Original Article

Time to Reconsider the Straddle-Arm Technique: Providing Care for the Conscious Infant who is Choking

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The practice of straddling the infant's legs on the rescuer's upper arm continues to be one method taught to support the infant in the delivery of back blows and chest thrusts in the clearing of a foreign body airway obstruction (FBAO) for a conscious infant. The personal teaching experience of the two authors suggests that this may not be physically possible in a substantial number of potential pairings of rescuers and infants. The purpose of this article is to present initial data from exploratory work to support this view, suggesting that continued work is required to improve the universality of the skill. This article serves as a report on work-in-progress.

The relief of a foreign body airway obstruction (FBAO) in a conscious infant is often taught as part of the portfolio of first aid skills covered in a formal learning context. From the observation of the authors in the role as Instructors and Instructor-Trainers (i.e., trainer-of-trainers), many instructors demonstrate and have learners return-demonstrate the skill by having the infant's legs straddle their arm during the delivery of back blows and chest thrusts (see Figure 1 for a depiction of the practice). A number of learners taking part in the authors' own courses have commented on the difficulty of the skill given the size of their own infants, suggesting that the skill is not as universal as it is often presented by facilitators. This paper examines the practice's historical roots and provides some initial data to suggest that the practice may not be realistic for some first aid learners (see Figure 2 for examples showcasing a lack of support for the infant's head). This article will review the origin of the skill, as well as highlight some anthropometric data to suggest that this practice requires further investigation. Since publicly available anthropometric data is scarce and out-of-date, a small-scale sample was collected by the authors to validate the initial anthropometric data. As a work-in-progress, this article ends with highlighting some alternatives that will be considered as further research is conducted on alternatives to the technique.

The History

In order to understand the origin of the practice, a literature search was conducted. As a backbone to the research, previous versions of the Guidelines were consulted from the American Heart Association (AHA) and the European Resuscitation Council (ERC), as well as Consensus on Treatment Recommendations (CoSTR) issued by the International Liaison Committee on Resuscitation (ILCOR). This was supplemented with a search of MEDLINE using headings infant AND (foreign body AND airway obstruction) as

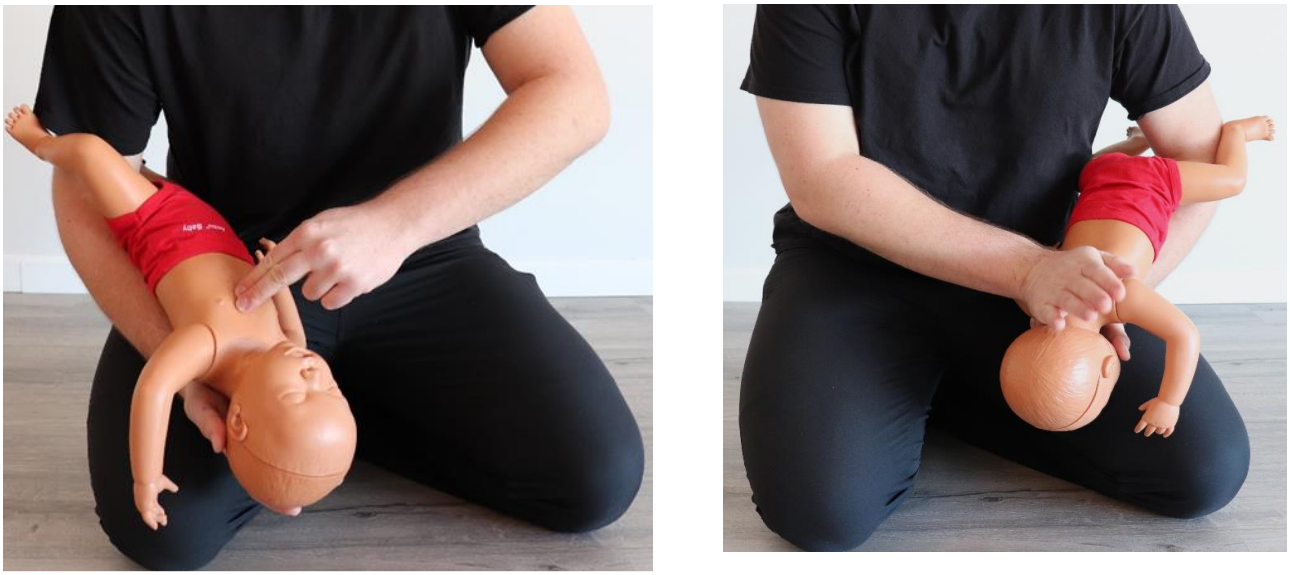


Figure 1: The practice in question: the infant's legs are straddled on the arm of the rescuer during the delivery of back blows and chest thrusts in an attempt to relieve a Foreign Body Airway Obstruction (FBAO).

well as a CINAHL search using keywords infant AND (foreign body airway obstruction OR foreign-body airway obstruction OR FBAO).

The description of the practice appears as early as 1980, with no accompanying reference:

> *If the victim is an infant, he is* ***straddled over the rescuer's arm*** *with the head lower than the trunk.* (Standards & Guidelines, 1980, p. 475; emphasis added)

In this case, an infant is defined as "anyone younger than 1 year" (Standards & Guidelines, 1980). The same version of Standards & Guidelines noted the technique, as described, may not be physically possible in all cases:

Figure 2: On the left, shows a rescuer who is unable to support the head of an infant mannequin in order to deliver chest thrusts while having the infant's legs straddling the rescuer's arm. On the right, shows a case where the rescuer is unable to support the head of the infant in preparation for the delivery of back blows. Figure 2b is from the Research Images Photo Bank, Canadian Red Cross Society, 2017. Reprinted with permission.

> *If the victim is a child, too large to straddle the rescuer's forearm, the rescuer kneels on the floor and drapes the victim across the thighs, keeping the head lower than the trunk. (Standards & Guidelines, 1980, p. 475)*

The next revision of Standards & Guidelines, dated 1986, adds a little more explicit description of the technique, and removes mention of the rescuer kneeling:

> *Rescuers whose hands are small may find it physically difficult to perform the back blows and chest thrusts in the described manner, especially if the infant is large. An alternate method is to lay the infant face down on the rescuer's lap, the head lower than the trunk, with the head firmly supported.* (Standards & Guidelines, 1986, p. 2960)

The 1992 and 2000 Guidelines continue endorsing the straddling technique, using identical wording in the two versions:

> *Back blows are delivered while the infant is supported in the prone position,* ***straddling the rescuer's forearm****, with the head lower than the trunk.* (Guidelines, 1992, p. 2259; American Heart Association [AHA], 2000, p. I-277; emphasis added)

However, the 1992 Guidelines were the last version to mention the alternative of placing the infant supine on the lap (Guidelines, 1992, p. 2259). This discussion disappears by 2000.

Although the 2005 (AHA, 2005), 2010 (Berg et al., 2010), and 2015 (Atkins et al., 2015) Guidelines do not explicitly describe it as straddling the forearm, images included in these versions of the Guidelines suggest a continued endorsement of the practice of straddling the infant, despite no explicit mention in text. Meanwhile, the European resuscitation community, in 2005 and 2010, had completely removed mention of the straddle, recommending that:

> *A seated or kneeling rescuer should be able to support the infant safely across their lap* (Biarent et al., 2005, p. S103; Biarent et al., 2010, p. 1370)

It can be implied that the straddle technique continued to be recommended within the North American community, given that no other alternative was introduced, nor was there an explicit discussion of why the practice of straddling the infant should no longer be used. This highlights why many instructors may continue to teach the skill using the straddle technique, despite the discussion in the early or European literature. Unfortunately, no evidence can be found in the literature explaining why such a technique was ever recommended in the first place.

Anthropometric Data

As highlighted in the review of the literature above, early discussions of the straddle technique certainly suggest that there was a keen awareness of size limitations. Yet, these discussions do not elaborate the probability that a rescuer would be able to physically perform the technique in question (i.e., the straddle), as opposed to requiring an alternative (e.g.., laying the infant across or on the lap). For the purposes of this discussion, being physically able to perform the skill requires the infant to be equal, or shorter in size, than the rescuer's forearm (the "rescue surface"). This allows the infant to be securely supported throughout the administration of chest thrusts and back blows. It is acknowledged that there are other conditions required to be able to perform the skill, such as the rescuer being able to hold the infant's weight, being able to balance the infant, or hold it securely while it may be squirming. However, these are necessary conditions to be met after the infant can be physically placed on the forearm. The definition of an infant will remain, for the purposes of this article, as someone under the age of 1 year. Potential rescuers will be taken to include children (11 years or older), which approximates the age where first aid delivery agencies begin teaching infant choking as part of a babysitting program; and adults (18 years or older), who may be learning the skill as part of a general first aid program.

To answer the question, two sets of publicly available sets of anthropometric data were found. The U.S. Consumer Product Safety Commission dataset contains infant and child measurements (CPSC, 1977). Although the age of the dataset suggests revisions would be necessary, two subsequent articles suggest

that re-norming the dataset is not imminently required (CPSC, 1998; Smith & Norris, 2000). Additionally, the timing of the dataset is quite relevant, as it would have entered consistent use at around the same time that the straddle technique was first described in the 1980 Standards & Guidelines. For adults, the publicly available dataset selected was published by the U.S. Army, by way of the ANSUR II study (2012). There are limitations in the use of this dataset; namely, that it represents the average military member who may differ from the diversity found within the general public, such as differences related to physical fitness standards required of military members. Given that these calculations are intended to be preliminary, these two publicly available datasets were considered appropriate for the task-at-hand, despite these inherent limitations.

The CPSC dataset describes a measurement that is highly relevant to the straddle technique: infant crown-rump length, as measured with the hips flexed at a 90-degree angle (see Figure 3). The mean and standard deviation of these measurements have been broken down by groups of three-month intervals (i.e., 0-2 months, 3-6 months, etc.). This ideally describes the length that would need to be accommodated in the space of a rescuer's forearm during the delivery of back blows or chest thrusts. In an ideal situation, the adult dataset would have a measurement that would be taken from the inside crease of the elbow, to the tip of the longest (middle) finger (see Figure 4). The closest measure to this available in the ANSUR II dataset describes a measurement from the outside of the elbow to the tip of the longest (middle) finger, measured with the elbow flexed at a 90-degree angle and positioned against the body (see Figure 5). Given that the rescuer's hand may support the infant in a more inferior position on the infant, such as the crown (in chest thrusts), or the jaw (in back blows), extra depth of the upper arm was approximated as equal for the purposes of this rough analysis of the data. Conveniently, the same measure (outside elbow to tip of middle finger) was also available in the CPSC dataset for the child rescuer. The CPSC data presents child means and standard deviations by one-year intervals, whereas the ANSUR II dataset presents the data as it relates to the total sampled military population, split by male and female data.

Figure 3: A demonstration of infant crown-rump length, as demonstrated on a CPR mannequin.

Figure 4: Ideal measurement relevant for straddling the infant: the inside elbow crease to the tip of the longest finger.

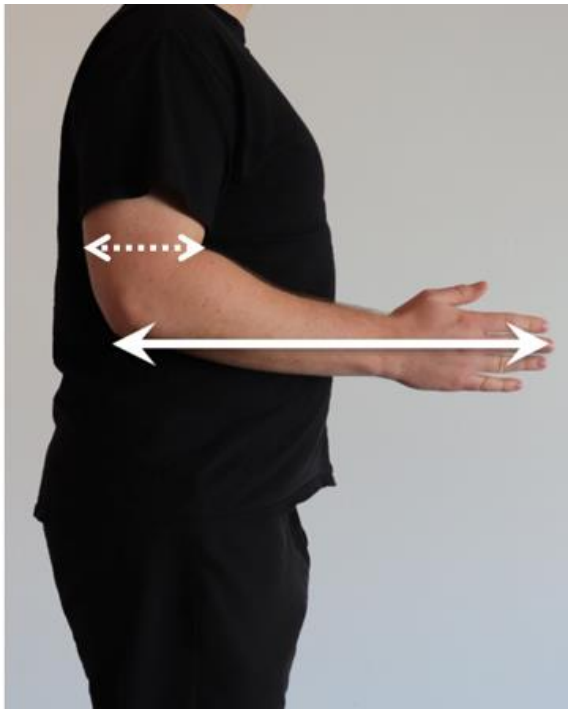


Figure 5: The solid line demonstrates the measurement available in the ANSUR II and CPSC datasets (outside elbow to tip of finger). The dotted line shows the difference between the ideal measurement, as seen in Figure 4, to the measurement available in the ANSUR II and CPSC datasets. For the purposes of this analysis, the dotted measurement was considered to be approximately equal to the inferior position that the rescuer grips the infant's head with.

These distributions were then weighted using data from Statistics Canada on the distribution of ages and genders in the Canadian population (2016). By combining data on the distribution of ages/genders with size measures of infants and child/adult rescuers, it became possible to calculate the proportion of all infant-rescuer pairings that would be physically plausible based on infant and forearm sizes alone. The final weighted sample suggests that only 64.4% of rescuer-infant combinations would be able to safely fit the infant with its legs straddled across the rescuer's upper arm. Removing child rescuers from the dataset only increases the proportion to 66.5%. This proportion is strikingly low, especially given the intention that first aid is a universal skill.

Small-Scale Validation Sample

The rescuer population that is most at-risk of being unable to perform the skill are younger rescuers, such as those older than 11 who would be taught this skill as part of a potential babysitting program. As such, a small-scale validation sample was designed. The intention in collecting the validation sample was to address two of the limitations of the publicly available dataset; namely: (1) the age of the publicly-available data (now more than 40 years past its original publication date); and (2), the assumption of rough equivalence of the outside, as opposed to the inside, elbow measurement on the rescuer.

In this sample, 63 young potential rescuers, aged 11-12, from a small Canadian municipality had the distance measured from the inside of their elbow to the tip of their longest (middle) finger. The sample was taken in a school, and only measured on students for whom informed consent from the parent, the teacher, and the youth was ascertained. Measurements were conducted with the elbow flexed against the body at a 90-degree angle, using a measuring tape and a single health professional researcher measuring all cases. These measurements were not sampled from within a babysitting program, restricting enrollment bias in the measurements.

The mean of the measurements was calculated as 41.15 cm, with a standard deviation of 2.46 cm. When the measurements of these youths were cross-referenced to infant crown-rump lengths contained in the CPSC dataset, only 1.8% of these potential rescuers would be able to fit the infant on their arms in accordance with the expectations of the straddle technique.

Mannequins as a Potential Culprit

In the personal experience of the authors in supporting instructors, it is striking to note the number of instructors who have not realized or considered that the skill may not be physically plausible outside of the learning environment. The mannequins used as learning aids in the learning environment may be partially to blame.

In this sub-study, both authors conducted measurements on four commercially available models of infant mannequins that are available on the Canadian market for the teaching of this skill. The measurement of interest was the infant crown-rump length, as defined earlier. Where the mannequin's legs were

unable to bend to the required angle, the authors used an approximation of the rump location. The two researcher's measurements were cross-referenced and were found to be identical to the centimeter. One mannequin was excluded from the analysis as it had neither rump nor legs for any clear approximation. The measurements were then cross-referenced against the CPSC dataset to find the age and percentile that most appropriately mapped to each model of mannequin. The identity of each mannequin manufacturer is intentionally suppressed from publication.

As Table 1 shows, many of the infant mannequins compare to very small infants. Given that the infant choking technique is taught for infants up to 12 months of age, this may lead to a false sense of security for facilitators and learners on their ability to successfully straddle the infant. In the case of the mannequin that was excluded from this analysis for having neither rump nor legs, learners would be unable to visualize the impact that the infant's legs may have in the performance of FBAO-relieving procedures.

Discussion

In order to build resilient communities through the delivery of first aid (see Pellegrino et al., 2017), it is important that first aid skills are, to the greatest extent possible, universal in their ability to be used by the public. The evidence suggests that the straddle technique is not as universal as intended. This necessitates the selection of alternative technique that would be able to accommodate the sizes of infants vs. rescuers, which is a necessary precondition for the skill to be delivered safely.

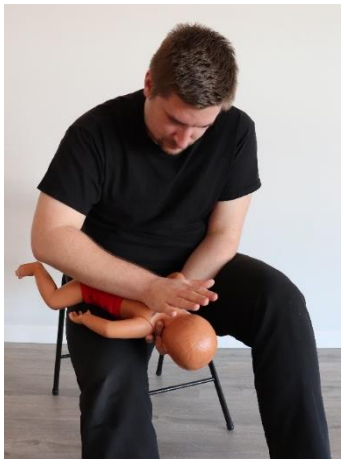
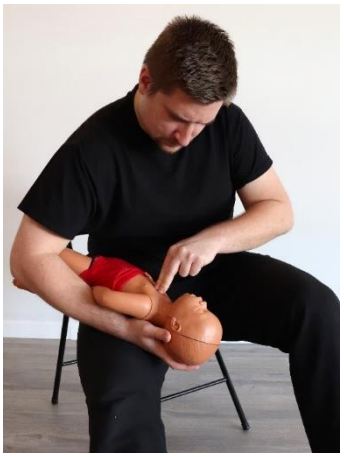
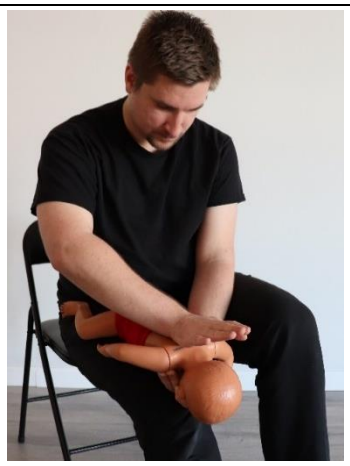
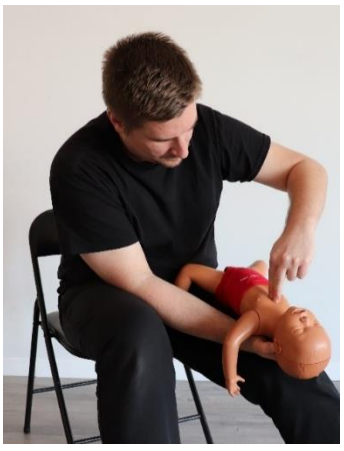
As a result, a comprehensive Internet search was conducted, with an aim of discovering alternate techniques that have evolved across various training agencies. The search started with a generic Google search, using keywords infant choking skill. Searches were filtered to recognizable training agencies, or information that directly cited a recognized training agency. For example, a parenting blog that described the skill with no citation was excluded; however, a news clip with a guest speaker from a National Red Cross Society was retained. Material was not limited to training agencies within the Red Cross movement. A second search was conducted on YouTube using simply the keywords infant choking, allowing the delivery of the full skill to be observed by the authors in video format. Apps from the Canadian Google App store, found with keywords first aid, were also included. Material from non-English training agencies was subjected to translation by Google Translate, and compared with any supplied images/video to ensure reasonable translation. The result of the search revealed three main varieties of infant holding, with some variants, which are reproduced in Table 2. The citations provided are not intended to be an exhaustive list of all training agencies who teach that method. The citations also do not necessarily represent the training agency's sole endorsement of that alternative. No publicly available information provided an explanation for the variations in skill.

The three alternative techniques vary in whether the rescuer is seated/kneeling, whether the infant is switched from one side of the rescuer to the other, and whether or not the same hand is used for the delivery of the back blows and chest thrusts. Regardless of technique, each ensures that the head of the infant is fully supported in the back blows and chest thrusts position, as well as during the transition from one to the other. All these alternative techniques remove the need for the infant to be straddled on the

Table 1: Three commercially available infant mannequin models on the Canadian market, their crown-rump lengths, and the equivalent actual size they may represent.

Mannequin Model	**Crown-Rump Length**	**Equivalent to a…**
Model A	35cm	2-month-old in the 5th percentile
Model B	40cm	average 2-month-old
Model C	40cm	average 2-month-old

Table 2: Alternative techniques to relieving FBAO in infants found in the review.

Technique	Images	
Alternative A Back blows are delivered on one side of the rescuer, while chest thrusts are delivered on the rescuer's other side. The infant's legs are tucked in between the rescuer's upper arm and the rescuer's body during the delivery of both back blows and chest thrusts. (New Zealand Red Cross, 2017) *Variant (not pictured)* Rescuer sits for the delivery of the skill (author AG).		
Alternative B The infant remains on one side of the rescuer for the delivery of both back blows and chest thrusts. During the delivery of back blows [left image], the infant's legs dangle over the rescuer's thigh. During the delivery of chest thrusts [right image], the infant's legs are tucked in between the rescuer's upper arm and the rescuer's body (author SL). *Variant (not pictured)* The rescuer's hands are reversed for the delivery of back blows from the positions pictured in the left image (British Red Cross, 2017). In other words, the pictured rescuer's right hand would be supporting the front of the infant and chin, while the pictured rescuer's left hand would be delivering back blows.		
Alternative C Back blows are delivered on one side of the rescuer, while chest thrusts are delivered on the rescuer's other side. While back blows and chest thrusts are being delivered, the infant's legs straddle the rescuer's thigh (St John Ambulance, 2016). *Variant (not pictured)* The rescuer's hands are reversed for the delivery of chest thrusts from the positions pictured in the right image (St John Ambulance, 2019). In other words, the pictured rescuer's left hand would be supporting the back of the infant's head, while the pictured rescuer's right hand would be delivering chest thrusts.		

arm, eliminating the size constraint of the rescuer's forearm.

There is not enough data currently available to recommend one technique over any of the other alternatives, which will continue to be addressed as this research project continues. In the experience of the authors, we believe the ideal technique should:

- **Be safe for the rescuer.** The technique must be performed in an ergonomic manner, that prevents further injury to the rescuer attempting the skill.
- **Be safe for the patient (infant).** The infant must remain properly supported throughout the procedure, with specific focus on maintaining a supportive grip of the head during the administration of the back blows, chest thrusts, and the transition between the two positions (whatever they may be).
- **Be quick to initiate.** The proposed technique must not require elaborate set-up time. The rescuer cannot spend an excessive amount of time positioning themselves in a manner that allows the start of the sequence to occur or spend an excessive amount of time positioning the infant in order to begin the sequence. For example, a technique that is only limited to the sitting position and cannot be adapted to a kneeling position would unnecessarily delay the start of the skill as the rescuer finds a sitting surface.
- **Allow the principles of the skill to be efficiently and successfully performed.** The technique should enable the performance of the back blows and chest thrusts and minimize any delays in switching the infant between back blows and chest thrusts.
- **Allow a wide range of potential rescuers to perform the skill.** Ideally, a degree of universality is to be expected in how a skill is taught. This means that it should be accessible for a large variety of audiences. This could include children acting as babysitters, individuals those who use mobility aids, or individuals of different body statures to name a few.

Many of the categories above do not have precise benchmarks defined. Some decisions will need to be made on a relative basis, whereas others will need to be made through a balance of the other categories.

Conclusion

Based on anthropometric measurements, this article suggests that the straddle-arm technique is not physically possible for a significant portion of rescuer vs. infant combinations. This effect is magnified in the younger rescuer population, such as young adult babysitters.

As is obvious from the discussion above, this project is still a work-in-progress. The authors will continue exploring this research question using anatomically correct infant mannequins, in size and weight, to compare the various alternatives identified against the proposed evaluation criteria outlined above. The goal of this research is to suggest a practice that can be adopted by a larger number of individuals, while still being able to deliver the clinical requirements of the skill: back blows and chest thrusts. In its idealized form, a first aid skill should be universally accessible.

Although some training agencies may not use the straddle technique, this article highlights key challenges as it applies to the teaching of first aid skills. First and foremost, change management requires not only highlighting positive changes to practice, but also explicitly noting when techniques are to be removed from practice (and the reasons for their removal). The removal of the size warning from versions of Guidelines may have inadvertently created a newer generation of instructors who were not aware of the previous warnings and have portrayed the skill as more universal than it is in practice. Secondly, the impact of mannequins – and other resources – within the learning environment cannot be underestimated. Mannequins must be realistic enough so that learners and instructors are able to get an appropriate sense of how the skill would be carried out, while respecting that some layperson learners may not be prepared to handle extremely realistic representations. Although the data required to create more anthropometrically-correct mannequins is currently available, it would be unwise to introduce such without preparing first aid facilitators on their use – especially given the cost of replacing mannequins. The benefit of more realistically sized mannequins at least would allow learners and facilitators to find alternative ways of delivering skills when learner differences prevent the default strategy from being used.

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