

## CASE REPORT

# Effect of the September 11, 2001 Terrorist Attack on a State Highway Patrol Trooper's Heart Rate Variability

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**Background:** On September 11, 2001, terrorists attacked the United States. By coincidence, a North Carolina highway patrol trooper was wearing an ambulatory ECG Holter monitor at this time as part of an air pollution study.

**Methods:** Heart rate variability parameters were analyzed: standard deviation of normal to normal beat intervals (SDNN) and percentage of interval differences >50 ms (PNN50).

**Results:** The trooper's heart rate variability changed immediately after learning about the terrorist attacks. Heart rate increased and PNN50 decreased, while SDNN increased strongly.

**Conclusions:** These changes suggest strong emotional sympathetic stress associated with parasympathetic withdrawal in response to the news about the terrorist attack.

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electrocardiography, ambulatory; stress, psychological; heart rate variability; human; adult

## CASE REPORT

On the morning of September 11, 2001, terrorists attacked the United States by piloting and crashing hijacked commercial aircraft into the New York World Trade Center and the Pentagon in Washington, DC. By coincidence, as part of a study investigating health effects of in-vehicle pollutant exposure,<sup>1,2</sup> a North Carolina state highway patrol trooper was wearing an ambulatory ECG Holter monitor at this time. The recording started in the afternoon of September 10 and ended on September 11 shortly after the terrorist attack when the trooper was called at his home in Raleigh, NC for special duty. The Figure 1 shows heart rate (beats per minute, bpm) and two measures of heart rate variability (HRV) during this twenty-hour period of

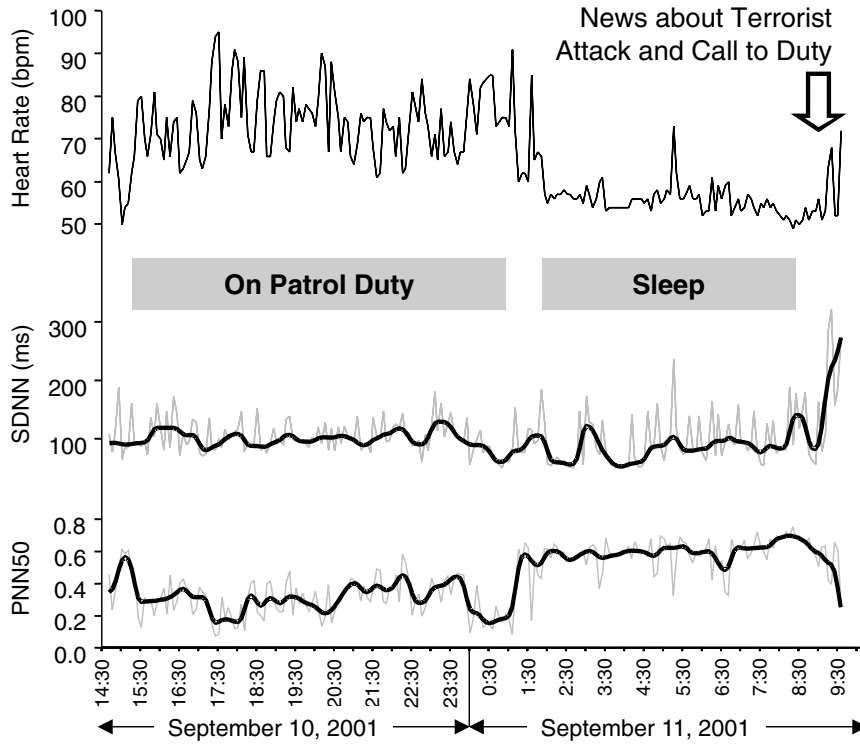
time: standard deviation of normal to normal beat intervals (SDNN) and percentage of interval differences > 50 ms (PNN50) were analyzed for 5-minute intervals. The gray line represents raw data while the black line represents a robust smoothing of the data.

The recording started with a resting period (as part of the study protocol), followed by nine hours of patrol duty. The trooper issued six citations and reported three accidents during this patrol. The high heart rate during work contrasts with a low rate during sleep. PNN50 is inversely related to the heart rate, while SDNN changes little during work and the subsequent sleep phase.

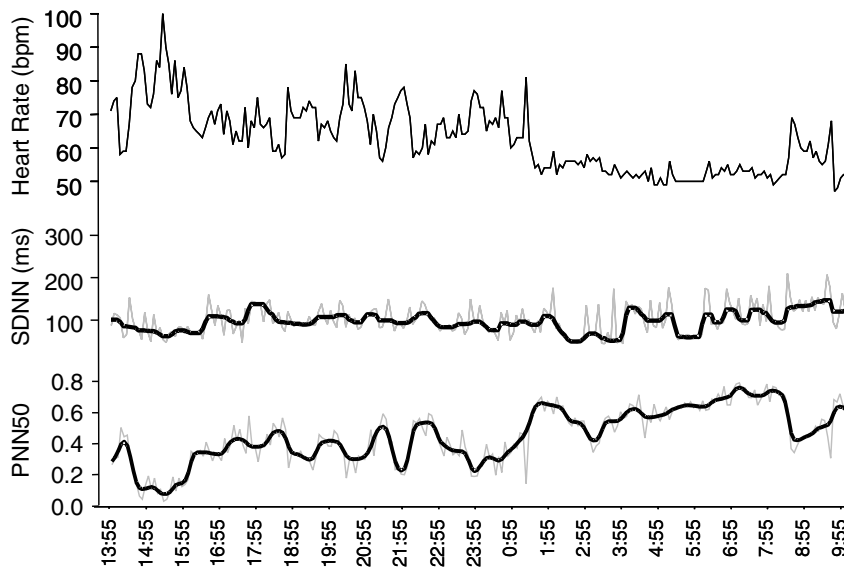
Shortly after waking up, the trooper's heart-rate variability (HRV) changed after learning about the terrorist attacks. Standard deviation of normal to

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One month later, same trooper, same work schedule



**Figure 1.** Response of heart rate and heart-rate variability parameters of a North Carolina state highway patrol trooper's ECG to the news about the terrorist attack on the USA on September 11, 2001. For comparison, the Holter results from a normal day (recorded 1 month later) with the same work schedule is shown in the lower panel.

normal beat intervals increased strongly and PNN50 decreased. The acutely changed heart rate and percentage of interval differences >50 ms correspond to levels observed during the previous day's patrol; however, SDNN was more than double compared to the patrol activity.

## DISCUSSION

The changes observed are suggestive of a sympathetic reaction to emotional stress. The drop in percentage of interval differences PNN50 reflects parasympathetic withdrawal, while the increase in SDNN suggests a strong increase in sympathetic output. These changes differ from published acute changes in HRV following other stressors such as an earthquake<sup>3</sup> or psychological laboratory stress,<sup>4</sup> where HRV parameters indicated mostly a parasympathetic withdrawal response without overly increased sympathetic activity. The stronger increase in sympathetic output observed here might reflect the intense emotional aspect of this particular stress—possibly the trooper got deeply upset or ready to fight when he heard the news about the terrorist attack. Note that none of the other "stressful" activities encountered by this trooper produced similar effects as he went about his normal work-related duties either on September

10 or in several subsequent Holter records, one of which, a month later, is shown in the lower panel of the figure.

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