Current Status of Simulation and Training Models in Urological Surgery: A Systematic Review

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Abbreviations and Acronyms

AR = augmented reality

BAUS = British Association of Urological Surgeons

FFC = fresh frozen cadaver

HoLEP = holmium laser enucleation of the prostate

LoE = level of evidence

LoR = level of recommendation

PVP = photoselective vaporization of the prostate

RARP = robot-assisted radical prostatectomy

RCT = randomized controlled trial

TURBT = transurethral resection of bladder tumors

TURP = transurethral resection of the prostate

UVA = urethrovesical anastomosis

VR = virtual reality

Purpose: Increased awareness of patient safety, advances in surgical technology and reduced working times have led to the adoption of simulation enhanced training. However, the simulators available need to be scientifically evaluated before integration into curricula. We identify the currently available training models for urological surgery, their status of validation and the evidence behind each model.

Materials and Methods: MEDLINE®, Embase® and the Cochrane Library databases were searched for English language articles published between 1990 and 2015 describing urological simulators and/or validation studies of these models. All studies were assessed for level of evidence, and each model was subsequently awarded a level of recommendation using a modified Oxford Centre for Evidence-Based Medicine classification, adapted for education by the European Association of Endoscopic Surgeons.

Results: A total of 91 validation studies were identified pertaining to training models in endourology (63), laparoscopic surgery (17), robot-assisted surgery (8) and open urological surgery (6), with a total of 55 models. Of the included studies 6 were classified Level 1b, 9 Level 2a, 39 Level 2b and 19 Level 2c. Of all the training models the URO Mentor™ was the only one to receive a level of recommendation of 1.

Conclusions: UroSimulation is a growing field and increasing numbers of models are being produced. However, there are still too few validation studies with a high level of evidence demonstrating the transferability of skills. Nevertheless, efforts should be made to use the currently available models in curriculum based training programs.

Key Words: technology assessment, biomedical; laparoscopy; models, anatomic, robotics; simulation training

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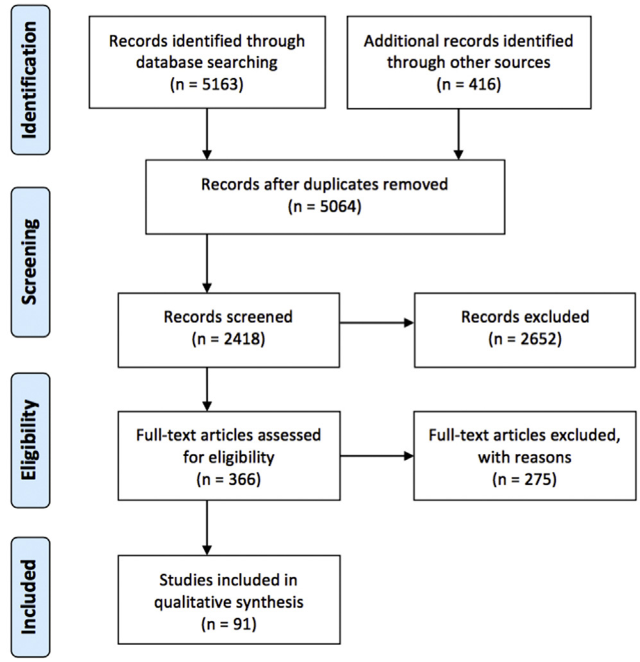
SURGERY as a craft has traditionally been learned via an apprenticeship program, in which the phrase, "see one, do one, teach one" was coined, describing how surgical skills were attained for many decades.[1] This method of training produced highly skilled surgeons for a number of generations. However, with increased awareness of patient safety, reduced working hours and financial constraints in health care organizations, this model has presented challenges for trainees to obtain the required level of competency.[2]

Further challenges have arisen with the development of minimally invasive techniques, largely associated with steeper learning curves. With the growing realization that a large part of the procedural learning curve does not require patients for skill acquisition, and that the skills can be learned on training models, there has been a boom in the production of training models.[3] This increase has brought about the need to evaluate these models scientifically to establish their educational value and role in training. Thus, an increasing number of validation studies are being conducted to investigate the usefulness of simulators. In this study we identify the currently available training models for urological surgery and their status of validation. We also evaluate the level of evidence for each training model, thereby establishing a level of recommendation.



Study selection process according to PRISMA statement

METHODS

This study was performed using the guidelines set out by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (see figure).[4]

Study Eligibility Criteria

Original research articles describing the validation and use of urology training models and simulators were included in the review (see supplementary references list, http://jurology.com/). Studies addressing basic surgical skills were excluded, as were those that only described the use of models without a validation process. Abstracts with insufficient information and nonEnglish articles were also excluded.

Information Sources and Search

A broad search was performed on MEDLINE, Embase and the Cochrane Library databases between January 1990 and December 2015. Search terms included "simulation in urology" and "simulation training in urology," which allowed for the majority of articles to be found. A further procedure specific search was performed using "TURP," "TURBT," "Nephrectomy," "HoLEP," "PVP," "PCNL," "Laser," "diode," "GreenLight" and "robotic" followed by "simulation" or "training" to supplement the identified studies.

Study Selection and Data Collection

After meeting the study inclusion criteria, articles were retrieved in full, and titles and abstracts were examined. Abstracts from conferences were also included if sufficient information could be extracted. Duplicates were removed. Full-text review further excluded studies which were not validation or educational impact studies. Potentially relevant articles found in the references of included articles were also retrieved and made subject to the inclusion/exclusion criteria.

Data Items

Selected data were extracted from each study, including the name of the model, institution/manufacturer, type of validation, number of participants and demographics. Models and simulators were classified into the categories of bench, augmented reality, virtual reality, animal and cadaveric. Results were tabulated and studies concerning each simulator were grouped together. The types of validity were classified according to the definitions of McDougall[5] and Van Nortwick et al[6] (see Appendix). The LoE for each study and LoR for each model were awarded using a modified educational Oxford Centre for Evidence-Based Medicine LoE and LoR classification system, as adapted by the European Association of Endoscopic Surgery (supplementary tables 1 and 2, http://jurology.com/).[7]

RESULTS

A total of 5,163 potentially relevant studies were identified. Upon review and examination of the full texts, 91 of the initially retrieved studies met the study inclusion criteria (see figure). Results were categorized into endourology, laparoscopic urology, robot-assisted urological surgery and open urological surgery (supplementary tables 3 to 7, http://jurology.com/). When studies failed to demonstrate