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Mapping the Demand for Serious Games in Postgraduate Medical Education Using the Entrustable Professional Activities Framework

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Abstract

Objective: Serious games are potentially powerful tools for residency training and increasingly attract attention from medical educators. At present, serious games have little evidence-based relations with competency-based medical education, which may impede their incorporation into residency training programs. The aim of this study was to identify highly valued entrustable professional activities (EPAs) to support designers in the development of new, serious games built on a valid needs-assessment.

Materials and Methods: All 149 licensed medical specialists from seven specialties in one academic hospital participated in seven different Delphi expert panels. They filled out a two-round Delphi survey, aimed at identifying the most valuable EPAs in their respective curricula. Specialists were asked to name the most highly valued EPA in their area in the first Delphi round. In the second round, the generated responses were presented and ranked according to priority by the medical specialists.

Results: Sixty-two EPAs were identified as valuable training subjects throughout five specialties. Eleven EPAs—''management of trauma patient,'' ''chest tube placement,'' ''laparoscopic cholecystectomy,'' ''assessment of vital signs,'' ''airway management,'' ''induction of general anesthesia,'' ''assessment of suicidal patient,'' ''psychiatric assessment,'' ''gastroscopy,'' ''colonoscopy,'' and ''resuscitation of emergency patients''—were consistently given a high score.

Conclusions: The future medical specialist is an active learner, comfortable with digital techniques and learning strategies such as serious gaming. In order to maximize the impact and acceptance of new serious games, it is vital to select the most relevant training subjects. Although some serious games have already targeted top-priority EPAs, plenty of opportunities remain.

Introduction

Motivation is an important drive for learning. ''Serious games'' are virtual learning environments designed to activate, entertain, and educate the player at the same time. Serious games are recognized as potentially powerful training methods in higher education, creating safe, off-site training environments for healthcare professionals.[1–3] Whereas simulations attempt to fully resemble the real action or scenario, serious games use narratives and challenges to draw the player into a storyline, scenario, or action. By doing so, they make learning occur playfully and effortlessly.[4,5] This leads to an active and repetitive form of learning.[6] A safe, game-based environment could therefore be an ideal format for problem-based adult learning, provided content is both relevant and valid.[4,7,8]

Although serious games have been developed for various subjects in medical education, their value in official medical educational programs remains limited. A recent systematic review shows that of 30 serious games aimed at training medical professionals, none had teaching goals or assessment strategies that match the existing medical curricula for

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residents.[2] This mismatch is not so surprising, as medical educators have never expressed a clear demand for game-based training solutions, nor have their priorities been disclosed to designers.

The aim of this study was to map priorities in the medical educational curricula in order to support game designers in developing targeted medical serious games. The primary research question focused on which clinical activities are top priority to residents in their educational curriculum—as perceived by the medical profession.

Materials and Methods

Study design

A cross-sectional study was performed among seven specialties in one academic hospital in The Netherlands between July 1, 2011 and January 31, 2012. All licensed medical specialists among the seven specialties were invited to join an expert panel within their own specialty—thereby creating seven different Delphi expert panels. Academic teaching hospitals in The Netherlands play a major part in training residents, and medical specialists themselves largely provide this training. Specialties participating in this study were as follows: anesthesiology, emergency medicine, gastroenterology, general surgery, gynecology, psychiatry, and radiology. This selection was based on (1) license to train residents, (2) cooperation with other specialties in the daily practice, (3) participation in the emergency room, and (4) willingness to participate.

The first Delphi round (the identification round) was directed at identifying important clinical activities performed by specialists for each specialty. The second round (the ranking round) was directed at ranking these different activities in order to identify top-priority activities for training purposes. Participants had to complete the first round to participate in the second round, as is customary in the Delphi methodology.[9] All identifiers were removed from the answers before interpretation and analysis. Approval by the Institutional Ethics Committee was sought. The committee determined this not necessary because of study type and participants. The study was conducted within the lawful privacy requirements in The Netherlands.

Identification of entrustable professional activities

All respondents received a personalized link to an electronic questionnaire (SurveyMonkey.com; SurveyMonkey® LLC, Palo Alto, CA), which allowed for one entrance per candidate. The participants were asked to identify one entrustable professional activity (EPA) that they considered top priority to their specialty's residency training and that had to be mastered by residents before participating in clinical rotations. This could be based on safety, complexity of the activity, or other reasons. EPAs are clinical activities that may only be entrusted to a sufficiently competent professional.[10] EPAs are meant to connect the more generalized competencies to the workplace.[11] This distinguishes the EPA as practical activity from the generalized medical competencies stated in residency training programs (such as the CanMEDS[12] or American Council on Graduate Medical Education[13] competencies).

As the EPA framework is fairly new to the specialties' teaching programs, EPA-based teaching programs are yet to be developed in The Netherlands. However, the EPA concept allows for a clear and concrete identification of key clinical activities in residency training. A definition of the EPA concept was delivered to the participants in the questionnaire.

The EPAs were pooled according to specialty. Two independent reviewers (M.G. and M.P.S.) excluded activities that did not meet the EPA definition given to the participants (''key activity in clinical practice that may only be entrusted to a competent professional''). In case of conflict, a third reviewer (J.M.C.S.) was consulted.

The survey addressed demographic characteristics as well as participants' experience with games. In the second Delphi round, each participant was asked to rank specialty-specific EPAs according to their value to residents' training (''Which EPA is most valuable to the resident to ensure good and safe conduct in the patient care practice?''). In order for a Delphi survey to be robust enough, minimum required response rate per specialty was set at 70 percent per round.[14]

The second round (the ranking round) required the participants to rank all EPAs from the first round according to priority.

Statistical analysis

Data were collected and analyzed using the Statistical Package for the Social Sciences version 16.0 software (SPSS, Chicago, IL) and R version 2.13.1 software (The R Foundation for Statistical Computing, Vienna, Austria). Confidence intervals (CIs) of the ranks derived from the second Delphi stage were calculated using the Monte Carlo resampling (''bootstrapping'') method, as ranking distributions are complex to represent mathematically.[15] Resampling was performed 5000 times to minimize resampling error.

Results

Participants

The first round questionnaire was sent to 149 medical specialists of seven specialties. The number of specialists per specialty varied between 46 (anesthesiology) and 7 (emergency medicine). An overview of the modified Delphi survey with response counts is given in Table 1. The first round of the survey had a response rate of 76 percent, with a variation between 69 percent and 100 percent between specialties. A total of 36 responses did not meet the definition of an EPA used in the study (Table 2).[16] Three examples are ''multitasking'' (considered a general competency relevant to many EPAs), ''laparoscopy,'' and ''stressful situations'' (both were considered too unspecific and to contain more than one individual EPA). In total, 7 responses contained more than one EPA, whereas 16 EPAs were stated more than once.

The results from the second round in the gynecology and radiology expert panels were excluded from the analysis because of low response rates (<70 percent).

Delphi survey

In total, 66 EPAs were indicated to have high priority to residency training within the seven specialties (see Supplementary Table S1; Supplementary Data are available online at www.liebertpub.com/g4h). The EPAs ''management of

Table 1. Demographic Characteristics per Specialty

	Anesthesiology	*General surgery*	*Gynecology*	*Emergency medicine*	*Radiology*	*Psychiatry*	*Gastroenterology*
Invited	46	20	21	7	24	15	16
Respondents							
Round 1	34	20	15	5	17	12	11
Round 2	24	17	9	4	8	9	9
Age (years) (mean)	46	48	48	40	46	47	49
Gender (percent)							
Male	62	80	33	80	59	67	64
Female	38	20	67	20	41	33	36
Experience with videogames (percent)							
Active	24	35	20	60	35	42	9
Past	47	40	33	0	29	20	55
None	29	25	47	40	36	38	36

Data are numbers unless stated otherwise.

trauma patients,'' ''cardiopulmonary resuscitation,'' and ''ultrasound-guided puncture'' were indicated by multiple specialties (surgery, radiology; anesthesiology, emergency medicine; and anesthesiology, radiology, respectively). The EPA ''diagnostic ultrasound' was identified as top priority by both radiology and gynecology, although it indicates two different clinical activities for these specialties.

Figure 1 shows the results of the second Delphi round per participating specialty. Forty-five EPAs were ranked according to the perceived importance to residency training per specialty. General surgeons indicated ''management of trauma patients'' (mean median rank = 11.0; 95 percent CI, 9.0, 12.0), ''placement of chest tube,'' and ''laparoscopic cholecystectomy'' (both mean median rank = 10.0; 95 percent CI, 9.0, 11.0) as most valuable out of 13 EPAs. Anesthesiologists indicated ''assessment of vital signs during surgery'' (mean median rank = 17.0; 95 percent CI, 15.0, 17.0), ''airway management'' (mean median rank = 15.0; 95 percent CI, 15.0, 16.5), and ''induction of general anesthesia'' (mean median rank = 14.5; 95 percent CI, 11.0, 15.0) as most valuable out of 17 EPAs. Psychiatrists indicated ''assessment of suicidality'' (mean median rank = 8.0; 95 percent CI, 6.0, 8.0) and ''psychiatric assessment'' (mean median rank = 7.0; 95 percent CI, 2.0, 8.0) as most valuable out of eight EPAs. Gastroenterologists ranked ''gastroscopy'' (mean median rank = 4.0; 95 percent CI, 1.0, 5.0) and ''colonoscopy'' (mean median rank = 4.0; 95 percent CI, 3.0, 5.0) the highest out of five EPAs. Emergency physicians indicated ''management of emergency patients (general) according to the ABCDE principle'' (mean median rank = 3.0) unanimously as the most important EPA in their residency training program.

Discussion

Primary findings

The development of teaching methods should correspond to both the needs of professional educators and those of the target group. This is the first study assessing prioritized teaching objectives for serious games in residency teaching curricula, using EPAs as a conceptual framework. A high value of eleven EPAs in the residency teaching curricula from five different specialties were found to have a consistently high value using a modified Delphi consensus survey and ranking methodology. The survey indicated three EPAs to be of particularly high value in different residency teaching curricula: ''management of trauma patients'', ''cardiopulmonary resuscitation'', and ''ultrasound-guided punctures''.

Applying games in medical curricula

Medical specialists train many, if not most, EPAs required in their training programs by observing and practicing in reality on live patients. Serious games and simulators offer safe practice environments to train these skills outside the clinic. Designing a serious game for one specific EPA requires

Table 2. Flow of Responses in the Analysis

	Anesthesiology	*General surgery*	*Gynecology*	*Emergency medicine*	*Radiology*	*Psychiatry*	*Gastroenterology*
Responses in round 1	34	20	15	5	17	12	11
Responses excluded (did not meet EPA definition)	11	6	6	1	6	2	4
EPAs formatted							
Split (to *n*)	2 (9)	2 (4)	0	0	0	2 (4)	1 (2)
Merged (to *n*)	19 (6)	5 (2)	5 (2)	2 (1)	2 (1)	6 (2)	5 (2)
Total number of EPAs	17	13	8	3	10	8	5

EPA, entrustable professional activity.

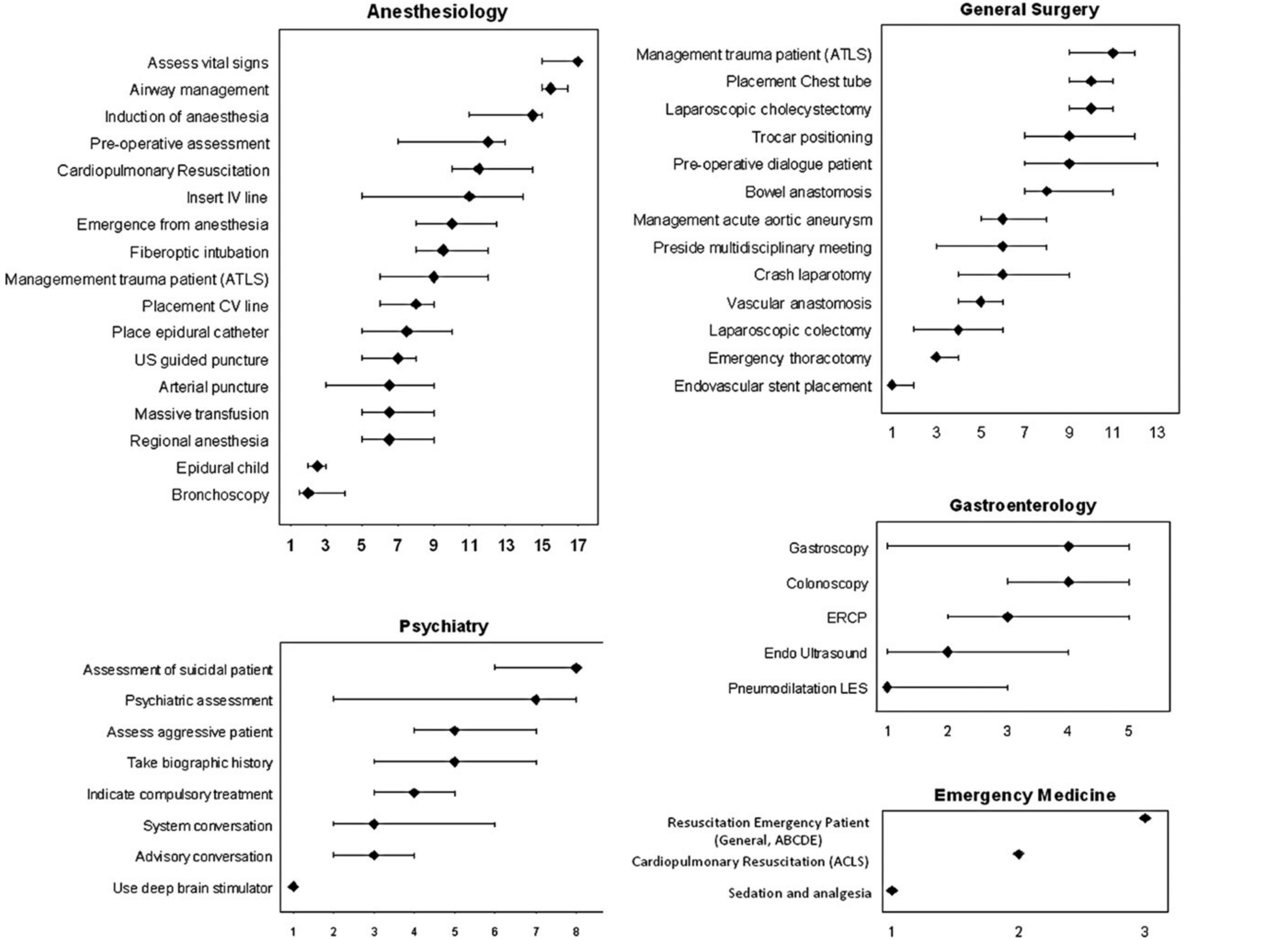

FIG. 1. Entrustable professional activities from five specialties ranked according to perceived educational value by respondents (1 = lowest rank; the highest rank depends on total number of ranks). Data depict median values (bars designate the 95 percent confidence interval of means after Monte Carlo resampling). ABCDE, airway–breathing–circulation–disability–exposure principle; ACLS, advanced cardiac life support; ATLS, advanced trauma life support; CV, central venous; ERCP, endoscopic retrograde cholangiopancreaticography; IV, intravenous; LES, lower esophageal sphincter; US, ultrasound.

careful consideration of the subtasks and competencies required. Not all of these can be trained in a virtual reality environment, let alone in a videogame. The educator and designer must determine the optimal use of the final product together. For instance, inserting a chest tube requires cognitive skills, procedural knowledge, and dexterity skills. Learning the procedural knowledge may be more important for a trainee prior to practicing the procedure on a patient than the dexterity skills. The first may very well be trained in a serious game, whereas the latter will presumably require a simulation model.

How do serious games fit into training one EPA then? Serious games cannot to be seen as substitutes for practice in reality. However, they do have the ability to shorten a trainee's learning curve outside the clinic. Zevin et al.[17] describe how technology optimizes the curriculum for laparoscopic gastric bypass surgery (an EPA in general surgery). Every EPA requires the design of specific training models (e.g., games) and evaluation tools. Their curriculum consists of five steps: (1) knowledge-based learning, using literature, videos, and workshops; (2) the deconstruction of the EPA into subtasks, identifying the most critical ones; (3) learning the practical skills in a virtual reality (e.g., game) environment, up to a specific level of competence; (4) demonstrating progress of these skills in reality; (5) and ongoing performance of the EPA on patients with decreasing levels of supervision.

This study is the first to draw a relation between the EPA framework and serious game design. Previous studies have assessed EPAs in postgraduate curriculum development.[18–21] Boyce et al.[18] assessed high-priority EPAs in the first year of the Australian psychiatry residency program. Conducting a risk assessment for suicide and aggressiveness received high endorsements in this study (82 percent endorsement [$n=488/2736$])—comparable to our findings. Conducting psychiatric assessments was not described as EPA as such, although other EPAs could be considered (e.g., acute assessment and management of psychiatric emergencies). Mulder et al.,[19] Shaugnessy et al.,[20] and Hauer et al.[21] assessed EPAs for curriculum development in physicians assistants, family medicine, and internal medicine training curricula, respectively. The EPA definition applied in this study was less strict than used when constructing medical curricula.[22] In such cases, competency levels must be defined for each residency year. This went beyond the reach of our research question.

Designing games for medical education

Serious games are currently mostly initiated by single academic institutions,[1,23,24] the military, and commercial parties.[25] In all of these cases, interests behind the game's development may differ from the goals and guidelines in official education and training programs. Yet, in the interest of their long-term survival, anchoring such innovative projects in the medical curricula from the start on could prove very beneficial. This strategy should prevent the proliferation of technologies that do not comply to (inter-) national educational standards, upheld by scientific and/or educational communities. Medical educators should safeguard learning content while not ''sitting on the chair'' of the game designers—in order to avoid ending up with a mere ''pdf behind glass'' or simulations that are not attractive enough to play in the end.[26] This is avoided by good co-creation by both game designer and educator.

Training programs for specific EPAs have been enriched by using various simulator types, from part-task trainers to mannequin-based simulation and virtual reality.[27] It must be clearly stated that in distinguishing between serious games, game-based simulations and simulators is a gray area, with considerable overlap.[28] For example, the Web-based virtual reality simulation abcdeSIM provides a case-based course in acute care through simulated scenarios.[24] In contrast, its use of competition through leader boards is a gaming technique, known to improve adherence to training.[29] When developing new games and simulations, educators should determine how a user-centered mix of techniques could deliver optimal learning outcome in each case specifically. The importance of user involvement in the design process therefore cannot be stressed enough.

The impact of serious games on learners' performance is promising, although the evidence is far from comprehensive.[2,30] A systematic review of the validation studies of serious games in medicine describes 30 serious games.[2] Two serious games show concurrent validity in experimental studies compared with conventional training methods. A second systematic review explores the effectiveness of serious games and videogames for all medical and nonmedical purposes[30]: out of 11 experimental studies with a pretest/posttest design, three games showed a positive learning effect, seven found no effect, and one found a mixed effect. Scientific proof of any training method's effectiveness is seen as an important precondition before its implementation in medical education is possible.[31]

Study limitations

This study reports a single-center proof-of-concept study, with results primarily applying to Dutch medical teaching curricula. Academic teaching hospitals are the cornerstones of residency teaching programs in The Netherlands. To confirm our results, further studies should determine high-priority EPAs from nonacademic hospital perspectives.

Medical educators are largely unfamiliar with games and related concepts. A direct inquiry for the demand for new developments among educators is therefore meaningless and would contain selection bias, as only respondents familiar to the concepts would be included. Prioritizing EPAs in educational curricula does provide more objective information on the areas in which new developments are most relevant.

With regard to reliability, Delphi surveys need to comply with several preconditions. It is important to maintain (1) objective panelist selection, (2) anonymity, in order to reduce group dynamics, (3) provide impartial feedback, and (4) obtain high response rates.[9] In this study, all specialists within one department were invited to the panels. Anonymity was maintained. Feedback on the EPA was provided after blinded assessment of the answers based on objective criteria. A minimum response rate of 70 percent was set (two panel groups had to be excluded). With regard to panel size, there appear to be no firm rules in literature, where panel sizes range from 4 to over 1000.[9] Hence, although our panel size varied significantly among the different panels, this was not perceived as a major problem, especially because response rates were carefully monitored in order to include full cohorts.

Conclusions

This study defines EPAs in five medical and surgical specialties, regarded as top priority by their educators.

Designers should develop technology-enhanced training solutions with high regard to validity of the educational content, starting with selecting top-priority subjects. Serious games provide a promising new direction in graduate medical education for the active learner.

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