



# Determining First Aid Knowledge and Skills Retention with Laypeople: A Randomized Controlled Trial in Nepal

Bert Avau, Axel Vande veegaete, Hans Scheers, Philippe Vandekerckhove, Emmy De Buck

**Background:** First aid (FA) education is important in building a resilient society. Millions of people are trained annually in FA worldwide. However, the knowledge concerning retention of FA and optimal retraining frequency is limited. The aims of the current study were to investigate the two-year retention of FA knowledge and skills, and to determine to what extent refresher courses with different contents after one year influence retention.

**Methods:** 502 Nepalese laypeople were trained in basic FA during 21 separate 4-day courses. One year after the basic FA course, participants received one of two refresher courses. The first one ("FA theory + FA skills") comprised theory on several FA topics, in addition to practical skills for cardiopulmonary resuscitation (CPR) and bleeding, while the other ("Other theory + other FA skills") did not include FA theory, but other concepts such as road safety, in addition to practical skills for CPR and fractures. Theoretical knowledge on non-resuscitative FA was assessed before (t0) and after (t1) the basic FA course, before (t2) and after (t3) the refresher course and two years after (t4) the basic FA course. Selected practical FA skills were assessed after the basic FA course (t1), before the refresher course (t2) and two years after the basic FA course (t4). Changes in theoretical knowledge and practical skills in function of time and type of refresher course were evaluated with linear mixed models analyses.

**Results:** FA theoretical knowledge and practical skills decreased significantly over time. Attending an active refresher course after one year was associated with a lesser decay in non-resuscitative FA knowledge ( $p=0.04$ ), while no effect could be shown on the retention of practical skills for bleeding ( $p=0.52$ ). Surprisingly, retention of practical skills for fractures was decreased in the group that was refreshed for this skill ( $p=0.006$ ). An exploratory analysis on practical CPR skills, comparing participants who participated in the refresher courses and those who did not, showed that those following a refresher had better skills retention over time ( $p=0.023$ ).

**Conclusion:** Retention in non-resuscitative FA knowledge, and resuscitative and non-resuscitative practical skills, decreases over two years. A refresher after one year seems to have modest effects on non-resuscitative FA knowledge and practical CPR skills. These results support providing annual refreshers.

The burden of injuries to global health is considerable (WHO, 2016), but simple first aid (FA) actions can reduce pre-hospital deaths significantly (Abe, Tokuda, Ishimatsu, & SOS-KANTO Study group, 2009; Murad & Husum, 2010). Furthermore, FA training is a cost-effective way to save lives (Laxminarayan et al., 2006), and reduce the burden of injuries in world regions

where emergency medical services (EMS) are not readily available (Geduld & Wallis, 2011; Husum, Gilbert, & Wisborg, 2003; Merchant et al., 2015).

More than 14 million people are annually trained in FA worldwide (Global First Aid Reference Centre, 2015). The Red Cross and Red Crescent Societies are among the main providers of FA

training. A 2015 survey by the Global FA Reference Centre (GFARC) of the International Federation of Red Cross and Red Crescent Societies (IFRC), showed that a majority (84%) of the FA certificates delivered have a validity date. However, validity periods vary from 1 to 5 years. Refresher courses are organized by 96 percent of Red Cross and Red Crescent national societies.

Despite the number of FA trainings and refresher courses organized worldwide, the evidence about retention of knowledge and skills for FA is limited (He, Wynn, & Kendrick, 2014). Jayaraman et al. (2009) showed a significant increase in FA knowledge in lay first responders in Uganda six months after following a one-day basic FA course on trauma, compared to the participants' knowledge prior to the course. Schumann, Schimelpfenig, Sibthorp, & Collins (2012) noted that FA knowledge was significantly decreased after a 4-, 8- or 12-month period, compared to immediately afterwards following a two-day wilderness FA course, with a larger decay after 12 months than after 4 or 8 months. Li, Sheng, Zhang, Jiang, & Shen (2014) investigated knowledge retention after a pediatric FA training in preschool staff. FA knowledge significantly increased immediately after the course, but decreased after 6 months, 9 months and 4 years, although still higher than at baseline. To our knowledge, no study has addressed the impact of refresher courses on non-resuscitative first aid skills retention.

The retention of resuscitative FA knowledge and skills was assessed in a systematic literature search by the International Liaison Committee on Resuscitation (ILCOR) (Greif et al., 2015). ILCOR (2015) concluded that there was insufficient evidence to recommend an interval for basic life support retraining for laypeople, but that basic life support skills decay after 3-12 months and frequent training improves these skills.

Considering the lack of uniformity in the validity period of FA certificates and in the interval for retraining FA providers on one hand, and the lack

of evidence on non-resuscitative FA retention on the other, additional primary research is paramount.

The objective of the present study was firstly to estimate the level of retention of non-resuscitative FA knowledge and skills of laypeople following a basic FA course, and secondly to assess the influence of a refresher course after one year on these knowledge and skills.

## Methods

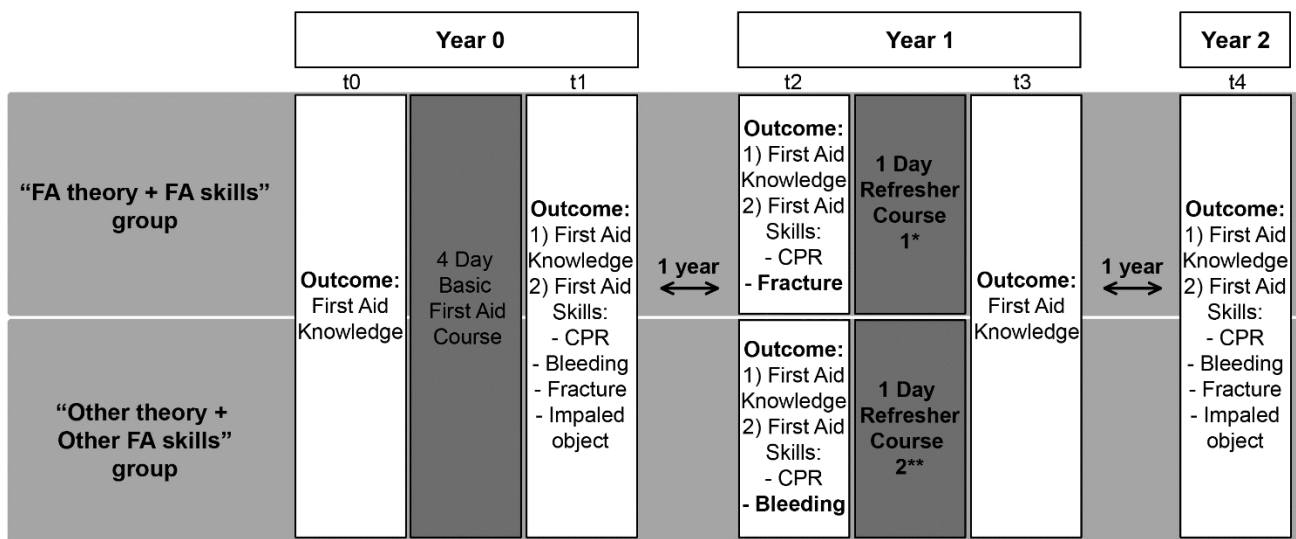
### Study setting and population

This randomized controlled trial was conducted in two districts (Bhaktapur and Kaski) in Nepal. According to a 2011 census by the Nepalese government, Bhaktapur is an urban district of approximately 69,000 households, with a population density of around 2,500 inhabitants per km<sup>2</sup> (Central Bureau of Statistics, 2012). Kaski is a more rural, mountainous area with approximately 126,000 households, and a population density of around 244 inhabitants per km<sup>2</sup>. The study population consisted of laypeople without medical or paramedical background following first aid training. Data were collected between November 2014 and December 2017 in the training centers of Nepal Red Cross Society in Bhaktapur city (Bhaktapur) and Pokhara (Kaski). In total, 502 people followed basic first aid training; 214 in Bhaktapur and 288 in Kaski.

### Study concept

A completed CONSORT checklist can be found in appendix 1. Participants, clustered in 21 courses, were trained in basic FA and tested for knowledge and skills retention. They were randomly divided per course in two groups. One year after the basic FA courses, participants received one of two refresher courses, "FA theory + FA skills" or "Other theory + other FA skills" (Figure 1). The refresher courses mainly differed in theory on non-resuscitative first aid, which was absent in the second refresher course. Both courses contained training on different practical skills. Details are described below.

Figure 1: Research timeline



\***Refresher course 1:** Practical skills for CPR and **bleeding**, theoretical refresher on **non-resuscitative first aid knowledge** (patient assessment, unconsciousness, shock, spinal injuries and burns).

\*\***Refresher course 2:** Practical skills for CPR and **fractures**, theory on **other knowledge** (road safety, triage, lifting/moving a victim, psychological first aid and first aid kit content).

### Basic training

All participants received a basic FA training course within the framework of a road safety program of Nepal Red Cross Society. This course was taught in Nepalese, the participants' mother tongue. Before starting (time point 0, t0), participants completed a questionnaire, to estimate baseline theoretical FA knowledge (Appendix 2). This questionnaire, set up in Nepalese, consisted of 20 multiple choice questions on FA and road safety, of which 8 were on non-resuscitative FA topics selectively refreshed in one refresher, but not in the other. These 8 questions were used throughout the study to determine knowledge retention and the effect of a refresher course.

The basic FA course was conducted over 4-days, with theory and practice on patient assessment, unconsciousness, respiratory problems and CPR, bleeding and shock, spinal injury, wounds and bandaging, fractures, burns and electrical injuries, bites and poisoning, and lifting and moving of a victim (Appendix 3).

The FA courses were taught by a limited number of skilled trainers. To ensure comparability, the course

content was standardized. All courses were supervised by a study coordinator, employed by Nepal Red Cross

Society. Content and timing were monitored per course using a checklist.

At the end of the course (t1), participants' theoretical FA knowledge was assessed again using the questionnaire, and practical skills were tested using a practical skills test for CPR, fractures, bleeding and impaled object. A maximal score of 25 could be obtained per skill (Appendix 4). The choice for these skills was based on their perceived importance in the Nepalese context by Nepal Red Cross Society.

### Refresher course

After one year, all subjects received a 1-day refresher course. Before starting (t2), participants completed the same knowledge questionnaire as the year before, to estimate one-year retention of non-resuscitative FA knowledge.

Since Nepal Red Cross Society considers resuscitation essential, CPR was taught and tested in both groups.

- In the “FA theory + FA skills” group, practical skills for CPR and fractures were tested at t2.

After this practical test, this group received a theoretical reiteration on non-resuscitative FA: patient assessment, unconsciousness, shock, spinal injuries and burns. In addition, they received a refresher on practical skills for bleeding and CPR.

- In the “Other theory + other FA skills” group, practical skills for CPR and bleeding were tested at t2. After this practical test, participants received theory on other concepts: road safety, triage, lifting and moving of a victim, psychological FA and content of a FA kit. This group then received a refresher on practical skills for fractures and CPR.

Via this design, the two test groups were each other's control with respect to practical skills for the non-resuscitative first aid topics fractures and bleedings. The practical skill first aid for impaled object was not refreshed in either group and acted as a negative control. Details on refresher course contents can be found in appendix 5. The refresher courses and assessments were performed by a limited number of skilled trainers.

At the end of the refresher courses (t3), both groups completed the theoretical knowledge questionnaire, while practical skills were not assessed due to time constraints.

#### ***Final retention test***

Two years after the basic training, all participants from both intervention groups were invited to determine their retention of non-resuscitative FA knowledge and resuscitative and non-resuscitative skills (t4). These tests were identical to those taken after the basic FA course.

#### **Sample size calculation and drop-out rate**

Change in theoretical non-resuscitative FA knowledge was the primary outcome. 215 subjects per group (430 subjects in total) were needed to detect a mean difference of 10% in scores between groups after two years (assuming a standard deviation of 30%, a drop-out rate of 50% after two years, and a power of 80%) (Meinert, 2012). This difference was based on a paper of Anderson, Gaetz, & Masse (2011), where multiple

choice exam scores were compared between subjects that had been trained only once and those who had renewed their certificate at least once. In an attempt to minimize drop-out, participants were actively invited to attend the refresher course after one year and the two-year follow-up measurement by Nepal Red Cross Society. Furthermore, lunch and beverages were provided for free during basic and refresher courses.

#### **Randomization and blinding**

The 21 course groups were randomized by using an online tool (Sealed Envelope, 2019). Different courses were block randomized (block size of 2) in one of both intervention groups in a 1:1 ratio. The randomization was done by researchers not involved in the practical organization or evaluation of the courses.

The FA trainers involved were not aware of the allocation status of the basic courses they provided, nor of the actual purpose of the refresher courses. They only knew a research project was ongoing to evaluate the courses, as they collected the consent forms. Participants alike were not aware of the true purpose of the study. As FA trainers also evaluated the tests, outcome assessors were also blinded of the actual goal of the study.

#### **Ethical considerations**

The participants were informed about the research and completed an informed consent form (Appendix 6). Briefly, they were informed that for research purposes, we would test their FA knowledge and skills, both during the basic course and if they would follow a refresher course. However, they were not aware of the purpose of the study, i.e. that they would receive a specific type of refresher course. FA trainers were not study subjects and did not need to provide informed consent. The protocol of this trial was approved by the Societal and Social Ethical Committee (SMEC) of the University of Leuven, and registered with file number G-201411100.

#### **Data management and statistical analyses**

Data management and statistical analyses were performed in R version 3.4.0 (R Core Team, 2016), using add on packages lme4 (Bates, 2015) and lmerTest (Kuznetsova, 2017).

Personal characteristics are expressed as medians with interquartile range (IQR) (continuous variables), or numbers with corresponding percentage (categorical variables). Groups of participants were compared for these continuous and categorical characteristics, using Kruskal-Wallis tests and  $\chi^2$  tests, respectively.

We investigated associations between knowledge and skills at different time points on the one hand and having attended a refresher course on the other hand by using linear mixed models, accounting for the repeated measures study design. Statistically significantly differing demographic variables were included in the models as a possible confounding factor. We tested the assumption of normal distribution of the error terms by visual inspection of the Q-Q plots of residuals. Results for all outcomes are presented as median test scores (ranging from 0 to 8 points for knowledge, and from 0 to 25 points for skills) with interquartile range (IQR). All tests were two-sided with  $\alpha=0.05$ .

## Results

### Baseline Characteristics

A total of 248 out of 502 (49%) enrolled subjects followed a refresher course after one year and completed the two-year follow-up assessment. For these complete cases, the primary analyses, investigating the influence of a refresher course on FA knowledge and skills retention, could be performed (CONSORT flowchart in appendix 7). This drop-out rate is close to the anticipated level (50%), on which the a priori power analysis was based.

Demographic characteristics of the participants, shown in table 1, did not differ significantly between groups, except participant's age, which is on average higher in the "Other theory + other FA skills" group ("FA theory + FA skills": Median 21, IQR [19;26.22] years vs "Other theory + other FA skills": Median 23, IQR [20;28.39] years,  $p=0.025$ ). As this difference is, albeit statistically significant, not very large, and this is a randomized study, we presume it occurred due to chance. Nevertheless, in further analyses, age is accounted for as a potential confounding factor.

### Analysis 1: Impact of a refresher course after one year on two-year retention of non-resuscitative FA knowledge

A mixed models analysis showed that the participants' non-resuscitative FA knowledge increased in both the "FA theory + FA skills" group (from 2 [1;2] at t0 to 6 [6;7] points at t1,  $p<0.0001$ ) and "Other theory + other FA skills" group (from 1 [1;2.75] at t0 to 6 [5.25;7] points at t1,  $p<0.0001$ ), immediately after the basic FA course (Figure 2). There were no differences between groups in baseline scores of knowledge, nor in the increase of scores.

Further analysis of the time-dependent course of participants' knowledge revealed that there was a significant decay at t2 ( $p<0.0001$ ), t3 ( $p=0.009$ ), and t4 ( $p<0.0001$ ) when compared to knowledge immediately after the basic FA course (t1) in both groups. The significant interaction between group and time at t4 ( $p=0.04$ ), indicates that the decay in knowledge was less pronounced in participants in "FA theory + FA skills" group, who received a reiteration on non-resuscitative FA, compared to those in the "Other theory + other FA skills" group. Introducing participants' age as a potential confounder showed that age has a significant, independent, negative effect on participants' knowledge ( $p = 0.02$ ), without altering any of the other conclusions made.

### Analysis 2: Impact of type of refresher course after one year on two-year retention of resuscitative and non-resuscitative FA skills

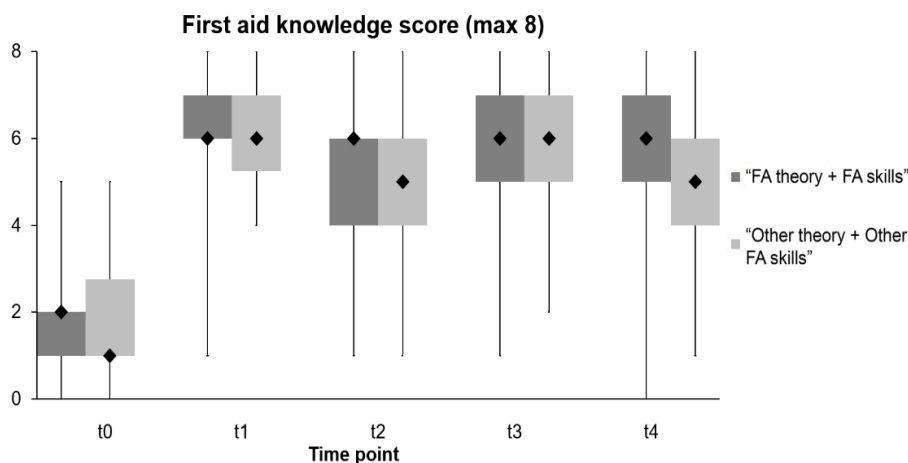
#### *Practical cardiopulmonary resuscitation skills*

The median scores for practical skills for cardiopulmonary resuscitation (CPR) after following a basic FA course were 20 [18;21] in the "FA theory + FA skills" group and 20.5 [19;22] in the "Other theory + other FA skills" group (Figure 3A). CPR skills were refreshed in both refresher courses. The median scores after two years were 20 [19;21] in the "FA theory + FA skills" group and 20 [19;21] in the "Other theory + other FA skills" group. There was no difference in

Table 1: Demographic characteristics of the participants

		<b>"FA theory + FA skills" group (count/median) n = 134</b>	Proportion (%) / interquartile range	<b>"Other theory + other FA skills" group (count/median) n = 114</b>	Proportion (%) / interquartile range	<b>Partial complete cases (no refresher) n = 52</b>	Proportion (%) / interquartile range	<b>Dropouts (count/median) n = 202</b>	Proportion (%) / interquartile range
<b>Sex</b>	Female	66	49%	62	54%	29	56%	118	58%
	Male	68	51%	52	46%	23	44%	84	42%
<b>Age</b>	-	21	[19;26.22]	23	[20;28.39]	23.5	[19;26.44]	22	[19.25;25.17]
<b>District</b>	Bhaktapur	35	26%	29	25%	29	56%	121	60%
	Kaski	99	74%	85	75%	23	44%	81	40%
<b>Education</b>	No scholar education	0	0%	0	0%	1	2%	1	0%
	Primary grade 1-5	1	1%	0	0%	0	0%	2	1%
	Lower secondary 6-8	4	3%	3	3%	0	0%	3	1%
	Secondary 9-10	16	12%	19	17%	8	15%	21	10%
	Higher secondary 11-12	55	41%	51	45%	16	31%	85	42%
	Higher education	55	41%	38	33%	23	44%	76	38%
	Not disclosed	3	2%	3	3%	4	8%	13	6%
	Unknown	0	0%	0	0%	0	0%	1	0%
<b>Employment</b>	Teacher	7	5%	9	8%	6	11%	8	4%
	Nurse, caregiver	2	1%	2	2%	1	2%	9	5%
	Business man/woman	2	1%	7	6%	1	2%	0	0%
	Shop keeper	0	0%	0	0%	0	0%	2	1%
	Craftsman/woman	0	0%	1	1%	0	0%	0	0%
	Student (higher education)	28	21%	19	17%	14	28%	52	26%
	Student (up to grade 12)	24	18%	17	15%	5	9%	18	9%
	Other	19	14%	13	11%	2	4%	22	11%
	Unemployed	3	2%	2	2%	2	4%	10	5%
Unknown	49	37%	44	39%	21	41%	81	40%	
<b>First aid knowledge score at t0</b>	-	2	[1;2]	1	[1;2.75]	2	[1;3]	2	[1;3]

Figure 2: First aid knowledge score

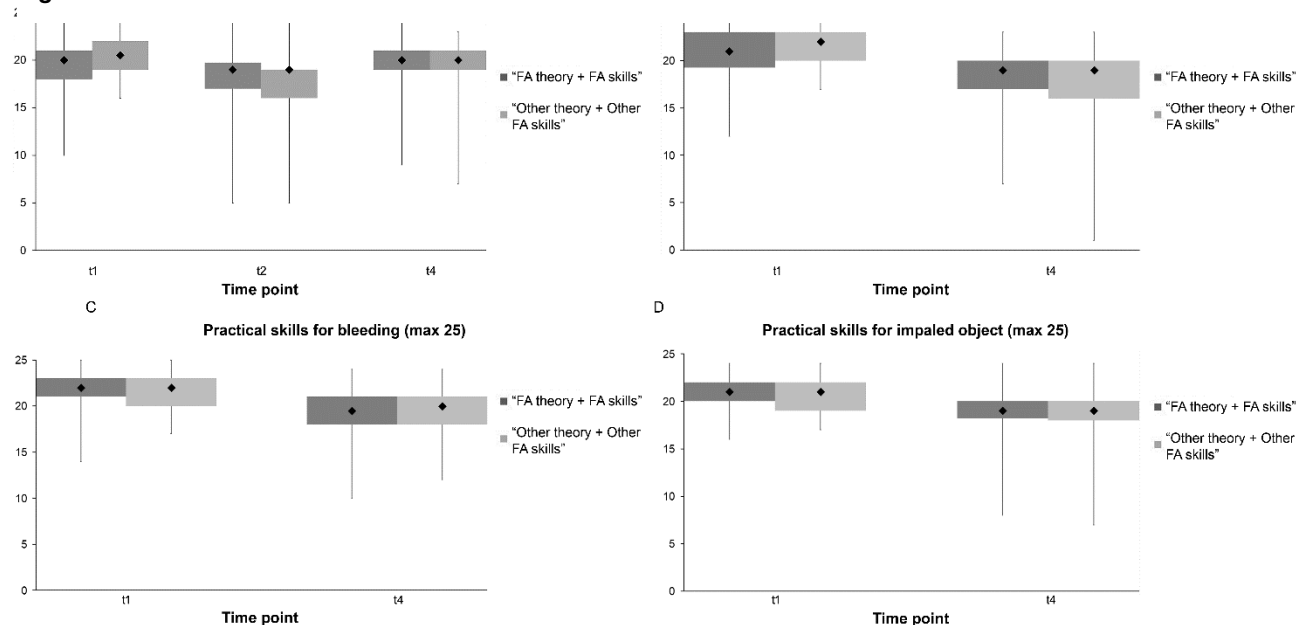


baseline scores (t1) between groups, but participants' CPR skills decreased significantly over time ( $p=0.0003$ ), irrespective of which refresher group they were in ( $p$  for interaction  $=0.34$ ). Adding participants' age to the model revealed a significant three-way interaction between type of refresher, participants' age and time ( $p=0.025$ ).

**Practical skills to provide FA for fractures**

The median scores for practical skills to provide FA for fractures after a basic FA course were 21 [19.25;23] in the "FA theory + FA skills" group and 22 [20;23] in the "Other theory + other FA skills" group (Figure 3B).

Figure 3: Practical skills



The practical skills for fractures were part of the "Other theory + other FA skills" refresher course. After two years, the fractures skills were 19 [17;20] in the "FA theory + FA skills" group and 19 [16;20] in "Other theory + other FA skills" group. There was no difference in baseline scores (t1) between groups, but fractures skills decreased over time ( $p<0.0001$ ). Fractures skills decreased significantly more over time in people following the

"Other theory + other FA skills" refresher course compared with people following the "FA theory + FA skills" refresher course ( $p$  for interaction  $=0.006$ ). Including participant's age as a potential confounder showed that the decay in practical fractures skills is associated with increasing age ( $p$  for interaction between time and age  $= 0.022$ ).

**Practical skills to provide FA for bleeding**

The median scores for practical skills to provide FA for bleeding after following a basic FA course were 22 [21;23] in the "FA theory + FA skills" group and 22 [20;23] in the "Other theory + other FA skills" group (Figure 3C). Practical skills for bleeding were part of the

“FA theory + FA skills” refresher course. After two years, the bleeding skills were 19.5 [18;21] in the “FA theory + FA skills” group and 20 [18;21] in the “Other theory + other FA skills” group. There was no difference in baseline scores (t1) between groups.

Participants’ bleeding skills decreased significantly over time ( $p < 0.0001$ ), irrespective of which refresher course they attended ( $p$  for interaction = 0.52). Including participants’ age as a potential confounding factor showed an independent negative effect of participants’ age on bleeding skills ( $p = 0.0008$ ), without altering any of the other conclusions made.

### ***Practical skills to provide FA for an impaled object***

The median scores for practical skills to provide FA for an impaled object after following a basic FA course were 21 [20;22] in the “FA theory + FA skills” group and 21 [19;22] in the “Other theory + other FA skills” group (Figure 3D). The practical skills for an impaled object were not part of the one-year refresher in any group. After two years, the median scores were 19 [18.25;20] in the “FA theory + FA skills” group and 19 [18;20] in the “Other theory + other FA skills”. There was no difference in baseline scores (t1) between groups.

A mixed models analysis showed that practical skills for an impaled object significantly decreased over time ( $p < 0.0001$ ), independently of the type of refresher ( $p$  for interaction = 0.33). Adding participants’ age to the model demonstrated an independent negative effect of participants’ age on skills for an impaled object ( $p = 0.019$ ), without altering any of the other conclusions made.

### **Analysis 3: Exploratory analysis of the impact of a refresher course after one year on two-year retention of practical cardiopulmonary resuscitation skills**

Fifty-two participants who did not attend a refresher course after one year did show up at the two-year assessment. This allowed an exploratory analysis to compare whether or not attending a refresher course (either the “FA theory + FA skills” or the “Other theory + other FA skills” refresher, which both

included practical CPR skills) influenced practical CPR skills after two years. There was an imbalance between people who completed the whole study and those who dropped out after one year regarding district of residence ( $p = 0.00012$ ), i.e. there was a larger dropout in people from Bhaktapur than from Kaski. Therefore, in addition to participants’ age, district was also included as a potential confounder.

A mixed models analysis, including age and district as confounding factors, showed independent negative effects of time point ( $p < 0.0001$ ), increasing age ( $p < 0.0002$ ) and residing in Kaski ( $p = 0.0003$ ) on practical CPR skills. In addition, there was a stronger decrease in practical CPR skills in participants that did not follow a refresher course ( $p$  for interaction time-group = 0.023). Furthermore, the decrease in practical CPR skills and the effect of not attending a refresher were attenuated in people of increasing age ( $p$  for interaction time-age = 0.041;  $p$  for interaction group-age = 0.027). A significant interaction between time point and residing in Kaski ( $p = 0.0005$ ) showed that the decrease of CPR skills over time was less pronounced in people from Kaski. Finally, a significant interaction between increasing age and residing in Kaski ( $p = 0.012$ ) suggests that the effect of age on CPR skills was less pronounced in people from Kaski. No significant interaction was observed between residing in Kaski and not having attended the refresher course ( $p = 0.4$ ).

### **Discussion**

This study investigated the two-year retention of non-resuscitative FA knowledge and resuscitative and non-resuscitative FA skills of laypeople following a basic FA course, and the influence of a refresher course after one year on this retention.

Our results show that FA skills and knowledge decrease significantly over two years. However, knowledge levels remain significantly higher than baseline. Skills levels remain remarkably high, with median differences of only 0-2 points, compared to skills measured immediately after basic training. For non-resuscitative FA, these results are similar to previous studies, which also show a limited decrease in knowledge and skills over time (Jayaraman et al., 2009; Li et al., 2014; Schumann et al., 2012). For CPR, several studies have



shown a decrease in skills over time, ranging from a decrease of 12% to 25% in the proportion of participants correctly performing CPR or skills applied correctly at 2 to 6 months after training (Andresen et al., 2008; Einspruch, Lynch, Aufderheide, Nichol, & Becker, 2007; Roppolo et al., 2007). Our results are in line with these findings.

The impact of the type of refresher course after one year on two-year retention of FA knowledge and skills seems limited. For non-resuscitative FA knowledge, a refresher containing theory on FA knowledge led to a modestly, but statistically significant, increased retention of non-resuscitative FA knowledge after two years, compared to the refresher course without FA theory. To our knowledge, our study is the first to evaluate the effect of retraining on non-resuscitative FA knowledge.

Practical FA skills for bleeding were not increased in participants that were retrained for FA for bleeding, compared to participants who did not retrain this skill. Surprisingly, FA skills for fractures were increased after two years in participants who were not retrained for this skill, compared to participants who were retrained. Potential reasons for this remain speculative. Perhaps there was an imbalance between groups in the number of participants who were exposed to injuries with fractures during follow-up. During the trial, Nepal was hit by an earthquake, which means many people were exposed to emergency situations. An alternative explanation may be that the “FA theory + FA skills” group, who were not retrained in fractures, performed a skills test in fractures prior to the start of the refresher. Skills for impaled object, which were not retrained in both groups, decreased in both groups similarly. To our knowledge, no other studies have previously looked at the effect of refreshers on non-resuscitative FA skills.

Practical CPR skills were refreshed in both intervention groups, for ethical reasons. Not surprisingly, these skills were not different between intervention groups after two years. The fact that a portion of participants dropped out after one year, but returned after two years, allowed us to compare this group, which did not receive any form of refresher, to participants that did receive a refresher on CPR. From this analysis, it seems

that a refresher after one year is beneficial for the retention of CPR skills. Other studies looking at the effects of retraining on CPR skills after one year show mixed results. Studies providing retraining via E-learning or mailings did not show a beneficial effect on CPR skills (Jensen, Mondrup, Lippert, & Ringsted, 2009; Stross, 1983). In contrast, a study using a more active simulation-based form of retraining showed improvements in pediatric CPR skills after receiving retraining, compared to no retraining (Bender, Kennally, Shields, & Overly, 2014). Our exploratory analysis is in line with the latter.

### **Limitations**

This study has several limitations. Firstly, there was a substantial loss to follow-up. Although this was expected, and anticipated for, it may have influenced the results, since there was an imbalance in loss to follow-up with respect to the district of residence. More people from Bhaktapur than from Kaski dropped out of the study, possibly because of demographic differences. Many participants from Kaski were housewives, whereas most participants from Bhaktapur were unemployed students. A large portion of these students found jobs during the follow-up period, because of which they were unavailable for participation in the follow-up period. In our exploratory analysis, we corrected for the potential influence of district of residence.

As a second limitation, it appeared not feasible to measure the four practical skills tests immediately before and after the refresher courses, as we initially intended to do. For practical reasons, it was decided to test practical skills only before the start of the refresher course (t2) and only half of the tests. Performing all the foreseen testing would have taken two days with an overnight stay for those travelling from far away. Now the tests and the refresher took only one day. The choice to test fractures in the “FA theory + FA skills” group, which was refreshed in skills for bleeding, and bleeding in the “Other theory + other FA skills” group, which was refreshed in skills for fractures, was made in the field, and was probably not the best choice. Indeed, the practical skills tests for fractures and bleeding may have served as a refresher themselves in the groups not

refreshed in these skills, thereby making the conclusions on the impact of refresher courses on these skills less valid. This provides us with a valuable lesson on the challenges of implementing a carefully designed protocol in remote settings.

Thirdly, during the study setup, the clustered nature of the sample was not taken into account. Individual participants were clustered into courses, which were the unit of randomization (Rutterford, Copas, & Eldridge, 2015). This means that with the current sample size, we achieved a statistical power of only 53% to detect significant changes in FA knowledge.

### Conclusion

In conclusion, this study aimed to evaluate the impact of a refresher course after one year on two-year non-

resuscitative first aid knowledge and skills retention in laypeople. It is the first in its kind to evaluate the effects of a refresher on non-resuscitative FA skills retention in laypeople. Our results suggest that retraining after one year has modest effects on two-year non-resuscitative FA knowledge retention. The findings on the impact of retraining after one year on two-year non-resuscitative FA skills retention are less reliable. In addition, an exploratory analysis indicates that two-year CPR skills retention may be improved in laypeople after having followed a refresher course after one year. Given the modest, but significant decrease in FA capacity observed over time, yearly retraining seems necessary. Further research is necessary to validate these conclusions.

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