The assessment of surgical skills as a complement to the training method. Revision*

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Abstract
Context and objective: The acquisition and improvement of surgical skills constitute a fundamental element in the training of any practitioner. At present, however, the assessment of these skills is a scarcely developed area of research. The aim of this study was to analyze the peculiarities of the various assessment systems and establish the minimum criteria that a skills and knowledge assessment system should meet as a method for assessing surgical skills in urological surgery.

Acquisition of evidence: Scientific literature review aimed at the various currently available assessment systems for skills and competencies (technical and nontechnical), with a special focus on the systematic reviews and prospective studies.

Summary of the evidence: After conducting the review, we found that the various assessment systems for surgical competence have, in our opinion, a number of shortcomings. There is a certain degree of subjectivity in the assessment of surgeons by the evaluators. The assessment of nontechnical competencies is not formally recorded. There is no description of a follow-up assessment or any basic parameters associated with healthcare quality. There is no registration of associated competencies associated with the various surgical techniques. There is also no ranking of these competencies and the specific peculiarities for their application.

Conclusions: We believe that the development of a new assessment system for surgical competencies (technical and nontechnical) aimed at assessing urologists in the various surgical...
Context

Medicine, and particularly surgery, have provided in recent years new materials, instruments, equipment, and new treatments and medical-surgical considerations for different diseases, implying a mandatory adaptation to them.\textsuperscript{1,2} Minimally invasive surgery, meanwhile, has had a steady growth, consolidating in most surgical specialties, including urology, but it requires the development of training programs to ensure adequate training.\textsuperscript{3} However, at present, the traditional method of surgical training is still in force, where the role of the learner is relatively passive and is subject to the acquisition of skills through imitation of the tutor, whose evaluation may be conditioned to their personal relationship, beyond objective academic criteria.\textsuperscript{4,5}

While the acquisition and improvement of surgical skills are a key element in the training of any professional, the assessment of these skills itself is, by now, a field with little development. Thus, the tools available today focus on the assessment of knowledge and the application thereof during surgery, and in the consideration of specific aspects of the surgical act. However, several authors consider that these assessment systems have a number of shortcomings such as some subjectivity, lack of reliability and validity, besides not systematically considering non-technical skills.\textsuperscript{6-8} Thus, the need for new models of education raises, based on structured surgical training programs, in which learning includes the continuous acquisition of knowledge, training of surgical techniques outside the operating room in safe environments through the simulation, and acquisition and assessment of skills and competencies with objective tools and based on evidence.\textsuperscript{9-11} Specifically, urology also needs models of training and assessment of capacities, in order to respond to learning of basic skills and improvement of more advanced skills.\textsuperscript{1,12-14} If, according to the dictionary of the Royal Spanish Language Academy, we understand the concept of competence as the skill and ability to do something, in the field of surgery it involves the skills, knowledge, and attitude to perform a surgical procedure, and it involves the surgeon’s ability to perform a particular required task.\textsuperscript{15,16}

Objectives

The main objective of this paper is to analyze the characteristics of the most common systems of evaluation of surgical skills and the different lines of work in this regard that
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Figure 1 Results of the survey of perception of training, with percentage rate according to rating from 1 (strongly disagree) to 5 (strongly agree).

various institutions and scientific societies around the world follow. In addition, we aim to establish the minimum criteria to be met by a system of assessment of skills and knowledge, as method of assessment of surgical skills in urological surgery.

Evidence acquisition

There has been a review of the scientific literature collected from different sources, Pubmed, WOK, and SciElo, aimed at the objectives proposed and according to the different evaluation systems of skills and competencies, technical and non-technical, available and in use today, with particular attention to systematic reviews conducted and prospective studies. In addition, we had the collaboration of 19 clinical experts and teachers in laparoscopic surgery, with high experience in the field of urology. Finally, we considered the opinion of 192 students of urologic laparoscopy of different activities carried out in 2013 and 2014 at the Center for Minimally Invasive Surgery Jesús Usón de Cáceres, who were consulted through personal interviews in terms of their perception of training, development, evaluation, and follow-up at a national level in Spain (Fig. 1). During the development of different activities, students were taken to answer a short questionnaire of 8 statements, made by themselves and not validated, where they had to indicate their level of agreement against them. The result was processed as a whole, in order to get a reference in terms of the orientation of the opinion of the students, who we understand do not constitute the entire population of specialists in urology, but a sample of it.

Evidence synthesis

The assessment of competences and skills is essential for graduate medical education, because it improves its
effectiveness, as well as having a clear focus on safe clinical practice. So far, the evaluation systems of training programs are based on their development and structure, and their potential to educate new surgeons, but not so much in their educational quality. The Accreditation Council for Graduate Medical Education (ACGME) finalized, in 1999, the need to consider the skills demonstrated by a surgeon, for proper evaluation and subsequent accreditation. They established, so, that every educational program must be based on practice and offer training in skills, attitudes, professionalism, patient care, medical knowledge, communication and teamwork skills.

The development of laparoscopy, in concrete terms, has meant the creation of a specific training program for surgeons in training, and for professionals who were already trained in conventional surgery. For this, the use of simulators and evaluation systems that can be made with them are essential. With this, surgical simulation provides an opportunity to improve the learning experience in new skills. With all that, adapting to the basic physical simulators and virtual or augmented reality simulators is a big investment, which is to be profitable. There are several factors, however, which limit the ability of training, such as the availability of a physical space, of adequate time and compatible with the working day, the obligation to respond to the demand for productivity, and also increased awareness of patients to medical errors. Since the 80s, the need to validate the ability of educational programs for surgeons and the evaluators themselves has been raised, where the role of the competences is essential, if these are perfectly well defined and based on objective criteria.

Next, the most extended evaluation systems of competences are collected, as well as their main characteristics. In 1975, the University of Dundee, Scotland, developed an evaluation system, with the incorporation of an established circuit of stations where all participants would rotate analyzing different aspects of various clinical procedures. For each of these stations, on real patient, actor, mannequin, or simulator, the parameters to be evaluated could be established a priori, so more control of the evaluation activity would be obtained. This system, the Objective Structured Clinical Examination, was first adopted in the U.S.A., and then in the U.K. and other English-speaking countries, as standard evaluation method.

From a similar approach, the University of Toronto, Canada, developed an evaluation method based on direct observation of students during a surgical procedure on experimental animal model and simulator, the Objective Structured Assessment of Technical Skill (OSATS). For the evaluation of surgical skills, we considered, on the one hand, a check with several items, according to the surgical procedure that was being assessed, where the evaluator should reflect whether the student makes each step correctly. In addition, a table with numerical rating is completed, where 7 general aspects are considered (Table 1), related to the development of the surgical technique. For each of these aspects, the specific characteristics for various skill levels described or demonstrated competence were described, 1 being the lowest level of demonstrated competence vs. 5, which is considered the ideal level.

Currently, OSATS is used to evaluate skills in different medical and surgical specialties, nursing and dentistry, although some authors consider that it can be costly financially due to the dedication required and that gets by without the actual clinical aspect, so they recommend complementing it with a traditional assessment of theoretical knowledge and other ancillary tests. However, it has a high reliability, it can distinguish between different levels of experience, and it allows for direct observation of the procedure.

### Table 1 Categories considered in the evaluation systems of technical skills.

<table>
<thead>
<tr>
<th></th>
<th>GOALS</th>
<th>GRITS</th>
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<tbody>
<tr>
<td>Respect for the tissues</td>
<td>Visual perception</td>
<td>Respect for the tissues</td>
</tr>
<tr>
<td>Time used and movements</td>
<td>Bimanual dexterity</td>
<td>Time and movements</td>
</tr>
<tr>
<td>Management of the instruments</td>
<td>Efficiency</td>
<td>Management of the instruments and knowledge</td>
</tr>
<tr>
<td>Knowledge of the instruments</td>
<td>Management of the tissues</td>
<td>Flow of the intervention</td>
</tr>
<tr>
<td>Rhythm/flow of the intervention</td>
<td>Autonomy</td>
<td>Knowledge of the procedure</td>
</tr>
<tr>
<td>Use of assistants and helpers</td>
<td></td>
<td>Use of the assistants</td>
</tr>
<tr>
<td>Knowledge of the procedure</td>
<td></td>
<td>Communication skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Depth perception</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bimanual dexterity</td>
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</tbody>
</table>

GOALS: Global Operative Assessment of Laparoscopic Skills; GRITS: Global Rating Index for Technical Skills; OSATS: Objective Structured Assessment of Technical Skill.

**Evolution and adaptation of assessment systems**

Over time, there have been other variations and adaptations that seek to get a better detail, cover other purposes in combination with other methods, or the evaluation of a particular type of surgery, such as bariatric or laparoscopic surgery.

One of the most developed and implemented adaptations of the OSATS system, the Global Operative Assessment of Laparoscopic Skills, refers to the evaluation of laparoscopic procedures. Thus, the McGill University Hospital of Montreal, and the University of Montreal, Canada, adapted the system from the 7 categories to be assessed, of OSATS, to 5 (Table 1) that they considered strategic: visual perception, bimanual dexterity, efficiency, tissue management, and autonomy.
Similarly, the Global Rating Scale has been developed, and its wider variant Global Rating Index for Technical Skills, consisting in consideration of 9 items. In this case, it is assumed that the aspects to consider are general, and they do not consider specific steps in a specific procedure, which could be applied to a wide variety of procedures without having to adapt or modify the system.\textsuperscript{46} Table 1 collects the competences considered in each of the systems.

The Fundamentals of Laparoscopic Surgery (FLS) program was developed by The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), in 2004, as a tool to assess the knowledge and the necessary surgical skills for basic laparoscopic surgery. The program has proved to be a reliable and valid system for measuring these parameters in this field.\textsuperscript{21,37,38} Many residency programs have adopted the FLS in their curriculum, and since 2009, the American Board of Surgery requires successful completion of the program for the certification of surgeons in the U.S.A. The program was designed to be applicable to all surgical specialists, including general surgeons, urologists, and gynaecologists.\textsuperscript{39,40} It is structured into 3 separate but complementary phases, beginning with a series of interactive teaching guides, with theoretical contents, a program in physical simulator, and a test of theoretical evaluation.\textsuperscript{40} The McGill Inanimate System for Training and Evaluation of Laparoscopic Skills deserves special mention as reference simulator in practice testing of the FLS program that aims to provide an opportunity to learn and practice basic skills for laparoscopic surgery in a relaxed, safe environment and with a low cost.\textsuperscript{27}

From the European Association of Endoscopic Surgery (EAES), the development of an evaluation system that aimed at accreditation of the capacities of a surgeon was supported, not so much because of the number of procedures performed, but for which competences it can demonstrate for the development of a surgical technique, following minimum parameters of efficacy and safety. Thus, the Laparoscopic Surgical Skills proposes a simulator training program (virtual or physical with organic and/or synthetic tissues), prior to any other more advanced step, with experimental animal model or direct practice on human patient. To date, this system is implemented in several European countries, through evaluation sessions, with which it is intended for it to be a European reference standard.\textsuperscript{41}

Also, the University of Hiroshima, Japan, developed in 2008 the Hiroshima University Endoscopic Surgical Assessment Device, based on an objective assessment of the direction and movement of the instruments, through the follow-up thereof, with a high correlation with the OSATS system, as a complement to the latter.\textsuperscript{42}

The point of view of urology

Urology, as other disciplines, is becoming more and more dependent on interdisciplinary collaboration between various fields of knowledge, technology, and innovation. As the field of urology continues to evolve, the recognition of the need for objective and efficient certification for students and a program of recertification of specialists has emerged as essential. Training programs must, thus, provide a curriculum that focuses on knowledge and skills, but also with regard to communication, cognitive and technical skills, with the inclusion of simulation-based training and practice on animal models. The benefits of teaching based on what the mentor knows, exclusively, are being questioned, while evaluation based on morbidity and mortality of patients, apart from validated, should be further developed.\textsuperscript{43}

Thus, in 1997, The University of Queen, Canada, developed the Queen’s Urology Examination Skills Training Program, as a test for the final year of residence, with a questionnaire and Objective Structured Clinical Examination adapted with different workstations for the objective assessment of the student, and which would serve as preparation for certification by the Royal College of Canada. Although it has been amended, as the CanMEDS for example, it has been obtained successful results.\textsuperscript{44}

Meanwhile, in the UK, and within The Intercolligate Surgical Curriculum, for urological surgery, which regulates the curriculum for the specialty in terms of clinical judgment, technical and operational skills, and professional and behavior skills, the need to overcome, at least once a year, the Annual Review of Competence Progression is established, where the surgical suitability of each student is examined.\textsuperscript{45}

On their part, the European Association of Urology (EAU), has been developing for years the European Training in Basic Laparoscopic Urological Skills, aimed at improving basic skills in laparoscopy. Compatible with the European Urology Residents Education Program, it includes different levels of practical training, a set of exercises on a specific simulator, an online theoretical training, and the possibility of a practical evaluable test.\textsuperscript{46} On the other hand, and nationally, the Virtual Hospital Valdecillas, in Santander, is also working on the development of training programs for residents, where their progress is evaluated through an adaptation of the Global Rating Scale, to validate the technical skills demonstrated by each surgeon.\textsuperscript{47}

The consideration of non-technical skills

In a hospital setting, the operating room is the place where there is a greater likelihood that adverse events occur, because of its different factors, such as the equipment and technological means, the staff and their abilities, and the work itself that they carry out with a patient. This combination of factors and their relationship to the behavior of people have already been analyzed in other high-risk environments, such as aviation, which has seen a significant influence of these factors on the development of the activity. Thus, certain problems of teamwork, communication errors, failure to consider cultural aspects and the established hierarchical barriers contribute to potential security flaws.\textsuperscript{49} From here, and looking for an analogy in the health sector, it seems necessary to establish systems for assessing skills, called non-technical because they are not included within the dexterity skills or knowledge, in order to ensure and improve the quality of care.\textsuperscript{50} In this sense, the Imperial College of London, developed in 2008 the NOTECHS system adapted to the surgical field, based on different levels specifically oriented to the actors of the surgical environment, who are assessed in communication and interaction, surveillance, and response to adverse situations,
teamwork, leadership and time management, and decision making. This tool, which in fact has recently been amended to create the NOTECHS II, with greater accuracy and adaptability to different surgical procedures, is under constant review and analysis, for better adaptability and reliability of use.50

In parallel to NOTECHS, the University of Aberdeen and the Royal College of Surgeons of Edinburgh, Scotland, began working on a similar system, NOTSS, with an identical orientation and based on the evaluation of the behavioral aspects of a surgeon in the operating room that may condition their medical knowledge, the use of equipment and resources, and the relationship with the team. This system also, working on skills management protocols, ORMAQs, aims to identify strategies that improve the effectiveness of team work and job satisfaction within a surgical department.51

Considering the development of the different evaluation systems, management and evaluation by skills, it has little historical journey in the field of surgical training, unlike what happens in the field of human resources and business management, for example. So, Martha Alles estimates in her works the need to list, define, and set standards for all the competences that a profesional can and must demonstrate, considering that each job will attend some skills and levels in particular. Adapting to other environments, such as health, from here, is a matter of time.15

In any case, we need to show that our education system is adequate for our purposes, and the evaluation system that we use has enough power to do so. There is therefore, for this, the construct validity, which refers to the extent to which the evaluation method can distinguish different levels of experience and content validity, which refers to whether the field of knowledge which aims to be evaluated is measured by the right tool. On the other hand, the concurrent validity shows the extent to which the evaluation results are correlated with the gold standard for this field of knowledge, and which is previously considered established. The face validity is the extent to which the tool is similar to real situations and in what sense. Finally, predictive validity, by far the most complex to show, tests the ability to predict the future performance of an activity, in a real situation.16 With all that, the combination of different assessment instruments tends to be the most complete option for observing technical skills. Therefore, a scientific approach is necessary for the development of tools for evaluating the technical skills and the incorporation of non-technical ones, later.17

### Proposal of new system for assessment of competences for urology

Considering the circumstances described above, our work team has developed the ESSCOLAP system. This procedure, which aims to address the shortcomings noted, in our opinion, in other evaluation systems is based on the definition, classification, and evaluation through a validated system of those competences, technical and non-technical, showing a surgeon depending on some set parameters, for urological laparoscopic surgical techniques, endourology and microsurgery with application to urology. Thus, a number of general competences, others specific to each of the surgical techniques considered are established (Table 2), and a rating system of 1 to 5, with specific definition of each of the values. For their development, 3 levels have been considered (Table 3 and Fig. 2): basic, which measures basic skills on a simulator; Advanced, which evaluates specific competences on experimental animal model; and Premium, which evaluates technical and non-technical skills on patient, in a hospital and based on health results.

### Table 2 Surgical techniques considered for Evaluation System for Surgical Competencies on Laparoscopy (ESSCOLAP), according to expert criterion.

<table>
<thead>
<tr>
<th>Laparoscopy</th>
<th>Endourology</th>
<th>Microsurgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total nephrectomy</td>
<td>Rigid</td>
<td>Vascular and nervous</td>
</tr>
<tr>
<td>Partial nephrectomy</td>
<td>Ureteroscopy</td>
<td>Microsurgery</td>
</tr>
<tr>
<td>Radical prostaticectomy</td>
<td>RIRS</td>
<td>Vasovasostomy</td>
</tr>
<tr>
<td>Pyeloplasty</td>
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</table>

### Table 3 Description of levels of the Evaluation System for Surgical Competencies on Laparoscopy (ESSCOLAP).

<table>
<thead>
<tr>
<th>Objective</th>
<th>Basic</th>
<th>Advanced</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Basic competences</td>
<td>Specific competences</td>
<td>Results in health</td>
</tr>
<tr>
<td>Tool</td>
<td>Training center</td>
<td>Training center</td>
<td>Hospital</td>
</tr>
<tr>
<td>Assessment scale System</td>
<td>Physical simulator</td>
<td>Experimental animal model</td>
<td>Patient</td>
</tr>
<tr>
<td>Objectives</td>
<td>Teachers</td>
<td>Teachers</td>
<td>In health</td>
</tr>
<tr>
<td>Levels</td>
<td>1-5</td>
<td>Assessment of specific tests per technique and according to surgical protocol</td>
<td>1-5 Monitoring of the intervention and follow-up</td>
</tr>
<tr>
<td>System</td>
<td>Circuit of training on inorganic and organic fabrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional tests</td>
<td>Tests of theoretical and application knowledge</td>
<td>Non-technical competences</td>
<td>Check of non-technical competences in real environment</td>
</tr>
<tr>
<td>Follow-up</td>
<td>Continuous assessment and student progress</td>
<td>Continuous assessment and student progress</td>
<td>Continuous assessment and student progress</td>
</tr>
</tbody>
</table>
Conclusions

So far, the different assessment systems of the most widely widespread systems, recognized and even validated, have, in our view, a number of shortcomings:

- There is some degree of subjectivity in the evaluation of a surgeon by the evaluator, as traditional systems show briefly defined the aspects to be considered for the corresponding values, but they are not defined for all of them, so intermediate values are at the discretion...
of the evaluator, there may appearing bias in their assessments.

- No assessment of non-technical skills is formally collected. In fact, a system that considers the evaluation of technical and non-technical capacities jointly has not been found. Follow-up of evaluation or basic parameters associated with health quality are not described. Except for the FLS system, where a follow-up of the professional is established, are not considered concepts as reevaluation, follow-up, or results extrapolated to health care quality.

- There is no record of skills associated with different surgical techniques, and the grading thereof and specific features for application are not described either.

Given these circumstances, we believe it is necessary to establish a new system of evaluation of surgical, technical, and non-technical skills, aimed at assessing urologists in different surgical techniques to optimize the resources available and improving the provision of services and care for the patient, from a theoretical evaluable program, a list of simulator exercises, which are complemented by exercises in experimental animal model and real-patient supervised testing, all structured under a system of defined competences.

Conflict of interest

The authors declare that they have no conflict of interest.

References


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