The Efficacy of Cardiopulmonary Resuscitation in the Prone Position

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ABSTRACT

Objective: *To ascertain whether cardiopulmonary resuscitation (CPR) is effective when performed on a mannequin in the prone position.*

Methods: *Thirty six registered nurses each performed 100 consecutive chest compressions on a Laerdal Resusci-Annie® mannequin immediately after an annual update of CPR technique from an Advanced Life Support (ALS) instructor. Compressions were performed on a mannequin turned to the prone position, on a standard examination couch. A gel-filled pad was placed between the sternum and couch. Nurses were instructed once to perform compressions in the midline, two-thirds the way up the torso 'between imaginary scapulae'. Efficacy of compressions was measured using an integral 'skillmeter' in the mannequin.*

Results: *Of 3600 chest compressions performed, 3376 were assessed by the skillmeter. 1168 (34.6%) compressions were 4 - 5 cm in depth, 1370 (40.6%) were 2 - 4 cm in depth, and 868 (24.6%) were less than 2 cm. Sixty one percent of nurses were able to perform adequate CPR at some stage through the cycle. Forty one percent managed to perform adequate CPR throughout the cycle.*

Conclusions: *Efficient CPR can be performed on a mannequin in the prone position, although additional instruction in technique is required. This may be applicable to patients turned to the prone position.* **(Critical Care and Resuscitation 2000; 2: 188-190)**

Key words: Cardiopulmonary resuscitation, prone position, mannequin

Chest compressions are one of the mainstays of basic life support algorithms, with the timing of their onset being one of the major determinants of survival from cardiac arrest.[1]

Patients may be turned to the prone position, either in the operating theatre for better surgical access (e.g. neurosurgery, spinal surgery), or, more recently, to improve oxygenation in patients with acute respiratory distress syndrome. Both sets of patients may suffer cardiac arrest whilst in the prone position and significant delays in the onset of cardiopulmonary resuscitation may ensue whilst sufficient numbers of staff are available to safely return the patient to the supine position and allow conventional CPR to commence.

There have been five case reports of CPR being performed on patients in the prone position with a favourable outcome. Of these, three were performed on children,[2-4] with a compressible thorax, and two in adults.[4,5] Four of these case reports[2-5] suggested using a sternal support, giving so-called 'reversed praecordial compressions' whereby indirect pressure from the back is transmitted to the sternum to achieve chest compression and cardiac output. To date no work has been done to assess how effective this might be.

The aim of this study was to assess effectiveness of CPR on a CPR mannequin placed in the prone position.

MATERIALS AND METHODS

Over an eight month period from March to November 1999, 36 registered nurses volunteered to perform CPR on a Laerdal Resusci-Annie®) mannequin turned to the prone position. Each nurse had just completed an annual CPR update given by an Advanced Life Support (ALS) accredited instructor during which a

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'success rate' of 70% for compressions and ventilations as judged by a skillmeter and observation was considered acceptable. Nurses were each asked to perform 100 chest compressions on the mannequin, which had been turned prone on a standard examination couch normally used to teach conventional CPR.

A gel-filled pad measuring approximately 12.5 cm x 7.5 cm x 7.5 cm was placed between the sternum of the mannequin and the couch to facilitate reversed compressions since most of the case reports had used reversed compressions with a sternal support, and preliminary studies without a sternal support suggested successful compression depth was dependent on the surface upon which the mannequin was placed.

No breaks in compressions were allowed for respirations, as this would be technically difficult, and most patients turned to the prone position have their airway secured with an endotracheal tube prior to being turned.

Nurses were instructed once to give chest compressions in the midline, approximately two-thirds the way up the body of the mannequin, 'between imaginary scapulae'. This site was chosen for two reasons. Firstly, it approximates the same region on the sternum where conventional chest compressions would be performed, and secondly this is where chest compressions were performed in the case reports with a favourable outcome.

Nurses were instructed to use a standard technique for chest compression with arms straight, using the palm of the hand, and with fingers of both hands interlocked. The nurse stood on the left-hand side of the mannequin which had been turned prone (i.e. would be the right-hand side of the mannequin in the normal supine position).

Effectiveness of chest compressions was assessed using a built-in skillmeter, with a remote display unit, which could not be seen by the nurse performing compressions. Depth of compression was noted, as was deviation from the midline.

RESULTS

Thirty six nurses performed a total of 3376 chest compressions, which were analysed by the skillmeter (91.8% of the total possible). Of these 3376 chest compressions, 1168 (34.6%) were effective (4 - 5 cm compression depth), 1370 (40.6%) were partially effective (2 - 4 cm compression depth), and 838 (24.6%) were ineffective (< 2 cm compression depth).

Twenty two of the 36 (61%) nurses were able to deliver effective compressions at some stage with a mean of 53% compressions being effective. Of these 22 nurses, 9 (41%) were able to perform 70% or more adequate compressions. There were wide variations in effectiveness of compressions between nurses, varying from 100% effective to 100% ineffective.

Of the 3376 compressions, 379 (11.2%) were assessed to be to the right of midline (left hand side of the prone mannequin), 141 (4.1%) were assessed to be too high, and 206 (6.1%) were assessed to be too low. No compressions were evaluated to be to the left of the midline (right hand side of the prone mannequin).

DISCUSSION

The results show that it is possible to perform chest compressions on a mannequin placed in the prone position, although adequacy varies greatly between individuals. The majority of nurses who performed adequate CPR on the mannequin also tended to perform a smaller number of poor compressions, towards the end of the CPR sequence. This was presumably due to fatigue. All nurses suggested that performance of CPR in the prone position was more tiring than performing CPR in the standard position, presumably because the force of compression is dissipated over a larger area than force used directly against the sternum, and therefore more energy is required to obtain adequate chest compression. However, the compliance of the mannequin in this position has not been compared with that of humans. Baubin *et al*, have shown that compression characteristics vary between mannequins, as do those of patients.[6]

An overall fraction of 35% effective compressions may seem low. However, studies have shown that in those trained to perform CPR, 54% to 88% do so poorly,[7-9] although performance can be improved with repeated trainings. The results show that those individuals who are able to perform adequate CPR in the prone position tend to perform reasonably throughout the resuscitation period (mean 53% effective compressions).

A support under the sternum would seem desirable to facilitate effective CPR in this position. Previous studies have used hands of those involved in the resuscitations, and sand bags.[2,3] This study used a gel-filled pad, often found in theatre to protect patients' bony prominences. Using a hand as a support under the patient, with the additional force of chest compressions may be very uncomfortable and possibly injurious to the individual's hand. Sandbags or gel-filled pads may be difficult to locate in times of emergency. The use of a 500 mL bag of intravenous fluid may be a reasonable and easily obtainable alternative, although its efficacy has not been studied.

An appreciable number of compressions were off the midline in the study which, in part, was due to the light weight of the mannequin, as it moved considerably during the decompression phase. A patient would

probably be less likely to move during such CPR techniques due to his, or her, greater mass. The placement of the sternal support may also be an important factor. No compressions deviated to the left of the midline; this may have been due to the fact that all compressions were performed with the nurse standing on the left-hand side of the prone-position mannequin.

It was also noted that the head of the mannequin extended on the neck appreciably during compressions, and the possibility of spinal cord damage during compressions was reviewed. However, normally in the patient who is managed in the prone position the head and neck are usually well supported and the neck extension of the mannequin was probably exaggerated due to its light weight and low inertia compared with a human.

There may be little alternative to CPR in the prone position. For example, if the brain or spinal cord are exposed during surgery, turning to the conventional supine position would cause neural damage. Institution of CPR immediately following a loss of cardiac output in a patient in the prone position, rather than waiting for sufficient staff to safely turn the patient back to the supine position, would save time and may improve the outcome as early institution of CPR leads to a better outcome following cardiac arrest.[1,10] It has been suggested a minimum of 4 and probably up to 6 staff are required to safely return a patient from the prone to supine position. As many of these patients have invasive monitoring, endotracheal tubes and urinary catheters in place, gathering sufficient staff and safely turning the patient may take as long as 5 minutes before conventional CPR can be commenced.

In summary, should a patient in the prone position suffer a cardiac arrest requiring CPR, this study has demonstrated that it can be performed effectively with the patient still in the prone position. However, a support under the sternum, such as a sandbag or 500 mL bag of fluid is required and additional training should be given to those attending patients placed in the prone position.

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