High time resolution cerebral oximetry to monitor chest compression rate in OHCA

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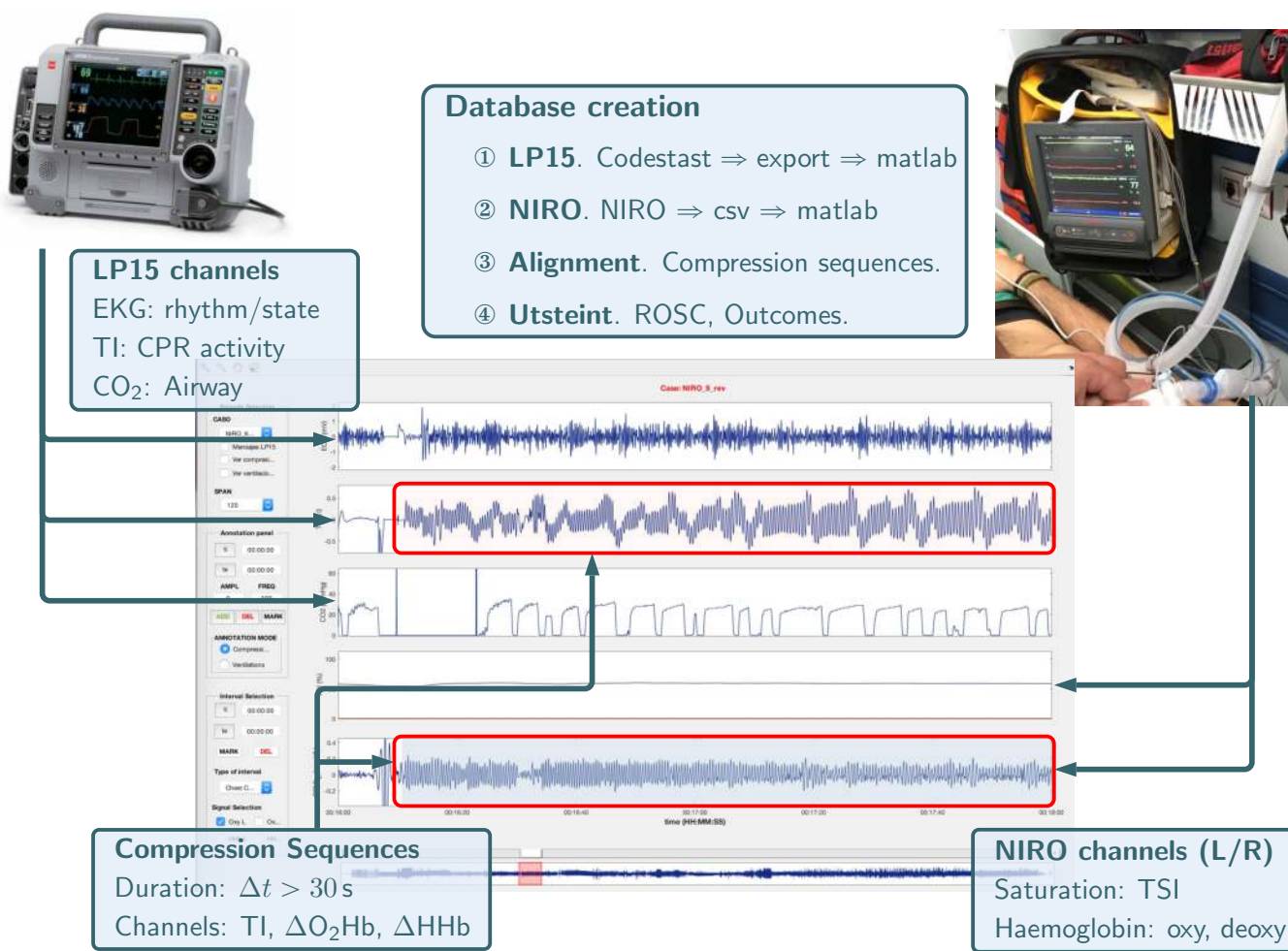EMERGENCIAS

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INTRODUCTION

Brain oximetry in out-of-hospital cardiac arrest (OHCA) is used to record saturation values every 2-4 seconds. But high temporal resolution brain haemoglobin concentration signals obtained by near infrared spectroscopy show chest compression activity during cardiopulmonary resuscitation.

The purpose of this study was to develop an algorithm to measure chest compression frequency during OHCA using cerebral oximetry signals.

DATA COLLECTION/ANNOTATION

Data collection and extraction

Database creation
① **LP15**. Codestast $\Rightarrow$ export $\Rightarrow$ matlab
② **NIRO**. NIRO $\Rightarrow$ csv $\Rightarrow$ matlab
③ **Alignment**. Compression sequences.
④ **Utsteint**. ROSC, Outcomes.

LP15 channels
EKG: rhythm/state
TI: CPR activity
CO_2: Airway

Compression Sequences
Duration: $\Delta t > 30\,\text{s}$
Channels: TI, ΔO_2Hb, ΔHHb

NIRO channels (L/R)
Saturation: TSI
Haemoglobin: oxy, deoxy

Summary of the dataset

Collected cases : The study period was March 2018-May 2019, and **29 OHCA cases** were collected. Median (IQR) delay for the connection of the oximeter was **8 (6-12) min** from LP15 power-on.

Compression sequences : In total **284 compression sequences** were analyzed, the median (IQR) duration was **1.1 (0.7-1.6) min**, and the number of compressions per sequence was **133 (90-179)**.
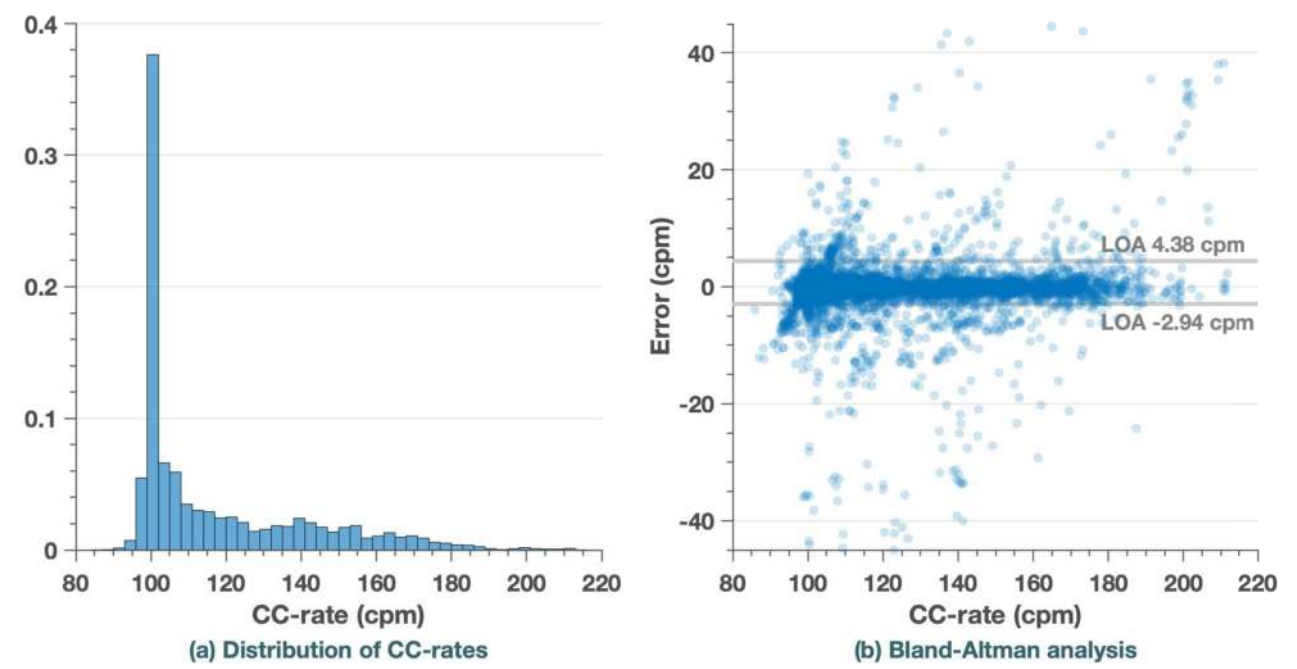
METHOD

Spectral method : Feedback every 5-sec using 10-sec haemoglobin concentration signal intervals. Compression frequency is the frequency at which the spectral amplitude is maximum.
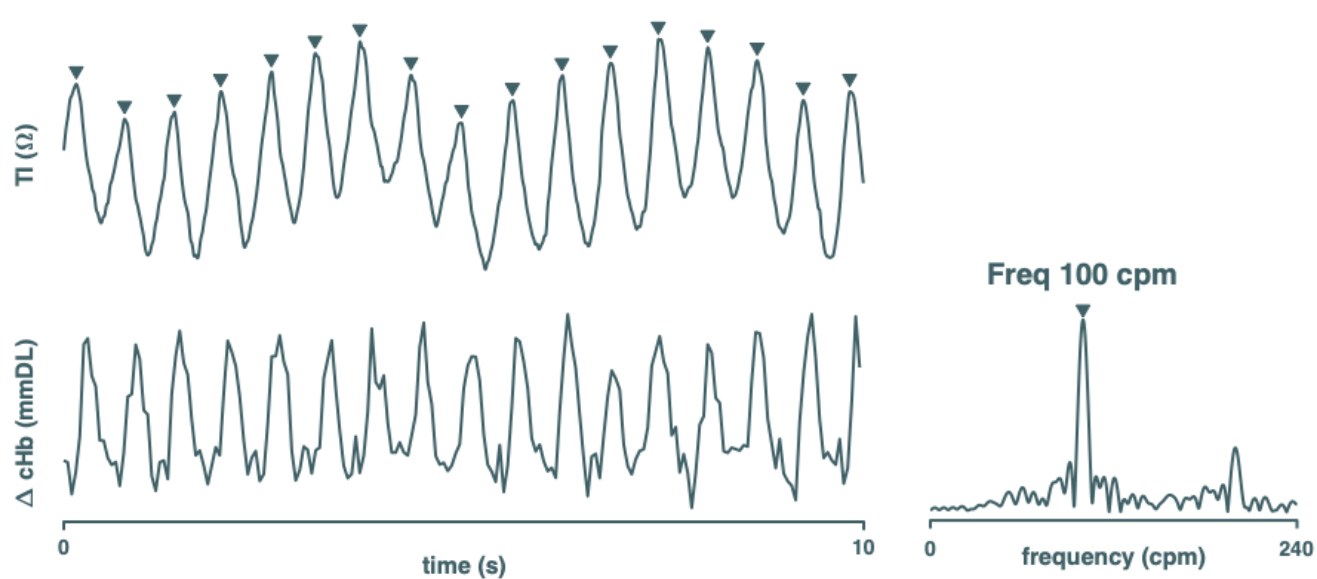

RESULTS

CC-rates and Bland-Altman

(a) Distribution of CC-rates

(b) Bland-Altman analysis

LOA 4.38 cpm
LOA -2.94 cpm

Error in CC-rate feedback

Channel	Error in CC-rate		
	Signed (cpm)	**Unsigned (cpm)**	**Relative (%)**
Left			
ΔO_2Hb	$-0.3\,(-26.6-5.5)$	$1.2\,(0.2-40.7)$	$1.0\,(0.2-32.0)$
ΔHHb	$-0.4\,(-38.4-7.7)$	$1.5\,(0.2-47.0)$	$1.3\,(0.2-39.0)$
ΔcHb	**$-0.2\,(-2.0-1.4)$**	**$0.6\,(0.1-3.6)$**	**$0.6\,(0.1-3.1)$**
Right			
ΔO_2Hb	$-0.2\,(-6.1-2.6)$	$0.8\,(0.1-19.1)$	$0.8\,(0.1-14.8)$
ΔHHb	$-0.3\,(-11.9-3.3)$	$1.0\,(0.2-28.9)$	$0.9\,(0.1-23.4)$
ΔcHb	$-0.2\,(-2.4-1.5)$	$0.7\,(0.1-5.5)$	$0.6\,(0.1-4.5)$

Table 1. Median (IDR) error in chest compression rate per channel

Saturation values and ROSC

(c) TSI for different outcomes

P-val = 0.7839

(d) Change in O_2Hb per chest compression
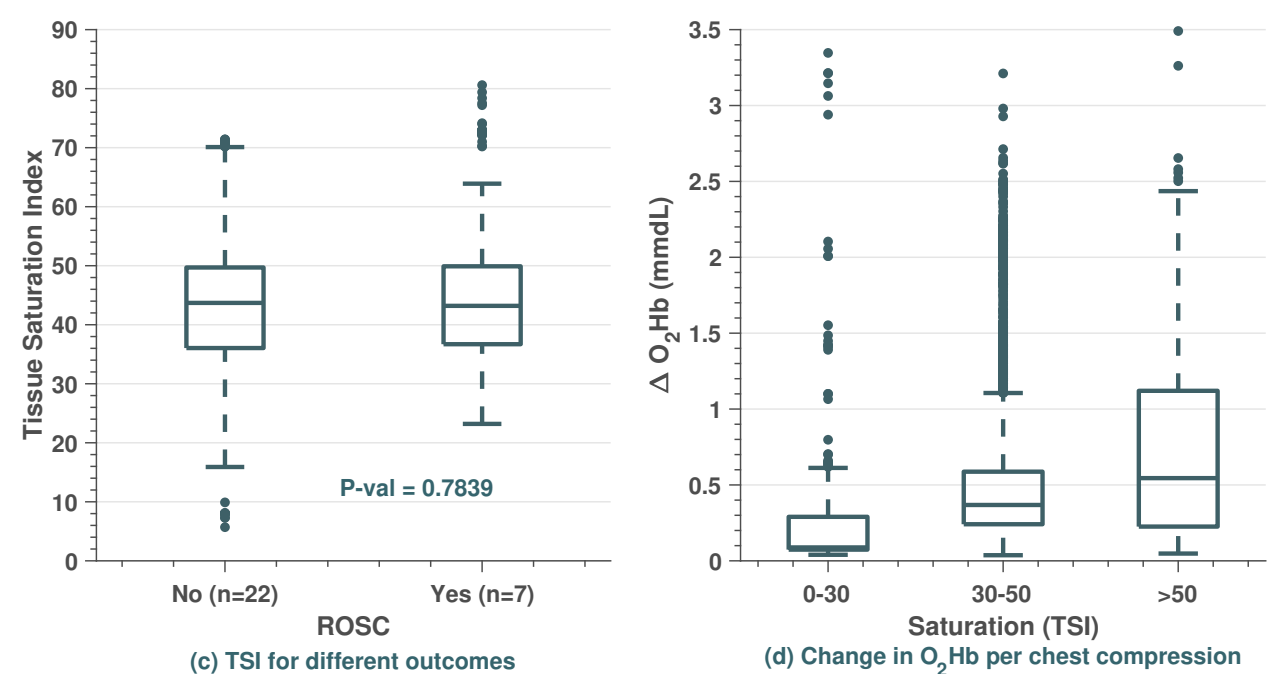
CONCLUSIONS

① **Visible compression activity**. Chest compressions produce visible haemoglobin changes in cerebral oximetry signals sampled with $f_s \geqslant 20\,\text{Hz}$.
② **Accurate rate feedback**. A spectral algorithm produced accurate compression rate feedback in over 5 hours of recordings.
③ **Best channel**. Total haemoglobin in both hemispheres, no difference between Left/right.
④ **Saturation**. No difference ROSC/no-ROSC during treatment (without ROSC), small sample for conclusive results.
⑤ **Future work**. Improve the feedback method, collect more cases (target $n \geqslant 50$), analyze CPR quality and haemoglobin variations.

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