Weaker compressions after night shift? The WeCAN manikin study

Anne-Laure Philippon[a,b], Antoine Nguyen[b], Pierre-Alexis Raynal[a,e], Julie Pernet[f], Guillaume Tachon[a,c], Bruno Riou[a,b], Alexandre Duguet[a,d] and Yonathan Freund[a,b]

To assess whether the quality of chest compressions (CC) differs before and after a night shift. We carried out a cluster randomized study in three Emergency Departments and three ICUs in Paris, France. Physicians were assessed on a control day and immediately following after a night shift. The primary endpoint was the proportion of CC with a depth greater than 50 mm. We analyzed 67 participants. The proportion of CC with a depth greater than 50 mm was similar on a control day and after a night shift [52% in both groups, mean difference of 0 (95% confidence interval: −17 to 17)]. Other indicators of CC quality were unchanged after a night shift, except for the mean depth of CC (51 vs. 48 mm, $P = 0.01$). We report in our sample that the quality of CC after a night shift is not inferior to a control day. ***European Journal of Emergency Medicine***

European Journal of Emergency Medicine 2015, **00**:000–000

Keywords: cardiac arrest, chest compression, cardiopulmonary resuscitation, fatigue, night work

[a]Sorbonne University, UPMC Univ Paris 06 UMRS INSERM 1166, IHU ICAN, [b]Emergency Department, [c]Medical-Surgical Intensive Care Unit, Institute of Cardiometabolism and Nutrition, [d]Intensive Care Unit and Department of Pneumology, Hôpital Pitié-Salpêtrière, [e]Emergency Department, Hôpital Saint Antoine and [f]Emergency Department, Hôpital Tenon, Assistance Publique - Hôpitaux de Paris (APHP), Paris, France

Correspondence to Yonathan Freund, MD, Service d'Accueil des Urgences, Groupe Hospitalier Pitié-Salpêtrière, 47-83 boulevard de l'hôpital, 75013 Paris, France
Tel: +33 1 84827129; fax: +33 1 42177001; e-mail: yonathanfreund@gmail.com

Received 17 February 2015 **Accepted** 9 April 2015

Introduction

Prognosis after in-hospital cardiac arrest (IHCA) still remains low with roughly 20% of inpatients who survive to discharge [1], although better than in out-of-hospital cardiac arrest (CA).

Quality of cardiopulmonary resuscitation (CPR) is of utmost importance to enhance prognosis and several studies showed that initial rhythm and depth of chest compressions (CCs) are associated with better outcomes [2]. Unfortunately, it has been widely described that these characteristics of CC are often insufficient in terms of the International Liaison Committee on Resuscitation (ILCOR) guidelines [3,4]. The practice of CC is an exhausting task, the quality of which has been reported to be reduced after 2 to 4 min of practicing.

Matot *et al.* [5] and Peberdy *et al.* [6] reported lower survival rates for IHCA when they occurred during the night. Tiredness of physicians after a night shift has been reported and may be a causal factor for this worsened prognosis. However, whether physical fatigue is associated with poorer outcomes still remains controversial as some studies did not find clinical differences in care or in mortality between night and day [7].

Our aim was to evaluate the influence of fatigue after a night shift on the quality of CC of emergency physicians and intensivists. We hypothesized that the quality of CC after a night shift was not inferior to that performed on a regular day.

Materials and methods

Study design

This was a prospective noninferiority cluster cross-over randomized trial that was conducted in three Emergency Departments (EDs) and three ICU in three academic hospitals in Paris (France) (NCT02123810). Participants were assessed for CC effectiveness during control days and separately immediately following a night shift. Centers were randomized to have their participants tested either on a control day and then following a night shift (control – night shift group) or following a night shift and then on a control day (night shift – control group). A control day was a day without night work in the past 24 h. Institutional Review Board of our hospital (Comité de Protection des Personnes – Ile de France 6) approved the study without the need for signed written informed consent.

We included participants for a 6-month period from February 2014 to August 2014. All physicians who worked in the participating departments were eligible and were asked to participate in the trial. We excluded those who refused to participate and those who did not work a night shift during the study period. To assess the quality of CC, we used an adult CPR-manikin (Resusci-Ann; Laerdal Medical Corporation, Stavanger, Norway) and its specific feedback software (BLS Debrief; Laerdal Medical Corporation), which provided us with quantitative measurements of CPR performances including number, rate and depth of CC, and percentage of CC

DOI: 10.1097/MEJ.0000000000000284

with correct depth (i.e. > 50 mm) or rhythm (i.e. superior to 100/min).

We tested participants both on a control day and after a night shift. The evaluation 'after a night shift' occurred on the following morning after handovers.

We tested participants in two periods of 2 min of CCs, with a pause of 2 min between them. Participants were evaluated during the second series of 2 min of CC (4–6 min). The scenario was a CA with asystole, and we asked participants to provide CC-only CPR (CPR with no ventilation). Participants were blinded to their performances. We recorded routine demographic data, and details on their night shift as duration, number of hours of sleep, and their perception of the night shift's intensity on a 1–10 scale, 10 being a very intense night shift.

Through the feedback software, we automatically recorded the following data on their CC: mean depth, mean rhythm, proportion of CC with correct rate, and depth. Correct CC was defined by a rate greater than 100 per minute and depth greater than 5 cm following 2010 ERC guidelines.

Endpoints

Our primary endpoint was the proportion of CC with a depth greater than 50 mm. The secondary endpoints included the proportion of CC at a rate greater than 100 per minute, the total number of CC in 2 min, the median rhythm, and depth of CC.

Statistical analysis

Gaussian distributed variables are expressed as mean (SD) and non-Gaussian as median with their 25–75 interquartile range (IQR). We used a paired Student's *t*-test for comparison of parametric data and a paired Wilcoxon test for nonparametric data. Mean differences were calculated with their exact 95% confidence interval. We made the assumption that the cross-over will correct the cluster inflation effect. With α at 0.05 and β at 0.2, accounting for an estimated median of the primary endpoint of 90% in the control group and a δ to reject noninferiority of 15%, we needed to recruit 46 participants to assess noninferiority. Statistical analyses were carried out using NCSS 6.0 (Statistical Solutions Ltd., Cork, Ireland).

Results

We enrolled 84 participants, 31 from one ED and two ICU in the control–night shift group and 53 from two EDs and one ICU in the night shift–control group. Seventeen participants' data could not be analyzed because of incomplete data to assess the primary endpoint. Baseline characteristics of the participants are reported in Table 1. Among the 67 participants, 51% were women and 70% were emergency physicians; their mean age was 32 years (SD 6).

Table 1 Baseline characteristics

	N (%)
Number	67
Age [mean (SD)] (years)	32 (6)
Sex	
Men	33 (49)
Women	34 (51)
Speciality	
Emergency	47 (70)
Intensivist	20 (30)
Grade	
MD	34 (51)
Trainees	33 (49)
Last BLS formation (years)	
This year	34 (51)
1–2	12 (18)
2–5	11 (16)
> 5	10 (15)
Number of cardiac arrest (years)	
0	10 (15)
1–5	29 (43)
5–10	14 (21)
> 10	14 (21)
Night shift duration (h)	
< 18	34 (51)
18–24	7 (11)
24–30	26 (38)
Hours of sleep [mean (SD)]	3 (1.7)
Night shift intensity [mean (SD)]	5 (1.8)
Control – night shift group	22 (33)
Night shift – control group	45 (67)

BLS, basic life support.

The median proportion of CC with a depth greater than 50 mm was similar in the two periods: 52% (IQR 12–100) before night shift and 52% (IQR 1–99) after night shift, with a mean difference of 0 (95% confidence interval: − 17 to 17). We did not find any other difference in CC characteristics (Table 2), except for a small decrease in the depth of compression that was not clinically significant, with a mean of 51 mm (SD 9) on a control day versus 48 mm (SD 12) after a night shift ($P = 0.01$).

Discussion

In this prospective multicenter study, we did not observe any difference in the quality of CC before and after a night shift. To our knowledge, this is the first study to evaluate the influence of night shift on CPR.

Several studies have previously assessed technical or psychomotor skills after a shift. In our study, we only evaluated technical skills. This repetitive task does not require any neurocognitive skill but rather physical capacities and is not a complex task to execute (unlike intubation or laparoscopic surgery). For these reasons, we assumed that there will be no significant difference in the execution of this short and simple task after a night shift.

Another reason that could explain our result is the stressful situation created by a CA, which could enhance physician skills as reported by Hunziker *et al.* [8], who found that stress was associated significantly with time to start CPR. In the same way, cortisol awakening response appears at the end of the night [9]. This increase in

Table 2 Characteristics of chest compressions before and after a night shift

	Before night shift	After night shift	Mean difference	95% CI	*P*
Proportion of CC with depth > 50 mm [median (IQR)]	52% (12–100)	52% (1–99)	0	−17 to 17	0.10
Proportion of CC with rate > 100/min [median (%)] (IQR)	100 (99–100)	100 (98–100)	0	0–0	0.80
Total chest compressions [mean (SD)]	237 (32)	230 (53)	−6.5	−19 to 6	0.30
Mean depth [mean (SD)]	51 (9)	48 (12)	−2.7	−5 to −0.5	0.01
Rhythm [mean (SD)]	119 (16)	118 (22)	−0.7	−6 to 4.5	0.80

CC, chest compressions; CI, confidence interval; IQR, interquartile range.

adrenal hormone could then explain the absence of difference in CC depth before and after the night shift.

Our primary endpoint was the depth of the CC. The proportion of CC with a correct rate is also very important in the prognosis of CA, but the goal of 100 CC per minute is often reached by physicians, and we hypothesize that the effect of the night shift would show even less on the rate of CC. Accordingly, we found in our sample that the median percentage of CC at a rate superior than 100 per minute is 100% in both groups. The CC characteristics of our sample are similar to the previous literature [3], with a median depth of 51 mm and a mean proportion of CC deeper than 50 mm of 52% before a night shift. The only change that we report after a night shift is the mean depth, which decreased from 51 to 48 mm. This is likely caused by the fatigue of the physicians at dawn, but does not imply a decreased quality of CC as the proportion of compressions with correct depth did not change, and hence had no clinical significance.

Our study had some limitations. First, we used a simulation technique to evaluate our participants and we can suspect that simulation does not mimic perfectly the conditions of CA and that we failed to reproduce the same amount of stress in tested physicians. However, Keitel *et al.* [10] showed that a simulated emergency situation can genuinely reproduce a stressful situation, and induced an increase of stress perception and cortisol concentrations in their participants. Second, our study was not blinded as participants knew the study objectives and they could have altered their physical capacities after a night shift to draw attention to the difficulty of night work. However, we assumed that this bias would not be in favor of our noninferiority hypothesis. Third, there might have been a relationship between the hardness of the shift (intensity and number of hours of sleep) and an alteration in CPR quality. However, we did not find such an association in our sensitivity analyses – although we may have lacked the power to report them. Finally, we estimated that the primary endpoint (a correct depth of CC) would have a mean of at least 90%, but in our sample, we report a mean of 52% CC with a depth greater than 50 mm. This could have modified the required sample size and our study is subject to a β error.

Conclusion

In our sample of intensivists and emergency physicians, we do not report any difference in the quality of CC on a normal day versus after a night shift. Other factors should be sought to explain the discrepancy in the survival of IHCA between night and day.

Acknowledgements

The authors would like to thank Dr B. Bloom (Barts Health NHS Trust, London, UK), Dr N. Segal (Hopital Pitie-Salpetriere, Paris, France), and Professor F. Lapostolle (Hopital Avicennes, Bobigny, France) for their help and support.

Conflict of interest

There are no conflicts of interest.

References

1 Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS. American Heart Association Get with the Guidelines–Resuscitation Investigators. Trends in survival after in-hospital cardiac arrest. *N Engl J Med* 2012; **367**:1912–1920.

2 Christenson J, Andrusiek D, Everson-Stewart S, Kudenchuk P, Hostler D, Powell J, *et al.* Resuscitation Outcomes Consortium Investigators. Chest compression fraction determines survival in patients with out-of-hospital ventricular fibrillation. *Circulation* 2009; **120**:1241–1247.

3 Abella BS, Alvarado JP, Myklebust H, Edelson DP, Barry A, O'Hearn N, *et al.* Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. *JAMA* 2005; **293**:305–310.

4 Lim SH, Shuster M, Deakin CD, Kleinman ME, Koster RW, Morrisson LJ, *et al.* Part 7: CPR techniques and devices: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2010; **81** (Suppl 1):e86–e92.

5 Matot I, Shleifer A, Hersch M, Lotan C, Weiniger CF, Dror Y, Einav S. In-hospital cardiac arrest: is outcome related to the time of arrest? *Resuscitation* 2006; **71**:56–64.

6 Peberdy MA, Ornato JP, Larkin GL, Braithwaite RS, Kashner TM, Carey SM, *et al.* National Registry of Cardiopulmonary Resuscitation Investigators. Survival from in-hospital cardiac arrest during nights and weekends. *JAMA* 2008; **299**:785–792.

7 Silbergleit R, Kronick SL, Philpott S, Lowell MJ, Wagner C. Quality of emergency care on the night shift. *Acad Emerg Med* 2006; **13**:325–330.

8 Hunziker S, Semmer NK, Tschan F, Schuetz P, Mueller B, Marsch S. Dynamics and association of different acute stress markers with performance during a simulated resuscitation. *Resuscitation* 2012; **83**:572–578.

9 Nakajima Y, Takahashi T, Shetty V, Yamaguchi M. Patterns of salivary cortisol levels can manifest work stress in emergency care providers. *J Physiol Sci* 2012; **62**:191–197.

10 Keitel A, Ringleb M, Schwartges I, Weik U, Picker O, Stockhorst U, Deinzer R. Endocrine and psychological stress responses in a simulated emergency situation. *Psychoneuroendocrinology* 2011; **36**:98–108.