<table>
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<tr>
<th>ARTICLE REFERENCES</th>
<th>OBJECTIVES</th>
<th>OUTCOME MEASURES</th>
<th>MAIN FINDINGS</th>
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</table>
| Abelson et al., 2015<sup>(40)</sup> | • Determine feasibility of creating a VR operating room  
• Evaluate simulator for face and construct validity | • Construct validity: metric data  
• Face validity: Likert-scale questionnaires (realism, inclination to use), Bedford Workload Scale and modified NASA-TLS Index scale | • Training environment evaluated as realistic  
• 82% of participants felt low workload or had enough spare capacity for additional tasks. All participants had minimal mental, physical, and temporal demand and none reported requiring a high amount of effort to complete the simulation  
• No statistically significant difference between attendings and trainees for all responses |
| Brewin et al., 2015<sup>(24)</sup> | • Assess validity of distributed simulation environment for NTS training  
• Evaluate educational impact | • Face, content and construct validity: questionnaires  
• NOTECHS  
• Educational impact: questionnaires completed after the simulations | • Good learning environment for NTS, judged realistic  
• NTS of experienced urologists significantly better than trainees establishing construct validity  
• All trainees felt more confident  
• Kirkpatrick level 1 evidence and indirect evidence of learning (Kirkpatrick level 2) |
| Brunckhorst et al., 2015<sup>(25)</sup> | • Evaluate feasibility, acceptability, content validity and educational impact of simulation-based curriculum integrating NTS | • NOTSS  
• Content validity: post-study questionnaire | • 100% of experts agreed integration of full immersion simulation was a useful tool for teaching non-technical skills  
• Curriculum-trained group: significantly higher NOTSS scores than control group  
• Feasibility of delivery of the curriculum was rated 9.27/10, enjoyment and productivity was scored at 9/10, difficulty of curriculum rated 4.93/10 |
| Cohen et al., 2013<sup>(41)</sup> | • Determine feasibility and reliability of skills assessment | • 7-point NTS competency scale for paramedics and T-NOTECHS (Trauma Non-Technical Skills Scale) | • Significant and strong correlations between expert assessors suggest reliability to carry out NTS assessments in virtual environments in major incident scenarios  
• No significant correlations between expert and self-assessment for NTS |
| Creutzfeldt et al., 2010<sup>(26)</sup> | • Evaluate (SA) Situation Awareness self assessment instrument  
• Analyze SA training in virtual settings | • SA: 9-items questionnaire + trainee’s own opinion of his or her SA during training  
• Concentration/attention: 10-items instrument | • SA increased from the first to the last scenario  
• Perception of SA corresponded to calculated SA  
• Correlation between SA and concentration |
| Dorozhkin et al., 2016<sup>(42)</sup> | • Establish face validity, usefulness and fidelity of virtual OR fire | • Perceived usefulness and face validity: questionnaire  
• Open-ended questions: improvements and | • Face validity established with high degree of satisfaction and usefulness  
• 33/49 participants preferred this modality of training over a traditional one  
• 47% of subjects offered suggestions on how to make the simulator look and feel more realistic |
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<th>Study</th>
<th>Objective</th>
<th>Methods</th>
<th>Findings</th>
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<tr>
<td>Greci et al., 2013&lt;sup&gt;(27)&lt;/sup&gt;</td>
<td>Develop and evaluate a virtual learning curriculum</td>
<td>Open-ended questions: technical challenges, course content, immersion Interviews and focus groups</td>
<td>All students improved postcourse disaster preparedness knowledge scores Emerging themes: team communication, team planning, team decision making Functioning in an unfamiliar environment was evaluated as requiring similar skills as during a disaster where rapid decision making with incomplete information</td>
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<td>Grover et al., 2015&lt;sup&gt;(28)&lt;/sup&gt;</td>
<td>Validate a simulation-based curriculum for cognitive and integrative competencies</td>
<td>Global performance: Integrated Scenario Global Rating Form (ISGRF) Communication skills: Communication Global Rating Scale (CGRS)</td>
<td>Participants significantly outperformed control group with respect to colonoscopy-specific performance, communication skills and global performance during the integrated scenario format assessment 4 to 6 weeks after training</td>
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<td>Heinrichs et al., 2010&lt;sup&gt;(43)&lt;/sup&gt;</td>
<td>Determine efficiency of a Virtual Emergency Department to train mass-casualty incidents (team skills)</td>
<td>Immersion, level of comfort, confidence, usefulness for clinical skills and team training: questionnaire Focus group</td>
<td>68% of the participants felt immersed Everyone felt they learned how to interact in the simulation &quot;Useful,&quot; &quot;Very Useful,&quot; or &quot;Extremely Useful&quot; for clinical skills training for 82% participants Participants gained confidence in ability to handle incidents</td>
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<td>Hudson et al., 2015&lt;sup&gt;(44)&lt;/sup&gt;</td>
<td>Examine perceived usability of Second Life (SL) as an immersive virtual environment</td>
<td>Perceived usability: System Usability Scale (SUS) Situation awareness: questionnaire with 27 items</td>
<td>SL considered usable in providing practice with complex scenarios of insulin administration. Perceived usability decreased among experienced nurses No significant association between years of nursing experience and SA scores was found.</td>
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<td>Khan et al., 2017&lt;sup&gt;(29)&lt;/sup&gt;</td>
<td>Evaluate effectiveness of a simulation-based training curriculum of NTS on novice endoscopists’ performance of clinical colonoscopy.</td>
<td>Modified Objective Structured Assessment NTS (M-OsANTS) ISGRF Integrated Scenario Communication Rating Form (ISCRF) General Self Efficacy Scale (GSE)</td>
<td>To inform the potential implementation of NTS into postgraduate gastrointestinal curricula, non-technical performance will be determined by comparing the scores from the M-OsANTS, ISGRF, ISCRF and GSE for both conditions and at 3 different times</td>
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| Khanal et al., 2014 (30) | - Evaluate efficacy of delivering advanced cardiac life support (ACLS) using a virtual reality simulator  
- Team performance: electronic checklist based on ACSL guidelines assessed by experts  
- Final questionnaire on training experience  
- No statistically significant difference in improvement of skills between groups  
- VR-based ACLS training simulator is significantly cheaper, easier to organize, and facilitates users to practice in a team from disparate locations without requiring an evaluator |
| King et al., 2012 (45) | - Evaluate usability of the environment  
- Evaluate learning effectiveness of scenarios  
- Evaluate integration into curriculum  
- Debriefing: exploration of team interactions  
- Satisfaction survey and questions on learning in the environment  
- Students appreciated to visualize the Emergency Room setting in a low-pressure situation  
- It provided students with opportunities to communicate with other disciplines, which they would not have had until in clinical practice  
- Students felt it was great preparation for non-virtual scenarios for clinical situations |
| Maschuuw et al., 2008 (31) | - Explore impact of self-belief of surgeons on laparoscopic performance using a VR simulator  
- General Self Efficacy (GSE) score  
- Technical metrics: time, economy of motion and damage parameters  
- No significant differences were found in gender or in GSE score between both groups  
- Motions of advanced trainees were more economic than novices, but no significant difference in time, error score and right instrument movements.  
- Novices GSE scores negatively correlates with economy of motion and time, while for advanced residents it is independent of laparoscopic performance |
| Paige et al., 2007 (46) | - Evaluate perception of simulated scenarios  
- Evaluate effectiveness for communication and teamwork during OR crisis  
- Teamwork assessment: communication, coordination and situational awareness  
- Questionnaire on perception of training effectiveness and specific attributes of teamwork  
- Sessions were found effective/very effective for improving teamwork, communication and recognizing problems in the OR |
| Riesen et al., 2012 (32) | - Improve interprofessional competencies  
- Determine acceptability of a blended learning environment  
- Self-perceived changes in interprofessional attitudes and competence: IEPS, ICCAS  
- Team performance assessment: TOSCE  
- Students perceptions: program assessment tool, and 16-item questionnaire  
- Significant differences pre and post workshop were found in ICCAS and IEPS scores  
- Significant improvement across the 3 simulations in all competencies  
- Program and learning experience were highly rated  
- Learner confidence and performance can be improved through education delivered in a virtual environment |
| Rogers, 2011 (49) | - Investigate how a simulation in Second  
- Individual clinical interviews: judgement,  
- Critical Life simulation is an artificial social structure where problem-based scenarios can be created |
<table>
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<tr>
<th>Authors, Year</th>
<th>Study Focus</th>
<th>Methods</th>
<th>Findings</th>
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| Life can encourage teamwork and collaborative problem solving | • Students can co-construct mental models experiencing human interaction in problematic environment
• Critical Life could develop cognitive understanding of team-orientated procedural and problem-based decision-making skills. | | |
| Rudarakanchana et al., 2014<sup>(33)</sup> | • Evaluate feasibility of integration of a VR simulator in an immersive simulation
• Investigate construct and face validity for training human factor skills during a crisis scenario | • Questionnaires: realism (face validity) and potential for use in team training for both technical and human factor skills
• Experienced team leaders were significantly faster than trainees
• Realism of the environment was scored very high and realism of the VR simulator was rated high
• Trainees rated the simulation more useful for technical skills training, and experts believed it more useful in enhancing communication skills
• Feasability, face and construct validity of a realistic crisis scenario integrating a VR simulator has been shown | |
| Sankaranarayanan et al., 2016<sup>(34)</sup> | • Establish face and construct validity of an immersive VR system
• Assess the effects of distractions and task interruptions | • 5-point Likert-scale subjective feedback questionnaire: realism, immersive experience, and effects of distractions and interruptions
• Performance decreased with added distractions and interruptions
• Subjects rated interruptions very high in their ability to affect performance and music distraction received the lowest mean rating
• Simulators rated as realistic to present distractions and interruptions in a simulated OR, immersion evaluated as intermediate. | |
| Shamim Khan et al., 2013<sup>(35)</sup> | • Establish feasibility and acceptability of simulation training for NTS | • Interviews: perception of simulated environment
• Feasability, acceptability and construct validity: questionnaires
• Construct-validity established: Seniors performed significantly better than junior trainees in all simulation sessions
• Increased cognitive load for trainees on VR simulator: pressure/anxiety about the unknown and interplay between technical and non-technical skills | |
| Sweigart et al., 2016<sup>(36)</sup> | • Test utility and acceptability of a virtual learning environment (VLE)
• Examine change in teamwork attitudes in interprofessional communication | • Effectiveness: TeamSTEPPS -TAQ (Teamwork Attitude Questionnaire)
• Utility: Time to complete scenarios and answers to questions within scenarios
• Acceptability: Likert-scale type questions
• Positive student feedback on ease of use and perceived effectiveness for teaching communication and professionalism t
• Scores on the T-TAQ revealed significant positive changes in leadership, situation monitoring, mutual support, and communication | |
| Umoren et al., 2017<sup>(48)</sup> | • Propose an introduction to TeamSTEPPS | • MCQ questions during the progression of the scenarios: designation of a
• Learner recognition of the SBAR communication tool was high across groups
• Knowledge of which component of SBAR was missing was lower across | |
| White et al., 2015<sup>47</sup> | Study quality of information transfer and teamwork during a simulated critical event | Communication skills: Critical Patient Information checklist and Interprofessional Communication Skills checklist | A substantial percentage of participants did not share 3 critical items and 87% of the participants missed a dosage error. 
- Items on Communication Checklist were missed by a substantial number of participants (introduction of self and task, closed-loop communication) 
- No statistically significant relationship between scores and years of nursing |
| Willaert et al., 2011<sup>37</sup> | Evaluate whether a part-task rehearsal of a surgical procedure on a VR simulator is as effective as a full-task one | Non-technical skills: NOTSS 
- Face validity and usefulness: questionnaire 
- Emotional, cognitive and physical stress: short version of State Trait Anxiety Inventory (STAI) questionnaire | Both groups scored acceptable scores in all categories of NOTSS. 
- Simulated procedure was found highly realistic. Simulation helped participants in decision-making, confidence, reduction of anxiety, and communication. Both strategies were as effective on stress levels. 
- For a moderately difficult case, a part-task patient specific VR rehearsal is as effective as a full-task one. |
| Wucherer et al., 2015<sup>38</sup> | Measure usability of simulator 
Explore relationship between mental workload and surgical performance during crisis | Cognitive workload: 3-item questionnaire and Surgery Task Load Index (SURG-TLX) 
Questionnaire: face validity and training value | Training resulted in a decrease of time, but significantly slower performances when crises 
- The more workload was experienced, the poorer was the surgical performance. 
- Telephone call seemed more disturbing compared to patient discomfort. |
| Youngblood et al., 2008<sup>39</sup> | Evaluate VLE for leadership and trauma management by comparing users' experience with a high-fidelity patient simulator (PS) | Leadership skills: EMCRM (Emergency Medicine Crisis Resource Management) scale 
Assessment of learning experience: debriefing and questionnaire | All participants evaluated simulation as “useful” or “very useful” to assess and manage trauma patients in Emergency Department (ED) 
- All participants showed significant improvement in team leadership 
- Students emphasized emotional impact of simulation in VLE 
- Both mannequin-based and VLE simulation of ED cases are valid training methods to improve EMCRM team leadership skills. |