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THE INFLUENCE OF TEAM LEADER STRESS ON TEAM EFFECTIVENESS AND LEADERSHIP EFFECTIVENESS IN A SIMULATED CPR SETTING

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Abstract (English version)

Providing cardiopulmonary resuscitation (CPR) is stressful task, in which effective leadership and high team effectiveness are important. The relation between team leader stress and its influence on the team effectiveness and leadership effectiveness in a CPR setting have not yet been studied thoroughly. Since the role of the team leader is very influential in such settings, studying the effect of the team leader has the potential to increase the overall effectiveness of medical teams in performing CPR. Besides that, few studies have been conducted about different kinds of effectiveness (like effectiveness in non-technical and technical skills). A cross-sectional mixed-methods study was conducted among 37 medical teams (4 students per team) in a master course Advanced Life Support (ALS). Team leader stress was measured through a questionnaire (self-reported stress) and the E4 wristband (psychophysiological stress measurement). Significant results were only found in some teams between team leader stress and technical skills. Interestingly, the self-reported stress that the team leader experienced, did significantly contribute to team effectiveness. However, the effect was positive instead of negative. This indicates that more self-reported team leader stress associates with a higher level of team effectiveness. The practical implications of these findings and suggestions for future research are provided in the discussion.

Abstract (Dutch version)

Het uitvoeren van een reanimatie is een stressvolle taak, waarin leiderschap en een hoge team effectiviteit erg belangrijk zijn. De relatie tussen team leider stress en de invloed daarvan op team effectiviteit en leiderschapseffectiviteit in een reanimatie setting is nog niet voldoende bestudeert. Gezien de rol van de teamleider veel invloed heeft in deze setting, heeft het bestuderen van het effect van stress op de team leider de potentie om de algehele effectiviteit van medische teams te verbeteren bij het uitvoeren van reanimaties. Daarnaast is er weinig onderzoek gedaan naar verschillende vormen van team effectiviteit (zoals effectiviteit in technische en niet-technische vaardigheden). Een cross-sectionele mixed-method studie is uitgevoerd onder 37 medische teams (4 studenten per team) in een master vak Advanced Life Support (ALS). Team leider stress is gemeten door een vragenlijst (zelf gerapporteerde stress) en de E4 armband (psychofysiologisch gemeten stress). Significante resultaten werden enkel gevonden tussen team leider stress en technische vaardigheden bij bepaalde teams. Wat interessant is, is dat de zelf gerapporteerde stress die de team leider ervoer, significant bijdroeg aan team effectiviteit. Echter, het effect was positief in plaats van negatief. Dit geeft de indicatie dat meer zelf gerapporteerde stress van de team leider geassocieerd is met een hoger niveau in team effectiviteit. The praktische implicaties van deze bevindingen en suggesties voor vervolgonderzoek kunnen gevonden worden in de discussie.

Introduction

Survival in cardiac arrest depends primarily on good quality cardiopulmonary resuscitation (CPR) (Nolan, Deakin, Soar, Böttiger & Smith, 2005). CPR is the manual application of chest compressions and ventilations to patients in cardiac arrest, done in an effort to maintain viability until advanced medical help arrives (Medical dictionary, 2017). Research has shown that the survival of cardiac arrest decreases 7 to 10% every minute that CPR is not given (Ali & Zafari, 2007; Larsen, Eisenberg, Cummins & Hallstrom, 1993). Applying CPR to prevent sudden cardiac death tends to be managed poorly by hospitals, despite the fact that this is a regularly occurring medical intervention (Kwok, Lee, Lau & Tse, 2003; Mudawi, Albouaini & Kaye, 2009). In hospital CPR is a team operation, and successful CPR requires clear leadership. However, the quality of leadership depends on a multitude of things, of which many are not yet studied thoroughly. To obtain the best CPR effectiveness as possible, it is therefore also relevant to look at the factors that influence leadership effectiveness and team effectiveness. An important factor that might negatively influences a team leader's effectiveness and therefore the team effectiveness is stress: the main topic of this paper.

Some research has already been done into the field of leadership, team effectiveness and stress in a CPR setting. Stress is defined as the bodily processes that results from conditions that place physical or psychological demands on an individual (Selye, 1973). Hunziker and colleagues (2011) outlined that, from a clinical perspective, one event causing high levels of acute stress is a cardiac arrest situation, which is a dramatic and very emergent situation that needs immediate action (i.e., giving CPR). There have been several studies that investigated the influence of stress in CPR. For instance, it has been shown that stress can become a threat for CPR effectiveness; this effect could be due to the idea that what is asked of the CPR performer is more then what the person is capable of to do (Dias & Neto, 2016). Stress could therefore negatively influence the CPR effectiveness. The role of the team leader is extremely important during CPR to have an effective and efficient resuscitation team. This is due to the fact that the team leader has a direct influence on how the team behaves which could have a great effect on a team's success or failure (Cole & Chrichton, 2006). Lack of teamwork and poor leadership are associated with poor CPR effectiveness and poor clinical outcome, as can be read in the review of Hunziker, Tschan, Semmer & Marsch (2013). There is evidence that leadership becomes more important during stressful periods, with team members often expecting more direction from a leader (Hayes, Rhee, Detsky, Leblanc & Wax, 2007). In conclusion, conducting CPR in a medical team can be a stressful experience which requires leadership to be performed adequately. Especially stress could negatively influence the effectiveness of the leadership and also the effectiveness of the whole team.

Although several studies have already been performed regarding team effectiveness in combination with stress in a CPR setting, the exact relation between the stress of the team leader and its influence on the team effectiveness and leadership effectiveness has not yet been studied thoroughly. To develop training programs and thereby improve medical personnel's ability to perform CPR, this relation should be further investigated. Since the role of the team leader is important, studying the effect of stress on the team leader has the potential to increase the overall effectiveness of medical teams in performing CPR. Besides that, few studies have been conducted about different kinds of effectiveness (like effectiveness in technical and non-technical skills and leadership effectiveness). Insight in different forms of effectiveness could help figure out where the focus should be on. Questions that arise are, for instance, whether there is a difference between technical skills (i.e., knowledge and abilities one needs to actually resuscitate a patient) and non-technical skills (i.e., team interaction, leadership and communication) and if there is a difference between the self-reported stress versus observed stress measurements.

This research has scientific relevance since knowledge about the influence of stress (subjective and objective) on the team leader and the link between team effectiveness and leadership effectiveness in a CPR setting is needed and has not been empirically established thus far. Also, the influence of two different kinds of team effectiveness and the link between leadership effectiveness will be established. In terms of practical relevance, knowledge about these facts can influence how medical personnel and medical students are trained. The educational programme could be influenced by the results in a positive way, leading to better educated medical personnel which could lead to better performing quality CPR and therefore saving more lives. The research question of this research that follows is "How does a team leader's psychophysiological and self-reported stress influence team effectiveness and leadership effectiveness in a simulated cardiopulmonary resuscitation setting?"

Theoretical Framework

1. CPR and the role of medical simulation and education

In order for medical personnel to be able to give CPR, a special training needs to be followed. In educational programmes of (technical) medical students, medical simulation is rapidly becoming the new standard for health care training (Huang et al., 2012; McGaghie, Isenberg, Petrusa & Scalese, 2010). The first courses that used simulation to train students were held in the early 1990s (Howard, Gaba, Fish, Yang & Sarnquist, 1992). Simulation is defined as “any artificial or synthetic environment that is created to manage an individual’s (or teams) experiences with reality” (Salas, Wildman & Piccolo, 2009, p.560). For medical students, it facilitates the training of clinical teams to be able to manage critical situations (like cardiac arrest) under realistic conditions. It is therefore assumed that the simulation creates real challenges and thus provides students with similar problems that might be encountered in hospitals (Flanagan, Nestel & Joseph 2004). Training in medical simulation also appears to influence skills. For instance, DeMaria et al. (2010) showed that effectiveness in Advanced Life Support (ALS) skills improved after following a simulation training and learning how to deal with the stressors. Skills improvement could lead to a better effectiveness in a (simulated) CPR setting. Furthermore, another benefit of using simulations is that learners can practice without harming real patients (Ziv, Wolpe, Small & Glick, 2004). Thus, medical simulation in CPR is important for medical students to prepare themselves for becoming future medical staff members and being able to give good quality CPR.

2. The importance of team effectiveness (in a CPR setting)

Team effectiveness is a common outcome variable which is assessed in terms of quantity and quality of outputs (Cohen & Bailey, 1997; Stewart & Barrick, 2000). According to Cohen and Bailey (1997) work teams are defined as a group of members who have a mutually shared responsibility, and are interdependent for achieving outcomes. Medical teams work the same way; teams who perform CPR have a shared responsibility to save the patient, and are also interdependent of each other for the achieved outcome and high quality team effectiveness. Team effectiveness depends on the technical and non-technical skills of the medical team. Technical skills (i.e., knowledge and abilities one needs to actually resuscitate a patient) and repeated training are important predictors for successful CPR (Hunziker, Tschan, Semmer, Howell & Marsch, 2010). The same study discovered that there is increasing evidence that human factors like team interaction, leadership and communication influence the effectiveness of CPR, which are the so-called non-technical skills. The importance of these non-technical skills is therefore also applicable to a CPR setting. Flin & Maran (2004) also describe non-technical skills in CPR as a focus on for instance leadership, communication and task distribution. Another study suggests that poor non-technical skills can contribute to 64 to 83% of critical incidents, in this case in anaesthetics (Arnstein, 1997). So poor effectiveness could lead to more critical incidents in patients and therefore a worse outcome. Andreatta, Hillard, & Krain (2009) stated that poor effectiveness in a medical setting can lead to a decrease in knowledge, skill-based surgical motion, technical information processing and effectiveness. Lastly, Marsch and colleagues, (2004) found that the situation surrounding medical personnel who provide CPR in a real environment, like human factors, can affect effectiveness, task distribution and leadership, which contributes even more to the importance of non-technical skills. Hence, when examining how medical teams perform CPR, both the technical and non-tech skills need to be assessed. The third section will further elaborate the influence of stress on team effectiveness. One of the human aspects that might influence the CPR effectiveness of a team is (leader) stress.

3. Stress in the context of CPR

Performing CPR in a simulated setting could lead to high psychological and physiological stress responses (Piquette et al., 2014). In a similar vein, other research showed that poor (individual) performance (in a simulation setting) led to the expression of stress related behaviours, such as facial expressions and oral anxiety (e.g., mouth, lip, tongue, etc) (Andreatta, Hillard, & Krain, 2009). According to Muller et al. (2009), medical simulator training can lower the stress load in real-life situations, because the medical effectiveness is improved so that critical situations can be handled more routinely. Performing CPR in a real life environment could still lead to stress, therefore practicing it as medical student is important. Muller and colleagues (2009) also show that patient simulation causes stress, but that even after a one day training, the stress level was reduced and the skills were improved. This indirectly shows that stress might influence performance of both the individual members as well as the team in CPR settings. In a similar vein, Pitt & Kellermann (2004) suggest that (in this case an adrenaline driven) stress response, when called to a cardiac arrest, may negatively affect the effectiveness in CPR. The response to acute stress may vary, depending on an individual's perception of demands and available resources. According to Piquette et al. (2014), medical trainees have identified that acute stress is also one of the factors that contributes to the occurrence of medical errors in acute care environments. Piquette also argues that very few studies have explored the (short-term) impact of these stressors on the effectiveness of medical personnel, because it is complex, unpredictable and it has a wide variety of responses. Reactions to stressors, even though they can vary among individuals, are prominent in a clinical crises and can decrease individual effectiveness in general (Johnston, Driskell & Salas, 1997). Lastly, Driskell, Salas & Johnston (1999) also argue that high levels of stress can decrease team effectiveness in a medical setting.

4. Measuring stress in the context of CPR, the possibilities

There are several ways to measure stress, of which the most common methods are through self-reported measures, biochemical measures and physiological measures. Hence, this is subsequently done in the form of questionnaires (self-reported) cortisol levels (biochemical measures) and heart rate or electrodermal activity (physiological measures).

When using self-reported measurements, the level of stress that respondents experience themselves is reported by the respondents. The downside of self-reporting however is that it has a subjective bias (Sandroni et al., 2004); it always represents merely the perception of the respondent, which does not necessarily overlap with objectively measured stress. Hunziker et al. (2011) however discovered that self-reported stress (stress/overload) was the only predictor for low CPR effectiveness.

The classical way to measure the biochemical output of stress is the stress hormone cortisol (Sapolsky, Romero & Munck 2000). Cortisol is a marker that reliably responds to acute psychological and physiological stress (Dickerson & Kemeny, 2004). However, research showed that there was no association between cortisol measured stress and CPR effectiveness (Hunziker et al., 2011).

Physiological measurements can be done by measuring heart rate or electrodermal activity (EDA). Heart rate is an objective indicator of stress (Roscoe, 1992; Veltman & Gaillard, 1998). Sandroni et al. (2004) found that team leader’s stress during ALS effectiveness in a simulated CPR setting causes an increase in heart rate. However, other research showed that heart rate had an inverse association on stress during CPR effectiveness, maybe due to physical activity, which according to Huziker is therefore limiting its value as a stress marker. (Hunziker et al., 2011). It is therefore interesting to assess other parameters of stress, such as EDA.

Considering the information above, it would be highly interesting to measure the influence of stress through the use of self-reported measures and physiological measures. High self-reported measurements for stress could be a predictor for low CPR effectiveness, but since there is a possibility that it is subjectively biased (Sandroni et al., 2014) it would be captivating to measure objective physiological EDA response in a simulated CPR setting as well. In that way, stress could be measured subjectively and objectively in order to see if both ways of measurements have similarities or differences in the stress levels.

5. Measuring Electrodermal Activity

Another way to physiologically measure stress is through electrodermal activity, which is the variation of the electrical properties of the skin in response to sweat secretion. A common reaction to stress includes sweating (Carrasco, 2003 & Negrao, 2000). A way to measure stress therefore is by measuring the sweat secretion. This can be measured relatively simple by means of electrodermal activity (EDA). EDA is a means to measure the conductivity of the skin, which is an indicator for sweat secretion since the skin conductance is proportional to the sweat secretion (Darrow, 1964). EDA refers, as mentioned earlier, to the variation of the electrical properties of the skin in response to sweat secretion. By applying a low constant voltage, the change in skin conductance (SC) can be measured non-invasively (Fowles, 1981). To the best of our knowledge, no research has yet been conducted with electrodermal activity in a (simulated) CPR setting. EDA has proven to be a relevant indicator of the stress level and emotional state of a person (Setz et al., 2010).

EDA can be best measured at places where the density of sweat glands is highest. This place is usually the palmar site of the hands or the feet (Cacioppo, Tassinary & Berntson, 2007). Skin conductance measurement is characterized into two types – tonic skin conductance level and phasic skin conductance response – which can roughly be thought of as “the smooth underlying slowly-changing levels” vs. “the rapidly changing peaks.” Figure 1 shows a high quality EDA signal. Skin conductance response (phasic activations) are circles. The tonic value is the more smoothly-changing level, approximated here by the straight white line (Support page Empatica wristband, 2017).

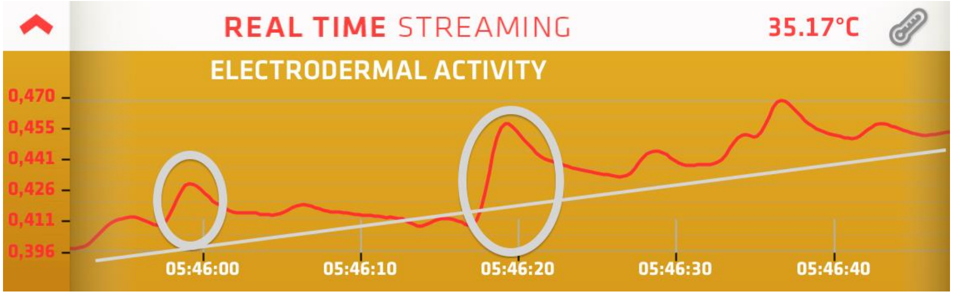

Figure 1: Phasic and tonic activations (Support page Empatica wristband, 2017)

The phasic part in EDA, also called a 'peak' occurs in reaction to a stimulus and is called skin conductance response (SCR). Figure 2 below shows an ideal skin conductance response, which also shows latency and recovery time. (Kappeler-Setz, Gravenhorst, Schumm, Arnrich & Tröster, 2013).

Skin conductance responses should appear between 1.5 and 6.5 seconds after the stimulus appears (include the amplitude, the latency between the stimulus and the onset and the recovery time) before going back to the normal level (Boucsein 1992). Skin conductance responses occur when coming in reaction with a stimulus. Non-specific responses also exist, which means that there are responses which happen spontaneously without any external stimulus. The frequency and the mean amplitude of these non-specific fluctuations are considered as measures of psychophysiological activation (Boucsein, 1992)

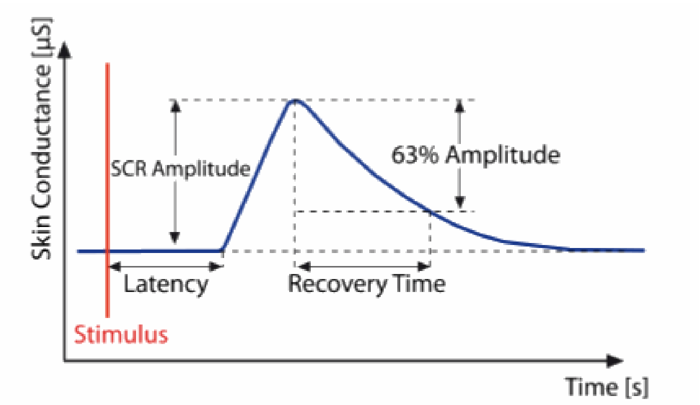

Figure 2: Ideal Skin Conductance Response (SCR) with typically computed features (Kappeler-Setz, Gravenhorst, Schumm, Arnrich & Tröster, 2013).

Skin conductance responses can be analysed by comparing the mean amplitude of individual peaks against a pre-stimulus baseline (Bach, 2009). According to Boucsein (1992) and Edelberg (1967), the standard peak detection defines the SCR amplitude as the difference of the skin conductance values at its peak and at the preceding trough (Benedek, 2010). A minimum amplitude criterion (e.g., 0.05 μS = microSiemens) was used in the research of Benedek (2010).

Research showed that EDA is a reliable indicator for stress, since skin conductance is measured through activity in the sympathetic nervous system, and this is not cofounded with the parasympathetic nervous system. One of the first studies into this area found that skin conductance corresponds with activity in the sympathetic nervous system. This was discovered by looking at the correlation between the sympathetic activities and skin conductance (Wallin, 1981). Other research found that there was convincing evidence for the sympathetic control of EDA, which was provided by studies measuring sympathetic action potentials in peripheral nerves while simultaneously recording EDA (Dawson, Shell & Filion, 1990).

Since EDA has proven to be a relevant indicator of the stress level it could be interesting to use EDA as a measurement for the stress level in a (simulated) CPR setting instead of other physiological measurements. Especially since former research found out that heart rate had an inverse association on stress during CPR effectiveness, maybe due to physical activity, which according to Hunziker is limiting its value as a stress marker. (Hunziker et al., 2011). Furthermore, it is also interesting to use EDA as a measure for stress, since it has not been used in (simulated) CPR studies, as far as known in current research. In the current study, we aim to examine if stress measured by EDA can predict several effectiveness outcomes in a CPR setting. As mentioned in earlier paragraphs, the influence of stress on the effectiveness outcome could be due to the fact that stress has been found to influence non-technical skills such as leadership. Therefore, in the next paragraph, the effect of stress on the team leader will be elaborated.

6. The influence of a team leader and stress in a (simulated) cardiopulmonary resuscitation setting

According to the team leadership model from Zaccaro, Rittman and Marks (2001), it is assumed that team leaders influence team effectiveness through effects on four general types of team processes: motivational, coordination, affective and cognitive processes. It was already mentioned above that leadership (as part of non-technical skills) is important in a CPR setting. Besides that, a review showed that effective communication skills, mutual effectiveness monitoring, maintenance of guidelines and task management are important in a medical (CPR) setting for a good team leader (Hunziker, Tschan, Semmer & Marsch, 2013). This parallels the description of non-technical skills in a (simulated) CPR setting in previous paragraphs. Team leaders and their teams must constantly communicate, coordinate, and interact effectively regarding all kinds of issues related to work output and team functioning (Marks, Mathieu & Zaccaro, 2001).

The team leader has a direct influence on how the team behaves and an individual team leader can have a great effect on a team’s success or failure (Cole & Chrichton, 2006). Since the role of the team leader has become more important, the American Heart Association (AHA) expanded their guidelines in 2010 regarding teamwork and leadership in Advanced Life Support. For instance, by recommending more training in the field of leadership in CPR settings (Hunziker, Tschan, Semmer & Marsch, 2013). The same research showed that medical students who receive leadership training showed improvements in CPR effectiveness and that lack of teamwork and poor leadership are associated with poor CPR effectiveness and poor clinical outcome.

For a team leader, it can be a challenging task to lead a team during a CPR setting. Having this leader role can cause stress (Schull, Ferris, Tu, Hux & Redelmeier 2001). Pittman, Turner and Gabbott (2001) discovered that in reality and in simulated CPR settings, team members often have never worked together before or even met before, which could make it even harder to lead a team. Furthermore, the same research indicated that it is often not the most experienced doctor who is the team leader, which means that the team leader possibly does not have enough leadership skills and resuscitation experience or training. Research into leadership effectiveness with unexperienced leaders like medical students can therefore also be interesting.

Observational studies have also shown that there is an association between leadership quality and team effectiveness in CPR (Marsch et al., 2004; Cooper & Wakelam, 1999). There is also evidence that leadership becomes more important during stressful periods, with team members often expecting more direction from a leader (Hayes, Rhee, Detsky, Leblanc & Wax, 2007). Therefore, a team leader needs to optimally use his or her qualities, or non-technical skills, to obtain a high level of team effectiveness and leadership effectiveness.

7. Current research

It can be concluded that stress could have an important influence on the effectiveness of a team in a (simulated) CPR setting and on the team leader who guides the team through the process. In addition it is interesting to examine the influence of stress on leadership effectiveness, since research above showed that the effectiveness of the leader can also influence the team. The question that arises is if stress of the team leader influences the team in a simulated CPR setting. The importance of technical skills and non-technical skills of team members and the team leader were discussed in the above. When studying team effectiveness, both technical as well as non-technical skills have to be considered. Due to this importance, this distinction is also made in the hypotheses, as to see if there is a different outcome when looking at the influence of stress at those two outcome variables for team effectiveness. All this is visualised in the figure below in an overview of the current research model.

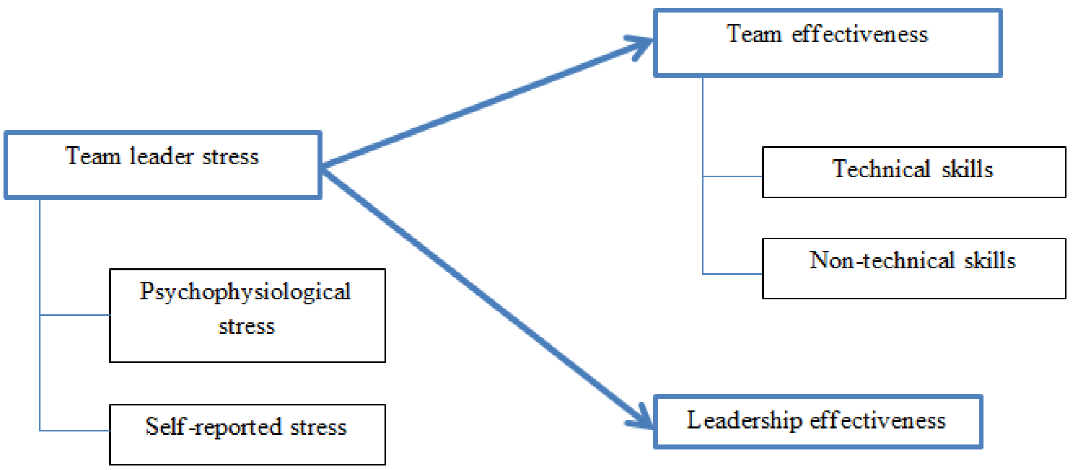

Figure 3: Current research model

Hence, on basis of the above, we propose:

1 A high level of psychophysical team leader stress and self-reported team leader stress will lead to a lower team effectiveness in <u>non-technical skills</u>

2 A high level of psychophysical team leader stress and self-reported team leader stress will lead to a lower team effectiveness in <u>technical skills</u>

3 A high level of psychophysical team leader stress and self-reported team leader stress will lead to a lower degree in <u>leadership effectiveness</u>

Method

Context

The research was conducted during the Advanced Life Support course (ALS) of the master programme of Technical Medicine at the Experimental Centre for Technical Medicine (ECTM), University of Twente. In this course, students practised cardiopulmonary resuscitation (CPR) on a simulated patient case. Teams of four students participated in a simulated CPR setting. Of these four students, one was the team leader who allocated tasks to the other three students. The other three students were given the roles of performing basic life support (BLS, 2 participants per group) and the other student circulated around the patient and gave the patient medicines et cetera.

The goal of the course was to enables students to adequately assess and treat a patient in a resuscitation setting according to protocolled guidelines by making use of a systematic clinical approach and medical technology. The simulated patient case took place in the ECTM which offers the latest state of the art simulation technology for research, development and education of students and professionals in health care. The Human Patient Simulator (e.g. METI/METIman) is fitted with the latest technology and is capable to respond like a real human. The simulation can replicate different scenarios, since every patient resuscitation is unique. With the Human Patient Simulator, Technical Medicine students and professionals can develop their clinical skills in a safe environment without placing any patient in jeopardy. Furthermore, the two simulation rooms are fully equipped with the necessary medical equipment (e.g., patient monitor, defibrillator). The computer to control the two Human Patient Simulators is located in the adjacent room, but are controlled by the instructors of the course in the two simulation rooms, via a laptop.

Sample

This study was a cross-sectional mixed-methods study, since multiple methods were used like observations, questionnaires and the E4 wristband. The design had 21 teams of four participants and one team of three participants. The team with three participants used an assistant from another team to make sure they were a team of four participants during each scenario as well. The participants were able to enrol themselves in a group of four. Out of each group, one participant was the team leader. During 4 practice sessions, every participant got the chance to be the team leader once in a scenario. The measurements took place during the trial assessment and the assessment of the course. During both sessions, 22 teams participated. However, only the data of 15 teams was used during the assessment. This was due to the fact that 7 teams had the same team leader during the pre-assessment as during the assessment. This could lead to biases in the data. So the data of 37 teams were used in total. The team leader was selected at random[1].

In total, 95 students were enrolled in the course: 87 students (92%) participated in this study. The rejection rate was 8%. Out of 87 students, 37 students in 37 teams were team leader in a scenario. Of the team leaders, 57% was female and 43% were male. Participants' age varied between 21 years and 27 years (*M*=22.59, *SD*=1.34), most of them were aged 22 years. Of the other 50 team members, 52% was female and 48% were male. The age of the participants varied between 21 years and 32 years (*M*=22.14, *SD*=1.67), most of them aged 22 years.

Measurements

Several measurements were used in the current study during the simulated CPR setting, but first the participants filled in an informed consent and a questionnaire with questions regarding gender, year of birth and previous ALS experience. The independent variable measured was the team leader stress. Team leader stress was measured in a psychophysiological manner through Electrodermal Activity (EDA) while wearing an E4 (empatica) wristband. Stress was also measured via a self-reported questionnaire. The dependent variable was the team effectiveness of the entire team and the leadership effectiveness. Team effectiveness was measured through two questionnaires, one regarding non-technical skills and one regarding technical skills. Leadership effectiveness was measured through the use of a questionnaire as well.

Team leader stress: Stress was measured in a psychophysiological manner through Electrodermal Activity (EDA) while wearing an E4 (empatica) wristband. The field researcher made sure that the team leader wore the E4 correctly. The team leader wore the E4 the entire duration of the scenario. The usable outputs of the E4 are the mean skin conductance response per minute and the mean amplitudes (average of the amount of peaks) of the respondents. In the paragraph analysis follows a description how the data from the E4 was conducted.

Stress was also measured was via a self-reported questionnaire with items developed by Tomaka, Blascovich, Kelsey, & Leitten (1993) and Tomaka, Blascovich, Kibler & Ernst

[1] In most teams, the team leader was selected at random. In 9 out of 37 cases, it happened that the teams chose the team leader themselves. Those cases all occurred during the trial assessment.

(1997). The questionnaire consisted out of two items ranging from 1 to 10. A reliability analysis in SPSS over these items gave a Cronbach's Alpha of .45, which indicates poor internal consistency. This could be due to the fact that the questionnaire had only two items, more items would probably have made the questionnaire more reliable. See appendix A for the used items. Self-reported stress had no significant correlation with skin conductance response (.26) and the amplitudes (.24).

Team effectiveness: The course had two instructors. Team effectiveness was measured after the simulation by one of the two instructors. The non-technical skills were measured through four items on team effectiveness out of the research of Gibson, Cooper, & Conger (2009) and were translated into Dutch. The items ranged on a scale from 1 to 7. A reliability analysis in SPSS over these items gave a Cronbach's Alpha of .94, which indicates excellent internal consistency.

The technical skills were measured through five items and were also rated by one of the two instructors. See appendix B for all items on team effectiveness including short explanations. The items ranged on a scale of 1 to 5. A reliability analysis in SPSS over these items gave a Cronbach's Alpha of .67, which indicates questionable internal consistency. Non-technical and technical skills seemed to correlate significantly (r=.81) with each other, which provides an indication that these measurements together form a good representative for team effectiveness .

Leadership effectiveness: Leadership effectiveness was measured through 5 items from Hooijberg (1996), ranging on a scale from 1 to 5. The questionnaire was filled in by one instructor per team after the scenario. The items were translated into Dutch and ranged from 1 to 5. A reliability analysis in SPSS over these items gave a Cronbach's Alpha of .96, which indicates excellent internal consistency. See appendix C for the used items. Leadership effectiveness correlated significantly with both non-technical skills (r=.90) and technical skills (r=.77), thus with team effectiveness.

Analysis

In this research, the analysis programme for statistics IBM SPSS version 23 was used to do the analysis, except for the analysis of the raw data of the E4 wristband. The data of the E4 wristband was downloaded from Empatica manager and renamed. The data was trimmed and measurements before and after the scenario were cut out. A continuous decomposition analysis (CDA) was conducted via Ledalab, a program which can be used via Matlab and which is also recommended by Empatica (see empatica.com). This analysis extracts the phasic information of the skin conductance signal and allows a detailed analysis of the skin conductance response. The data was imported and a continuous decomposition analysis (CDA) was conducted per individual. The frequency was 4 Hz (identical to the frequency which was used during recording). The results were exported in form of a skin conductance response list whereby the onset and the amplitude of the individual skin conductance response were given. A self-written program was used in order to calculate the amount of skin conductance response per minute. The program was written in Python and can be used for the analysis of Ledalab results, as for example the results of the CDA. The given output that was included in SPSS was the skin conductance response per minute and the mean of the amplitudes.

As mentioned before, measurements were held at two moments, during a trial assessment (22 teams) and during an assessment (15 teams). In order to be sure that it was statistically acceptable to combine both samples for an analysis, an independent sample t-test for non-parametric data was conducted: the Mann-Whitney test. The Mann-Whitney test was conducted for all the variables independently. The results were not significant for all the different variables, which meant that it was statistically acceptable to take both samples together and that the trial assessment was comparable with the real assessment. See appendix D for the results of the Mann-Whitney test.

Most of the variables were not normally distributed, with the Shapiro-Wilk normality test being significant on almost all the variables. When data is not normally distributed, various transformations for normality can be effective (Field, 2009). Also with log transformation the data remained non-normally distributed. In this case, the data was transformed with LG10 (attempt 1), LN (attempt 2) and SCRT (attempt 3). See appendix D for the results of the normality tests of the data and after transformations with LG10; LN and SCRT. Since de data remained to be non-normally distributed, it was decided upon to continue the analysis with the original dataset. Concluding, the data was not normally distributed and N=37.

A non-parametric correlational analysis was conducted, using Spearman correlations, to look at the relationship between the variables. As mentioned above, the EDA had two outputs, skin conductance response and the amplitudes. It appeared that skin conductance response and the amplitudes correlated significantly at r=.92. Due to the rule of multicollinearity (Field, 2009), only one of the two could be added in the analysis. Skin conductance response was chosen instead of the amplitudes, since the amplitudes showed non-normal residuals in the entire sample. In order to also look at differences in the assessment sample, the analysis was also held for the assessment sample only. Both skin conductance response and the amplitudes are analysed in the assessment sample, but separately from one another because of the multicollinearity. The hypotheses of this research questioned if one variable influenced another variable significantly. To test the hypothesis, a multiple regression analysis was performed (Field, 2009).

Results

Descriptive statistics

When looking at the descriptive statistics, non-technical skills and technical skills appear to score around the same range (since non-technical skills had a scale of 1-7 and technical skills of 1-5). The standard deviation of technical skills is lower than non-technical skills or leadership effectiveness. The self-reported stress is higher than the average value of the scale. See table 1 for an overview of the descriptive statistics of the variables.

Table 1: Descriptive statistics of variables

	Self-reported stress	Skin conductance response	Amplitudes	Non-technical skills	Technical skills	Leadership effectiv-eness
Mean	6.58	61.48	1.36	5.32	3.82	3.87
Standard deviation	.80	40.48	1.86	1.05	.51	1.02
Minimum	5	2.76	.05	3.25	2.40	2
Maximum	8	115	7.53	7	4.80	5

N=37 (except self-reported stress, N=36)

Relationship between stress, team effectiveness and leadership effectiveness

Spearman correlations were calculated for the independent variables self-reported stress (1), skin conductance response (2), amplitudes (3) and the dependent variables non-technical skills (1), technical skills (2) and leadership effectiveness (3). See table 2 for an overview of the correlations. First of all, no significant correlations were found between the independent variables and the dependent variables. Significant correlations were found in-between the dependent variables. Non-technical skills and technical skills correlated significantly (r=.81) and vice versa. Non-technical skills and leadership effectiveness also correlated significantly (r=.90) and vice versa, and are therefore both highly interdependent of one another. Lastly, technical skills and leadership effectiveness correlated significantly (r=.77). Concluding, an effect was shown in-between the variables but not between the independent and dependent variables.

Table 2: Spearman correlations

	1	2	3	4	5	6
1. Non-technical skills						
2. Technical skills	.81**					
3. Leadership effectiveness	.90**	.77**				
4. Self-reported stress	-.01	.23	.04			
5. Skin conductance response	.06	.28	.05	.26		
6. Amplitudes	.08	.30	.10	.24	.92**	

N=37 (except self-reported stress, N=36). **= Correlation is significant at the 0.01 level (2-tailed).

Hypothesis testing

In this section, a regression analysis was conducted on nine different models within three different dependent variables. The three dependent variables are non-technical skills (1), technical skills (2) and leadership effectiveness (3). The first results that can be read per variable are the models with self-reported stress and skin conductance response as independent variables in the entire sample. Secondly, the results are shown of models with self-reported stress and skin conductance response in the assessment sample. Lastly, the results are shown of models with self-reported stress and amplitudes in the assessment sample.

Non-technical skills

Self-reported stress and skin conductance response

The hypothesis questioned if a high level of psychophysical team leader stress and self-reported team leader stress would lead to a lower team effectiveness in non-technical skills. The multiple regression analysis model was not significant ($F=.08$; $p=.92$). This means that the hypothesis is rejected and that it is not statistically proven that a high level of team leader stress leads to a lower team effectiveness in non-technical skills. Furthermore, R squared ($R^2=.005$) suggests that approximately 0.5 percent of variability in non-technical skills is explained by team leader stress, which is rather low. The parameters shown in table 3 below show no significant values as well.

Table 3: Linear regression model non-technical skills (**entire sample**)

	b	*SE B*	*β*	p
Constant	5.66	1.52		.001
Self-reported stress	-.06	.24	-.05	.80
Skin conductance response	.00	.01	.06	.73

R^2=.005, adjusted R^2=-.06

When splitting the data into the two original samples trial assessment and assessment, a significant result was found in self-reported stress (p=.04) in the assessment sample. The model in itself is however not significant (F=2.62; p=.12). Contrary to our expectations, the Beta of self-reported stress in the assessment sample is not negative but positive (B=.78). This means that higher self-reported stress would lead to a higher score in non-technical skills. The skin conductance response shows a negative Beta (B=-.003) but is so close to zero that the contribution is rather small, and the variable is not significant to the model (p=.53) so not much can be said on the link between skin conductance response and non-technical skills. R squared is higher (R^2=.32) suggesting that approximately 32 percent of variability in non-technical skills is explained by team leader stress.

Table 4: Linear regression model non-technical skills (**assessment sample**)

	b	*SE B*	*β*	p
Constant	.65	2.28		.78
Self-reported stress	.78	.34	.57	.04
Skin conductance response	-.003	.01	-.16	.53

R^2=.32, adjusted R^2=.20

Self-reported stress and amplitudes

When splitting the data into the two original samples trial assessment and assessment and focus on the amplitudes in the assessment sample, a significant result was found in self-reported stress (p=.049). The model in itself is however not significant (F=3.03; p=.09). Contrary to our expectations, the Beta's of self-reported stress and the amplitudes in the assessment sample are not negative but positive B=.73 (self-reported stress) and B=.09 (amplitudes). The variable amplitude is not significant to the model (p=.34) so not much can be said on the link between the amplitudes and non-technical skills. R squared (R^2=.36) suggests that approximately 36 percent of variability in non-technical skills is explained by team leader stress.

Table 5: Linear regression model non-technical skills (**assessment sample**)

	B	*SE B*	*β*	p
Constant	.53	2.23		.82
Self-reported stress	.73	.33	.54	.049
Amplitudes	.09	.09	.24	.34

R^2=.36, adjusted R^2=.24

Technical skills

Self-reported stress and skin conductance response

The hypothesis questioned if a high level of psychophysical team leader stress and self-reported team leader stress would lead to a lower team effectiveness in technical skills. The multiple regression analysis showed no significant results, leading to a non-significant regression model (F=1.53; p=.23). This means that the hypothesis was rejected and that it is not statistically proven that a high level of stress leads to a lower team effectiveness in technical skills. R squared (R^2=.09) suggests that approximately 9 percent of variability in technical skills is explained by team leader stress. Table 6 below shows an overview of the parameters and their contribution to the model. All parameters do not have a significant contribution to the model.

Table 6: Linear regression model technical skills (**entire sample**)

	b	*SE B*	*β*	p
Constant	3.00	.72		.000
Self-reported stress	.10	.11	.15	.38
Skin conductance response	.003	.002	.23	.22

R^2=.09, adjusted R^2=.03

When splitting the data into the two original samples trial assessment and assessment, no significant results were found (F=2.68; p=.11) in the assessment sample. The parameters had no significant contribution as well. Contrary to our expectations, the Beta's are not negative but positive B=.40 (self-reported stress) and B=.002 (skin conductance response). R squared (R^2=.33) suggests that approximately 33 percent of variability in technical skills is explained by team leader stress.

Table 7: Linear regression model technical skills (**assessment sample**)

	b	*SE B*	*β*	p
Constant	1.06	1.31		.43
Self-reported stress	.40	.20	.52	.06
Skin conductance response	.002	.003	.19	.48

R^2=.33, adjusted R^2=.21

Self-reported stress and amplitudes

When splitting the data into the two original samples trial assessment and assessment and focus on the amplitudes in the assessment sample, a significant result is found in the model (F=5.05; p=.03). When looking at the individual parameters, self-reported stress showed a significant contribution (p=.04), but the amplitudes did not (p=.07). Contrary to our expectations, the Beta's are not negative but positive again B=.41 (self-reported stress) and B=.09 (amplitudes). Furthermore, the R square is higher (R^2=.48) suggesting that approximately 48 percent of variability in technical skills is explained by team leader stress

Table 8: Linear regression model technical skills (**assessment sample**)

	b	*SE B*	*β*	p
Constant	.97	1.15		.42
Self-reported stress	.41	.17	.52	.04
Amplitudes	.09	.05	.43	.07

R^2=.48, adjusted R^2=.38

Leadership effectiveness

Self-reported stress and skin conductance response

The hypothesis questioned if a high level of psychophysical team leader stress and self-reported team leader stress would lead to a lower degree in leadership effectiveness of the team leader. A multiple regression analysis showed no significant results (F=.21; p=.81). This means that the hypothesis is rejected and that it is not statistically proven that a high level of stress leads to a lower degree in leadership effectiveness of the team leader. R squared is rather low (R^2=.01) suggesting that only approximately 1 percent of variability in leadership effectiveness is explained by team leader stress. All parameters do not have a significant contribution to the model. Contrary to our expectations, the Beta's are not negative but positive again B=.04 (self-reported stress) and B=.003 (skin conductance response).

Table 9: Linear regression model leadership effectiveness (**entire sample**)

	b	*SE B*	*β*	p
Constant	3.48	1.47		.02
Self-reported stress	.04	.23	.03	.86
Skin conductance response	.003	.004	.10	.58

R^2=.01, adjusted R^2=-.05

When splitting the data into the two original samples trial assessment and assessment, no significant results were found (F=2.00; p=.18) in the assessment sample. The parameters had no significant contribution as well. Contrary to our expectations, the Beta's are not negative but positive B=.76 (self-reported stress) and B=.00 (skin conductance response). R squared (R^2=.27) suggests that approximately 27 percent of variability in leadership effectiveness is explained by team leader stress.

Table 10: Linear regression model leadership effectiveness (**assessment sample**)

	b	*SE B*	*β*	p
Constant	-1.09	2.56		.68
Self-reported stress	.76	.38	.52	.07
Skin conductance response	.00	.01	-003	.99

R^2=.27, adjusted R^2=.11

Self-reported stress and amplitudes

When splitting the data into the two original samples trial assessment and assessment and focus on the amplitudes in the assessment sample, no significant result is found in the model (F=3.26; p=.08). When looking at the individual parameters, self-reported stress (p=.06) and the amplitudes (p=.20) showed no significant contribution as well. Contrary to our expectations, the Beta's are not negative but positive again B=.74 (self-reported stress) and B=.13 (amplitudes). Furthermore, the R square (R^2=.37) suggests that approximately 37 percent of variability in technical skills is explained by team leader stress.

Table 11: Linear regression model leadership effectiveness (**assessment sample**)

	b	*SE B*	*β*	p
Constant	-1.24	2.37		.61
Self-reported stress	.74	.35	.50	.06
Amplitudes	.13	.10	.33	.20

R^2=.37, adjusted R^2=.256

Discussion

This study examined the influence of a team leader's psychophysiological and self-reported stress on team effectiveness and leadership effectiveness in a simulated CPR setting. Since the role of the team leader is important and has a direct influence on how the team behaves, this could have a large effect on a team's success or failure (Cole & Chrichton, 2006). Hunziker and colleagues (2011) outlined that, from a clinical perspective, one event causing high levels of acute stress is a cardiac arrest (i.e., giving CPR). It was therefore important to examine the influence of stress of the team leader on the team effectiveness of and leadership effectiveness. On basis of previous studies we hypothesized that a higher level of stress (psychophysical and self-reported) would lead to a lower team effectiveness (in technical and non-technical skills) and a lower degree of leadership effectiveness. Contrary to our expectations, the results showed that this was not the case in the entire sample when stress was measured in outputs of self-reported stress and EDA. However, in the assessment sample, the model of technical skills was significant and the parameter self-reported stress had a significant contribution as well. Interestingly, this significant contribution was positive instead of negative, indicating that higher levels of self-reported stress would lead to better technical skills. When looking at the assessment sample only, this effect also appeared in non-technical skills. The models were not significant, but self-reported stress on its own was a significant predictor in both models in non-technical skills in the assessment sample and had again a positive contribution indicating that higher levels of self-reported stress would lead to better non-technical skills.

All hypothesis had to be rejected, since they stated that team leader stress would lead to a lower team effectiveness (in technical and non-technical skills) and a lower degree of leadership effectiveness. In leadership effectiveness, no significant results were found. In team effectiveness, as mentioned above, significant results were found in self-reported stress in the assessment sample but the contribution was positive instead of negative. The research question examined how team leader's psychophysiological and self-reported stress influences team effectiveness and leadership effectiveness in a simulated cardiopulmonary resuscitation setting. As a result, this research found that a higher level of stress is associated with a higher level of team effectiveness and that no significant results were found in leadership effectiveness. Apparently, when looking at stress, the assessment sample was a more accurate and representative sample in this research, since they showed more significant results. This could be explained by the fact that students were graded during the assessment, but not during the trial assessment. It is therefore important that participants in a research regarding (stress, team and leader effectiveness) CPR are students in an assessment setting, and that they should be evaluated and graded.

Previous research showed that team leader stress can become a threat for CPR effectiveness; this effect could be due to the idea that what is asked of the CPR performer is more then what the person is capable of to do (Dias & Neto, 2016). However, this research did not take into account that stress could also lead to better team effectiveness. Research of Keitel et al. (2011) found a positive relationship between stress and team effectiveness in a simulated emergency situation, which according to them indicates that high stress responsiveness might be a predictor of good performance. The hypothesis stated that higher team leader stress would lead to lower effectiveness (on team and leadership level). However, contrary to our expectations, the Beta's were mostly positive and not negative. This would indicate that higher team leader stress would lead to higher effectiveness (on team and leadership level). It might be that the amount of stress that was measured in the participants was just high enough to perform better instead of less, in accordance with the research of Keitel et al. (2011).

This research looked into the combining factors of stress, performance and leadership and how they related to each other. A high significant relation was found between team effectiveness (non-technical skills and technical skills) and leadership effectiveness. Literature states that leadership has a great influence in providing CPR (Cole & Chrichton, 2006), and for providing CPR you need good technical skills (Hunziker, Tschan, Semmer, Howell & Marsch, 2010), so this significant relation proves the upcoming importance of good quality leadership in technical skills. However, when looking at the results of the hypothesis, team leader stress had only a significant influence on team effectiveness (non-technical and technical skills) and not on leadership effectiveness. Apparently, when looking at the model, the team effectiveness is more influenced by stress than the leadership effectiveness. Even though the literature states that leadership has a great influence in providing CPR (Cole & Chrichton, 2006), the team leader is highly dependent of the team. Instead of focussing on the leader, it could be fruitful to focus more on the team level and the team dynamics.

Limitations

This research had some limitations. First of all, Hunziker et al. (2011) discovered that self-reported stress (stress/overload) was the only predictor for low CPR effectiveness, above and beyond objective psychophysiological stress. Therefore, in this research self-reported stress was also measured. The difference between this research and that of Hunziker et al. (2011) was that they used heart rate as psychophysiological measurement instead of EDA. Self-reported stress was found to have no significant influence on team effectiveness or leadership effectiveness in the entire sample. Also, the self-reported stress did not correlate with the EDA but had a rather weak connection. It is therefore hard to distinguish what kind of measurement is the best representative for stress. Self-reported stress was the only variable that showed significant results within the models in the assessment samples, suggesting that self-reported stress was a more reliable source for indications of stress than the EDA. However, the downside of self-reporting is that it has a subjective bias (Sandroni et al., 2004); it always represents merely the perception of the respondent, which does not necessarily overlap with objectively measured stress. On the other hand, psychophysiological measured stress is measured by modern technology, which could also have errors and one could then argue that the own interpretation and feeling of stress is a better representative for stress. Even though no correlation was found between self-reported stress and psychophysiological measured stress, it is still important to examine both in order to examine the relationship between team effectiveness and leadership effectiveness and to find out which measure could be a better representative for stress.

When looking at the EDA, skin conductance responses can be analysed by comparing the mean amplitude of individual peaks against a pre-stimulus baseline (Bach, 2009). EDA can be best measured at places where the density of sweat glands is highest. This place is usually the palmar site of the hands or the feet (Cacioppo, Tassinary & Berntson, 2007). So, a proper baseline and measuring at the palmer site of the hand is an important factor to be able to carefully analyse the EDA data. Since the baseline that was collected during the scenarios was so little (e.g., sometimes only a few seconds) it was not possible to use this. Furthermore, the E4 wristband measured the skin conductance response at the wrist, but has proven to measure EDA in a valid and reliable manner (Empatica, 2017). This research did not only use the amplitudes but also the mean skin conductance response per participant. Both measures did not show significant results with team effectiveness and leadership effectiveness, nor correlated with self-reported stress but only correlated with each other. A reason for this could be the missing baseline and not being able to properly interpret the data, this being a limitation of this research. To contribute to that, the descriptive statistics of the skin conductance response showed large differences, meaning that the EDA differed a lot per individual.

Another reason for the fact that stress did not influence team effectiveness and leadership effectiveness could be the learning moments of the participants. As mentioned in the method section, the participants all had chances to exercise before the trial assessment and assessment. DeMaria et al. (2010) showed that effectiveness in Advanced Life Support (ALS) skills improved after following one simulation training and learning how to deal with stressors. This means that this could be a reason that the stress level of the participants had a lower influence on team and leadership effectiveness then was expected, since they already gotten better at providing CPR and the setting and location of the assessment was identical.

Furthermore, there was a limitation in gathering the data for the three dependent variables. The questionnaires for team effectiveness and leadership effectiveness were filled out by one of the two teachers of the course in which the measurement took place. Due to practical reasons, half of the groups were rated by one teacher, while the other group simultaneously were rated by the other teacher in the other room. This unfortunately means that it was not possible to do an inter-rater reliability analyses and look at the inter-rater agreement of both teachers, which influences the reliability of the results.

Strong points and suggestions for further research

This research had several strong and unique points. First of all, this research used a cross-sectional mix-methods design, since multiple methods were used like questionnaires and the E4 wristband. If the research would add one other measurement, like video observations, then there would be triangulation. Video observation could be used to code the behaviour of the respondents and their stress levels, to see if this matches the self-reported and psychophysiological measured stress. This is therefore also a suggestion for further research. In that case, the leader/team member behaviour can be coded during the scenarios and compare it to the self-reported stress and the psychophysical stress that was measured. This might help to understand the link between stress and behaviour better, and therefore the influence of stress on effectiveness (on team and leadership level).

Secondly, there was a high and significant relationship between technical and non-technical skills, indicating that both measurements are a good representative for team effectiveness. Since technical skills are needed to give CPR and non-technical skills like leadership are becoming more important, it was very interesting to examine both measures.

Suggestions for further research are to look more into the combination of these two team effectiveness measurements. It is interesting to know if other research find correlating results as well and if team effectiveness in CPR in the future can be measured by a combination of leadership, non-technical skills and technical skills.

Thirdly, positive points about the measurements can be made as well. The questionnaires showed good internal consistency, except for self-reported stress but this could be due to the amount of items (N=2). The other items showed good internal consistency which means that the questions within the questionnaires were reliable. Subsequently, if two teachers would rate the participants for their team effectiveness or leadership effectiveness, then the inter-rater agreement can be taken into account as well, which is a suggestion for further research. Also, in the field of measurements, using the E4 (empatica) wristband to measure the EDA was unique in the field of (simulated) CPR settings, since this had not happened before to the best of our knowledge. Also, both measures (skin conductance response and amplitudes) correlated significantly with one another. If the E4 (empatica) wristband is used in further research, it is of great importance though that there is a good, stable and reliable baseline measured for every participant before starting the scenarios and it is measured at the palmar site of the hand.

Fourthly, it would be interesting to do research over a longer period of time. As mentioned in the method section, the participants had several sessions to practice their CPR skills, which could also have influenced the stress level of the participants during the assessment. When looking at the teams over time, it can be researched if there are interesting significant changes in the skills of the students over time and if there are differences between the students stress levels and influence on team effectiveness and leadership effectiveness. Another positive factor is that there would simultaneously be more respondents, because it is possible to follow all the participants (since they constantly rotate the role of team leader) instead of just the participants who were leader during this research. This makes the number of respondents at least three times as high.

To conclude, it was hypothesized that a higher level of stress (psychophysical and self-reported) would lead to a lower team effectiveness (in technical and non-technical skills) and a lower degree of leadership effectiveness. Contrary to our expectations, this research found that a higher level of stress is associated with a higher level of team effectiveness and no significant results were found in leadership effectiveness. It is interesting to do more research in the area of CPR, team effectiveness, leadership effectivness and stress (while looking at the above mentioned suggestions for further research) and to explore if team dynamics play a more important role in a team in CPR. This in order to reach the end goal; to educate the medical students into becoming the best doctors who can perform good quality CPR in order to save more lives.

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Appendix

Appendix A

The self-report stress questions were based on the items of Tomaka, Blascovich, Kelsey & Leitten (1993) and Tomaka, Blascovich, Kibler & Ernst (1997). The questions were translated into Dutch:

1. Hoe stressvol vond je het uitvoeren van het scenario?

1	2	3	4	5	6	7	8	9	10
Helemaal niet stressvol								Extreem stressvol	

2. In hoeverre was je in staat om goed om te gaan met het zonet uitgevoerde scenario?

1	2	3	4	5	6	7	8	9	10
Slecht								Perfect	

Appendix B

The team effectiveness scale used for non-technical scales was based on the items of Gibson, Cooper & Conger (2009). The team effectiveness scale used for technical scales was based on the assessment form of the instructors of the ALS course, developed together with the instructors of the course. See the questions (in Dutch) below, together with an extra explanation (in Dutch) regarding the technical skills questions:

Team effectiveness non-technical skills

	Erg inaccuraat				Erg accuraat		
	1	2	3	4	5	6	7
1. Dit team is een consistent goed presterend team	◯	◯	◯	◯	◯	◯	◯
2. Dit team is effectief	◯	◯	◯	◯	◯	◯	◯
3. Dit team maakt weinig fouten	◯	◯	◯	◯	◯	◯	◯
4. Dit team verzet kwalitatief hoog werk	◯	◯	◯	◯	◯	◯	◯

Team effectiveness technical skills
1 = onvoldoende, 5 = uitstekend

	- -	-	+/-	+	+ +
	1	2	3	4	5
5. ALS-protocol					
6. Uitvoering handelingen					
7. Diagnostiek en klinisch redeneren					
8. Therapeutisch plan					
9. Werkwijze					

Extra information technical skills questionnaire

1. ALS protocol

Onder ALS protocol wordt verstaan:

a. primaire diagnose: De patiënt aanspreken, schudden, respons afwachten, in mond kijken en/of voelen, chinlift, look/listen/feel (≥ 7 sec.), en pols voelen (≥ 4 sec) voor start compressies.
b. Reanimatie cyclus: directe start na primaire diagnose, minimale interruptie, 30:2 ratio compressies: beademingen
c. Snelle ritmecheck: vroeg en juiste interpretatie
d. Indicatie defillibratie: shock vs. non-shock
e. Opvolging handelingen protocol: aanhouden 2 min. cycli

2. Uitvoering handelingen

Onder uitvoeringen handelingen wordt verstaan:

a. Compressie techniek: juiste handplaatsing, frequentie (100/min)
b. Kap beademing techniek: correcte mayo tube maat selectie + plaatsing, en correcte handpositie + teugtoediening.
c. Ritmecheck methodiek: onderbreken compressies, pols voelen, en gezamelijke interpretative ritme.
d. Defillibratie techniek: correct gebruiken defillibrator, waarschuwing omgeving (“*bed vrij*”).
e. Intubatie techniek: material selectie en controle, juiste intubatie techniek (max. 12 sec), en controle via look/listen/feel techniek.
f. Medicatie toedieningswijze en dosis: juiste concentratie en juiste toegangsroute.

3. Diagnostiek en klinisch redeneren

Onder diagnostiek en klinisch redeneren wordt verstaan:

a. ABCDE systematiek: volgorde en compleetheid
b. Inzet anamneses: relevantie en compleetheid (algemene, speciële, aanvullende anamnese)
c. Inzet lichamelijk onderzoek: relevantie en compleetheid (volgens ABCDE)
d. Inzet diagnostische technieken: relevantie en compleetheid (monitor, lab, ECG, echo, X-thorax)
e. Interpretatie diagnostische informatie: juiste interpretatie diagnostische uitslagen (anamnese, lichamelijk onderzoek, monitor, lab, ECG, echo, X-thorax)
f. Diagnostische conclusie: correcte diagnose stelling
g. Reassessment: herevaluatie bij verandering status

4. Therapeutisch plan

Onder dit item wordt verstaan:
   a. Behandeling onderliggende oorzaak: passende behandeling
   b. Post-resuscitation care: overdracht naar passende afdeling/specialist, en adequate follow-up strategie

5. Werkwijze

Onder werkwijze wordt verstaan:
   a. Closed loop communicatie: naam benoemen, bevestigen, heldere communicatie
   b. Onderling overleg en samenwerking: overleg en samen besluit nemen, en elkaar helpen bij onzekerheid.
   c. Overdracht volgens SBAR: SBAR componenten aanwezig

Appendix C

The leadership effectiveness questions were based on the items of Hooijberg (1996). The questions were translated into Dutch.

Leadership effectiveness

	1	2	3	4	5
	Volledig mee oneens			Volledig mee	
10. Vergeleken met andere leidinggevenden is deze leidinggevende **niet** erg efficiënt					
11. De manier waarop deze leidinggevende functioneert is een goed voorbeeld voor andere leidinggevenden					
12. Deze leidinggevende slaagt er vaak **niet** in doelen te					
13. Deze leidinggevende heeft succes binnen het team					

	Zeer ineffectief			Zeer effectief	
14. Ik vind deze leidinggevende: zeer ineffectief (1) - zeer effectief (5)					

Appendix D

Table 12: Normality test of the data (entire sample)

	Shapiro-Wilk		
	Statistic	df	Sig.
Self-reported stress	,946	36	,077
Skin conductance response	,885	36	,001
Amplitudes	,700	36	,000
Non-technical skills	,938	36	,044

Technical skills	,950	36	,108
Leadership effectiveness	,866	36	,000

*=Lilliefors Significance Correction

Table 13: Normality test after transforming data with LN

	Shapiro-Wilk		
	Statistic	df	Sig.
Self-reported stress	,938	36	,045
Skin conductance response	,860	36	,000
Amplitudes	,940	36	,051
Non-technical skills	,906	36	,005
Technical skills	,905	36	,005
Leadership effectiveness	,822	36	,000

*. This is a lower bound of the true significance.
**. Lilliefors Significance Correction

Table 14: Normality test after transforming data with LG10

	Shapiro-Wilk		
	Statistic	df	Sig.
Self-reported stress	,938	36	,045
Skin conductance response	,860	36	,000
Amplitudes	,940	36	,051
Non-technical skills	,906	36	,005
Technical skills	,905	36	,005
Leadership effectiveness	,822	36	,000

*. This is a lower bound of the true significance.
**. Lilliefors Significance Correction

Table 15: Normality test after transforming data with SCRT

	Shapiro-Wilk		
	Statistic	df	Sig.
Self-reported stress	,943	36	,063
Skin conductance response	,900	36	,003
Amplitudes	,875	36	,001
Non-technical skills	,924	36	,017
Technical skills	,930	36	,025
Leadership effectiveness	,846	36	,000

*. This is a lower bound of the true significance.

Appendix E

Table 16: Results Mann-Whitney test

Null hypothesis	Sig.	Decision
The distribution of self-reported stress is the same across both groups	.511	Retain the null hypothesis
The distribution of skin conductance response is the same across both groups	.225	Retain the null hypothesis
The distribution of the amplitudes is the same across both groups	.105	Retain the null hypothesis
The distribution of non-technical skills is the same across both groups	.350	Retain the null hypothesis
The distribution of technical skills is the same across both groups	.334	Retain the null hypothesis
The distribution of leadership effectiveness is the same across both groups	.636	Retain the null hypothesis

Asymptotic significances are displayed. The significance level is .05. [1]Exact significance is displayed for this test