

# Saving lives in spaceflight - a guideline for cardiopulmonary resuscitation in microgravity

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## Background

As mankind strives to explore space beyond the moon by planning **space exploration missions** to Mars and as **space tourism** becomes closer to operational viability, medical planning for those missions must consider the possibility of life threatening medical emergencies.

For Earth, well-established and proven guidelines concerning cardiopulmonary resuscitation (CPR) are published. Nevertheless, such a guideline does not exist for the special environment of microgravity, despite mankind is exploring space since 1961. Nonetheless, several studies have been conducted to investigate the feasibility and best technique of CPR in microgravity. The aim of this guideline is to critically appraise all the literature of CPR in weightlessness and create the most **up to date evidence-based guidance** for its application under the special circumstances of spaceflight.

## Methods

A **task force** was created by the German Society of Aerospace Medicine (DGLRM) to develop a guideline for CPR in weightlessness, based on the member's clinical and scientific background. Then standardized questions using the PICO-model were created, to guide the **systematic literature review**, which was mainly performed using "PubMed". The retrieved 4,356 abstracts were then screened using the browser-based tool "abstrackr" in double-reviewer technique, and the selected papers were subsequently reviewed utilizing the GRADE-method. The guideline was then divided into **15 sections** and the recommendations for each section were finalized by 2 experts. All proposed recommendations were then presented to the whole task force and subject to a **structured consensus finding process** using the RAND-DELPHI method.

## Results

Similar to Earth-based guidelines, a differentiated approach to CPR with a division into **basic life support (BLS)** and **advanced life support (ALS)** is necessary for the special environment of microgravity. In immediate BLS, the chest compression method of choice is the **Evetts-Russomano method (ER)**, whereas in an ALS scenario, with the patient being restrained on the Crew Medical Restraint System, the **handstand method (HS)** should be applied. Airway management should only be performed if at least two rescuers are present and the patient has been restrained. A **supraglottic airway device** should be used for airway management where crew members untrained in endotracheal intubation (ETI) are involved.

## Conclusion

CPR in microgravity is **feasible** and should be applied according to the Earth-based guidelines of the AHA/ERC in relation to fundamental statements, like urgent recognition and action, focus on high-quality chest compressions, compression depth and compression-ventilation ratio. However, the **special circumstances** presented by microgravity and spaceflight must be considered concerning central points such as rescuer position and methods for the performance of chest compressions, airway management and defibrillation.



**Figure 1**

Application of chest compressions using the handstand-method (left) and Evetts-Russomano-method (right) during parabolic flight

Braunecker S, Douglas B, Hinkelbein J. Comparison of different techniques for cardiopulmonary resuscitation in microgravity—a simple mathematic estimation of cardiopulmonary resuscitation quality for space environment. Am J Emerg Med 2015; 33: 920–924



**Figure 2**

Endotracheal intubation during parabolic flight

Groemer GE, Brimacombe J, Haas T, De Negueruela C, Soucek A, Thomsen M, Keller C. The feasibility of laryngoscope-guided tracheal intubation in microgravity during parabolic flight: A comparison of two techniques. Anesth Analg 2005; 101: 1533–1535

## Sections of the recommendations

Chest compressions	Defibrillation	End of CPR
Automated devices	Intravenous access	Telemedicine
Airway management	Medication	Reversible causes
Ventilation	Training	Technical limitations
Suction	ROSC	Ethics

No.	Recommendations	Quality of evidence (QoE)	Consensus	Strength of recommendation
#10	The endotracheal intubation remains the gold standard for securing the airway if performed by a skilled provider and SHOULD be executed in that case.	moderate	strong	<b>1B strong recommendation moderate-quality evidence</b>
#11	When endotracheal intubation is attempted patient and rescuer should be restrained using the Crew Medical Restraint System.	moderate	strong	<b>1B strong recommendation moderate-quality evidence</b>
#12	If no rescuer with extensive training in endotracheal intubation is present a second generation supraglottic airway device SHOULD be used for airway management.	moderate	strong	<b>1B strong recommendation moderate-quality evidence</b>

**Table 1**

Examples of the preliminary recommendations concerning airway management during CPR in microgravity

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