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Brief Reports

MANUAL VERSUS MECHANICAL CHEST COMPRESSIONS ON SURFACES OF VARYING SOFTNESS WITH OR WITHOUT BACKBOARDS: A RANDOMIZED, CROSSOVER MANIKIN STUDY

Gabriel Putzer, MD,* Anna Fiala, MD,* Patrick Braun, MD,* Sabrina Neururer, BSC,† Karin Biechl, MD,* Bernhard Keilig, MD,* Werner Ploner, MD,‡ Ernst Fop, MD,‡ and Peter Paal, MD*

*Department of Anesthesiology and Critical Care Medicine, Innsbruck Medical University, Innsbruck, Austria, †Department of Medical Statistics, Informatics and Health Economics, Innsbruck Medical University, Innsbruck, Austria, and ‡Institute of Mountain Emergency Medicine at the European Academy, Bozen, Italy

Corresponding Address: Gabriel Putzer, MD, Department of Anesthesiology and Critical Care Medicine, Innsbruck Medical University, Anichstrasse 35, 6020 Innsbruck, Austria

□ **Abstract—Background: Chest compression quality is decisive for overall outcome after cardiac arrest. Chest compression depth may decrease when cardiopulmonary resuscitation (CPR) is performed on a mattress, and the use of a backboard does not necessarily improve compression depth. Mechanical chest compression devices may overcome this problem. Objectives: We sought to investigate the effectiveness of manual chest compressions both with and without a backboard compared to mechanical CPR performed on surfaces of different softness. Methods: Twenty-four advanced life support (ALS)–certified rescuers were enrolled. LUCAS2 (Physio-Control, Redmond, WA) delivers 52 ± 2 mm deep chest compressions and active decompressions back to the neutral position (frequency 102 min^{-1}; duty cycle, 50%). This simulated CPR scenario was performed on a Resusci-Anne manikin (Laerdal, Stavanger, Norway) that was lying on 3 different surfaces: 1) a concrete floor, 2) a firm standard mattress, and 3) a pressure-relieving mattress. Data were recorded by the Laerdal Skill Reporting System. Results: Manual chest compression with or without a backboard were performed correctly less often than mechanical chest compressions (floor: 33% [interquartile range {IQR}, 27–48%] vs. 90% [IQR, 86–94%], $p < 0.001$; standard mattress: 32% [IQR, 20–45%] vs. 27% [IQR, 14–46%] vs. 91% [IQR, 51–94%], $p < 0.001$; and pressure-relieving mattress 29% [IQR, 17–49%] vs. 30% [IQR, 17–52%] vs. 91% [IQR, 87–95%], $p < 0.001$). The mean compression depth on both mattresses was deeper with mechanical chest compressions (floor: 53 mm [range, 47–57 mm] vs. 56 mm [range, 54–57 mm], $p = 0.003$; standard mattress: 50 mm [range, 44–55 mm] vs. 51 mm [range, 47–55 mm] vs. 55 mm [range, 54–58 mm], $p < 0.001$; and pressure-relieving mattress: 49 mm [range, 44–55 mm] vs. 50 mm [range, 44–53 mm] vs. 55 mm [range, 55–56 mm], $p < 0.001$). In this ~6-min scenario, the mean hands-off time was ~15 to 20 s shorter in the manual CPR scenarios. Conclusions: In this experimental study, only ~30% of manual chest compressions were performed correctly compared to ~90% of mechanical chest compressions, regardless of the underlying surface. Backboard use did not influence the mean compression depth during manual CPR. Chest compressions were deeper with mechanical CPR. The mean hands-off time was shorter with manual CPR.** © 2016 Elsevier Inc.

□ **Keywords—backboard; chest compressions; CPR; LUCAS; manikin; mattress**

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INTRODUCTION

Chest compression quality is decisive for survival and good neurologic outcome of patients in cardiac arrest

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(1). However, conducting chest compressions is highly complex and may be even more challenging on a soft surface. Compression depth may decrease when cardiopulmonary resuscitation (CPR) is performed on a mattress, and even the use of a backboard does not necessarily improve compression depth (2–5). In-hospital CPR is commonly performed manually on patients lying in a bed and stabilized on a backboard.

When CPR is performed manually on a mattress, several factors (e.g., backboard, bed height, and type of mattress) influence and may reduce the efficacy of chest compressions. Mechanical chest compression devices deliver uninterrupted chest compressions that conform to guidelines and may therefore improve the quality of CPR on a mattress.

The aim of this study was to compare mechanical with manual CPR with and without a backboard performed on different surfaces. The primary outcome was the percentage of correct chest compressions relative to total chest compressions. Secondary outcomes were depth, pressure point, complete pressure release and rate of chest compressions, hands-off time, and time to first defibrillation.

METHODS

The local ethics committee waived the requirement for approval. This prospective, randomized, cross-over manikin study was conducted at the Innsbruck University Hospital, Austria. Twenty-four advanced life support (ALS)–certified rescuers were enrolled. All had been trained by European Resuscitation Council (ERC) ALS-certified instructors on manual and mechanical CPR according to the 2010 guidelines (6). The rescuers formed teams of 2 and each rescuer performed the same CPR scenario on different surfaces in a randomized order with manual and mechanical chest compressions. The manual scenarios were conducted once with and once without a backboard (Figure 1). At the end of each scenario the rescuer was asked to assess the efficacy of chest compressions and the level of fatigue using a 100-mm visual analog scale.

The Lund University Cardiac Assist System (LUCAS2; Physio-Control, Redmond, WA) is an electrically powered piston device that provides 52 ± 2 mm deep chest compressions and active decompressions back to the neutral position with a frequency of 102 min^{-1} and a duty cycle of 50%. A back plate is positioned under the patient and is locked with the upper part of LUCAS2 and acts as a counter-support for chest compressions.

CPR was performed on a Resusci-Anne manikin (Laerdal, Stavanger, Norway) on different surfaces (e.g., on a concrete floor, a firm standard mattress [MoltoMed; Moltoplast, Innsbruck, Austria], and a pressure-relieving mattress [Thera Rest Classic; KCI, San

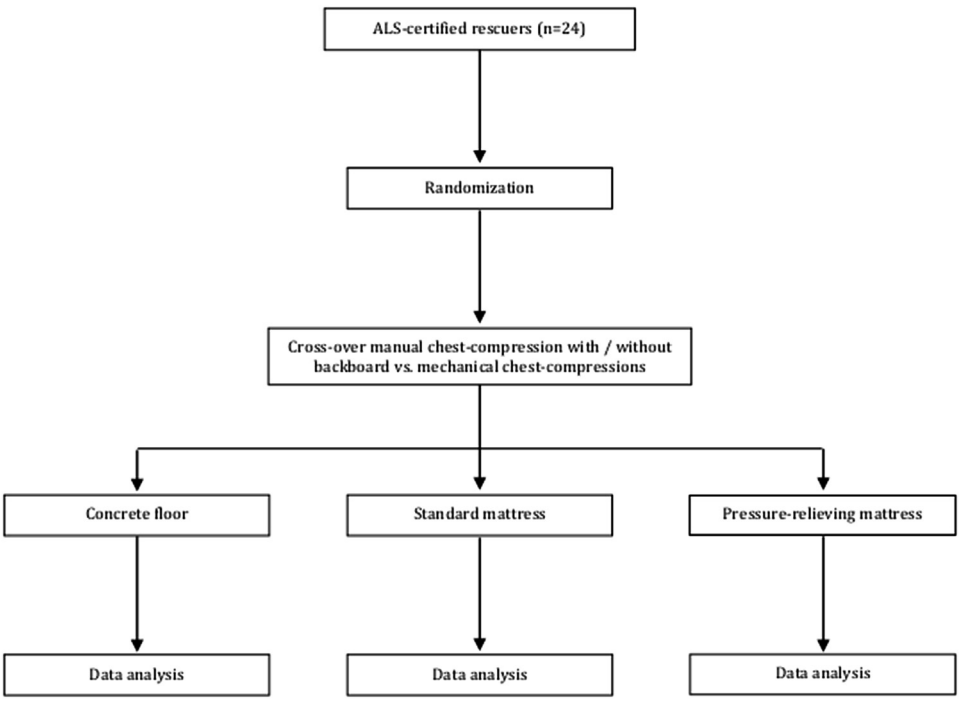

Figure 1. The rescuers performed the same CPR scenario on different surfaces in a randomized order with manual and mechanical chest-compressions. The manual scenarios were conducted once with and once without a backboard. ALS = Advanced life support.