2019.

questions fell in the “difficult” (five questions) to “moderately difficult” (13 questions) range.

The Embryology Laboratory and Reproductive Genetics Knowledge test was validated with the use of KR-21 analysis, which measures interterm consistency of the test when the test answers are not dichotomous. The KR-21 value of 0.825 is consistent with acceptable reported values of interterm consistency and validity. The Cronbach alpha is another statistical test used to measure validity, but KR-21 was used because of the range of test item difficulty.

### Normality Testing

To assess normality, we compared the mean and median of the pre-test scores (0.512 and 0.55), suggesting minimal if any left or right skew. Furthermore, the proportion of data that fell within 1 standard deviation and 2 standard deviations was assessed. We expected that 28/41 participants (68%) would score within the mean  $\pm$  1 SD and observed that 25 nurses fell within 1 SD. It was expected that 39/41 subject scores (95%) would be within 2 SDs and observed that all 41 scores fell within this range. We expected that all of the data would fall within 3 SDs, and this was observed to be true. Based on these observations, the data reasonably approximated the 68-95-99 rule, and did not demonstrate notable skewness. The assumption of normality was tested by means of the Shapiro-Wilks value ( $W = 0.968212$ ;  $P = .113412$ ), and the sample was accepted to have a normal distribution.

### Knowledge Assessment

The pre- and postintervention scores on the knowledge assessment showed significant difference in the nurses' scores in aggregate. Figure 1 illustrates the pre- and postintervention scores of the nurses, and the change in scores of embryology

questions ( $P < .00068$ ; blue bars) and in scores of genetics questions ( $P < .00001$ ; red bars). The postintervention assessment was offered 2 weeks after the intervention to measure the nurses' recall of the material.

**Previous education and courses in embryology and genetics.** Figure 2 portrays the impact of the relative level of education on knowledge development during the educational process. Those with a Bachelor degree or less had statistically significant increases in scores. Subjects with advanced degrees demonstrated improved knowledge, although the number of subjects was low and did not achieve statistical significance. Notably, when embryology and genetics findings were individually assessed, all groups demonstrated statistically significant increases in knowledge.

Of the 61 nurses who completed the demographics survey, 12 had some previous exposure to embryology in some type of formal instruction and 18 had some instruction on reproductive genetics. A subanalysis was performed on these groups to determine if previous exposure was helpful. A paired  $t$  test was performed which demonstrated statistically significant differences in pre-test knowledge levels between participants who had completed a previous course in fertility or genetics and those that did not. The previous courses led to higher baseline and post-test scores when analyzed by subject and when analyzed together.

**Time spent at counseling patients versus other duties.** Reproductive endocrinology nurses spent much of their time counseling patients, according to the self-reporting demographic survey. Among the subjects, 44% spent  $\geq 50\%$  of their time counseling patients on medications and treatment. When teaching was also included, more than 68% of the subjects spent  $\geq 50\%$  time on these job responsibilities. Because nurses reported actual time spent counseling in percentages, to do statistical analysis the participants were broken into two groups: those who spent  $\leq 50\%$  of their time counseling

FIGURE 1

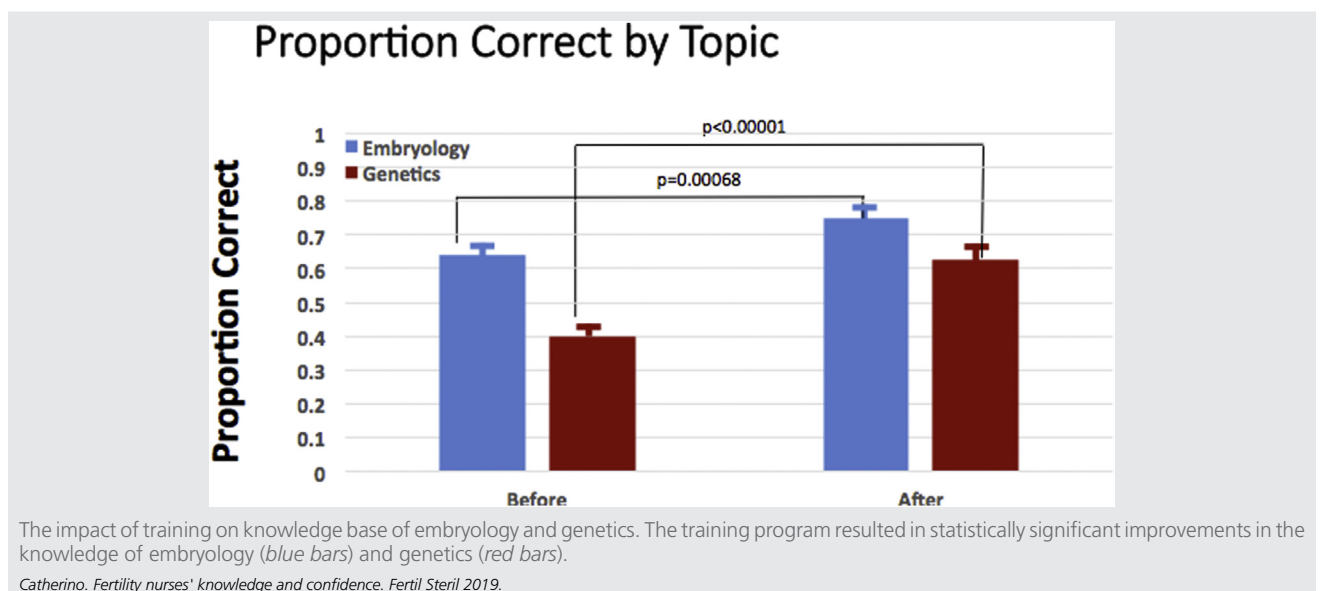
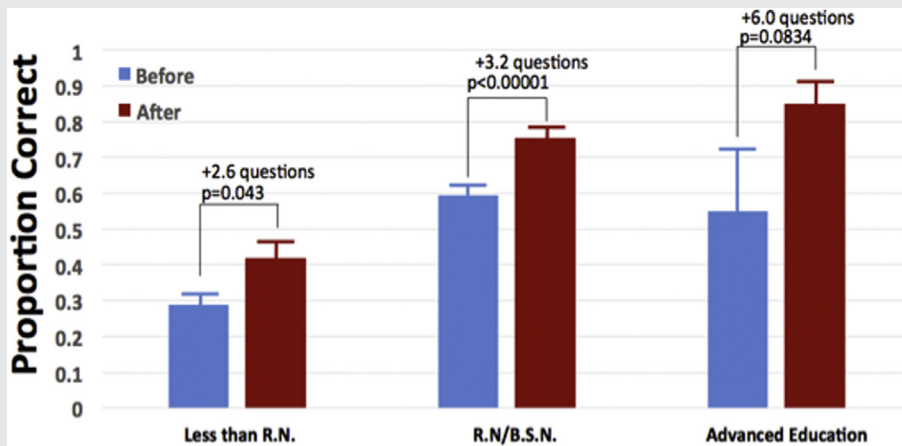


FIGURE 2



The impact of education level on knowledge testing. Among fertility nurses with an advanced degree, the impact of the educational training did not achieve statistical significance ( $P=.0834$ ), at least partially because of low numbers. However, all nurses with a Bachelor degree or less education demonstrated statistically significant improvement with training. When embryology and genetics knowledge scores were analyzed separately, all but one nurse benefited from training, regardless of educational exposure. Blue bars represent percentage correct before the training, and red bars represent testing 2 weeks after training.

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( $n = 23$ ) and those who spent  $>50\%$  ( $n = 18$ ). A paired  $t$  test was performed to see if there were statistically significant differences in pre- and post-test scores between these two groups. There were statistically significant differences between the two groups on the pre-test embryology domain ( $P=.047$ ). There were no other statistically significant differences between the two groups of nurses. The nurses who counseled patients more often scored higher overall on the pre- and post-tests. Regardless of their percentage of time spent counseling patients, all but one of the nurses showed improvement in their knowledge scores (Fig. 3).

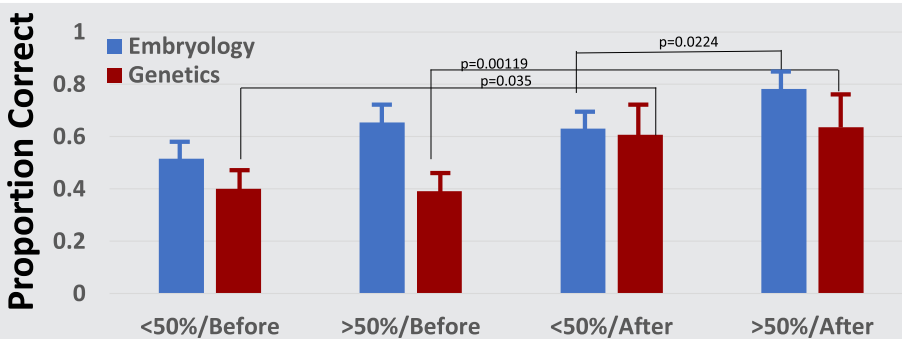
### Self-Efficacy and Confidence

The NSECS, a Likert-type scale survey tool, was validated. The NSECS was shown to be reliable and to have high internal

consistency as determined by an overall Cronbach alpha of 0.8595, which indicates excellent reliability. There was a range of the individual questions' reliability scores from a low of 0.8324 for the question, "I am confident that I can explain different methods of fertilization to patients," to a high of 0.8733 for the question, "I need more education about fertility laboratory procedures to be truly confident in my job."

Self-efficacy in nurses improved after the intervention in the individual self-efficacy statements, numbers 1–5, as indicated by a paired  $t$  test that showed statistically significant differences (Supplemental Fig. 1, available online at [www.fertstert.org](http://www.fertstert.org)). Participant responses reflected movements from neutral to slightly positive perception and from close to neutral/slightly above neutral to "agree." In the general competence self-efficacy and confidence questions, questions

FIGURE 3



The impact of time invested in patient counseling on improvement in knowledge with training. Subjects were divided into those who provided counseling for  $\leq 50\%$  of their time and those who counseled  $>50\%$  of their time. Nurses with greater counseling responsibilities had greater improvement in both domains of embryology and genetics knowledge compared with those with less counseling responsibilities.

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6–9, there was no significant difference between the before and the after self-efficacy scores. Reproductive endocrinology nurses, in general, are quite confident in the areas of general competency and confidence. For the two questions that asked if the nurses felt that they needed further training to be confident, questions 10 and 11, the nurses' responses, on average, decreased significantly, which reflects a neutral perception and indicates that respondents, after intervention, did not perceive that they required more training in embryology laboratory and reproductive genetic testing to be truly confident in their job.

### Qualitative Data

The open questions allowed the nurses to comment on the format of the education and the benefit of increased confidence. Regarding counseling patients and discussing the results of genetic test and embryo morphology assessments, a theme of confidence emerged in the free text, with, after the educational intervention, 66% of nurses feeling more confident in discussing embryology and genetic testing with patients, 27% feeling about the same level of confidence, and 7% feeling that they needed more information to feel truly confident.

### DISCUSSION

This educational research study of nurses was created, implemented, and evaluated to determine the baseline level of self-efficacy and knowledge of the embryology laboratory and reproductive genetics and to increase both the knowledge and the self-efficacy of nurses. Results indicated a statistically significant difference in the pre- and post-knowledge test and the level of self-efficacy and confidence of the nurses. These results demonstrate the need for such a curriculum and the utility of the curriculum in helping nurses to more effectively and efficiently counsel patients. There are no peer-reviewed manuscripts about the level of knowledge of embryology and genetic testing and self-efficacy of nurses working in a fertility clinic. This study was the first of its kind to begin to build such a body of research. The learning was a voluntary exercise, and there was no mandate by the fertility clinics to finish the study. In the pre-test/post-test model, dropout is expected and steps were taken to minimize it. Despite e-mailing the nurse managers about the number of nurses that did not follow-up with the study, dropout remained at a rate of 32%. Because we were blinded to the individual nurses we could not ask individuals to complete the survey. We hypothesized that perhaps the nurses who did not feel confident on the first measurement tools were the ones who did not take the post-test measurement, but the pre-test scores between the two groups were not statistically significant. Finally, because the clinic was blinded as to the nurses who completed the entire battery of surveys and tests, there was minimal Hawthorne effect, the behavior to work harder and perform better due to observation.

Currently, most novice nurses are taught by experienced nurses, often by "on-the-job" in-house training courses; thus, training has been demonstrated in two studies to be often

interrupted and noncontinuous, and given a low priority in the clinic (3, 4). Once the novice nurse has shown proficiency in the basics of information needed to be a fertility nurse, continuing education becomes an even lower priority for the practice (4, 9). Further exacerbating the problem is that nursing curricula do not incorporate the basics of cell biology, embryology, and genetics, so even nurses who might be motivated to educate themselves in the science of the embryology laboratory may lack some of the basic information to build on, as construct education theorists describe (7, 8). Even further, most often nurses are recruited from the labor and delivery ward, who for a variety of reasons, decide to stay in women's health and are employed by a fertility clinic. The training of a labor and delivery nurse does not prepare them in any way for the complex topics of discussion in a fertility clinic.

In the present research, of the 41 who completed both the pre- and the post-surveys, eight nurses reported that they had previous exposure to embryology laboratory information and 11 described previous exposure to reproductive genetics. Based on the nurses' qualitative assessment and the differences in the pre- and post-test scores, this type of practical knowledge of the embryology suite and reproductive genetic testing was helpful to their understanding and aided their counseling efforts to patients in the embryology laboratory section but not in reproductive genetics. This study provided a practical review of the building blocks missing from nursing curricula. The lecture gave the nurses the necessary statistics and understanding of cell biology to help their patients make informed decisions about the plethora of tests and options available to them as fertility patients.

Until employed by a fertility center, many nurses reported not needing to understand the embryology laboratory nor reproductive genetics. However, for counseling and answering patient questions, information to conceptualize what is happening during cell division clearly helps the nurses in understanding where the errors can and do occur in embryos. Furthermore, an understanding of the process of cell division, together with gene structure and division, may make explaining the options to patients easier.

Development of a nursing program by the American Society for Reproductive Medicine has partially addressed the need of the nurses. This 16-hour membership-only online program for nurses has not been well attended by the fertility nurse community. One issue may be that nurses prefer mobile learning options (cellular phone applications or podcasts) versus Powerpoint and lecture (9, 10). Peddie et al. note that there is no formal training program available for fertility nurses to date, further supporting the idea of on-the-job training (5). Another critical issue may be that the nurses are expected to hold knowledge that was never taught to them, and therefore to move beyond these tenets, to explain and counsel patients about options and choices for care, may be difficult. Creating an environment that encourages growth beyond university education will be helpful to the nurse who desires further education to be a more informed counselor and nurse to her patients. Additionally, we show that, without the understanding of the biologic basics, it is

very difficult for that learning to be grounded in previous learning, a constructionist theory of learning (7, 8). Grounding the nurses in cellular division, spindle biology, and DNA disposition proved to be helpful. Describing two biologic fundamentals was helpful in meeting the learning objectives of the study participants. Finally, nurses describe counseling patients as representative of the majority of their time in the ART clinic, and so understanding of all points of a fertility patient's journey is imperative.

The need for reproductive endocrinology nurses is on the rise. As embryology laboratory and reproductive genetic testing continue to evolve, nurses need to be able to understand the impact of these tests and procedures and to be comfortable and confident in the role of counselor and in obtaining informed consent from patients and their partners. Despite the need for basic biologic education as foundational building blocks for more advanced knowledge, it is lacking in nursing curricula. The reported roadblocks in teaching these basic tenets at the clinic level are lack of time, lack of expertise, and lack of institutional support in education of fertility nurses. The present study demonstrates that nurses have a desire and ability to learn and that learning improves confidence in counseling patients.

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**Evaluación de una intervención educativa para enfermeras de endocrinología reproductiva para el asesoramiento de los pacientes en los test embriológicos y genéticos**

**Objetivo:** Estudiar el impacto de un programa educativo en la base de los conocimientos de las enfermeras de endocrinología reproductiva en embriología y en temas genéticos para determinar tanto la mejora en el conocimiento como en la confianza de la capacidad de las enfermeras para aconsejar en esos temas.

**Diseño:** Estudio intervencional.

**Lugar:** Clínicas.

**Paciente(s):** Ninguno, los sujetos fueron enfermeras de endocrinología reproductiva.

**Intervención (es):** Prueba de autoeficacia del conocimiento previo a la intervención, exposición educativa y pruebas de seguimiento de 2 semanas.

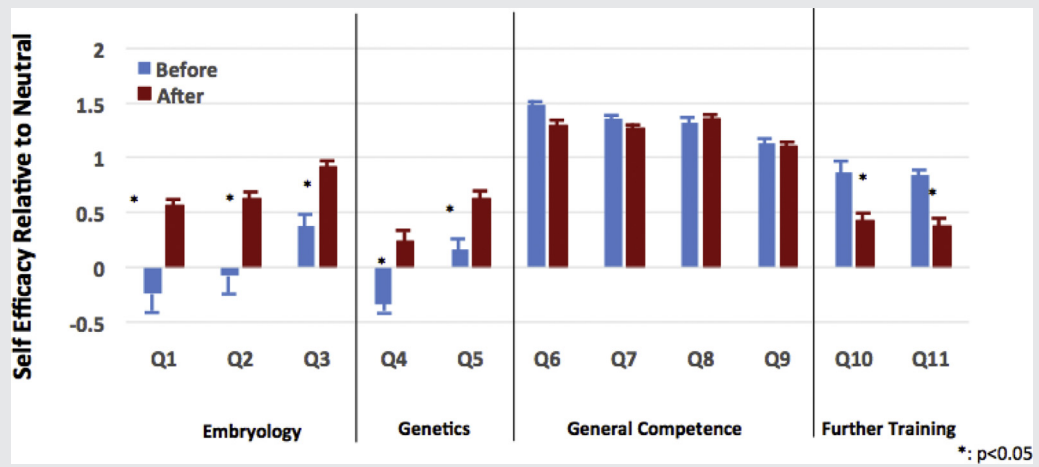
**Principales medidas de resultados:** Puntuaciones en pruebas de conocimiento y de autoeficacia.

**Resultados:** Las enfermeras, independientemente de los logros educativos, demostraron aumentos estadísticamente significativos en el conocimiento tanto de embriología como de genética, el cual se conservó al menos 2 semanas después de la intervención educativa. Además, la confianza de las enfermeras aumentó después de la intervención, y los datos cualitativos respaldan el deseo de aumentar las oportunidades educativas.

**Conclusión (es):** Las enfermeras se benefician de los esfuerzos educativos enfocados, lo que resulta en un mejor conocimiento de embriología y genética. Esta mejora en la base de conocimientos mejorada resultó en una mayor confianza de la enfermera para la educación del paciente.



SUPPLEMENTAL FIGURE 1



Reproductive endocrinology nurses self-efficacy before and after training. Data presented on a Likert-type scale, normalized around “neutral,” which is designated as zero. Negative numbers represent disagreement and positive numbers agreement with statements. Self-efficacy improved with education in embryology and genetics, whereas self-efficacy in general competence was consistently elevated despite training. Both before and after training, nurses felt positive about the value of further training. Blue bars represent percentage correct before the training, and red bars represent testing 2 weeks after training.

Catherino. Fertility nurses' knowledge and confidence. *Fertil Steril* 2019.