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LETTERS TO THE EDITOR AND OTHER SHORT COMMUNICATIONS

Knee versus CPR Posture for Life-Threatening Bleeding Control by School Aged Children

To the Editor,

A pilot study was conducted as part of a middle school science project, evaluating the force generated in a model of bleeding control by the cardiopulmonary resuscitation (CPR) posture compared with that generated by a single knee in school-aged children. This model consisted of a force plate (Vernier, Beaverton, OR, US), topped with silicone to resemble the feeling of tissue, covered with a pair of blue jeans with red paint simulating a wound in the inguinal area (Figure 1). This model has been used in a prior study of bleeding control (Charlton BS, et al., 2021). Data were collected on Vernier Graphical Analysis software v4.10.0 (Beaverton, OR, US) and analyzed with GraphPad (Prisma, version 9.5.0). The school granted written approval (following IRB protocols for non-regulated research institutions) and required verbal consent only from the participants. This project was part of a middle school science project for one author (BSC). The parents (JRC, NPC), who are clinicians and scientists, helped instill the idea and contributed to developing the methodology. The student (BSC) was responsible for participant recruitment, data collection, and drafting of the manuscript. Parents (JRC) helped analyze the data and edit the final manuscript (JRC, NPC).

Figure 1: Bleeding Control Model.

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Following verbal consent, participants were randomized to begin direct manual compression over the simulated area of bleeding with either the CPR posture (two hands overlapping with locked arms) or a single knee (Figure 2). Participants were instructed that they were attempting to stop a life-threatening bleeding and told to hold maximal pressure for the three-minute duration of the experiment. Data was continuously recorded every 0.5 seconds for 180 seconds. Participants were then allowed to rest for five minutes and repeated the procedure using the alternate method. Weight and height were recorded. No participants reported any injury that they felt would hinder their application of pressure.

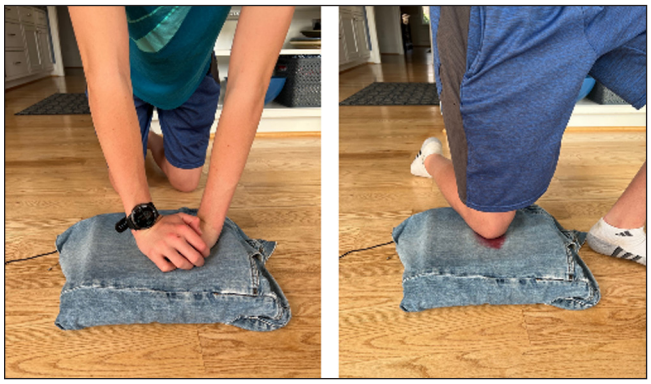

Figure 2: CPR Posture (left), Knee (right).

Twenty school aged children participated, ranging from 7 to 15 years old (mean: 12.1) and weighing between 26kg (57.3 lbs) and 74kg (163.1 lbs), mean: 46.8 kg (103.2 lbs). Forty percent were female. The average force generated by the CPR posture was 46.4 ± 7.2 lbs. The application of pressure with a single knee generated, on average, 70.2 ± 10.9 lbs. The average maximum pressure with the CPR posture compared with a single knee was 71.9 compared with 96.5 lbs respectively. The average minimum pressure with the CPR posture compared with a single knee was 23.7 compared with 34.7 lbs respectively. With both methods, the force generated decreased over time with a mean change in force of 48.3 lbs with the CPR posture compared with 61.8 lbs with a single knee. While the slope of force generated by a single knee application was steeper than the CPR posture, the average application of force at the end of the three-minute study period was greater than that of the CPR posture (Figure 3).

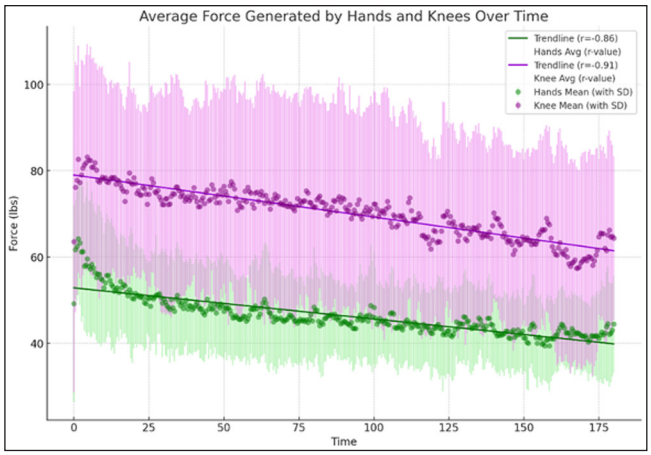

Figure 3: Force Over Time.

There are several limitations of this pilot study that limit its generalizability. This study was conducted in a controlled setting with a model of bleeding control. Applied pressure and fatigue may vary in real-life situations. In addition, force was measured rather than pressure. The surface area of a single knee is similar to the size of a palm and, therefore, would be expected to generate a similar pressure. However, the CPR posture utilizes hands which are typically more dexterous than the knee and may allow the rescuer to apply more accurate pressure. As this was a proof-of-concept pilot study a limited number of participants were enrolled. A larger study is necessary to confirm these findings and allow for further stratification of the data. Despite these limitations, the data generated provides new insights into the force generated using two methods of controlling life-threatening bleeding by school-aged children.

These data suggest that in the school-aged population, the use of a single knee is a good alternative to using the CPR posture to apply pressure to a life-threatening bleeding. The single knee position generated equal, if not better force than using the CPR posture. Using a single knee to apply pressure to a bleeding area would also be a hands-free approach that would allow the rescuer to perform other actions such as call emergency services (ex. 9-1-1) or apply a tourniquet.

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Mr. Charlton and Drs. Charlton,

The Editorial Board of the IJFAE was pleased to receive your letter about your project regarding the proof of concept around using a knee to provide pressure on an extremity wound. The importance of first aid education for children cannot be overstated. The Kids Save Lives statement, endorsed by the World Health Organization, advocates for early and regular training in resuscitation for all school-age children (Böttiger & Van Aken, 2015). In cases of trauma, the most crucial first step is stopping life threatening bleeding, as any attempted resuscitation would be futile without adequate bleeding control. This underscores the potential of first aid education to save lives.

While tourniquets and pressure dressings are increasingly available, the straightforward and effective method of applying direct manual pressure remains the simplest, quickest, and easiest way to control initial bleeding (National Association of Emergency Medical Technicians, 2020, p. 72). Your pilot mannequin study revealed that for school-age children, using one knee to apply pressure generates greater compressive force than the bimanual technique. Despite its limitations, such as reduced dexterity compared with hands and limited applicability to certain anatomical wound sites, this technique remains a potential alternative technique for controlling external bleeding.

Firearm injuries have tragically been a leading cause of mortality among children in the United States and one-third of these events are witnessed by other children (Centers for Disease Control and Prevention, 2023). This means that school children have the potential to save lives using simple actions like applying direct pressure, which they can easily learn. This knowledge can empower children to be the difference between life and death for a schoolmate, friend, or family member.

Furthermore, teaching first aid knowledge and science to children is not just about saving lives, it's about fostering curiosity and early research interests. The science of first aid is practical and relevant to everyday life. Pilot studies like this offer creative solutions that can be validated and ultimately save lives. This practicality and relevance can engage children in learning and inspire all of us to explore the world of science.

Sincerely,
Marcus Lo, MD
Editorial Board Member

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