



**Title: Backboard Use During Cardio-Pulmonary Resuscitation: A Review of The Guidelines and Clinical Effectiveness**

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**Context and policy issues:**

A backboard, made of wood, plastic, or other material, is inserted under the torso of a patient that is to receive cardiopulmonary resuscitation (CPR) in order to provide a firm surface during chest compression. In comparison to a hospital bed, firm surfaces have been shown, either by demonstration or through mathematical modeling, to improve the quality of chest compression during CPR by increasing depth of compression.<sup>1-3</sup> Effective chest compression may result in better patient outcomes by increasing blood flow, however this correlation is not well-established in humans.<sup>4</sup> While the use of a backboard may provide some benefit during CPR, at the same time, it is necessary to delay or stop performing CPR in order to place the backboard under a patient, which may increase mortality risk.

Backboards are not uniformly recommended as equipment in facilities where CPR is performed. For example, the American Academy of Pediatrics recommends the presence of backboards among the equipment used for resuscitation in free-standing urgent care facilities and in community hospitals.<sup>5,6</sup> In contrast, the Resuscitation Council in the UK does not list backboards amongst its recommended equipment for the management of adult and pediatric cardiopulmonary arrest.<sup>7,8</sup> The Canadian Pediatric Society minimum equipment guidelines for pre-hospital care include backboards, but they are intended for the purpose of spinal immobilization.<sup>9</sup>

The objective of this review was to summarize current recommendations for the use of backboards during CPR in a hospital setting, and to assess the evidence regarding the clinical effectiveness of backboards relative to other surfaces when used in CPR.

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## Research questions:

1. What are the guidelines for use of a backboard for patients experiencing cardiac arrest in a hospital setting?
2. Is there any evidence that using a backboard enhances or promotes effective chest compression in patients experiencing cardiac arrest in a hospital setting?

## Methods:

A limited literature search was conducted on key health technology assessment resources, including OVID MedLine, CINAHL and Embase, Pubmed, The Cochrane Library (Issue 1, 2008), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, EuroScan, international HTA agencies, and a focused Internet search. Results included studies published between 2000 and May 2008, and were limited to English language publications only. No filters were applied to limit the retrieval by study type. This search was supplemented by hand searching the bibliographies of selected papers.

Citations were screened and selected by one reviewer (ET). Trial quality was assessed using the Oxford CEBM Critical Appraisal for Therapy Articles.<sup>10</sup>

## Summary of findings:

Four sets of guidelines<sup>11-14</sup> and three randomized trials<sup>4,15,16</sup> were retrieved. One of the trials was published in abstract form only.<sup>16</sup> No health technology assessments, systematic reviews, meta-analyses, or non-randomized studies were found.

### *Guidelines*

In 2005, the European Resuscitation Council (ERC) published Guidelines for Resuscitation.<sup>11</sup> These guidelines were derived from the 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations produced by the International Liaison Committee on Resuscitation (ILCOR). An evidence-based approach was used to create the guidelines; literature reviews, study evaluations, grading of the evidence, and recommendations were systematized and documented. The guidelines included sections on adult basic life-support, adult advanced life support, and pediatric life support. While all three sections described techniques for chest-compression in CPR, they do not specifically mention the use of backboards for optimizing chest compression. Backboards are only mentioned in a section of the guidelines that describe CPR techniques and devices, where two devices that are operated with a backboard [mechanical pistons and load distributing bands (LDB)] are described. The section on adult advanced life support recommends that equipment used for in-hospital CPR be standardized throughout a hospital, as recommended by Gabbott *et al.*,<sup>17</sup> however backboards are not among the listed equipment in this reference. Gabbott *et al.* further reference the UK Resuscitation Council website for a recommended list of equipment,<sup>7,8</sup> which also does not include backboards.

The UK Resuscitation Council published resuscitation guidelines in 2005.<sup>12</sup> These guidelines are an abbreviated version of the ERC Guidelines. They contain sections on adult basic and advanced life-support, pediatric basic and advanced life support, and in-hospital resuscitation. Similar to the ERC Guidelines, there is emphasis placed on proper chest compression during

CPR, however there is no mention of the use of backboards during this procedure. As was previously mentioned, the UK Resuscitation Council does not include backboards among its recommended equipment for in-hospital adult resuscitation<sup>8</sup> or pediatric cardiopulmonary arrest.<sup>7</sup>

In 2005, the American Heart Association (AHA) published its Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.<sup>13</sup> As with the ERC Guidelines, the AHA Guidelines are based on the evidence evaluation from the 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations in collaboration with ILCOR. The section of the guidelines that relates to adult basic life support recommended the use of a hard surface to maximize the effectiveness of chest compression. Either a backboard or the floor is suggested as examples of such surfaces. The guidelines on pediatric advanced life support recommended a backboard across the full width of the bed to provide optimal support for effective chest compressions. As with the ERC Guidelines, the section on CPR techniques and devices mention backboards only in relation to mechanical pistons and LDBs. There are no references in the guidelines that specifically relate to the use of backboards in CPR.

In 2006, ILCOR published treatment recommendations for pediatric basic and advanced life support.<sup>14</sup> These guidelines were based on the same evidence review used for the ERC and AHA guidelines. While these guidelines describe CPR procedure and technique, they do not mention the surface on which this procedure might be best performed.

### *Randomized controlled trials*

Perkins *et al.* reported a randomized controlled cross-over trial that studied the effects of a backboard, bed height, and operator position on compression depth during simulated resuscitations on manikins in 2006.<sup>15</sup> Twenty trained basic life support student instructors were randomized to each of two phases of the study. In the first phase, subjects were randomized to perform 3 minutes of continuous chest compressions on a manikin placed on a standard hospital bed with a foam mattress in each of the following scenarios: standing on the floor next to the bed (standard CPR), standing on the floor next to the bed with the manikin placed on a backboard, or kneeling on the bed next to the manikin (no backboard). Each subject performed compressions in all three scenarios in a randomized order. In the second phase of the study, a different group of instructors were randomized to perform either standard CPR or low CPR, where the height of the bed was reduced to its lowest level. A backboard was not used in either of these two scenarios. The authors found no difference in external chest compression (ECC) depth between standard CPR ( $29 \pm 7$  mm) compared with CPR performed with a backboard ( $31 \pm 10$  mm). ECC rate was slightly slower with standard CPR ( $92 \pm 8$  min<sup>-1</sup>) versus CPR with a backboard ( $97 \pm 10$  min<sup>-1</sup>), and this difference was statistically significant ( $p < 0.05$ ). The authors found no differences in compression depth in the kneeling and lowered height interventions, compared with standard CPR. In addition, no differences were found between interventions with respect to ECC duty cycle, fatigue, and compression effectiveness. In the first phase of the study, the time taken by a resuscitation team to place a backboard beneath a volunteer lying on hospital bed and restart CPR was measured in 6 instances. The average time taken to place a backboard underneath a volunteer was  $10.6 \pm 4$  seconds (range: 6.6-16.7 seconds). While it was mentioned in the discussion that placing a backboard under a patient interrupts chest compression, they did not comment on the possible impact of the time delay observed in this study on patient outcomes. The authors noted that a limitation of this study was that it used a resuscitation manikin model which allowed comparison to international guidelines but did not

measure hemodynamic responses to each of the interventions, and that impact on hemodynamics should be determined in human or animal studies.

In 2007, Anderson *et al.* reported a randomized double-blinded cross-over trial that compared the quality of ECC with and without a backboard.<sup>4</sup> Twenty-three orderlies who were trained to give ECC to cardiac arrest victims were randomly assigned to perform ECC for 2 minutes on two identical manikins placed on a standard foam mattress hospital bed, with one of the manikins having a backboard placed underneath it. The backboard was covered with an overlay sheet. The orderlies performed ECC while standing on a stool by the side of the bed. The authors reported a significantly greater mean compression depth with the backboard ( $p < 0.0001$ ), with a difference of 5mm (95%CI: 3.6-7.5mm). They also reported a significantly higher proportion of compressions  $>40$ mm with the backboard (92% vs. 69%,  $p = 0.0007$ ). They found no differences in compression rate, duty cycle, percentage of compressions with incomplete release, or percentage of compressions of correct depth (40-50mm). The authors noted two limitations to the study; first that the study was performed on manikins which may differ from humans in term of weight, stature, and compliance of the thorax; and second, that the participants were informed of the purpose of the study which may have led to more vigorous compression in both groups.

An animal study was reported by Bridges *et al.* at the American Academy of Critical Care Nurses National Teaching Institute in 2004 and was published in abstract form.<sup>16</sup> The objective was to assess the efficacy of CPR on two types of litters, which often serve as hospital beds in the military (NATO and Decon), both with and without a backboard. The rationale was that during cardiac arrest, CPR may be delayed in order to move a patient from a litter to the floor. Outcomes included end-tidal CO<sub>2</sub> (ETCO<sub>2</sub>), coronary perfusion pressure (CPP), and return of spontaneous circulation (ROSC). A randomized four-group design with repeated measures was used. Sixty-four pigs were anesthetized and placed over the stiffest part of the litter. Ventricular fibrillation was induced for 4 minutes without CPR and then CPR was performed for 8 minutes, followed by defibrillation. Chest compression depth was 5 centimeters. During CPR, there were no significant differences in ETCO<sub>2</sub> or CPP between the NATO litter with or without a backboard or the Decon litter with a backboard, however these outcomes were significantly lower with the Decon litter without a backboard ( $p < 0.05$ ). ROSC was 18%, with increased survival observed with the NATO litter, with or without a backboard ( $p < 0.09$ ). The authors concluded that a backboard was not necessary on NATO litters, however they should be used on Decon litters.

#### *Quality assessment of randomized trials*

Table 1 provides a summary of the critical appraisal of the randomized studies reviewed in this report. In all three studies, there was some random assignment of treatment, the treatment groups (or the persons performing the intervention) appeared to be similar at the start of the trial, and apart from the assigned intervention, groups appeared to be treated equally during the study. It was unclear if all patients or persons performing the intervention were accounted for and there was no double-blinding in two of the studies.<sup>15,16</sup> Treatment effect was clearly reported in two of the three studies.<sup>4,15</sup> Among the three studies reviewed, the Andersen study<sup>4</sup> appears to be the best-conducted and reported.

**Table 1: Critical Appraisal of the Randomized Controlled Trials**

Critical Appraisal Criterion <sup>10</sup>	Perkins <i>et al.</i> <sup>15</sup>	Andersen <i>et al.</i> <sup>4</sup>	Bridges <i>et al.</i> <sup>16</sup>
Assignment of treatments randomized?	Yes	Yes	Yes
Were groups similar at start of trial?	Yes	Yes	Yes
Were groups treated equally?	Yes	Yes	Yes
Were all patients entered in trial accounted for?	Unclear	Yes	Unclear
Were measures objective or was trial double-blind?	No	Possibly	No
How large was the treatment effect?	2mm - NS	5mm – p<0.0001	Unclear
How precise was the estimate of the treatment effect?	Precise	Precise	Unclear

### Limitations

There is variation in the recommendations for the use of backboards in the guidelines that were reviewed. In addition, there is no evidence in these guidelines, and little evidence in the published literature, regarding the effectiveness of the use of backboards in CPR.

Among the studies that were found, none were performed on human subjects, and some assumptions must therefore be made regarding the relation of the observed results to human patients.

The Perkins study<sup>15</sup> found no treatment difference for the use of the backboard, however this study was not blinded and instructors may have compensated their efforts in performing CPR when a backboard was not present.

The Andersen study<sup>4</sup> observed a statistically significant difference in chest compression of 5mm, however it is unclear what the implications of this difference are on clinical outcomes. One may also question the extent to which orderlies remained blinded to the presence of a backboard under the manikin while they performed CPR.

In the Bridges study,<sup>16</sup> it may be that NATO litters are sufficiently firm so that the addition of a backboard does not affect outcome, while it has an impact on the Decon model. This may suggest some justification for the use of a backboard; however, we have very limited information about the structure of these litters from this abstract report and can not easily draw conclusions. In addition, this study was not conducted using standard hospital beds.

Some data were found regarding time delay in placing a backboard under a patient,<sup>15</sup> however the sample size for this estimation was small (n=6). In addition, the study from which these results were obtained found no treatment effect in using a backboard, suggesting a possible net negative impact of using this device when considering the time delay as well. These results are not however conclusive and the Andersen study, in contrast, was positive. The potential impact of a time delay relative to the benefits of using a backboard may be difficult to assess for practical and ethical reasons, particularly in human patients.

## **Conclusions and implications for decision or policy making:**

Backboards are a commonly recommended and used device during CPR, and the assumption for their efficacy may be due in part to reports on CPR chest compression quality on other firm surfaces on which CPR is performed. An earlier report by Perkins *et al.*<sup>1</sup> suggested that the quality of chest compression is better when performed on the floor compared with any type of mattress (foam or air, inflated or deflated) and that a key factor is bed height. Given these observations, the authors bring into question the benefit of backboards, as a deflated mattress may provide a very similar surface, however no direct assessment of backboards was made in this study. Perkins' later study<sup>15</sup> of backboards found that they had no impact on chest compression depth, as was seen in this review.

There is very little conclusive evidence regarding the effectiveness of backboards in a hospital setting, or in other settings, and on their impact on patient outcomes. At the same time, given the emphasis placed on appropriate chest compression depth in CPR guidelines, the plausibility that surface may affect the ability to properly perform chest compressions, and the difficulty of obtaining definitive data on the relative impact of chest compression depth and time delay in human patients, it is likely that backboards may continue to be used, albeit with some inconsistency. In the interim, additional study of the effectiveness of backboards during CPR is required.

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