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### Prehospital logistics and therapy delays in urban vs. rural regions: implications for quality of acute ST-elevation myocardial infarction care

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**Background:** Treatment and time goals for STEMI care are clearly defined in national and international guidelines. However, initiation of therapy relies in accurate diagnosis after first medical contact (FMC). Prehospital logistics with fast transfer to the next available 24/7 PCI-center can be challenging, especially in rural areas and for transfers across state-borders in Germany.

**Objective:** To analyze quality of STEMI care in a high volume PCI center serving a city and a large rural area with focus on EMS (emergency medical service) logistics. Two groups of patients admitted by EMS: (1) direct PCI-center admission vs. (2) secondary admission after transfer from a non-PCI hospital were compared.

**Methods:** Various administrative, procedural, therapeutic and clinical parameters were registered for each patient including timelines of acute treatment (tables). Inaccurate treatment delays were calculated as cumulative time in any prolongation in timely diagnosis or therapy after FMC.

**Results:** From 340 consecutive STEMI patients in or registry, 299 patients were transferred by EMS. Reperfusion therapy with PPCI was significantly delayed and required double of the time in patients secondary transferred from a non-PCI hospital (Contact-to-Balloon: 195.6±134.8 min vs. 99.6±45.3 min, p<0.001, table 1). An inaccurate delay in timely treatment (delay in correct diagnosis or deferred therapy) was determined in 45% of the patients transferred from non-PCI hospitals vs 26% of directly

admitted patients (p=0.02, table 1). Accordingly, correct STEMI diagnosis was established by EMS physician prehospital only in 7.1% in the transfer group vs. 61.9% in the direct admission group (p<0.001, table 1). Our data suggest different reasons for STEMI patients falsely transferred to non-PCI hospitals: a) lower qualification of EMS personnel with ECG misinterpretation and/or false working diagnosis, b) inadequate prehospital logistics with transfer of patients to the next near-by hospital instead of next PCI-center, c) personal or system "thresholds" of EMS physicians in rural areas preventing a direct transfer to PCI-centers. Further analysis of the transfer group (table 2) showed even longer treatment times for patients transferred across state borders compared to transfers within a state (C2B: 264.8±142.2 vs. 143.7±107.0 min, p<0.05, table 2). Importantly, transfers across state borders were not associated with a longer absolute distance (km) to PCI center. However, a rescue helicopter was used for across-state transfers in one third of the cases.

**Conclusion:** Quality of acute STEMI care is significantly worse in rural areas predominantly due to suboptimal prehospital logistics and poor pre-hospital emergency care. Our data underline the importance to establish local STEMI networks irrespective of state borders with clearly defined pre-hospital transfer strategies, continuous medial education of EMS personnel and assesment of local quality of care.

**Table 1: Logistics of emergency medical service (EMS) and quality of care comparing patients with direct admission to PCI center vs. patients transferred from non-PCI hospitals**

|  | Transfer from non-PCI hospital | Direct admission to PCI-center | p       |
|--|--------------------------------|--------------------------------|---------|
| N  | 42                             | 257                            |         |
| Use of rescue helicopter                                     | 20.5 %                         | 0 %                            | < 0.001 |
| Delay of timely treatment (%)                                | 44.7 %                         | 25.8 %                         | 0.020   |
| Prehospital source of delay                                  | 70.6 %                         | 83.6 %                         | n.s.    |
| Delay of timely treatment (min)                              | 128.8 ± 121.2                  | 73.5 ± 61.6                    | 0.025   |
| Prehospital time (min)                                       | 76.3 ± 45.2                    | 47.2 ± 21.9                    | 0.022   |
| On call hours  | 57.1 %                         | 51.4 %                         | n.s.    |
| Alert of PCI center prior EMS arrival & direct cath transfer | 66.7 %                         | 72.4 %                         | n.s.    |
| No prehospital ECG recording                                 | 10.0 %                         | 6.3 %                          | n.s.    |
| Physician establishing STEMI diagnosis (cases, %)            |                                |                                | < 0.001 |
| Primary care physician                                       | 2.4 %                          | 10.5 %                         |         |
| EMS physician  | 7.1 %                          | 61.9 %                         |         |
| Emergency room physician (total cases, %)                    | 83.3 %                         | 18.7 %                         |         |
| ER physician in referring hospital                           | 69.0 %                         | n/a                            |         |
| ER physician in PCI-center                                   | 14.3 %                         | 18.7 %                         |         |
| Cardiologist of PCI-center                                   | 7.1 %                          | 6.6 %                          |         |
| Door-to-cath (min)   | 49.3 ± 105.1                   | 22.9 ± 43.4                    | 0.005   |
| Door-to-balloon (min)  | 84.4 ± 111.0                   | 55.0 ± 47.5                    | 0.004   |
| Contact-to-balloon (min)                                     | 195.6 ± 134.8                  | 99.6 ± 45.3                    | <0.001  |

**Table 2: Logistics of EMS and quality of care comparing patients transferred from non-PCI hospitals within state vs. across state borders. \*p < 0.05**

|                                 | Transfer within state (N = 28) | Transfer across state borders (N = 14) |
|---------------------------------|--------------------------------|--|
| Use of rescue helicopter        | 8.3 %                          | 28.6 %                                 |
| Prehospital time (min)          | 62.7 ± 40.8                    | 108.3 ± 77.5                           |
| Door-to-cath (min)              | 38.7 ± 62.1                    | 30.0 ± 52.1                            |
| Cath-to-puncture (min)          | 13.2 ± 7.1                     | 12.0 ± 5.9                             |
| Puncture-to-balloon (min)       | 19.0 ± 8.6                     | 21.5 ± 14.4                            |
| Door-to-balloon (min)           | 71.9 ± 70.3                    | 67.9 ± 62.6                            |
| Contact-to-balloon (min)        | 143.7 ± 107.0                  | 264.8 ± 142.2*                         |
| Delay of timely treatment       | 32.0 %                         | 69.2 %*                                |
| Delay of timely treatment (min) | 133.3 ± 104.3                  | 124.2 ± 146.2                          |