Original Article

Effects of Emergency Transportation—Additional Stress for the Patient ?

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ABSTRACT The emergency transport in an ambulance can be a considerable physical and psychical stress for the patient. In this report we prove by means of a test with volunteers and up-to-date literature that stress during transport is an important, not to be neglected factor for the prognosis of the patient. We determined the hemodynamic and endocrinological values of 54 volunteers to verify this statement. Each volunteer was subject to one high speed emergency transport and one smooth transport. Significant differences of all measurements [heart rate ($p \leq 0.001$)], blood pressure, cortisol ($p \leq 0.01$), prolactin, somatotropine and ACTH between the two modes of transportation (emergency transport and smooth run) confirmed our presumption that, especially in the case of cardiac diseases, particularly fast transportation represents an additional danger. Especially in the case of cardiac diseases a very fast transport should not have absolute priority, it can do more harm than good.

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Introduction

It has been shown that, in emergency cases, an adequate preclinical treatment of the patient results in a better prognosis[1]. During a typical emergency transport, the patient is generally subjected to stress caused by vibration, acceleration, braking, and noise which are caused by fast and heavy driving of the ambulance. The risk for the patient is often underestimated, especially in the case of a problematic cardiac situation[1,4,5]. Here, stress can seriously aggravate the patient's state of health.

The aim of the study was to analyze the amount of stress caused by different modes of transportation, using healthy volunteers, in order to draw valuable conclusions concerning real emergency transportation. To demonstrate stress in a healthy volunteer, we noted changes in the following measurements : heart rate, blood pressure, free plasma cortisol and ACTH. These are considered to be objective indicators of stress[1,4-7,10,12,13,15,19].

Materials and Methods

The group of volunteers consisted of 54 persons (26 female, 28 male), aged 20 and 60 years (average age : 28 years). All subjects were healthy and had given their written consent beforehand. The recruited volunteers were not involved in hospital care, nor did they work at a fire or police department. Most of them were members of the local skiing club.

Volunteers were supine and strapped onto a stretcher. The roads were clean and the surface was tarred. The standardized 13 kilometer route was closed off from public traffic. It was located at the former U. S. Army territory in Wildflecken/Bavaria. The ambulance was driven by a professional driving school teacher. Each subject was transported twice ; one ride was fast and jarring with siren (simulating typical emergency transport), the other was slow and smooth without siren. The mode of the first transport (fast or slow) was determined at random

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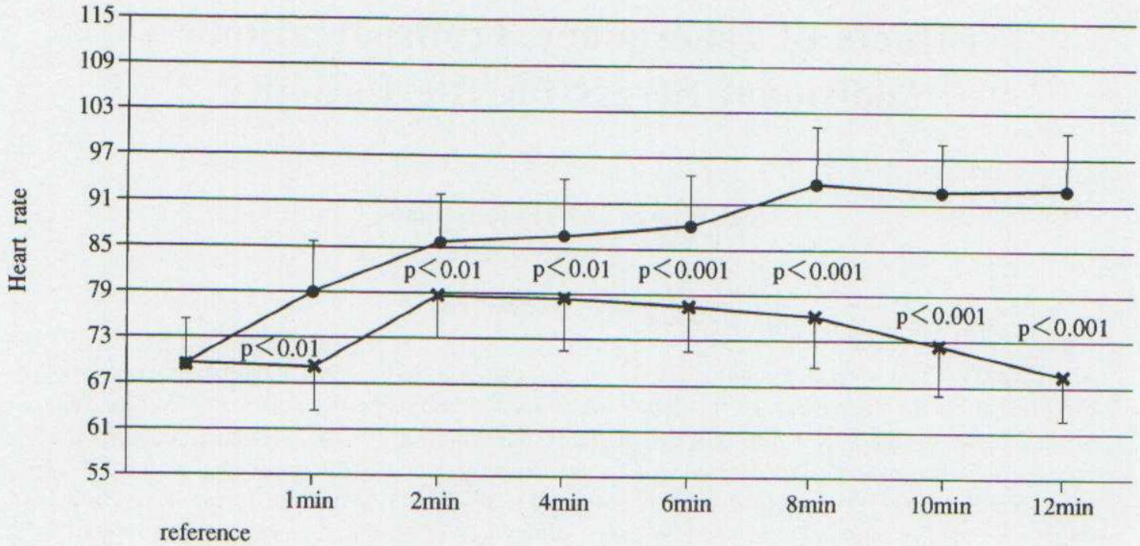

Fig. 1. The plots represent the development of the average heart rate of all 54 volunteers during both transports.
●-● = fast ride ; ✖-✖ = slow ride

beforehand so that a systematic mistake due to adaptation mechanisms[2,3] could be avoided. The average speed during the fast ride was 72 km/h ; the driver braked and quickly accelerated 12 times. The average speed of the slow ride was 40 km/h ; braking and sudden accelerations were avoided.

The baseline values for the subjects were taken before the beginning of the test in a warm (21°C), quiet room. Heart rate and blood pressure were taken 3 times before transport to gain adequate reference values and 7 times during transport at different specific times (**Fig. 1**). Blood samples for the measurement of cortisol and ACTH were taken once before, 3 times during, and 3 times after transport (**Fig. 2**). During transport, heart rate was documented continually by a 3-pole ECG and pulse oxymeter. Blood pressure was measured oscillometrically every two minutes using an OMRON M4, R3. All blood samples were taken from venous blood out of the intermedial cubital vein. The serum of blood samples was separated and frozen for subsequent analysis in the Central Laboratory of the Fulda City Hospital. This analysis made use of enzyme immunoassay, based on the AxSYM Assay© (MEIA). The ACTH values were determined by means of the DYNOtest ACTH© an immunoradiometric two-step assay using the coated-tube technique. For the statistical analysis, the Wilcoxon test was performed. Only data from subjects with a complete series of analyzed control and test specimens were included.

Results

The monitoring of the heart rate revealed the most significant differences (Fig. 1). No considerable individual differences of frequency occurred. During the slow transport, a maximum heart rate was reached within two minutes. After 12 minutes, the rate had returned to the level of the reference value. These measurements were significantly different ($p \leq 0.001$) from those obtained during the fast transport. A difference of more than 10 percent was recorded after 1 minute ($p \leq 0.01$) ; this difference continued to increase. During simulated emergency transport, a plateau was reached after 8 minutes which lasted the duration of the 15 minute trip. After 15 minutes, in 40 percent of the subjects no adaptation (bradycardia) could be noted.

We found that the mean arterial blood pressure reacted in a similar way. During the fast ride systolic values up to 180 mmHg were recorded. The mean arterial pressure during the fast run was an average of 122 mmHg (SD = 12). When the plateau was reached after 8 minutes, the mean arterial pressure was 130 mmHg (SD = 14). During the smooth ride, the mean arterial pressure was 108 mmHg (SD = 8). The highest systolic blood pressure values were reached within 2 to 4 minutes (144 mmHg). The differences between the two modes of transportation proved to be very significant ($p \leq 0.01$) concerning the arterial pressure and the development of the heart rate.

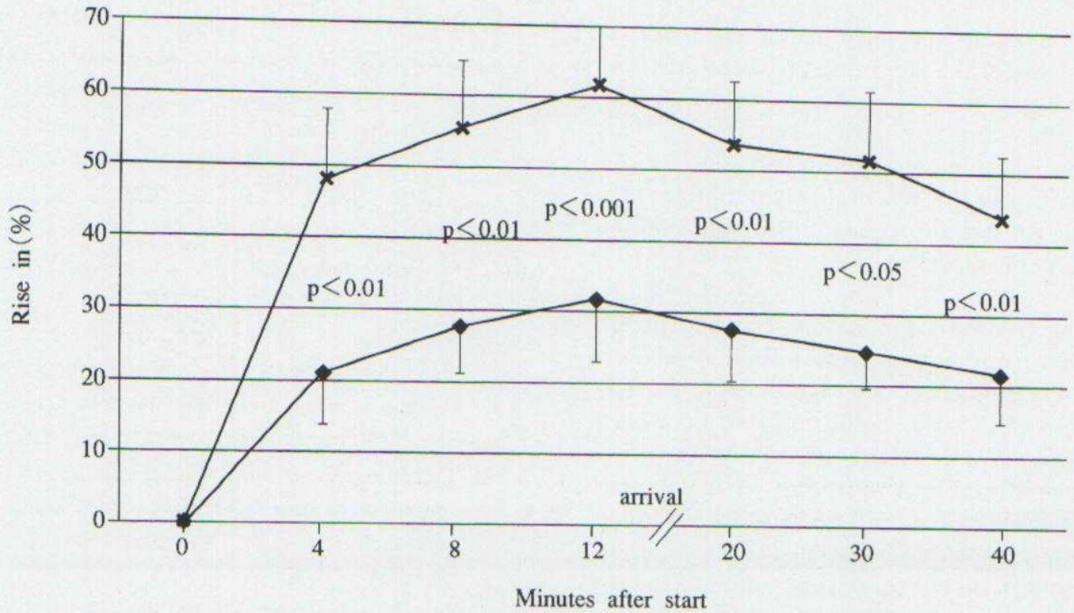

Fig. 2. Representation of the rise in average cortisol levels in all 54 subjects, with reference to the initial individual repose value, during slow and fast transport and during an observation period following transport ($p \leq 0.01$).
✖-✖=fast ride ; ◆-◆=slow ride

We measured cortisol in the peripheral venous blood and found that it reached a peak, on average, 12 minutes after the beginning of transport (Fig. 2). The increase of cortisol during the fast trip, in relation to the initial individual repose value, was an average of 30 percent higher than during the slow trip ($p \leq 0.01$). In one case, cortisol values of up to 94 mg/dl were noticed during the fast trip, while no volunteer reached a cortisol peak of more than 40 μg/dl during the slow trip. In all of the individual volunteers, the measurements taken during the fast trip were higher than during the slow trip.

ACTH reacted in a similar way. The values documented during fast transport were an average of 30 percent higher than during slow transport ($p \leq 0.05$). The peak occurred 4 to 10 minutes after the commencement of transport.

Discussion and Conclusion

Emergency transport is an exceptionally stressing situation for the patient. He suffers from organic pain and also from fear, because he is unable to judge the extent and consequences of his sickness or injury. Additionally, the patient finds himself in unfamiliar surroundings. Physical manipulation of the patient, such as venipuncture, causes additional stress[3)]. With diseases affecting the heart, such as myocardial infarction or angina pectoris, the typical fear of death also causes stress[5)]. These factors are responsible for a high level of sympathetic activity. However, the risk of acute cardiac decompensation rises with increased oxygen demand, which can be triggered by stress[1)].

In our study, we simulated these circumstances and demonstrated that changes in homeostatic measurements occur in volunteers, especially during a fast and jarring ride. This indicates that the emergency patient certainly suffers from enormous physical and mental stress. The stress response activates adaptation mechanisms in the organism in order to increase its ability to cope with a stressful situation[6-8)]. We chose ACTH and cortisol as measurable indicators of a stress response in the sympathoadrenomedullary and pituitary-adrenocortical systems. ACTH rises within four minutes after the onset of stress to a level up to six times the ordinary value[3,9,10)]. This results in a peak of the concentration of cortisol in the blood of humans after 10 to 20 minutes[11,12)]. Elevated cortisol rates can be documented two hours after the peak[4,11)]. These temporarily elevated values do not depend on the circadian rhythm[13,14)].

Adaptation mechanisms which respond to the intensity and duration of stress reduce the amount of stress affecting a subject[9)]. This response takes place approximately 10 to 60 minutes after the onset of stress. It is characterized by an abruption of the stress response in spite of the persisting provocative stimulus[8,17,18]. The change in heart rate is widely considered to be the most important factor[4,10,13,16]. This phenomenon was demonstrated in our study. Fig. 1 reveals a plateau in the heart rate eight minutes into the trip, after an initial increase, during the simulated emergency transport.

Stress during transport can be caused by different factors. Apart from mental stresses, such as anxiety, many physical influences are significant[9,19,20]. The vibrations associated with rapid transport have been shown to cause adverse health effects[1,2,7]. Additionally, an uncomfortable positioning of the patient causes more stress and should be avoided[1,21]. Emergency transport in densely populated areas is impossible without a siren. However, this noise can induce physical and psychological stress as well[22,23].

Our study demonstrates that even young healthy persons without any cardiac disease show significant differences in their homeostasis after a simulated form of ambulance transportation. The way the patient is transported (fast or slow, jarring or smooth) is, apart from the obligatory optimal first aid including pain therapy, psychological care, sedation and cardio-protective medication, the only factor which is totally dependent upon the behavior of the rescue team. A fast transport may not be appropriate in all situations, especially in the case of a cardiac emergency, when it can do more harm than good. The prognosis of the patient depends decisively on an adequate mode of transportation.

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