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Impact of scenario based training on asthma first aid knowledge and skills in school staff: an open label, three-arm, parallel-group repeated measures study

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ABSTRACT

Objective: To test the hypothesis that scenario-based skills training is more effective than knowledge training alone in improving the asthma first aid skills of school personnel. Education developed specifically for non-primary caregivers such as school staff is vital to minimize the risk of mortality associated with asthma. **Methods:** Schools were allocated to one of three arms to compare AFA knowledge and AFA skills. Arm 1 underwent conventional asthma training, arm 2 underwent scenario-based training and arm 3 had a combination of the two. Conventional asthma training involved a didactic oral presentation. The scenario-based skills training required the participant to describe and demonstrate how they would manage a child having a severe exacerbation of asthma using equipment provided. Follow-up occurred at 3 weeks post baseline and again between 3–7 months after the first training/education visit. **Results:** Nineteen primary schools (204 participants) were recruited. One-way ANOVA and Bonferroni Post-Hoc Tests showed there was a significant difference in AFA skills scores between the study arms who underwent scenario-based training; arms 2 and 3 (91.5% and 91.1%) and arm 1 who underwent conventional asthma training (77.3%) ($p < 0.001$). AFA knowledge improved significantly in all study arms with no differences between study arms. Improvements seen in both AFA knowledge and AFA skills were maintained over time. **Conclusions:** Scenario-based training was superior to conventional didactic asthma training for AFA skills acquisition and overall competency in the administration of AFA and should be included in future asthma training programs.

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Asthma; asthma first-aid; knowledge; skills; competency; teachers; schools

Background

International Asthma Guidelines [1,2], acknowledge the importance of asthma education and consider it a key component of asthma management. While it is obvious that education for the patient with asthma and their guardians should cover preventative measures to facilitate optimal symptom control, we believe the education of a wider circle of people is also important, particularly those non-primary caregivers who are periodically responsible for children with asthma. This cohort require a greater focus on practical issues around asthma including the recognition and treatment of an acute exacerbation [3–7], otherwise known as asthma first aid (AFA).

The need for AFA training is supported by a review of asthma deaths in the United Kingdom in

2012 [8] which showed that less than 50% of patients were given medical treatment (including AFA) before reaching the emergency department [8]. The need for AFA training was also supported in a report by Greiling et al. [6] who analyzed 38 deaths of school children in the United States, they found that there were delays in receiving medication due to lack of training, lack of access to reliever medication, or due simply to the teacher not responding to the child's call for assistance.

When exploring effective training methods for the non-primary caregiver in AFA we found that skill acquisition in a medical context had been well documented in the literature [9,10]. Medical education for both students and health professionals have embraced scenario based learning, and shown improvements in

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skills and behaviors as well as overall competence and application of knowledge [10–12]. However, there is very little research on the use of scenario based training in asthma management education [13].

Our hypothesis was that skills-based scenario training was superior to conventional didactic group asthma education for training school staff in both AFA skills and AFA knowledge. We also hypothesized that after receiving the scenario-based training the improvements in AFA knowledge, AFA skills and overall competency in AFA would be retained over time.

Methods

A parallel-group open label three arm repeated measures study was conducted into AFA education in

primary (elementary) school staff. The researchers assessed both AFA knowledge and AFA skills at different time points across three study arms (Figure 1). The provision and assessment of the skills-based intervention and the sample size calculations were based on findings from a previous study [14]. Ethical approval to conduct the study was granted by the Human Research Ethics Committee of The University of Sydney (2014/605).

Recruitment

All schools in metropolitan and greater metropolitan Sydney, who had requested asthma training from Asthma Australia (a not for profit consumer advocacy body), were recruited. Institutions consenting to

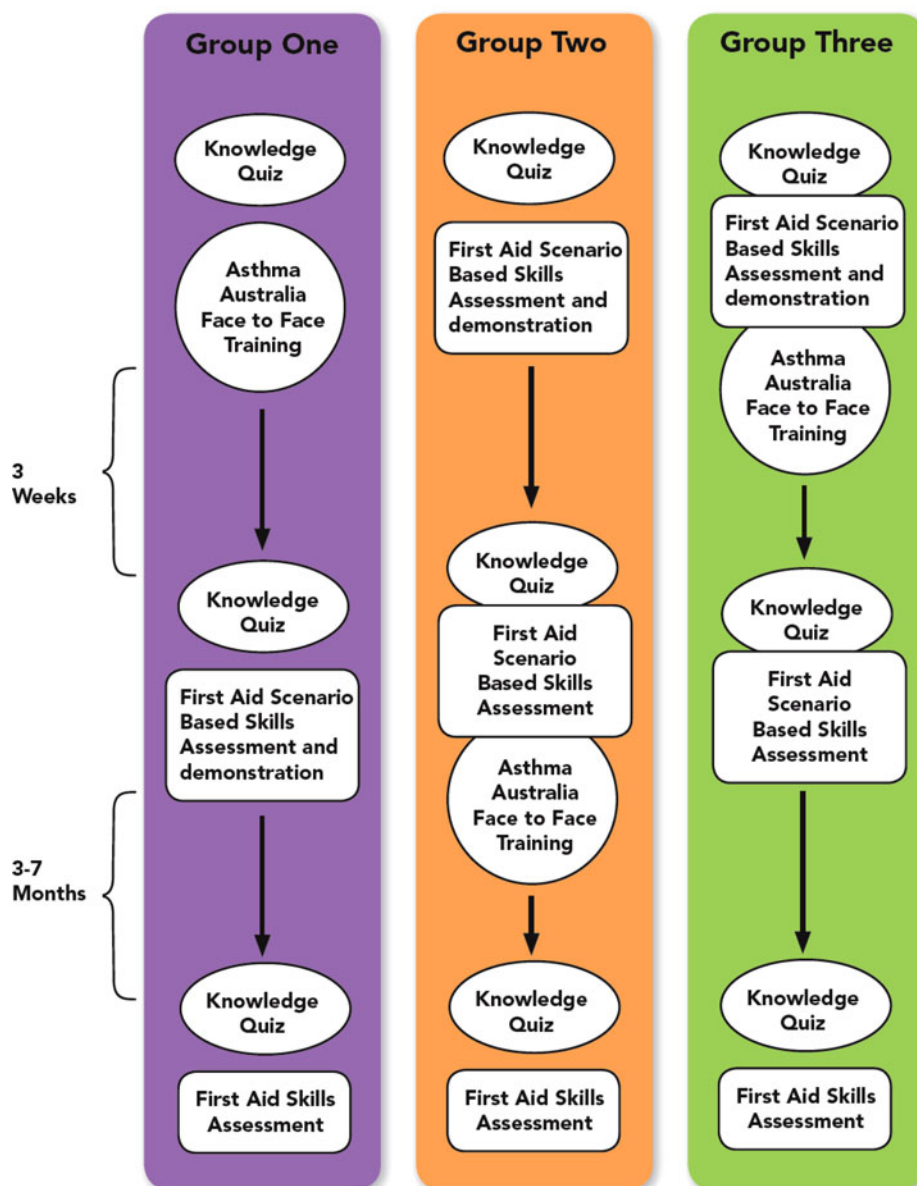


Figure 1. Study design.

participate were subsequently allocated to one of the three study arms (Figure 1). The first follow-up visit was scheduled to occur at a time convenient to the school as close to 21 days post the first visit as possible. The third visit was also scheduled at a time convenient to the school at least 3 months from the initial intervention. Schools were allocated to study arms based on convenience. The scheduling of visits which required the face to face asthma training had to occur on a day which was allocated to staff meetings or continuing education. To keep within the 21 days which separated visit 1 and visit 2 schools were allocated to that arm which allowed for the dates to fall outside of school holidays and other commitments.

Individual staff at each school were provided with an information statement and a consent form was obtained for all participants. Demographic information for each participant was collected, including information regarding prior asthma education. Details pertaining to location of the school and number of pupils were also obtained.

Intervention

This study compared Asthma Australia's face-to-face group presentation alone; (study arm 1 (knowledge only arm)), with scenario-based training alone (study arm 2 (scenario only arm)); or a combination of both programs (study arm 3 (combination arm)). The Asthma Foundation of NSW (a branch of Asthma Australia) facilitated the group training presentation which was delivered face-to-face via PowerPoint slides by different trained presenters. This standardized presentation took one hour and covered asthma facts, management and medications, as well as treatment of an asthma exacerbation via AFA.

All recruited staff members completed the 14 item true/false asthma first aid knowledge questionnaire (AFAKQ) at baseline and subsequently received the educational intervention according to their study arm. The AFAKQ is a validated tool [15] which was specifically developed to evaluate changes in AFA knowledge. (Appendix 1) At the second and the third visits, the AFA knowledge questionnaire was readministered (Figure 1).

All participants were given the AFA scenario-based assessment at visit 2 and visit 3 and only arms 2 (scenario only arm) and arm 3 (combination arm) were given the scenario-based assessment at baseline (Figure 1). The scenario-based training consisted of a one-on-one interview with the researcher in which the participant was given a scenario read verbatim by the

researcher (Appendix 2) and was assessed on their performance using a 13 item scenario checklist (Table 1). Three slightly different scenarios were utilized across the three visits however each was functionally interchangeable asking the same core questions. This was done so that the participant felt like they were being tested with a new case at each visit. The participant was asked to go through all the steps they would take to treat a child who was showing signs of an acute, and severe exacerbation of asthma. Each of the scenarios concerned a 5–6 year-old child who was not known to have a diagnosis of asthma. In all scenarios, the child was experiencing wheeze and breathlessness consistent with a severe exacerbation of asthma. It was made clear that the child could not talk in sentences due to their breathlessness. The participant was provided with a wide variety of inhalers and air chambers/spacers for demonstration purposes. Direction was only given to allow the participant to show what they knew about the each step. An example being that the participant would be prompted to stipulate how many puffs of short acting beta agonist (SABA) they would administer, but if they could not put the spacer device together then they were told that there was no one there to help so they had to decide what else to do. At the completion of the assessment the incorrect steps were discussed and demonstrated, hence the skills assessment was both a training and assessment tool. No information about asthma knowledge or prior asthma experience was disclosed prior to the assessment. No data was collected regarding the opinions or beliefs of the participants.

The scenario checklist was developed by the research team for the pilot study [14] and modified slightly for our purposes to fit with the age of the child in the three scenarios that were utilized. The tool was based on recommendations from current guidelines on appropriate management of a person requiring AFA [1,16]. These guidelines state that a SABA be administered immediately in accordance with the directions on the person's individual written asthma action plan (WAAP) [1,16]. In Australia, when the WAAP is unavailable the current Australian Resuscitation Council (ARC) guidelines recommend getting the person to sit down and remain calm. They go on to recommend that the person be given four puffs (doses) of SABA with a spacer in addition to practical measures such as calling the ambulance [1,17]. Other international guidelines [16,18], offer similar recommendations with variations around the timing of the SABA administration (Appendix 3).

Table 1. Scenario checklist showing mandatory requirements (marked P) which must be included to achieve a pass.

Step	Action	Yes (2)	Partial (1)	No (0)
1.	Sits child upright was calm and reassuring	<u>P</u>	<u>F</u> Leaves child <u>un</u> attended	<u>F</u> Moves child or lies them down
2.	Organises for the ambulance to be called	Calls ambulance straight away or just after administering SABA	Calls the ambulance after 2 rounds of AFA or within 10 minutes	Does not call the ambulance or calls after more than 10 minutes
3.	Correct medicine selected.	<u>P</u> Any SABA inhaler	<u>F</u> Any SABA in a turbuhaler	<u>F</u> Any Preventer inhaler (eg long acting beta agonist (LABA) or inhaled corticosteroid (ICS))
4.	Correct device selected.	<u>P</u> (inhaler)	<u>P</u> (nebulizer)	<u>F</u> No device selected
5.	Spacer (and mask) selected as required equipment that is age appropriate.	<u>P</u> Child	<u>P</u> Adult or baby	<u>F</u> No device selected.
6.	Inhaler shaken.	Shakes before use	Remembers to shake after the 1 st round.	Does not shake at all
7.	Inhaler inserted correctly into spacer.	1 st attempt	2 nd attempt	3 or more attempts or no attempt
8.	Single puffs of Ventolin provided for each inhalation of the spacer (not multiple puffs together).	<u>P</u> (1 puff)	<u>F</u> (2 puffs) or Removed inhaler cap after the first round and then gave 1 puff.	<u>F</u> (3 or more puffs) Or Did not remove inhaler cap.
9.	Reported correct number of single puffs appropriate for asthma first aid.	<u>P</u> (4 puffs)	<u>P</u> (2–3 or 5 puffs)	<u>F</u> <2 or >5 puffs
10.	Allowed child tidal breaths between Ventolin puffs.	<u>P</u> Normal breath	<u>P</u> big breath	<u>F</u> Hold breath
11.	<u>Outcome-(Child has improved and is breathing normally)</u> Reported staying with the child to monitor while waiting for medical assistance.	Waited with the child	Left but came back to check and/ or left someone such as another child with them	Left the child unattended.
12.	<u>Alternative (Childs' breathing has not improved)</u> Reported knowing to wait before starting another round (4 puffs) of Ventolin treatment.	<u>P</u> 4 minutes	<u>P</u> 0–3 minutes or 5–6 minutes)	<u>F</u> More than 6 minutes
13.	Reported knowing to keep going with Ventolin treatment while waiting for ambulance.	<u>P</u>	<u>F</u> Stopped after 2 or more rounds (2x 4 puffs) despite symptoms of acute exacerbation	<u>F</u> Only gave max of one round (4 puffs)

P = Mandatory requirement for a Pass.

F = This score will produce a Fail result.

The maximum score was 26 points with 2 points for each completely correct response, and 1 point for each partially correct response.

Whilst the raw skill score derived from the scenario checklist gave some indication of the aptitude of the participant to perform AFA the clinical relevance of the result required further analysis. A pass or fail score for competency was allocated to each participant to provide a definitive indication of their ability to administer successful AFA. This scoring system was determined through consultation with experts and ensured that those with high skills scores who had missed a crucial mandatory step were properly differentiated from those who had performed adequately. A pass result indicated that the expert opinion minimum skills performance had been achieved, or in practical terms the AFA skills result provided the hypothetical child with an adequate chance of surviving the life

threatening asthma exacerbation. The minimum skills performance together with explanations of each criteria are detailed in Table 1. The participant is allocated a pass result for competency when no answer/demonstration had fallen into a box highlighted by F in Table 1.

Data analysis

All data collected were analyzed using IBM SPSS Statistics Version 22 [19]. Normality tests were conducted using the Kolmogorov-Smirnov test. Descriptive analyses were made on demographic data using the Mann-Whitney *U* test. First-aid knowledge scores and skills scores were analyzed using a mixed between-within subjects Analysis of Variance

(ANOVA). Skills scores at the second time point were also analyzed using One Way ANOVA with Bonferroni and Dunnett-T Post-Hoc Tests. Wilcoxon Signed Rank Tests were also used for skills data at the third time point.

For proportional data which related to competency scores, Related-Samples McNemar's test and Chi Squared test of independence were used. A two-tailed, 5% (0.05) level of significance was used for all statistical procedures. All available data were used for analysis at the second time point (visit 2) for both knowledge and skills.

Results

Nineteen primary schools in metropolitan Sydney were recruited to the project. The schools were from diverse socio-demographic regions. They were located in inner city suburbs, urban environments and semi-rural locations. In total, 204 participants were recruited to the study between November 2014 and November 2015. There were 177 participants who completed the second visit spread evenly between the three arms with 56 in arm 1 (knowledge only arm) and 60 in arm 2 (scenario only) and 61 in arm 3 (combination). Due to the longer time period between the second and third visit there were 136 participants who completed all three visits (44, 41, and 51 participants respectively in arms 1–3).

The demographics of our participants were measured at baseline. There was a mean age of 45 years (range 23–73). The majority (77%) were teachers. Only five participants (2%) had a degree in healthcare, one being in physiotherapy, one in nursing, and the remaining three did not specify. Participants had varying levels of education (Table 2). Most staff (71%) reported receiving asthma training prior to baseline. There was no significant difference in the proportion of staff with prior asthma training between the arms ($p=0.17$). The knowledge score for those who had received prior asthma training at baseline ($M=10.6$,

$SD\ 2.1$) was statistically higher, compared to no prior training ($M=9.6$, $SD\ 2.5$) $p=0.003$. As prior asthma training was dispersed evenly between the three arms it was decided that there was no need for covariance analysis.

Despite the fact that the data for both knowledge scores and skills scores were not distributed normally Mixed Between-Within ANOVA and One way ANOVA were used as these tests are appropriate when applied to data with only moderate deviations from normality [20], which have sample sizes which are relatively equal [21].

Knowledge scores

A mixed between within subjects ANOVA conducted at the second time point with the higher number of participants who had completed visits 1 and 2 ($n=177$) showed that there was no significant difference between the arms at visit 2 (Wilks' Lambda = 0.86, $F(1,174)=28.4$ ($p<0.001$) partial eta squared of 0.14). However there was a significant improvement within each of the arms at visit two ($F(2,174)=0.115$ ($p=0.89$) ($p<0.001$)) (No significant interaction effect was present for the analysis at visit 2 $p=0.089$). This analysis was repeated at the third time point (Table 3) with all participants who completed all three visits ($n=136$), and again no significant main effect or difference was found between the arms ($p=0.74$) however each of the arms had significantly improved across the three time points ($p<0.001$). While it is worth noting that there was a significant improvement in knowledge within each of the three arms the small increase of less than 2 points out of 14 may not be meaningful or particularly relevant (Table 3).

Skills assessment

A mixed between within subjects ANOVA performed on skills scores between baseline and visit 2 for arm 2

Table 2. Participant prior education demographics.

	Arm 1	Arm 2	Arm 3	Total for all arms and % of total respondents
Participants with prior asthma education	44	42	53	139 (71%)
Qualification of teachers				
Degree	41	45	44	130 (84%)
Diploma	9	9	5	23 (16%)
Previous Education				
Postgraduate University Degree	19	21	16	56 (29%)
University degree	25	26	32	83 (43%)
Non-university diploma	11	8	6	25 (13%)
Higher School Certificate	2	5	2	9 (5%)
School Certificate	4	2	11	17 (9%)
Primary school education only	3	2	0	5 (3%)

Table 3. Knowledge scores (mean $\pm$ standard deviation) over three visits from baseline to follow up.

	Arm 1 ($n = 44$) (Conventional oral presentation)	Arm 2 ($n = 41$) (Scenario training)	Arm 3 ($n = 51$) (Conventional oral presentation and scenario training)
Baseline (Visit 1)	10.3 (73.6%) $\pm$ 2.4	10.8 (77.1%) $\pm$ 1.7	10.2 (72.9%) $\pm$ 2.7
3 Weeks (Visit 2)	10.8 (77.1%) $\pm$ 1.7	11.1 (79.3%) $\pm$ 1.6	11.5 (82.1%) $\pm$ 1.3
3–7 Months (Visit 3)	11.3 ^a (80.7%) $\pm$ 1.8	10.9 ^a (77.9%) $\pm$ 1.5	11.4 ^a (81.4%) $\pm$ 1.4

^aWilks' Lambada = 0.89, $F(2,132) = 8.12$ ($p < 0.001$) partial eta squared of 0.11. Main effect $F(2,133) = 0.296$, $p = 0.74$. partial eta squared of 0.004. (No significant interaction effect between time and treatment was present $p = 0.089$).

Max score for AFAQ was 14.

Knowledge Scores included for those who completed all three visits.

(scenario only arm) and arm 3 (combination arm) showed that there was a substantial main effect of time with skills scores significantly improving within each arm (Wilks' Lambada = 0.286 (1,119) = 296.5 ($p < 0.001$) partial eta squared 0.714 ($p < 0.001$)). However there was no significant main effect or difference between the skills scores for the scenario only arm (arm 2) and the combination arm (arm 3); $F(1, 119) = 0.563$ $p = 0.46$ partial eta squared 0.005. (No significant interaction effect was seen $p = 0.14$.) No skill results were available for arm 1 at baseline as they did not undergo scenario training until their second visit.

Skills scores at the second visit underwent a one way ANOVA which showed that there was a significant difference between the study arms. ($F(2,174) = 25.42$, $p < 0.001$). The *post hoc* comparisons revealed a significant difference in AFA skills between the knowledge only arm (arm 1) and each of the arms who received scenario-based training at baseline (arm 2 ($p < 0.001$) and arm 3 ($p < 0.001$)) however there was no difference between arm 2 (scenario only) and arm 3 (combination arm) ($p = 0.945$). Note the full complement of participants who completed visits 1 and 2 were included in the above analysis ($n = 177$).

At the final visit, the skills assessment score for our knowledge only arm (arm 1) had significantly increased between visit 2 and visit 3 ($p < 0.001$) since receiving scenario based training at visit 2 (Table 4). There were non-significant incremental increases in skills scores between visits 2 and visit 3 in those arms who received scenario training at baseline; (arm 2 ($p = 0.36$) and arm 3 ($p = 0.22$)) (Table 4). This demonstrated that skill improvements were maintained over 3–7 months in these arms.

Competency assessment

The skills scores then underwent a secondary analysis so that an assessment could be made regarding competency to administer AFA (Table 5). At visit 2 for those arms who had scenario based training at baseline (arm 2 and arm 3) the proportion of participants

who had met the minimum criteria had increased, and a Chi-squared test for independence revealed a significant association between scenario-based training and achieving a competent assessment ($p < 0.001$) (Table 5).

At visit 3 the participants who received scenario based training for the first time at visit 2, Arm 1 (knowledge only arm) had a significantly greater proportion of people pass the competency assessment ($p = 0.013$) (Table 5). Overall these data show that our scenario-based skills training was effective in providing most participants with the expert determined minimum skill level required for successful AFA.

Results from the study demonstrated that scenario-based training was more effective than the conventional didactic oral presentation for improving skills necessary for the provision of AFA. Further to this, there was a significant association between scenario-based training and acquiring the minimum skills necessary to successfully administer AFA.

Discussion

This research suggests that when educating people on how to administer AFA a brief one-to-one hands-on skills-based assessment with feedback is superior to a didactic, 1-h group asthma education session. As shown in previous research [22–31] asthma knowledge improves after asthma education. Our research indicates that there was high baseline knowledge which improved minimally regardless of the training that was provided. The high baseline knowledge scores were expected with 71% of the cohort having undergone previous asthma training, however, previous asthma training had only a small effect on AFA knowledge scores; with a difference of only 1 point out of 14 between the groups. This implies that knowledge around asthma management may be intuitive and easily picked up through exposure to children with asthma in a school environment. Whilst the baseline knowledge scores improved significantly post-intervention in each of the study arms an improvement of only 1 to 2 points may not imply a

Table 4. Mean skills scores $\pm$ standard deviation for three study arms over three visits from baseline to follow up.

	Arm 1 (<i>n</i> = 44) (Conventional oral presentation)	Arm 2 (<i>n</i> = 41) (Scenario training)	Arm 3 (<i>n</i> = 51) (Conventional oral presentation and scenario training)
Baseline (Visit 1)	N/A	15.9 (61.2%) $\pm$ 4.7	17.8 (68.5%) $\pm$ 4.5
3 Weeks (Visit 2)	19.7 ^a (75.8%) $\pm$ 4.8	23.9 ^b (91.9%) $\pm$ 1.8	24.1 ^c (92.7%) $\pm$ 2.0
3–7 Months (Visit 3)	23.3 ^a (90%) $\pm$ 1.9	24.2 ^b (93.1%) $\pm$ 2.0	24.8 ^c (95.4%) $\pm$ 1.6

Wilcoxon Signed Rank Test showed:

^aArm 1 *z* = -5.135, *p* < 0.001.

^bArm 2 *z* = -0.914, *p* = 0.36.

^cArm 3 *z* = -2.296, *p* = 0.22.

Maximum skill score was 26.

Scores included for those who completed all three visits.

Table 5. AFA competency for three study arms over three visits from baseline to follow up.

	Proportion of participants who were competent at AFA Arm 1	Proportion of participants who were competent at AFA Arm 2	Proportion of participants who were competent at AFA Arm 3
Baseline (Visit 1)	N/A	10/69 (14.5%)	12/68 (17.6%)
3 Weeks (Visit 2)	22/56 (39%) ^{a,b}	45/60 (75%) ^{a,c}	45/61 (74%) ^{a,d}
3–7 Months (Visit 3)	29/44 (66%) ^b	31/41 (76%) ^c	45/51 (88%) ^d

Comparisons of the 3 arms at visit 2.

^aA Chi-squared test for independence at visit 2 (*n* = 177), $\chi^2 = 20.31$, *p* < 0.001, $\phi = 0.34$ This was a comparison between the groups at the 2nd time point alone.

Comparisons of change in the three arms from visit 2 to visit 3.

The Related Samples McNemar Test showed:

^bArm 1 the increase in proportion of participants passing competency was significant (*p* = 0.013).

^cArm 2 the proportions of people who passed the competency assessment in visit 2 was not significantly different (*p* = 1.0).

^dArm 3 the proportions of people who passed the competency assessment in visit 2 was not significantly different (*p* = 0.92).

meaningful change in knowledge. It also appears that there may be a ceiling effect. However, most relevant to our research was the fact that these relatively high levels of AFA knowledge did not translate into a high skill level when it came to the administration of AFA.

The most important finding from this research was that scenario based training had a significant impact on the ability of the participant to administer AFA and the improvements were maintained over time. The significant difference at the second time point between those participants who underwent scenario-based training at baseline (arm 2 and arm 3) and the knowledge only arm who had no scenario based training (arm 1) clearly defines the impact of the scenario based training on AFA performance. Further to this we were able to show a significant improvement in skills and competency at the third visit for arm 1 (knowledge only arm) after scenario based training at visit 2. It was also interesting to note that a second scenario training session (provided to arms 2 and 3) did not produce any further improvements in skills scores. Scenario training has been studied in other forums with similar results. A recent study of student nurses performance and knowledge after virtual simulation involving deteriorating patients in an emergency setting showed that performance and knowledge were significantly improved post intervention [32]. It was interesting to note that like our

research knowledge scores were not a predictor of skills performance [32].

If we look to the discipline of educational psychology it becomes clear why conventional didactic asthma training would not enhance skill acquisition to the same extent as scenario or simulation based training. Educational psychology defines skill acquisition in three stages [33]. The first being the cognitive stage when the knowledge is committed to memory and rehearsed or contextualized (when to do what). The second stage is the associative stage where errors are detected and eliminated and the process is proceduralized, and finally the autonomous stage where the skill can be performed with little effort almost automatically. When this theory is applied to our research it becomes clear that the knowledge questionnaire which has long been used to assess educational interventions [13] while relevant to the cognitive stage of skill acquisition is unlikely to give a good indication of the overall skill level of the participant. Our skills-based assessment (simulation training) could be likened to the associative phase of skill acquisition.

We believe this research to be timely and necessary as there is very limited work in skills or scenario-based training in asthma education. Only one study [34] was found which looked at skills in AFA and this used a pre-post design and a competency based tool to assess AFA skills. The results are not directly comparable as the educational component was completed

over different timeframes [34]. In the absence of a direct comparator, parallels could be drawn with education around cardio pulmonary resuscitation (CPR) and skills training for nursing students in emergencies. European CPR guidelines [35] state that it is essential that basic education for CPR includes a simulation or hands on component as it has been linked to improved patient outcomes (through before and after studies) [35]. There are limited studies which directly compare CPR simulation training to conventional training, however in both instances simulation based training improved real life performance of CPR skills [10,35].

Whilst our research using simulation based training for AFA was performed face to face it is important to note that simulation can and does take many forms including online, small instructor led groups or one on one. However regardless of the format through which the training was provided it has been reported that when applied to CPR training it has provided the recipient with knowledge, attitude and skills to deal with the emergency in a structured and systematic manner [36].

Strengths/limitations

This study was the first to our knowledge to take the form of a comparative trial in assessing the effectiveness of AFA training. We specifically targeted the non- primary care-giver of children with asthma working within a school. We felt this group should be prioritized as they are highly likely to be called upon to manage asthma emergencies given the prevalence of asthma and the number of hours spent at school. Schools are very busy places, and the small amount of time which is allocated to asthma education must be strategically utilized. The controlled observational nature of the scenario testing was also a strength. The scenario-based study tools (written scenario and scenario checklist) meant that the observations were simple to administer and easily replicated by other researchers. Whilst we were restricted to opportunity sampling based on convenience, our sample was drawn from diverse locations, with a variety of backgrounds and levels of education.

There are, however, some limitations that need to be stated. Firstly, our study design did not allow for a baseline skills assessment without feedback in our knowledge only arm. This decision was made because the actual “hands on” component was itself a major

aspect of the training in addition to the immediate feedback that was given. It was therefore felt that it was impossible to separate the training component from the assessment component in our scenario based training. Further to this the elimination of feedback for the participant in this proposed knowledge only arm had they had a baseline skills assessment, would have almost been impossible as the one on one nature of the training made it impossible to eliminate non-verbal communication. However, moving forward from our findings it may be useful in future research to explore the separate effects of the “hands on” scenario based assessment and the feedback components of this intervention by providing the skills based assessment only, with no feedback to a control arm. Secondly, there were also limitations with questionnaires that were used. The AFAKQ whilst validated [15], could benefit from further psychometric testing to assess its temporal stability (repeatability), sensitivity and usefulness. Sensitivity appears to be in question when one looks at the relatively high knowledge scores in this cohort and the low AFA competency amongst our participants. The questionnaire also contained double negatives which may have led to confusion. The design of the demographic questionnaire was a further limitation as it did not clearly ask for an asthma diagnosis, hence we were unable to comment on the effect that this would have had on our results. Thirdly, the scenario-based checklist has not yet been validated, however it had been used in the previous pilot study [14]. Whilst the AFAKQ has been validated [15] it too would benefit from further validation including assessing usefulness amongst experts (such as doctors working in emergency departments). The parameters chosen as “pass/fail” criteria for competency in the scenario checklist (Table 1) have been rigorously discussed by the research team and respiratory experts, however, some may argue that less than two inhalations of salbutamol would be adequate to save a life, and others may argue that multiple puffs into the spacer at one time may still deliver enough SABA to save a life. For the purpose of this study, arbitrary cutoffs based on expert opinion and first aid guidelines [1] were chosen. Finally, this study could have had selection bias, as the assessors were not blinded to the study arm, however this was limited by having two assessors at a school for over 90% of the visits. As expected in a busy transient environment such as a primary school there were participants lost to

follow up. However, at the crucial second time point there were still 177 participants from the original 204 and these were fairly evenly dispersed between the study arms. There was also variability with the time frame that the participants had to complete the study. The timing of the third visit was delayed at some schools due to school holidays, especially the summer break over December and January. The busy school environment was also challenging. Teachers were often giving up their recess and lunchtimes and they sometimes had to rush, which led to less time available for feedback and coaching for some. Less time often meant greater stress and there is a possibility this could have impacted answers in both knowledge and scenario tests. This phenomenon was however common in many schools in all study arms at all time-points limiting any associated bias.

Future directions

This research points to a need to move forward and ensure that those who are responsible for educating the staff in schools and childcare centers incorporate a hands-on skills-based training session into their education session. While it is not practical to train participants on a one-on-one basis as performed in this project, future evaluation of a group-based skills-training session should occur. On-line training utilizing avatars or other augmented reality to enable scenario testing is another area for future research with the very real possibility that we could show reduced morbidity and mortality associated with asthma as a result scenario based AFA training.

Conclusion

Asthma first-aid knowledge improved only minimally regardless of the intervention. Asthma first-aid skills and competency were significantly superior in those participants who had scenario-based training either alone or in combination with a didactic oral presentation on asthma management compared to those who had the oral presentation alone. All improvements seen in AFA knowledge, skills and overall AFA competency were maintained over a time period of 3–7 months. Our research suggests that the asthma educational requirements of staff at schools should include a hands on skills based component to ensure competency.

Human subjects approval statement

This research was approved by the Human Research Ethics Committee at the University of Sydney on 23 August 2014: Project No.: 2014/605

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Disclosure statement

No conflicts of interest are reported with any of the authors. The authors alone are responsible for the content and writing of the article.

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Appendix 1

Asthma first aid knowledge questionnaire

The following 14 statements concern Asthma First Aid. Please read each of the statements carefully and circle the response that you feel best fits each statement (i.e. is the statement TRUE, or FALSE?). If you are unsure as to whether the statement is true or false, please DO NOT respond to that item(s).

		True	False
1	Spacers are NOT recommended when giving asthma first aid to children.	T	F
2	An ambulance should still be called, when a child known to have asthma is able to breathe normally after reliever inhalers have been used.	T	F
3	When a person is having a sudden onset of asthma symptoms you should lie them on their side.	T	F
4	Wheeze, cough, and difficulty in breathing, are signs that a person needs to use reliever inhalers immediately.	T	F
5	Reliever inhalers are usually blue.	T	F
6	Administering high doses of reliever medicines to a child who is having a sudden onset of asthma symptoms is UNLIKELY to cause harm.	T	F
7	When administering asthma first aid it is important to ask the child to hold their breath after each puff of reliever medicine is delivered via the spacer.	T	F
8	When administering asthma first aid you should NOT waste time by shaking the reliever inhaler.	T	F
9	Reliever inhalers only contain anti-inflammatory medicines.	T	F
10	When administering asthma first aid, it is best to put four puffs of reliever medicine into the spacer at one time and ask the person to take four big breaths.	T	F
11	It is possible for a person with mild asthma to have a severe asthma attack.	T	F
12	When a child has a sudden onset of asthma symptoms, they should drink lots of liquids such as water.	T	F
13	When asthma symptoms occur suddenly, taking inhaled corticosteroids will make the narrowed breathing tubes (airways) wider so it is easier to breathe.	T	F
14	When administering asthma first aid, it is recommended to wait 4 minutes and assess the child after delivering the first four puffs of reliever medicine.	T	F

Appendix 2

Scenario 1

Today you are working and there is only two staff currently on duty in the playground (yourself and a colleague). Jessica is a 5 year old girl who you do not know very well. First thing this morning when her mother dropped her off, she mentioned that she has begun to notice that Jessica might have croup as she has had some trouble breathing lately and asks you to keep an eye out for her in the playground. She also reports that Jessica has been getting a dry cough at night. Her mother says she has an important meeting this morning so cannot keep Jessica at home. As you watch over the children during play time, you notice that Jessica has stopped chasing her

friends and is sitting by the side. She is not as active as usual and looks a bit upset. When you approach her, you hear a whistling sound when she breathes out, and the muscles at the base of her neck are tugging. She appears to be having trouble talking and she is coughing. What do you do?

Outcome

If Ventolin is given, after a few puffs, Jessica appears to recover, her breathing less labored, she is no longer coughing and is no longer upset – is there anything else you would do?

Alternative

Jessica does not appear to improve after being given some Ventolin – what would you do?

Scenario 2

Today you are at a cross country event. You have a mobile phone you are with another teacher, you are both responsible for one of the cross country stations and you are situated about 25 meters from the marshaling tent which you know has all the first aid equipment. You are watching the children running around and you notice a little boy in the under 7s who is walking, he then stops walking and sits down he seems upset. When you approach him, you hear a whistling sound when he breathes out, and the muscles at the base of his neck are tugging. He appears to be having trouble talking and he is coughing. What do you do?

Outcome

If Ventolin is given, after a few puffs, Johnny appears to recover, his breathing is less labored, he is no longer coughing and is no longer upset – is there anything else you would do?

Alternative

Johnny does not appear to improve after being given some Ventolin – what would you do?

Scenario 3

You are on duty after school and there are only a few kids left waiting to be picked up. It is approaching 3.30 and you notice that Olivia who is 6 years old is still waiting for her mum to pick her up. She is running around the playground chasing a butterfly. You take her into the office and call her parents but cannot get through. When you go back to Olivia you notice that she is sitting down and upset. When you come closer you hear a whistling sound when she breathes out and she is coughing a lot. The muscles at the base of her neck are tugging and when you ask her if she is OK she has trouble talking.

Olivia is in your class and you have never been lead to believe that she has asthma. You ask her if she has asthma and she looks at you and shrugs. What do you do?

Ventolin is given and after a few puffs Olivia appears to recover her breathing is less labored she is no longer coughing and no longer upset- Is there anything else you would do?

Alternative: Olivia does not appear to improve after being given ventolin what do you do?

Appendix 3

Country	Protocol	Reference
United Kingdom	The UK stipulates that the person should be given their SABA immediately via a spacer at varying times and then repeated if necessary while waiting for an ambulance.	Guidance on the use of emergency salbutamol inhalers in schools: Department of Health; 2015. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/416468/emergency_inhalers_in_schools.pdf [last accessed 13 May 2016]. Asthma UK Website. Available from: https://www.asthma.org.uk/advice/asthma-attacks/ [last accessed 22 Nov 2017].
United States	It appears that there is no generic asthma first aid protocol in the United States (US), however it is recommended that the person is given their SABA via a spacer or nebulizer if necessary. However, in the primary school environment where the child is unknown to have asthma, US protocols dictate that they are to be given SABA according to their symptoms and/or peak flow readings, and an ambulance is to be called immediately.	National Heart Lung and Blood Institute. Managing Asthma a Guide For Schools: 2008 (updated 2014). Available from: http://www.nhlbi.nih.gov/files/docs/resources/lung/NACI_ManagingAsthma-508%20FINAL.pdf [last accessed 30 Apr 2016]. National Heart Lung and Blood Institute. Management of Asthma Exacerbations: School Treatment Suggested Emergency Nursing Protocol for Students with Asthma Who Dont Have a Personal Asthma Action Plan 2011. Available from: http://www.nhlbi.nih.gov/health-pro/resources/lung/asthma-school-suggested-protocol-for-students-without-plan-html [last accessed 30 Apr 2016].
GINA Guidelines	GINA guidelines recommend that for the child 5 years and under who is having worsening symptoms of asthma the parent/carer should initiate treatment with two puffs of inhaled SABA given one puff at a time via a spacer device with or without a facemask, and repeated a further two times at 20 minute intervals, if needed. However they do state that urgent medical attention should be sought if the child's symptoms are not relieved promptly by the SABA.	Global Strategy For Asthma Management and Prevention Global Initiative for Asthma (GINA) 2015. Available from: http://www.ginasthma.org/ [last accessed 2 Jun 2016].

Appendix 4

Demographic questionnaire

Please enter the number which corresponds to the following the day of your birth, the month of your birth and your street number. For example I was born on the 8th of April and I live at No 3 Unit 11 Cosy Street. My code is 080403

Your code _ _ _ _ _

This will be your unique code for the duration of the research project.

Who is completing this questionnaire?

- 1 Teacher with degree
- 2 Teacher with diploma
- 3 Day Care worker with degree
- 4 Day care worker with diploma
- 5 Parent/Guardian
- 6 Other. Who? _____

4. What language do you mainly speak at home?

- 1 English
- 2 Other - please list _____

5. How many children are there in your care (i.e your class)? _____

6. What is your year of birth? _____

7. Have you taken a degree in health care?

1 No

2 Yes. Which one? _____

8. What is your school/centre postcode? _____

9. What is your level of education? Circle the highest level you have taken.

- 1 Primary school
- 2 School certificate (equivalent to year ten)
- 3 Higher School Certificate (leaving certificate/year 12)
- 4 Non University Diploma
- 5 Bachelors Degree (University)
- 6 Postgraduate University Degree

10. Have you received any Asthma Education? If yes, please describe (who provided, how long did it go for, what was covered, when did you do it?)