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## Hybrid simulation for obstetrics training A systematic review

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1 **Hybrid simulation for Obstetrics training: a systematic review.**

2

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18

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**Abstract**

Hybrid simulation is defined as the use of a patient actor combined with a task trainer within the same session. We sought to investigate the level of evidence about the clinical benefits of hybrid simulation training in obstetrics. We searched MEDLINE using the keywords: Obstetrics AND Medical Education AND (Standardized patient OR Hybrid simulation). A total of 155 studies were screened, from which we selected 11 articles were selected from the title and the abstract in PubMed. For each study, data about the type of simulation, the level of evidence according KirkPatrick’s hierarchy was collected. There is evidence that clinical benefit for patients exists for Shoulder Dystocia, and Cord prolapse. For Non-technical skills, such as communication or team training, hybrid simulation was also effective. Whether hybrid simulation offers better training for communication and better immersion than high-fidelity simulation for learners remains to be investigated.

**Keywords :** Simulation, Hybrid, Patient-Actor, Obstetrics, Medical Education, Training, Immersion, Non Technical Skills.

40 **Introduction**

41           Validity and benefits of simulation medical training are now well admitted<sup>1</sup>. In France,  
42 it is recommended to use simulation at every level of training to prevent from medical errors<sup>2</sup>.  
43 Alinier et al.'s classified gradually the different types of simulation-based training as following:  
44 0. Written simulation ; 1. Three dimensional models ; 2. Screen-based simulator computer ; 3.  
45 Standardized patients (SP) or Hybrid simulation ; 4-5. High Fidelity mannequins<sup>3</sup>.

46           Hybrid simulation is defined as the use of two or more simulation modalities within the  
47 same simulation session. Typically, a task trainer or partial simulator is realistically affixed to  
48 a standardized patient (SP), allowing training and assessment of both technical and  
49 communication skills. Hybrid simulation may be particularly interesting in the field of  
50 obstetrics. Indeed, obstetricians have to operate/deliver the patient and at the same time to  
51 communicate efficiently with her. During labor and delivery, most procedures occur in  
52 conscious women, often accompanied with close family members, all of them having an  
53 important emotional charge. The professionals need to correctly managed the emergency and  
54 take into consideration the needs and concerns of both patient and her partner, in a very short  
55 time. The interaction with a "real" patient combined with hands-on clinical practice may reflect  
56 the complexities associated with birth.

57           The Kirkpatrick pyramid was used to rank medical education studies depending on the  
58 main outcome in four levels: 1—student satisfaction; 2—progress in theoretical and practical  
59 knowledge outside the clinic ; 3—benefit on clinical skills or behavior ; and 4—impact or  
60 benefit for the patient<sup>4</sup>.

61           We sought to review the literature and investigate the current level of evidence about  
62 the clinical benefits of hybrid simulation training in the field of obstetrics according to the  
63 Kirkpatrick Hierarchy.

64

65 **Methods**

66 This review was planned, conducted, and reported in adherence with the Preferred  
67 Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards of quality<sup>5</sup>.

68 A search of scientific publications was conducted in PubMed, using the keywords:

69 -Obstetrics AND Medical Education AND (Standardized patient OR Hybrid  
70 simulation).

71 We searched MEDLINE and ClinicalTrials.gov. Eligible studies had to be published  
72 in English after year 2000 and to investigate the use of hybrid simulation in the specific field  
73 of obstetrics to health profession learners at any stage (initial and continuous) in training.

74 Systematic reviews were not included.

75 Based on Kirkpatrick's hierarchy, we included studies reporting the level of the learning  
76 outcome, and we specified if non-technical aspects were considered. For each study, we notified  
77 if technical skills or non-technical skills were investigated.

78 The date of last searched was 2018, November the 12<sup>th</sup>.

79

80

81 **Study Selection**

82 A total of 155 studies were screened, from which 10 articles were selected from the title  
83 and the abstract in PubMed. Four articles were excluded afterwards because they were dealing  
84 with high fidelity simulation, and one article was excluded because it was describing a  
85 simulation scenario, with no evaluation. Six more articles were added from the bibliographies  
86 (**Figure 1** – Article flow chart). No additional article was added from ClinicalTrials.gov.

87 A total of 11 articles were analyzed, presented in **Table 1**.

88 We distinguished the articles addressing technical skills from those addressing non-  
89 technical skills as well as the involved studied skill(s).

90

91

92 **Results**

93

94 **Using Hybrid simulation to improve Technical skills**

95 *Improving preeclampsia management*

96 In a randomized study by Fisher et al., hybrid simulation was used for eclampsia training  
97 in 38 obstetrics and gynecology (OB/GYN) residents<sup>6</sup>. They involved a standardized patient  
98 with a display of simulated maternal vital signs and fetal heart rate monitoring. This study  
99 compared hybrid simulation alone, traditional lecture alone, and a combination of both. Three  
100 months later, they assessed student competency through an “eclampsia drill score” between the  
101 3 groups, during a simulation-based evaluation.

102 Postintervention management scores were significantly better in the “simulation-based  
103 intervention” groups compared with the “lecture only” group. Significantly higher residents in  
104 the “Simulation group” group knew the correct dose and route of calcium gluconate  
105 administration compared with the “Lecture Only” (73% vs 25%;  $p=0.05$ ). Their results  
106 demonstrated that simulation-based training was superior to traditional lecture alone for  
107 teaching crucial technical skills to manage eclampsia, in a simulated environment. Skills  
108 transfer to patients was not investigated in this study (Kirkpatrick level 2).

109 In a randomized study by Ellis et al., hybrid simulation in local hospitals was compared  
110 to high-fidelity simulation in simulation centers<sup>7</sup>. A total of 140 junior, senior obstetricians,  
111 and midwives participated to this training about eclampsia management. The evaluation was  
112 based on a simulated scenario with a patient-actor. Two assessors independently reviewed all  
113 video recordings of the eclampsia scenario, and scored the competency thanks to an “eclampsia  
114 checklist”.

115           It appeared that both types of simulation training, hybrid and high-fidelity, were  
116 associated with improved management of eclampsia: better completion of tasks in a reduced  
117 time. Eclampsia training in a regional simulation center with high-fidelity mannikins seemed  
118 to confer no advantage over local training with hybrid simulation (basic mannequins and  
119 patient–actor) in terms of management scores (Kirkpatrick level 2). Again, in this study, the  
120 level of immersion of the participants for both simulation modalities was not investigated,  
121 neither were non-technical skills.

122

### 123 *Shoulder Dystocia Management*

124           In another randomized study by Crofts et al., a severe shoulder dystocia was simulated  
125 in a hybrid simulation scenario. A PROMPT Birthing Trainer (Limbs and Things Ltd, Bristol,  
126 UK) was integrated with a patient–actor, and compared to a high fidelity mannequin scenario<sup>8</sup>.  
127 Participants (45 doctors, 95 midwives) were taken individually into a delivery room, given a  
128 standardized description of the scenario, and asked to complete the shoulder dystocia delivery.  
129 The simulation was continued until either delivery of the posterior arm of the baby, the  
130 participant chose to stop, or 5 minutes had elapsed.

131           The management of the simulated shoulder dystocia was assessed using the following  
132 outcome criteria: 1) success or failure of delivery, 2) the head-to-body delivery time, 3)  
133 performance of appropriate actions, 4) force applied, and 5) communication.

134           Both types of training were associated with improved performance. They highlighted  
135 in both groups a better use of basic maneuvers (81% to 95%), more successful deliveries (43%  
136 to 83%), and a better communication with the patient (57 to 83%), comparing pre- and post-  
137 training. Comparing both types of simulations, the high-fidelity training was associated with a

138 higher successful delivery rate than training with hybrid simulation: 94% versus 72%  
139 (P=0.002).

140 The same team conducted a 6-12 months follow-up study after this training. For the  
141 majority of staff, a 40-minute shoulder dystocia training session was sufficient to gain and  
142 sustain the skills required to manage shoulder dystocia. One year after the first evaluation, 94%  
143 of participants who had been able to achieve delivery could still do so<sup>9</sup>.

144 In a level 4 Kirkpatrick study, published in 2008, the same team in Bristol compared the  
145 management and the neonatal outcomes of births complicated by shoulder dystocia before and  
146 after the introduction of shoulder dystocia hybrid training<sup>10</sup>. They found a significant reduction  
147 in neonatal injury after shoulder dystocia from 30/324 (9.3%) to 6/262 (2.3%) with a relative  
148 risk of 0.25 [CI95% 0.11–0.57], thanks to hybrid training.

149 The same team showed in another study published in 2016 a decade after the  
150 introduction of training, that there were no cases of brachial plexus injury lasting over 12  
151 months in 562 cases of shoulder dystocia, since hybrid training had been introduced<sup>11</sup>.

152

### 153 *Cord Prolapse Management*

154 In a study by Siassakos et al., the impact of the introduction of hybrid simulation team  
155 training was measured. They compared the improvements in the management of cord prolapse  
156 before and after the implementation of hybrid simulation training<sup>12</sup>.

157 Umbilical cord prolapse is an acute obstetrical emergency which occurs when the  
158 umbilical cord becomes compressed as it lies ahead or alongside the fetal presenting part,  
159 occasioning fetal hypoxia, and requiring rapid identification and intervention<sup>13</sup>. They  
160 conducted simulation training with a patient-actor, and a cushion to imitate a pregnant  
161 abdomen, a model of a baby with its umbilical cord, and a mock perineum. The scenario was

162 run in a labor room and stopped when teams decide to move the woman to theatre for a  
163 caesarean section.

164         Afterwards, in all actual cases of cord prolapse, they measured before and after team  
165 training, the diagnosis-delivery interval (DDI), the proportion of caesarean section (CS) in  
166 whom actions were taken to reduce cord compression, and neonatal outcomes (rate of low  
167 Apgar scores; rate of admission to neonatal intensive care unit).

168         They showed that after training, there was a statistically significant reduction of the  
169 diagnosis – delivery time interval from 25 to 14.5 minutes ( $P < 0.001$ ). In other words, hybrid  
170 simulation training permitted teams to go faster in a situation of cord prolapse (Kirkpatrick  
171 level 3). Post-training, there was also a significant increase in the proportion of caesarean  
172 sections where recommended actions to reduce cord compression had been performed (from  
173 34.78 to 82.35%,  $P = 0.003$ ).

174         However, they did not find significant differences in neonatal outcome. The reduction  
175 in the rate of neonates with low Apgar scores (from 6.45 to 0%  $p=0.3$ ) and in the rate of neonate  
176 admission to intensive care (38.46 to 22.22%) was not statistically significant ( $p=0.2$ ).

177

## 178 **Using hybrid simulation to improve Non-Technical skills:**

### 179 *Improving communication*

180         In a study by Crofts et al., about shoulder dystocia hybrid training, there was no  
181 difference in the post-training communication according to the type of mannequin used (81%  
182 of good communication in the low fidelity versus 84% in the high-fidelity group,  $p=0.697$ ).  
183 However, those trained on the high-fidelity mannequin were significantly less likely to have  
184 called for pediatric support ( $P=.003$ )<sup>8</sup>.

185         In another study by Siassakos et al., audio-video recordings of eight postpartum  
186 hemorrhage hybrid simulations were collected and communication patterns were analyzed.

187 Two of the four teams received extra training in specific teamwork behaviors the other half  
188 received only clinical training. Communication patterns in a new simulated situation were  
189 analyzed. There was a reduction in the total number of communications after training. Teams  
190 that received additional teamwork training used more directed commands after training. When  
191 commands were directed to specific individuals, tasks were more likely to be acknowledged  
192 and performed<sup>14</sup>.

193 In another study by the same author, 24 medical students were trained first with high-  
194 fidelity simulation teaching and then a refresher session for which the same students were  
195 randomly allocated to either a “tuto” or “hybrid simulation”. Afterwards, they were asked to  
196 deliver a baby with simulated shoulder dystocia in a hybrid scenario, with communication  
197 measured with a perception score rated by the actress herself. Primary outcome measure was  
198 their communication score. The percentage of participants with good communication scores  
199 (4/5) was also significantly higher for the hybrid simulation group (74% HYB versus 22% SGT  
200  $p=0.03$ ). They concluded that hybrid simulation improves students' communication skills<sup>15</sup>.

201

### 202 *Improving patient perception of safety*

203 In another study by Crofts et al, pre and post training perception of safety,  
204 communication, and respect were rated by the patient actor himself. They compared the  
205 improvements in those items between hybrid simulation and high-fidelity computerized  
206 mannikin. The rating was done by a five-point Likert scale with the following affirmations :  
207 Communication : “I felt well informed due to good communication” ; Respect: “I felt I was  
208 treated with respect at all times”, Safety: “I felt safe at all times”. It appeared that both  
209 trainings improved outcomes, but during simulated post-partum hemorrhage, safety and  
210 communication scores were significantly higher for teams trained locally with a patient-actor

211 compared with teams trained at the simulation center using a computerized patient manikin  
212 (safety  $p = 0.048$ , communication  $p = 0.035$ )<sup>16</sup>.

213

214 In another study by Siassakos, hybrid simulation was used to determine patient's  
215 perception of safety. A total of 108 professionals were video recorded during management of a  
216 patient-actor with a simulated obstetrical emergency. The trained patient-actor scored the  
217 quality of interaction with the staff. They showed important variation in staff interaction with  
218 the patient, some teams not exchanging a single word and others striving to interact with the  
219 patient-actor. This shows that although technical skills are precisely guided by algorithms,  
220 communication is not standardized at all. In that study, most teams failed to communicate  
221 efficiently with the patient-actor. There was a significant correlation between patient-actor  
222 perceptions of communication, respect, and safety and individual behaviors. The patient-actor  
223 perception of safety was better when the content of the communication episodes included  
224 certain items of information (nature of the emergency, immediate treatment, cause of the  
225 emergency, condition of baby, non-verbal staff interaction episodes, number and duration of  
226 the communication episodes)<sup>17</sup>.

227

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229

230

231 **Discussion**

232 This review shows that considering technical aspects of obstetrical emergencies  
233 management, hybrid simulation training is as efficient as high-fidelity training, which are  
234 superior than traditional lecture or written classes. However, non-technical aspects need more  
235 investigation, as well as immersion evaluation.

236 Most of obstetrical emergencies have been taught by hybrid simulation already:  
237 shoulder dystocia (0.1% of births in France), pre-eclampsia (between 0.5 to 3%), post-partum  
238 hemorrhage (5%), and cord prolapse (0.1%)<sup>18</sup>. For shoulder dystocia, Kirkpatrick level 4  
239 evidence exists, as it has been proven that hybrid simulation training reduces the rate of brachial  
240 plexus injuries, with a sustained effect<sup>11</sup>. For cord prolapse, it has been shown that team  
241 effectiveness is improved, with a reduce Diagnosis-to-Delivery Interval (Kirkpatrick level 3).  
242 For pre-eclampsia and post-partum hemorrhage, it has been proved that trained teams have a  
243 better knowledge of drug doses in a simulated situation (Kirkpatrick level 2), but no benefit in  
244 terms of maternal mortality has been yet proven.

245 It is to notice that, although it is a quite frequent (0.19%) and potentially harmful obstetrical  
246 situation, no data exists about unplanned home delivery simulation training. It has been shown  
247 that in the case of unplanned home deliveries, neonatal morbimortality is higher<sup>19,20</sup>. In most  
248 countries no obstetrical team are dedicated to unplanned home deliveries, and these situations  
249 are under the responsibility of emergency teams. As they are not well trained for deliveries,  
250 hybrid simulation could also be interesting for them.

251 It seems that hybrid simulation is more often associated to in situ simulation while high  
252 fidelity scenario, are more often taking place in dedicated simulation centers. This could be  
253 because of the facilities of transportation of birthing trainers compared to high fidelity  
254 computerized mannikins, which are heavy and need connection with a computer. Simulation  
255 centers are expensive; 'on-site' clinical simulations might be an acceptable alternative for the

256 study of teamwork. Familiarity with the environment, equipment and personnel might improve  
257 psychological and environmental fidelity and could be an advantage over unfamiliar simulation  
258 centers, particularly for team training. Of course, difficulties encountered with he uses hybrid  
259 simulation are the cost and the training of patient-actors.

260 All types of simulation training seem to improve non-technical skills as well. However,  
261 whether hybrid simulation is more efficient than high-fidelity simulation to teach non-technical  
262 skills is not well established. Training with patient-actors may offer some advantages to teach  
263 better communication, as suggested by Crofts et al.'s study in post-partum hemorrhage  
264 scenario<sup>16</sup>.

265 In a delivery room, good communication with the mother and the father has been identified  
266 as a key point<sup>17</sup>. Unfortunately, a significant number of women are dissatisfied of their delivery,  
267 as attested by public debates about obstetrical violence, particularly if they experienced an  
268 emergency<sup>21</sup>. As post hoc debriefing may be insufficient after traumatic medical birth<sup>22</sup>, a good  
269 opportunity to prevent dissatisfaction would be a more efficient communication during the  
270 acute event. In a systematic review, factors associated with dissatisfaction around birth were:  
271 the amount of support from caregivers, the quality of the caregiver-patient relationship, and  
272 their involvement in decision making, and all of these can be taught by simulation. These factors  
273 appeared to be so important for women satisfaction that they override the influences of age,  
274 socioeconomic status, ethnicity, childbirth preparation, pain, immobility, or medical  
275 interventions<sup>23</sup>.

276 Hybrid simulation may also be associated with better learner satisfaction, as the interaction  
277 may be more realistic. Construct validity evidence is necessary for all types of simulation-  
278 training, including hybrid simulation. The level of immersion of the participants is of primary  
279 importance for the learning adherence<sup>24</sup>. If the simulated scenario is not immersive enough,

280 learners can be refrained from giving the best of themselves, affecting both technical and non-  
281 technical skills. Whether hybrid simulation affects immersion positively is unknown.

282

### 283 **Conclusion**

284 With this review we sought to gather all information about hybrid simulation in the field of  
285 obstetrics. There is evidence that hybrid simulation is an effective tool to teach both technical  
286 and non-technical skills training and should be expanded. However, construct validity evidence  
287 studies are needed. Whether hybrid simulation offers better training for communication and  
288 offers better immersion than high-fidelity simulations for learners remains to be investigated.

289

290

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365

366 **Figure Legends**

367

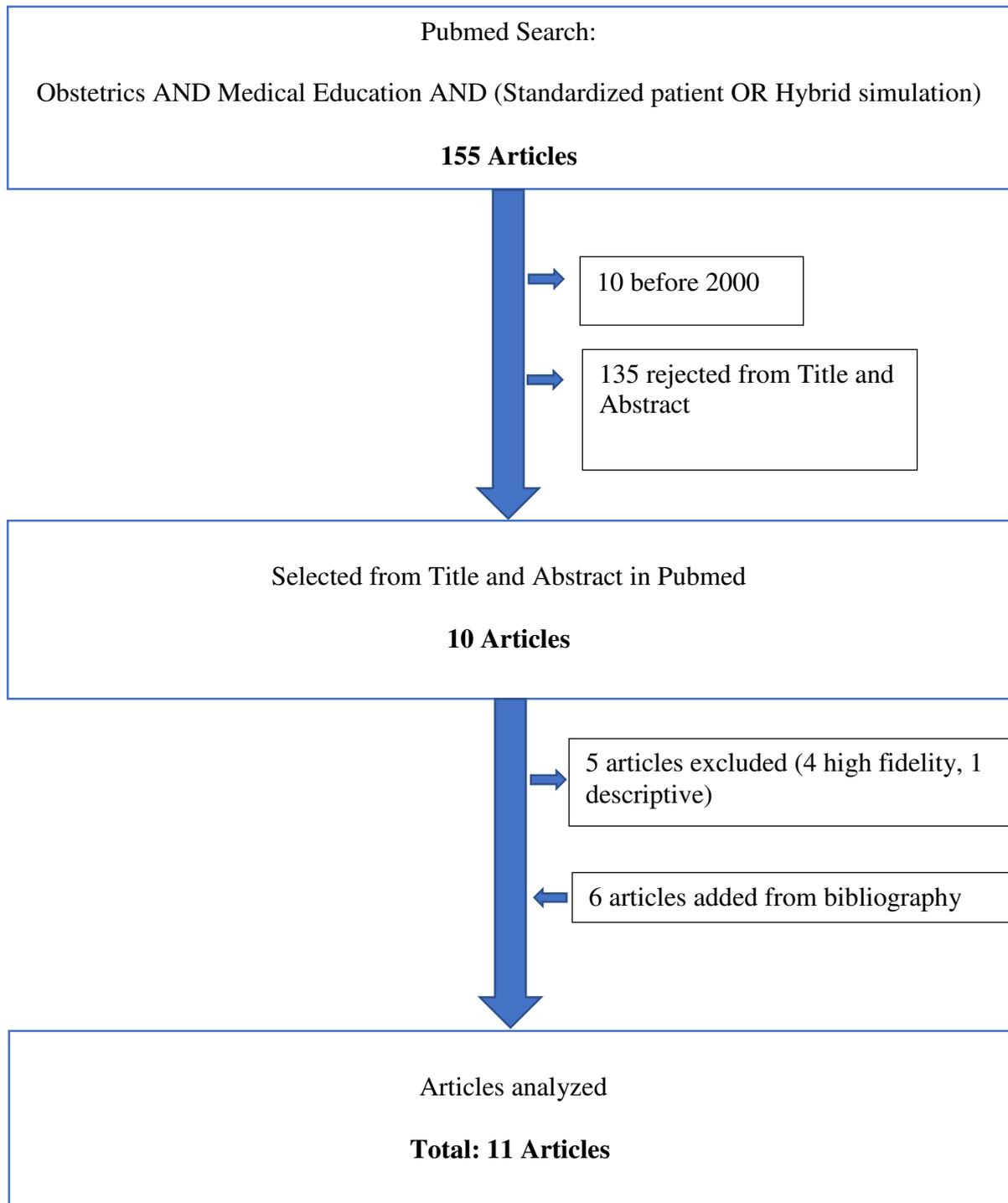
368 **Table 1.** Literature overview of obstetric hybrid simulation

369

370 **Figure 1.** Flow Chart

371

**Figure 1. Flow Chart**



**Table 1.** Literature overview of obstetric hybrid simulation

Author	Year	Journal	N	Theme	Immersion	Kirkpatrick	Simulation Type	Technical skills	Non-technical skills
Crofts et al.	2006	Obstetrics and Gynecology	132	Shoulder Dystocia	0	2	Hybrid versus High Fidelity	-Success of delivery -Head-to-body delivery time -Appropriate actions -Force applied	-Communication with patient
Crofts et al.	2007	Obstetrics and Gynecology	122	Shoulder Dystocia	0	2	Hybrid versus High Fidelity	-Success of delivery -Head-to-body delivery time -Appropriate actions -Force applied	-Communication with patient -Skill retention at 6 to 12 months
Crofts et al.	2008	Quality and Safety in Healthcare	139	Post-partum hemorrhage	0	2	Hybrid versus High Fidelity	0	-Patient perception of Safety -Communication
Ellis et al.	2008	Obstetrics and Gynecology	140	Preeclampsia	0	2	Hybrid versus High Fidelity	Eclampsia Checklist Completion of tasks Time	0
Siassakos et al.	2009	BJOG	34/28	Cord Prolapse	0	3	Hybrid	-Diagnosis to delivery interval -Actions to reduce cord compression -Neonatal outcome	0
Draycott et al.	2008	Obstetrics and Gynecology	324/262	Shoulder Dystocia	0	4	Hybrid	-Brachial plexus injuries in babies	0
Siassakos et al.	2009	Journal of Obstetrics and gynaecology	46	Post-partum Haemorrhage	0	2	Hybrid	0	-Teamwork
Fisher et al.	2010	AJOG	38	Preeclampsia	0	2	Hybrid versus Lecture	Eclampsia Drill Score Route and dose of MgSO4	0
Siassakos et al.	2010	Simul Healthcare	24	Shoulder Dystocia	0	2	Hybrid	0	-Communication
Siassakos et al.	2011	Simul Healthcare	108	Obstetrical emergencies	0	2	Hybrid	0	-Communication -Patient Safety Perception
Crofts et al.	2016	BJOG	562	Shoulder Dystocia	0	4	Hybrid	-Brachial plexus injuries in babies	-Sustained effect 12 years after training introduction

BJOG : British Journal of Obstetrics and Gynecology

AJOG : American Journal of Obstetrics and Gynecology