Metrics to characterize the narrowness of manual chest compressions during out-of-hospital cardiopulmonary resuscitation

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INTRODUCTION

- Resuscitation guidelines recommend providing chest compressions at a **rate of 100–120 min⁻¹** and a **depth of 5–6 cm**.
- However, **two manual chest compressions with the same depth and rate may be very different**. In the following example, the compression depicted in blue is much **narrower** than the compression depicted in red.

- Animal studies have analyzed different compression/decompression patterns using mechanical pistons, and concluded that **high-impulse compression/decompression improves blood flow**.
- Currently, there is **no independent metric to quantify the narrowness** of manual chest compressions.

Aim: To analyze four metrics that characterize the **narrowness of chest compressions**, and to study their relationship with chest compression rate and depth.

MATERIALS AND METHODS

- Thirty out-of-hospital cardiac arrest episodes** (one per patient) collected by the TVF&R agency in OR (USA) using MRx defibrillators were analyzed.
- The episodes contained the **chest displacement signal** acquired by a CPR assist pad.
- Chest velocity** was derived from the displacement signal.
- For each chest compression, **four metrics were measured**:

- ▶ **RV**: maximum release velocity.
- ▶ **CV**: maximum compression velocity.
- ▶ **T_{ef}**: effective compression duration (time depth is in excess of 5 mm).
- ▶ **T_{ef}/T_c**: effective compression proportion (ratio between effective and total compression duration).

RESULTS

- 66 971 chest compressions were annotated.
- Median (5th, 95th percentile) of the metrics:

CV	433 (253, 699) mm/s
RV	267 (164, 417) mm/s
T_{ef}	368 (276, 446) ms
T_{ef}/T_c	69 (54, 77)%
- For every 10 mm increase in depth, CV and RV increased 97 and 63 mm/s, respectively.
- For every 10 min⁻¹ increase in rate, T_{ef} decreased 21 ms.
- For every 10 mm and 10 min⁻¹ increase, T_{ef}/T_c increased 1.5% and 1.1%, respectively.

CONCLUSIONS

- CV** and **RV** → high correlation with depth.
- T_{ef}** → high correlation with rate.
- T_{ef}/T_c** → **low dependency with depth and rate**.
- T_{ef}/T_c** could be used to **characterize the narrowness of chest compressions**, independently of depth and rate.
- Further studies** are needed to analyze the influence of narrowness on outcomes from cardiac arrest.