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ARTICLE

Proficiency in oocyte retrieval assessed by the learning curve cumulative summation test

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Dr Lionel Dessolle graduated in 1992 from Pitié-Salpétrière Medical School in Paris, France. Between 1993 and 2001, he performed his residency in obstetrics and gynaecology and a fellowship in gynaecological surgery in Paris University Hospitals. He also obtained a Master degree in reproduction physiology. He is currently working in the department of obstetrics and gynaecology of Brest University Hospital. His main research interests concern how the development of prediction models and the use of innovative statistical tools might help improving cares and outcomes in infertility patients.

Abstract The number of procedures required for a trainee to reach proficiency in oocyte retrieval and the criteria applied to define performance are not well defined. To evaluate the learning curve of oocyte retrieval, this study prospectively evaluated three trainees over 6months. Oocyte retrieval was monitored by the learning curve–cumulative summation test (LC-CUSUM), a specific statistical tool designed to indicate when a predefined level of performance is reached. Oocytes were retrieved from one ovary by the trainee and from the second ovary by a senior operator in a randomized manner. The main outcome measure was the ratio of oocytes collected and follicles aspirated. A trainee's ratio of ⩾80% of the senior operator's defined success. From 17 to >50 procedures were necessary for the trainees to reach the predefined level of performance. Cumulative summation tests implemented after the learning phase confirmed that performance was maintained. The present study confirms the large variability in acquiring proficiency for surgical procedures. It provides an exportable model for a quantitative tailored monitoring of the learning curve and for continuous monitoring of performance in oocyte retrieval.

KEYWORDS: CUSUM, LC-CUSUM, learning curve, oocyte retrieval, quality control.

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Introduction

Oocyte retrieval is a common surgical procedure in assisted reproduction treatment and one that is considered to be easily mastered. However, the number of procedures required for a trainee to learn the procedure is not well defined.

Various methods can be used to determine whether a trainee has reached proficiency. Although standard practice is currently to perform a recommended number of procedures under supervision, this approach is not well tailored to the individual. A statistical tool, the learning curve–cumulative summation test (LC-CUSUM), has been developed to help decide when the learning curve for a procedure is complete by indicating when it has reached a predefined level of performance (Biau and Porcher, 2010). Cumulative summation (CUSUM) techniques have simple formulations, intuitive graphical representations and are capable of detecting small persistent changes (Biau et al., 2008b; Montgomery, 2008).

The purpose of the present study was to evaluate LC-CUSUM as a tool to monitor the learning curve of oocyte retrieval.

Materials and methods

Patients

Over a 6-month period, this study prospectively evaluated the first oocyte retrievals performed by three first-year residents in reproduction medicine in the university IVF centre in Nantes, France. Their performances were compared with that of a senior gynaecologist, each patient being her own control. All the patient data, records of clinical and biological procedures and the programme results were entered in a registered database on a daily basis.

The patients consisted of consecutive women undergoing IVF or IVF with intracytoplasmic sperm injection in 2011. The criteria for patient selection for IVF and the management of ovarian stimulation have been reported elsewhere (Dessolle et al., 2010).

All the patients gave informed consent to the procedures and the use of their data for research purposes. All the trainees consented to the study. The study protocol was approved by a local ethics committee on 31 December 2013.

Oocyte retrieval

Trainees performed oocyte retrieval under supervision of a senior gynaecologist. Each trainee was on duty for an entire week and performed all the procedures, depending on the patient consent and the senior gynaecologist's decision. The procedures were standardized and guidelines were given to the trainees at the beginning of the training course and repeated for as long as necessary.

In this department, trainees learn oocyte retrieval under supervision by performing aspiration on one side and a senior gynaecologist performing aspiration on the other side. At the beginning of their training, trainees learn the basic technique with a syringe and needle, then they learn to use an aspiration machine. For the purpose of the present study, the side aspirated by the trainee was determined by randomization using sealed and numbered envelopes. For this randomization, 70, 70 and 50 envelopes were generated for the three trainees, respectively. Each set of envelopes was nominative. 50% contained a sheet 'left' and 50% contained a sheet 'right'. The envelopes were mixed up and then numbered so that the order could not be changed. If the trainee was unable to complete the procedure or if the senior considered that the trainee was not performing it safely, the trainee's retrieval was stopped and completed by the senior gynaecologist.

The procedures were performed under general anaesthesia or local anaesthesia with sedation, according to the patient's choice. Polyvidone iodine rinsed with sterile serum was used for antisepsis. All transvaginal ultrasound-guided oocyte retrievals were performed using 10-ml syringes and 18-gauge 300-mm needles. Only follicles $\geqslant$14mm were aspirated. Follicular fluids were analysed immediately after aspiration, after being passed to the IVF laboratory through a small window communicating with the operating room. The fluids of each ovary were observed independently and the embryologists collecting the oocytes were kept blinded to which operator had performed the aspiration.

The main outcome measure was the ratio of the number of oocytes collected and the number of follicles aspirated. A secondary outcome measure was the incidence of immediate or delayed complications requiring surgical suture, laparoscopy, laparotomy, blood transfusion or antibiotics.

LC-CUSUM and CUSUM

The LC-CUSUM test was developed to detect when a process has reached a predefined level of performance (Biau and Porcher, 2010). A score is computed from the results (failures and successes) of the successive procedures performed. The score decreases with a success and increases with a failure. When the score reaches a predefined limit, the trainee is considered proficient (this is similar to rejecting the null hypothesis when the test statistic of a Student's t-test or chi-squared test is above a predefined value). The LC-CUSUM has a very intuitive graphical representation: the score is plotted on the Y-axis against successive observations on the X-axis.

Once a trainee has demonstrated competency, his or her performance is monitored with a standard CUSUM test (Page, 1954). The CUSUM test is designed to detect when performance deviates to an inadequate level and has a similar, albeit on the opposite side of the X-axis, graphical representation: the score increases with failures and if the limit is hit, performance is considered inadequate.

LC-CUSUM and CUSUM tests can be used to monitor any technical procedure provided a success and a failure can be defined. Binary but also continuous data can be monitored. To implement CUSUM tests, clinicians have to define what they consider adequate and what they consider inadequate performance.

In the present study, a failure was recorded for the trainee if he or she was unable to perform or complete the