OPEN

Impact of the Use of Simulated Patients in Basic First Aid Training on Laypeople Knowledge, Skills, and Self-efficacy

A Controlled Experimental Study

Bert Avau, PhD;

Anne-Catherine Vanhove, PhD;

Hans Scheers, PhD;

Stijn Stroobants, PhD;

Karen Lauwers;

Philippe Vandekerckhove, MD, PhD;

Emmy De Buck, PhD

Background: First aid training is a cost-effective way to improve public health, but the most effective methods to teach first aid are currently unclear. The aim of this research was to investigate the added value of simulated patients during first aid certification trainings.
Methods: Occupational first aid trainings organized by the Belgian Red Cross between September 2018 and August 2019 were allocated to either training with a simulated patient or regular training, for the topics "stroke" and "burns." Participants' knowledge and self-efficacy related to these topics were assessed at baseline, directly after training and after 1 year. First aid skills for "stroke" and "burns" and participant satisfaction were assessed after training. Knowledge and self-efficacy were measured via a questionnaire, and skills were assessed during a practical skills test. Data were analyzed using generalized linear mixed model analyses.
Results: A total of 1113 participants were enrolled, 403 in the simulated patient group and 710 in the control group. First aid knowledge and self-efficacy increased strongly immediately after training. These increases did not differ between groups, nor did the level of practical skills. The simulated patient group had a significantly increased retention in first aid knowledge after 1 year, compared with control, while retention in self-efficacy did not differ. Participant satisfaction with training was similar between groups.
Conclusions: Using simulated patients during occupational first aid trainings for laypeople did not improve outcomes immediately after training but did improve retention of first aid knowledge after 1 year. These results support the use of simulated patients during first aid training.
(*Sim Healthcare* 00:00–00, 2022)

Key Words: Patient simulation, nonresuscitative first aid, first aid education, simulation training, laypeople.

BACKGROUND

First aid is defined by the European Resuscitation Council as "the initial care provided for an acute illness or injury. The goals of first aid include preserving life, alleviating suffering, preventing further illness or injury, and promoting recovery."[1] Teaching laypeople first aid is an extremely cost-effective way to improve global health, with estimates of US $5 to 11 invested per disability-adjusted life year averted.[2] Large efforts are therefore being made globally to train as many people as possible to deliver first aid.[3] Systematic reviews available indicate that first aid training improves trainees' knowledge and skills, but the most effective methods to teach first aid remain unclear.[4,5]

Simulation training, which can include the use of real-life simulated patients, high-fidelity mannequins, or virtual reality, has been used in emergency care education for health professionals.[6–8] However, to our knowledge, no study has yet investigated the impact of simulated patients during first aid training for laypeople. The aim of this study is therefore to evaluate whether using simulated patients during a basic 3-day first aid certification training, compared with traditional training, has an effect on trainees' first aid–related knowledge, skills, and self-efficacy (the belief in one's ability to deal with a situation[9]), both immediately after and 1 year after training. Given that it is not feasible to use a simulated patient for all topics taught during a 3-day first aid certification training, we opted to use the simulated patient specifically for the topics "burns" and "stroke."

METHODS

A detailed study protocol has been published in advance.[10] A concise version is presented hereinafter.

Ethics Approval and Consent to Participate

This study has been evaluated and approved of by the Social and Societal Ethical Committee (SMEC) of Leuven University (KU Leuven), Belgium, with following file number G- 2018 06 1273. Participants signed an informed consent before participation and were free to end participation at any time, without consequences. This study is registered at Clinicaltrials.gov as NCT03608982 (August 1, 2018).

Study Design

This is a nonrandomized controlled experimental study, conducted within the daily routine of the Occupational First Aid Service of the Belgian Red Cross (BRC), between September 2018 and August 2019, with follow-up between September 2019 and December 2020. The study was intended to be randomized, but because of logistical constraints, allocation was determined by availability of simulated patients, rather than being completely random.

The Occupational First Aid Service organizes 3-day first aid certification trainings (18-hour training) for employees on a wide range of first aid topics. The 3 days of trainings are taught in groups of approximately 10 people, over a period of 3 weeks. Most of these trainings are taught in Dutch, although some trainings may be taught in English or French, upon request. Typically these trainings do not involve simulated patients both during training or examination. After the training, the participants demonstrate their acquired skills and knowledge during a certification examination. To retain their certificate, participants are required to follow an annual refresher training.

For the purpose of this study, part of the trainings involved teaching using simulated patients. Whether a simulated patient was allocated to a training was determined by administrative employees involved in the practical organization of the trainings, based on availability of the simulated patients. The participants in the trainings were not aware beforehand of whether a simulated patient would be present or not. Before the start of the trainings, baseline first aid knowledge and self-efficacy, as well as some demographic factors, were assessed via a questionnaire (see Table, Supplementary Digital Content 1, http://links.lww.com/SIH/A848, containing questionnaires and skills checklists used for participant assessment). At the end of the training, the first aid certification examination consisted of the following: participants were asked to demonstrate the acquired first-aid related skills by providing first aid to the simulating examiner. Second, first aid knowledge and self-efficacy were assessed, in addition to participant satisfaction with the training, using the same questionnaires used for baseline assessment. One year after the training, retention in first aid knowledge and self-efficacy was assessed via the same questionnaire, before the start of their annual refresher training.

Participants

Participants to this study were employees from different companies enrolled in an occupational first aid certification training organized by the BRC. Participants were eligible to participate if they were 16 years or older, followed a training taught in Dutch and provided an informed consent. Participants were not eligible if they were younger than 16 years, followed a training in French or English, or the participant or their employer declined participation.

Interventions Studied

The first aid certification trainings were taught by professional first aid trainers, employed by the BRC. Training content and materials were standardized and consisted of lectures with a slide show, questions and answers conversations, and practical exercises. The topics taught were principles of first aid, cardiopulmonary resuscitation, first aid for bleeding and skin wounds (day 1), first aid for burns, syncope, stroke, head and neck injuries, eye injury, epilepsy, chest pain, respiratory problems, choking and poisoning (day 2), first aid for injuries to bones, muscles and joints, blisters, diabetes, the legal framework for first aid, and a brief revision (day 3).

Simulated Patient

In trainings involving a simulated patient, the simulated patient was specifically used during the topics "burns" and "stroke." These topics were chosen because they are a part of the regular curriculum of occupational first aid trainings organized by the BRC. These are also topics for which the use of a simulated patient is feasible and which are complementary to each other in terms of practical actions required and severity of the condition. During the practical exercises, after participants had received the theoretical explanations, a simulated patient would unexpectedly enter the room. This simulated patient was a BRC employee, professionally involved in patient simulation. This person combined acting distress and pain with make-up, thereby mimicking an ill or injured person's condition as truthfully as possible. For the topic "burns," the simulated patient entered the room with a large, second-degree burn (using make-up) on the lower arm. For the topic "stroke," the simulated patient was present in the room and suddenly feigned a hemiparalysis of the right side of the body. The person responded positive to the face-arm-speech-time test, which is recommended to be used by laypeople to recognize a person with a stroke.[1] This means that the simulated patient showed facial droop when asked to smile or show teeth, the person's right arm drifted or was unable to lift, and the person's speech was slurred.

The first aid instructor then asked 2 participants to actively provide first aid to the simulated patient. After first aid was provided, a group discussion involving the participants, the simulated patient and the first aid instructor followed on how first aid was provided, what went well, and what could be improved.

Control

The trainings without simulated patient were identical to the trainings with simulated patient, except for the use of the simulated patient. Instead, participants were shown video clips and case photographs to demonstrate first aid techniques for stroke and burns. There was no interaction or active involvement of the participants during the demonstration.

Blinding

The first aid trainer and simulated patient could not be blinded, because of the nature of the intervention. However, they were instructed to follow a strict routine, to minimize any influence of lack of blinding. Participants were aware that they were part of a study assessing BRC's first aid training quality, but they were not aware of the study's aims nor of the characteristics of the other study arm and can therefore be considered blinded.

Outcomes Measures

The main outcomes studied were knowledge, self-efficacy, and skills related to first aid for burns and stroke. Knowledge and self-efficacy were assessed using questionnaires (see Table, Supplementary Digital Content 1, http://links.lww.com/SIH/A848, containing questionnaires and skills checklists used for participant assessment), before the start of the training, during the examination at the end of the training, and 1 year after training. The knowledge questionnaires consisted of 10 multiple-choice questions on burns and stroke, which could be answered either correctly or falsely, leading to a maximal knowledge score of 10. For blinding purposes, these questions were blended in with 10 questions on other first aid topics. The self-efficacy questionnaires consisted of 6 questions, to be answered on a 5-point Likert scale, on participant's self-efficacy to provide first aid to a person with a stroke or a burn (see Table, Supplementary Digital Content 1, http://links.lww.com/SIH/A848, containing questionnaires and skills checklists used for participant assessment). This led to a possible score range between 5 (no self-efficacy at all) and 30 (full self-efficacy). The questions were blended in with 6 questions on other first aid topics, for blinding purposes.

First aid skills were demonstrated once via a practical skills test, during the certification examination at the end of the training, which was videotaped for independent analysis afterward. Skills were demonstrated on the first aid instructor and were assessed via a checklist, assessing 8 essential skills for burns and 6 for stroke (see Table, Supplementary Digital Content 1, http://links.lww.com/SIH/A848, containing questionnaires and skills checklists used for participant assessment), independently by 2 researchers. Disagreements in scoring were resolved by discussion. Where needed, a third researcher was involved. Participants could score a total of 18 points, 9 for burns and 9 for stroke. The skills tests took place during the certification examination, and were supplemented by skills tests for resuscitation (legal obligation), and 1 additional life-threatening and non–life-threatening first aid situation (for blinding purposes).

Secondary outcomes for this study were participant satisfaction with the first aid training (10-point scale) and cost associated with the training.

Data Management and Statistical Analyses

Data were anonymized and inserted in a database, and analyzed by independent, blinded researchers. Demographic characteristics between study groups were compared using a χ^2 test (categorical data) or a Mann-Whitney U test (continuous data). Outcome data were analyzed via a generalized linear mixed model in the open source software of the R-project for statistical computing, version 3.4, using the R-studio interface.[11,12] The main predictor variable was study arm. Other fixed effect covariates were age, sex, educational level, having previously experienced a first aid situation, and previous first aid training. Training group and participant were included as random variables, with participant nested within training group. Company ordering a training was anticipated to be a random effect in the analyses, but given only a handful companies actually ordered more than one training, this would have needlessly complicated the analyses.

Only complete cases were analyzed per time point, in a per-protocol analysis. The level of statistical significance was 5%. Normality of the data was verified with a Shapiro-Wilk test and by inspection of the histogram; data were found not to be normally distributed. They are therefore presented as medians with interquartile ranges.

The anticipated sample size for this study, based on the primary outcome retention in first aid–related self-efficacy after 1 year, was 496. This number took into account a power level of 90%, a statistical significance level of 5%, a total variance of 0.75, a within training and within company correlation coefficient of 0.025, an average of 10 participants per training, and 1.35 trainings organized per company.[13,14] Anticipating a dropout after 1 year at both the company (41%) and participant level (30%), we envisioned to recruit 1202 participants.

RESULTS

The Occupational First Aid Service of BRC trained a total of 1858 people in first aid between September 2018 and August 2019. Of the total number trained, 1113 people consented to participate. In 46 trainings, involving 403 participants, a simulated patient was used, while in 83 trainings, involving 710 participants, no simulated patient was used during first aid training (Fig. 1). The demographic characteristics of the participants allocated to the intervention and control group are described in the Table. No statistically significant nor practically relevant differences in demographic characteristics were noted between simulated patient and control group.

First Aid Knowledge

Before Versus Immediately After Following a Training Course

A total of 949 of the initially 1113 enrolled participants (85%) completed the knowledge questionnaires during the certification examination, of which 334 (83%) in the simulated patient and 615 (87%) in the control group (see Table, Supplementary Digital Content 2, http://links.lww.com/SIH/A849, for demographics of this subgroup with complete data). Reasons for dropout include withdrawal of consent and not showing up for the certification examination. Compared to those with complete data, median age was higher in the dropouts (38 vs. 35 years, $P = 0.01$). Baseline knowledge scores (T0) were similar in the simulated patient and control group, with a median score of 4 (2–5) in both groups (Fig. 2A). The knowledge scores after following training (T1) increased to a median of 7 (6–8) in both groups. The mixed model analysis indicated that a simulated patient had no impact on the increase in first aid–related knowledge scores ($P = 0.15$; see Table, Supplementary Digital Content 2, http://links.lww.com/SIH/A849, containing further analysis details).

One-Year Retention

Retention of knowledge after 1 year (T2) could be assessed in 237 participants (21%): 89 (22%) in the simulated patient group and 148 (21%) in the control group. In this subgroup with complete data at T2, compared with the dropouts, there were more females (50% vs. 41%, $P = 0.03$) and the median age was lower (32 vs. 36 years, $P < 0.001$). Nevertheless, first aid knowledge scores at T0 and T1 were similar to the knowledge scores at these time points in the whole sample, with a median of 4 (3–5) at T0 in both groups and an increase at T1 to 7 (7–8) in the simulated patient group and 7 (6.75–8)
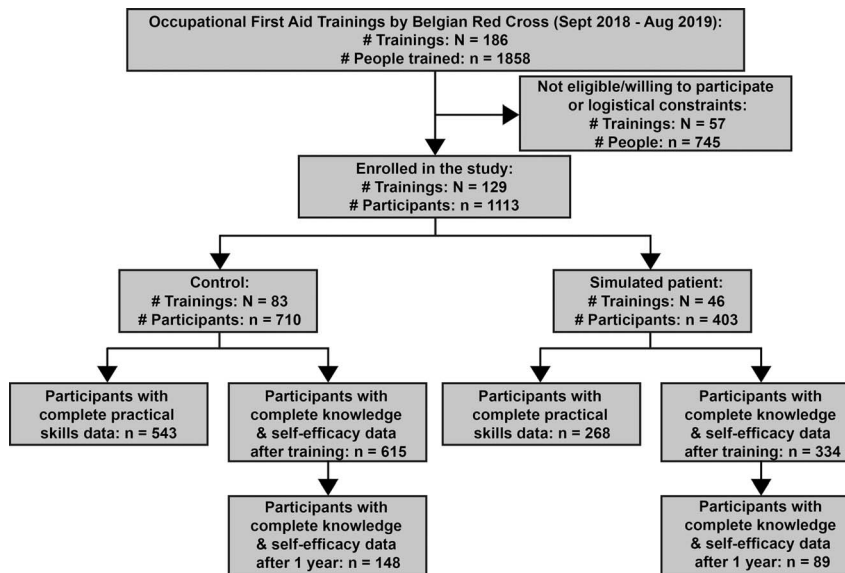
FIGURE 1. Flow diagram of the study, illustrating enrollment, group allocation, and follow-up of study participants.

in the control group. This suggests the complete cases to be representative for the whole sample. Knowledge scores at T2 remained higher than at T0, with a median score of 6 (5–7) in the control group, compared with 7 (6–8) in the simulated patient group (Fig. 3A). The increase in first aid knowledge at T2, compared with baseline, was statistically significantly higher in the simulated patient group, compared with the control group ($P = 0.02$), which was not the case at T1 ($P = 0.67$, see Table, Supplementary Digital Content 2, http://links.lww.com/SIH/A849, containing further analysis details).

First Aid Self-efficacy

Before Versus Immediately After Following a Training Course

The same people who completed the knowledge questionnaire also completed the self-efficacy questionnaire. First aid self-efficacy scores were similar at T0, with a median score of 17 (13.25–20) in the simulated patient group and 17 (14–20) in the control group (Fig. 2B). Self-efficacy scores increased

at T1 to a median of 26 (24–28) in both groups. A simulated patient during training did not impact the increase in self-efficacy scores ($P = 0.21$, see Table, Supplementary Digital Content 2, http://links.lww.com/SIH/A849, containing further analysis details).

One-Year Retention

The same 237 participants for whom 1-year retention in knowledge could be assessed also completed the self-efficacy questionnaire after 1 year. First aid self-efficacy scores were similar at T0 and T1 in this subgroup with complete data, as compared with the whole sample, with scores of 18 (15–20) and 27 (25–28) in the simulated patient group and 17 (14–20.25) and 27 (25–28) in the control group at T0 and T1, respectively. Self-efficacy scores remained high in both groups at T2, with scores of 24 (23–26) in the simulated patient group and 24 (22–26) in the control group (Fig. 3B). A simulated patient did not influence increases in self-efficacy, compared with baseline, neither at T1 ($P = 0.84$) or T2 ($P = 0.96$, see

TABLE 1. Demographic Characteristics of the Study Sample

|	Total	Control	Simulated Patient	$P \chi^2$ or Wilcoxon Signed-Rank Test
Sex, female	476 (43%)	291 (41%)	185 (46%)	$P = 0.14$
Sex, male	632 (57%)	414 (58%)	218 (54%)	
Sex, undisclosed	3 (0.3%)	3 (0.4%)	0 (0%)	
Sex, unknown	2 (0.3%)	2 (0.3%)	0 (0%)	
Age	35 (28–45)	36 (28–46)	35 (28–44)	$P = 0.09$
Educational level, no/primary school	29 (3%)	22 (3%)	7 (1%)	$P = 0.43$
Educational level, high school	566 (51%)	352 (50%)	214 (53%)	
Educational level, bachelor's degree	308 (28%)	200 (28%)	108 (27%)	
Educational level, master's degree or higher	209 (19%)	136 (19%)	73 (18%)	
Educational level, unknown	1 (0.1%)	0 (0%)	1 (0.2%)	
Prior FA education, no	737 (66%)	464 (65%)	273 (68%)	$P = 0.43$
Prior FA education, yes, occupational FA by BRC	188 (17%)	130 (18%)	58 (14%)	
Prior FA education, yes, other FA education	187 (17%)	116 (16%)	71 (18%)	
Prior FA education, unknown	1 (0.1%)	0 (0%)	1 (0.2%)	
Prior FA experience, no	701 (63%)	448 (63%)	253 (63%)	$P = 0.96$
Prior FA experience, yes	411 (37%)	262 (37%)	149 (37%)	
Prior FA experience, unknown	1 (0.1%)	0 (0%)	1 (0.2%)	

FA, first aid.
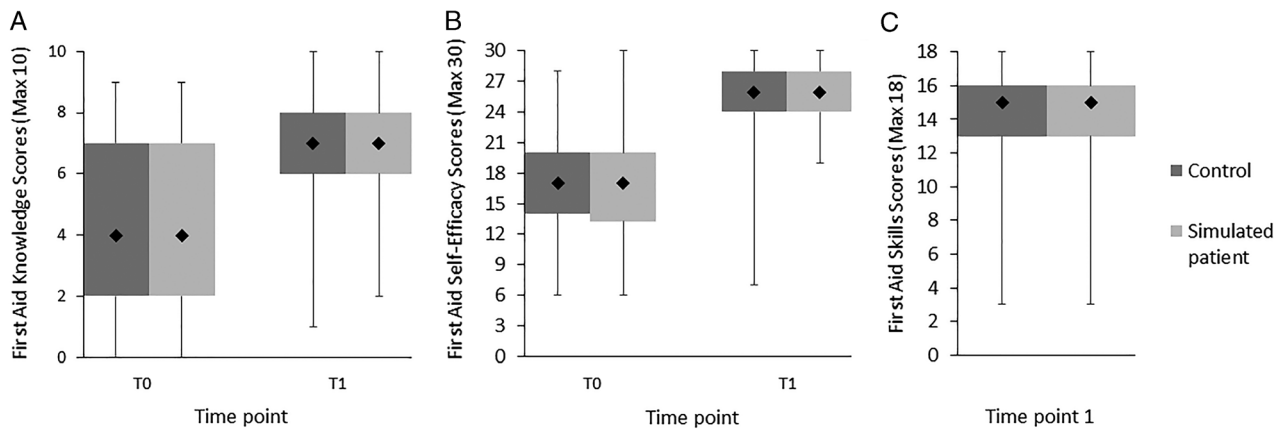
FIGURE 2. First aid knowledge (A), self-efficacy (B), and skills (C) scores before (T0) and immediately after (T1) after a first aid certification course with (n = 334 for knowledge and self-efficacy and 268 for skills) or without a simulated patient (n = 615 for knowledge and self-efficacy and 543 for skills).

Table, Supplementary Digital Content 2, http://links.lww.com/SIH/A849, containing further analysis details).

First Aid Practical Skills Immediately After Following a First Aid Certification Training Course

First aid skills scores after the occupational first aid certification training were available for 811 participants (73%), 268 (67%) in the simulated patient group and 543 (76%) in the control group. These numbers are lower than for the knowledge and self-efficacy outcomes, as some participants consented to completing questionnaires, but not to having their skills assessment recorded on camera. There were no statistically significant, nor practically relevant differences in demographics between this subgroup with data available and the dropouts. First aid skills scores after training were 15 (13–16) in both groups (Fig. 2C). A simulated patient had no impact on first aid skills scores after first aid training (P = 0.78, see Table, Supplementary Digital Content 2, http://links.lww.com/SIH/A849, containing further analysis details).

Secondary Outcomes: Participant Satisfaction and Cost Analysis

Participant satisfaction scores after following an occupational first aid training were available from 1002 people, including some for whom no complete data on knowledge and self-efficacy were available. Median satisfaction scores were 9 (8–10) in both groups. Using a simulated patient in the training had no influence on participant satisfaction scores (P = 0.39, see

Table, Supplementary Digital Content 2, http://links.lww.com/SIH/A849, containing further analysis details).

The incremental costs associated with organizing a training with a simulated patient, compared with a regular training include salary cost for the simulated patient at €275 per training and make-up to simulate the injuries at €5 per training. All other costs remain constant, regardless of the involvement of a simulated patient. Given that the average number of participants per training is 8.6, incremental cost per person to follow a training with a simulated patient is €32.5. The only outcome for which a simulated patient had a statistically significant impact was knowledge at T2, with a median difference of 1 point between simulated patient and control group. Therefore, the incremental cost per knowledge point gained at T2 is estimated to be €32.5.

DISCUSSION

This study aimed to evaluate the added value of using simulated patients when training laypeople in an occupational first aid certification course, for the topics "stroke" and "burns." Simulated patients did not seem to have an impact on the immediate increases in first aid–related knowledge or self-efficacy, nor on first aid skills and participant satisfaction measured after training. However, a simulated patient did seem to have an impact on knowledge, but not self-efficacy, measured 1 year after training. This suggests that involving simulated patients in training may exert its impact on retention, rather than acquisition of
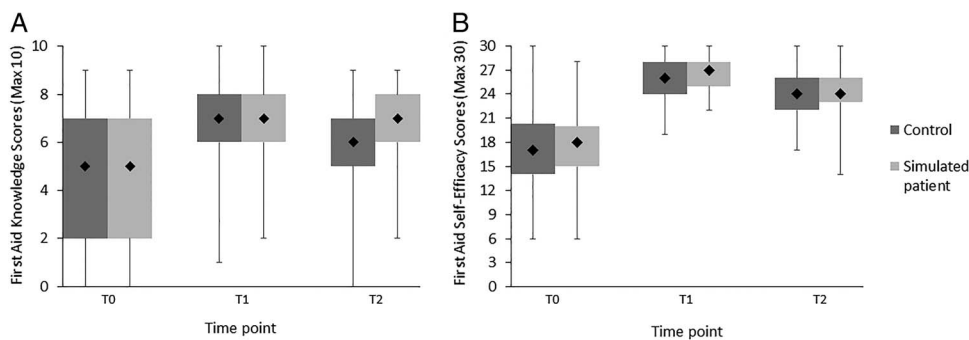
FIGURE 3. First aid knowledge (A) and self-efficacy (B) scores before (T0), immediately after (T1), and 1 year after (T2) after a first aid certification course with or without a simulated patient for the subgroup of participants with complete data at T2 (n = 89 for the simulated patient group and 148 for the control group).

© 2022 The Author(s). Published by Wolters Kluwer Health, Inc. on behalf of the Society for Simulation in Healthcare.

knowledge. Participant satisfaction with the training was not influenced by the involvement of a simulated patient, but given a median score of 9 of 10 in the control group, the margin for improvement was very small.

The main goal of using a simulated patient during healthcare education is providing the learners with a more "immersive" experience. This is thought to increase interactions during training, thereby improving communication between healthcare worker and patient.[15,16] In first aid training, similarly, the idea of using simulated patients is that laypeople, who are generally not used to encounter ill or injured people, get a more realistic feeling of what it is like to provide first aid. Therefore, we expected that mainly self-efficacy would be impacted by training with a simulated patient. However, this could not be demonstrated. The fact that retention of, but not increase in, knowledge was influenced by using a simulated patient suggests that using the simulated patient influences the hardwiring of new information in the participant's memory. This may be due to the impression the simulated patient makes by simulating convincingly, thereby inducing a mild level of stress, which has been suggested to enhance learning.[17] Alternatively, the simulated patient also adds to the diversity in educational approaches used. Prior research has already shown that using different teaching methods, including problem-based and interactive methods, results in better educational outcomes.[18] It would have been interesting to see whether retention in first aid skills after 1 year would have been influenced by the simulated patient, but practical feasibility precluded us from measuring this important outcome.

Several studies with healthcare professionals have already assessed the impact of using simulated patients during training. Lee et al[19] reported that training with mannequins improved trauma assessment scores, compared with simulated patients in surgery interns, whereas Ali et al[8] concluded that trauma evaluation knowledge and skills improved equally in final-year medical students trained with either mannequins or simulated patients. Wisborg et al[7] assessed experiences of hospital trauma teams receiving training with both a simulated patient and a mannequin. Trainees' perceived educational outcomes did not differ but they had a slight preference for a simulated patient in scenarios where the ill or injured person is supposed to be conscious and interaction is needed. Correspondingly, Coffey et al[15] noted an increased number of verbal and non-verbal interactions in clinical teams dealing with simulated patients during emergency care scenarios, compared with mannequins. Miotto et al[20] could not demonstrate any added value of using both simulated patients and mannequins, compared with using mannequins alone, in advanced life support courses for healthcare workers.

In addition to these studies comparing simulated patients with mannequins, Herbstreit et al[16] compared using simulated patients to traditional small-group seminars in fourth-year medical students trained in emergency care scenarios. Training with simulated patients led to statistically significantly increased clinical examination skills, but not knowledge, compared with following traditional seminars.

Strengths of this research include its innovation. This is the first study on the use of simulated patients for teaching first aid to laypeople. Our study focused on the nonresuscitative topics "stroke" and "burns," which are less well studied than resuscitative first aid training.[21] These 2 topics were selected as they are complementary to each other, with (1) stroke being life-threatening while burns are generally less so and (2) burns requiring more practical treatment actions while stroke is mainly about recognizing what is wrong and quick action.[1,22] The participants and outcome assessors were blinded for participants' group allocation, and the trainers and simulated patients followed a strict procedure, ensuring high fidelity in delivery of the intervention, as well as outcome assessment. Furthermore, our study measured 1-year retention of knowledge and self-efficacy, which is not common in first aid education research.[4] Finally, given its embeddedness in the operations of the BRC, results of this work are directly applicable to the daily routine of our Occupational First Aid Service and likely also other first aid training organizers.

This study has several limitations as well. The lack of randomization could have caused imbalances between intervention and control group. However, analysis of the main demographic characteristics suggests this not to be the case. Secondly, there is a large dropout after 1 year. This was anticipated and accounted for in our a priori power analysis but turned out to be even larger than expected, in part because of the COVID-19 pandemic. The dropout resulted in unbalanced test groups after 1 year, which was mitigated by correcting for confounding in the mixed model analyses. However, there is still a risk that unknown confounders remained present. The larger than expected dropout also means that we were unable to reach our desired sample size after 1 year, but nevertheless, a statistically significantly increased knowledge retention could be demonstrated, while the effect size for retention in self-efficacy was that small, which we are confident that a larger sample would not lead to differing conclusions. The subgroup with complete data after 1 year was slightly younger, with a higher proportion of females. This may be a limitation regarding generalizability of our results to the whole population of workplace first aiders, where the majority is male (a consequence of the legal framework on workplace first aid and the predominance of males in heavy industry jobs in Belgium). Theoretically, the fact that 1-year retention data were collected for a substantial part of the participants via an online survey imposes the risk that these people could look up correct answers for the knowledge test.[23] However, given that there were no consequences to a poor test score, there was no direct incentive for them to actually do so.

In conclusion, this study is the first of its kind to evaluate the added value of using simulated patients during first aid training for laypeople. Simulated patients do not seem to impact increases in knowledge and self-efficacy, nor practical skills and satisfaction, measured immediately after training. In contrast, 1-year retention of knowledge, but not self-efficacy, seems to improve when using a simulated patient. These data support the use of simulated patients during first aid training.

REFERENCES

1. Zideman DA, Singletary EM, Borra V, et al. European Resuscitation Council Guidelines 2021: first aid. *Resuscitation* 2021;161:270–290.

2. Laxminarayan R, Mills AJ, Breman JG, et al. Advancement of global health: key messages from the disease control priorities project. *Lancet* 2006;367(9517):1193–1208.

3. *International Federation of Red Cross/Red Crescent Societies: International First Aid Resuscitation and Education Guidelines 2020.* Montrouge, France: Global First Aid Reference Centre; 2020. Available at: https://www.globalfirstaidcentre.org/first-aid-guidelines-2020/. Accessed April 26, 2021.

4. He Z, Wynn P, Kendrick D. Non-resuscitative first-aid training for children and laypeople: a systematic review. *Emerg Med J* 2014;31(9):763–768.

5. Balhara KS, Bustamante ND, Selvam A, et al. Bystander assistance for trauma victims in low- and middle-income countries: a systematic review of prevalence and training interventions. *Prehosp Emerg Care* 2019;23(3):389–410.

6. Abelsson A, Rystedt I, Suserud BO, Lindwall L. Learning by simulation in prehospital emergency care—an integrative literature review. *Scand J Caring Sci* 2016;30(2):234–240.

7. Wisborg T, Brattebo G, Brinchmann-Hansen A, Hansen KS. Mannequin or standardized patient: participants' assessment of two training modalities in trauma team simulation. *Scand J Trauma Resusc Emerg Med* 2009;17:59.

8. Ali J, Al Ahmadi K, Williams JI, Cherry RA. The standardized live patient and mechanical patient models—their roles in trauma teaching. *J Trauma* 2009;66(1):98–102.

9. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev* 1977;84(2):191–215.

10. Avau B, Vanhove AC, Vandenlindenloof M, et al. Evaluating the impact of simulated patients on knowledge, skills and attitudes of laypeople following a basic first aid course: protocol for a cluster-randomized controlled trial. *Int J First Aid Educ* 2019;2(2).

11. *RStudio Team: RStudio: Integrated Development for R.* Boston, MA: R Studio, PBC; 2020.

12. *R Core Team: R: A Language and Environment for Statistical Computing.* Vienna, Austria: R Foundation for Statistical Computing; 2016.

13. Rutterford C, Copas A, Eldridge S. Methods for sample size determination in cluster randomized trials. *Int J Epidemiol* 2015;44(3):1051–1067.

14. Teerenstra S, Moerbeek M, van Achterberg T, Pelzer BJ, Borm GF. Sample size calculations for 3-level cluster randomized trials. *Clin Trials* 2008;5(5):486–495.

15. Coffey F, Tsuchiya K, Timmons S, Baxendale B, Adolphs S, Atkins S. Simulated patients versus manikins in acute-care scenarios. *Clin Teach* 2016;13(4):257–261.

16. Herbstreit F, Merse S, Schnell R, et al. Impact of standardized patients on the training of medical students to manage emergencies. *Medicine (Baltimore)* 2017;96(5):e5933.

17. Tyng CM, Amin HU, Saad MNM, Malik AS. The influences of emotion on learning and memory. *Front Psychol* 2017;8:1454.

18. Hattie JAC. *Visble Learning: A Synthesis of Over 800 Meta-analyses Relating to Achievement.* Abingdon, United Kingdom: Routledge; 2009.

19. Lee SK, Pardo M, Gaba D, et al. Trauma assessment training with a patient simulator: a prospective, randomized study. *J Trauma* 2003;55(4):651–657.

20. Miotto HC, Couto BR, Goulart EM, Amaral CF, Moreira Mda C. Advanced Cardiac Life Support Courses: live actors do not improve training results compared with conventional manikins. *Resuscitation* 2008;76(2):244–248.

21. Reveruzzi B, Buckley L, Sheehan M. School-based first aid training programs: a systematic review. *J Sch Health* 2016;86(4):266–272.

22. Meyran D, Cassan P, Avau B, Singletary E, Zideman DA. Stroke recognition for first aid providers: a systematic review and meta-analysis. *Cureus* 2020;12(11):e11386.

23. Clifford S, Jerit J. Is there a cost to convenience? An experimental comparison of data quality in laboratory and online studies. *J Exp Pol Sci* 2014;1(2):120–131.