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ECG on the run: Continuous ECG surveillance of marathon athletes is feasible

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The condition of an athlete's heart has for the first time been accurately monitored throughout the duration of a marathon race. The real-time monitoring was achieved by continuous electrocardiogram (ECG) surveillance and data transfer over the public mobile phone network to a telemedicine centre along the marathon route. This new development in cardiac testing in endurance athletes, said investigators, "would allow instantaneous diagnosis of potentially fatal rhythm disorders".

Following trails in two marathon races, the investigators now describe online ECG surveillance as feasible and "a promising preventive concept". They explain in their first report of the technique how "in the case of life-threatening arrhythmias, the emergency services located along the running track could be alerted to take the runners at risk out of the race and start extended cardiologic diagnostics and treatment".

The investigators, from the Center for Cardiovascular Telemedicine, Charité-Universitätsmedizin in Berlin, present their results on Friday (31 October) at the first European Congress on e-Cardiology and e-Health, with a full report published today in the *European Journal of Preventive Cardiology*.

Proof of the method's concept was achieved during two marathon races in Germany, in each of which five healthy runners (mean age 41.7 years) were equipped with a small ECG device and smart phone worn on the arm. Data transfer between the ECG monitor and phone was by Bluetooth technology. The ECG data were streamed from the device to

the investigators' telemedicine centre in Berlin, where the data were monitored live and stored for later analysis.

During the trials all ten participants completed the two marathons without problems (in a mean time of 3h 37min) but there were differences in the quality of ECG streaming. In the first race, with more than 7000 runners and 150,000 spectators, there was virtually no accurate streaming from the ECG device because of errors in both the Bluetooth connection and connectivity of the phone to the mobile phone network.

New software to connect both devices was thus introduced for the second race six months later (with more than 15,000 runners and 300,000 spectators), and the athletes were asked to wear each device (ECG and smart phone) on the same arm. As a result of the changes, the quality of streaming ECG data was "excellent", with mean transfer time for an ECG wave complex measured at just 72 seconds.

Thus, on this second attempt feasibility was demonstrated in the two essential parameters: rapid transfer time of ECG data; and the continuity of ECG information between individual mobile phones and the medical centre.

Next on the agenda, say the investigators, is a miniaturised ECG device "to improve comfort and acceptance". And generally, they add, the system should ideally "be able to transmit ECG signals reliably, even under extreme conditions, such as running, with extensive body movements of the sweating athletes. Moreover, there should be no interruption in ECG data transfer within a mobile phone network, even under the condition of an extreme workload caused by thousands of mobile phone customers (athletes and spectators) allocated in a very limited geographical area".

As background to the study the investigators note that sudden cardiac death is rare - though not unknown - among marathon runners and other endurance athletes. In 2012 one 42-year-old runner died at the end of the London marathon, the event's second death in three years. All such tragic events are widely publicised - as in the case of UK soccer player Fabrice Muamba, whose heart stopped for 78 minutes during a televised game in 2012 - and raise inevitable questions about cardiovascular evaluation in endurance sports. In Italy, for example, the risk of sudden cardiac death is now considered so real that preparticipation screening (with ECG) is obligatory in all athletes and sports players.

This study's principal investigator Professor Friedrich Köhler confirmed that the risk of sudden cardiac death in endurance running is indeed "low", citing a 2012 study in which the incidence of cardiac arrests was put at 0.54 per 100,000 runners. However, he added that preparticipation screening is not able to detect this risk with any certainty.

Now, for real time evaluation to step up from proof of concept to the practical level, there are still technical problems to solve. "First," said Professor Köhler, "we need a way to handle the monitoring of, say, a thousand runners. One solution could be some 'intelligent' IT middleware, which might identify and select all pathological ECG findings for further analysis in the telemedical centre. And second, if the system does signal an abnormal ECG, how do we identify that individual runner at risk among so many runners - and how do we alert the paramedics out on the course?"

Nevertheless, the two experiments reported today suggest that the concept works, and Professor Köhler indicated its high public health potential in other areas. "The marathon might be just a first indication for the continuous surveillance of vital parameters with mobile phone technology," he said. "There are opportunities in other endurance sports and even in other fields - perhaps in the drivers of high speed express

trains."

More information: Spethman S, Prescher S, Dreger H, et al. Electrocardiographic monitoring during marathon running: A proof of feasibility for a new telemedical approach. *Eur J Prevent Cardiol* 2014: DOI: 10.1177/2047487314553736

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