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

2

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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 admitted¹. In France,
42 it is recommended to use simulation at every level of training to prevent from medical errors².
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 mannequins³.

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 patient⁴.

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 quality⁵.

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 12th.

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) residents⁶. 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 centers⁷. 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 scenario⁸.
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 so⁹.

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 training¹⁰. 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 introduced¹¹.

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 training¹².

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 intervention¹³. 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 ($P=.003$)⁸.

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 performed¹⁴.

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 skills¹⁵.

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 $p = 0.035$)¹⁶.

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)¹⁷.

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%)¹⁸. 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 effect¹¹. 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^{19,20}. 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 scenario¹⁶.

265 In a delivery room, good communication with the mother and the father has been identified
266 as a key point¹⁷. 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 emergency²¹. As post hoc debriefing may be insufficient after traumatic medical birth²², 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 interventions²³.

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 adherence²⁴. 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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296

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365

366 **Figure Legends**

367

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

369

370 **Figure 1.** Flow Chart

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Figure 1. Flow Chart

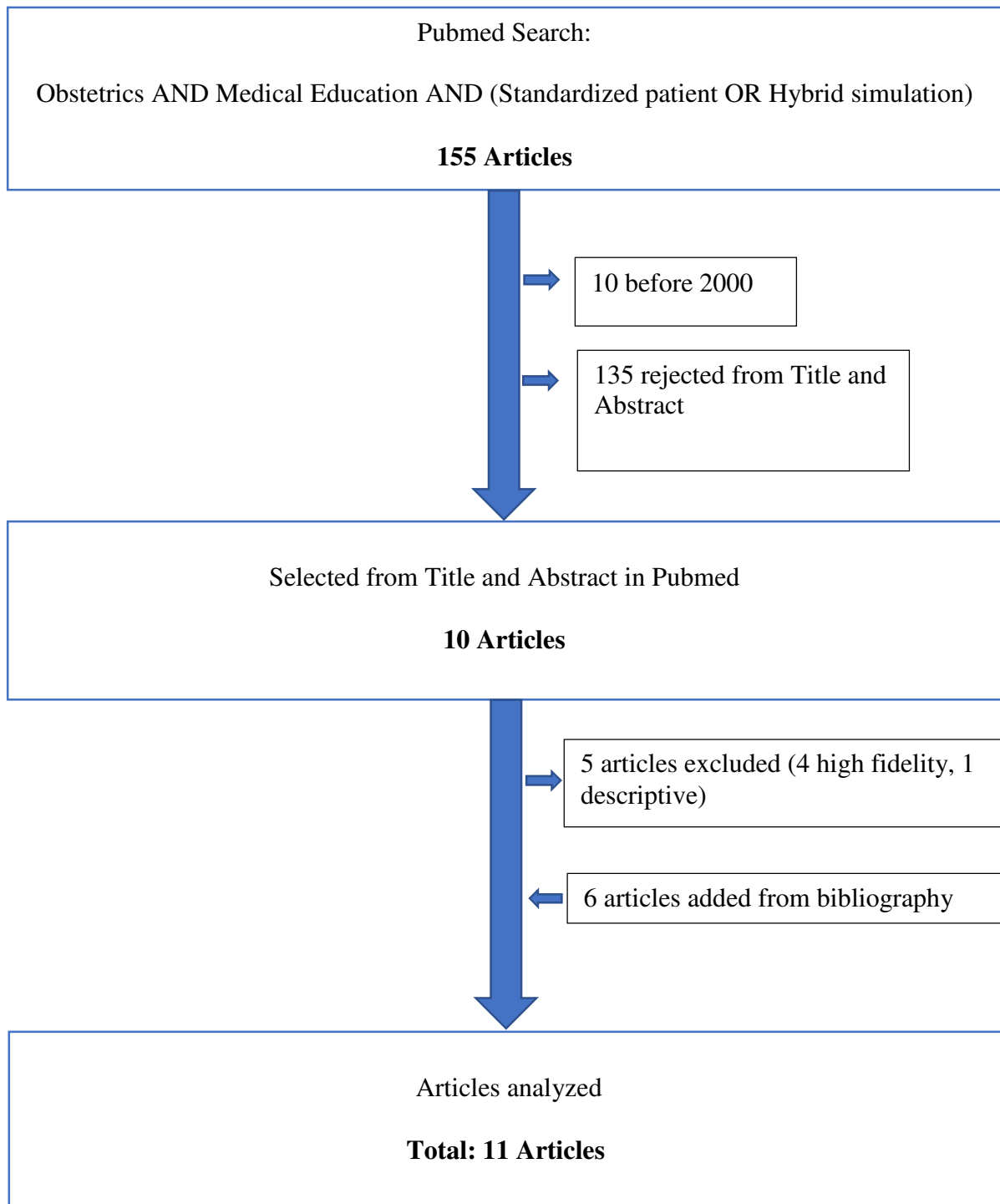


Table 1. Literature overview of obstetric hybrid simulation

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