Supplementary table 1. Characteristics of the study population in witnessed and unwitnessed patients by study phase

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Witnessed | *p* value | Unwitnessed |  | *p* value |
|  |  | Phase I | Phase II | Phase III | Phase IV | 　 | Phase I | Phase II | Phase III | Phase IV |  |
| 　 | 　 | N | % | N | % | N | % | N | % | 　 | N | % | N | % | N | % | N | % | 　 |
| Total |  | 3747 | ` | 3491 | 100.0 | 3766 | 100.0 | 3485 | 100.0 |  | 4810 | 100.0 | 4296 | 100.0 | 4727 | 100.0 | 4341 | 100.0 |  |
| Gender, Female | 1270 | 33.9 | 1118 | 32.0 | 1310 | 34.8 | 1190 | 34.1 | 0.08 | 1703 | 35.4 | 1457 | 33.9 | 1621 | 34.3 | 1473 | 33.9 | 0.38 |
| Age, year, median (IQR) | 72 (58-80) | 70 (56-80) | 72 (59-80) | 70 (57-80) | <0.01 | 73 (59-80) | 71 (58-80) | 73 (59-80) | 72 (58-80) | 0.03 |
| Season |  |  |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | <0.01 |
|  | March to May | 1889 | 50.4 | 0 | 0.0 | 1837 | 48.8 | 0 | 0.0 |  | 2448 | 50.9 | 0 | 0.0 | 2319 | 49.1 | 0 | 0.0 |  |
|  | June to August | 553 | 14.8 | 1043 | 29.9 | 501 | 13.3 | 1086 | 31.2 |  | 638 | 13.3 | 1251 | 29.1 | 637 | 13.5 | 1314 | 30.3 |  |
|  | September to November | 0 | 0.0 | 1751 | 50.2 | 0 | 0.0 | 1732 | 49.7 |  | 0 | 0.0 | 2205 | 51.3 | 0 | 0.0 | 2168 | 49.9 |  |
|  | December to February | 1305 | 34.8 | 697 | 20.0 | 1428 | 37.9 | 667 | 19.1 |  | 1724 | 35.8 | 840 | 19.6 | 1771 | 37.5 | 859 | 19.8 |  |
| Event at weekend | 1130 | 30.2 | 1089 | 31.2 | 1140 | 30.3 | 1012 | 29.0 | 0.28 | 1359 | 28.3 | 1226 | 28.5 | 1386 | 29.3 | 1204 | 27.7 | 0.40 |
| Event Time |  |  |  |  |  |  |  |  | 0.77 |  |  |  |  |  |  |  |  | 0.54 |
|  | 00-05 | 463 | 12.4 | 389 | 11.1 | 427 | 11.3 | 410 | 11.8 |  | 602 | 12.5 | 497 | 11.6 | 594 | 12.6 | 507 | 11.7 |  |
|  | 06-11 | 1259 | 33.6 | 1202 | 34.4 | 1273 | 33.8 | 1188 | 34.1 |  | 1734 | 36.0 | 1596 | 37.2 | 1686 | 35.7 | 1619 | 37.3 |  |
|  | 12-17 | 1058 | 28.2 | 1019 | 29.2 | 1117 | 29.7 | 1029 | 29.5 |  | 1340 | 27.9 | 1199 | 27.9 | 1333 | 28.2 | 1165 | 26.8 |  |
|  | 18-23 | 967 | 25.8 | 881 | 25.2 | 949 | 25.2 | 858 | 24.6 |  | 1134 | 23.6 | 1004 | 23.4 | 1114 | 23.6 | 1050 | 24.2 |  |
| Metropolis | 1647 | 44.0 | 1585 | 45.4 | 1690 | 44.9 | 1507 | 43.2 | 0.27 | 2046 | 42.5 | 1785 | 41.6 | 1908 | 40.4 | 1749 | 40.3 | 0.09 |
| Place of event |  |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | 0.43 |
|  | Public | 800 | 21.4 | 844 | 24.2 | 876 | 23.3 | 869 | 24.9 |  | 830 | 17.3 | 755 | 17.6 | 816 | 17.3 | 746 | 17.2 |  |
|  | Private | 2910 | 77.7 | 2594 | 74.3 | 2828 | 75.1 | 2539 | 72.9 |  | 3908 | 81.2 | 3460 | 80.5 | 3837 | 81.2 | 3540 | 81.5 |  |
|  | Other | 37 | 1.0 | 53 | 1.5 | 62 | 1.6 | 77 | 2.2 |  | 72 | 1.5 | 81 | 1.9 | 74 | 1.6 | 55 | 1.3 |  |
| Co-morbidity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Diabetes | 727 | 19.4 | 717 | 20.5 | 812 | 21.6 | 702 | 20.1 | 0.13 | 993 | 20.6 | 907 | 21.1 | 985 | 20.8 | 957 | 22.0 | 0.38 |
|  | Hypertension | 1110 | 29.6 | 1143 | 32.7 | 1284 | 34.1 | 1148 | 32.9 | <0.01 | 1371 | 28.5 | 1312 | 30.5 | 1423 | 30.1 | 1325 | 30.5 | 0.10 |
|  | Heart disease | 599 | 16.0 | 580 | 16.6 | 715 | 19.0 | 556 | 16.0 | <0.01 | 680 | 14.1 | 645 | 15.0 | 682 | 14.4 | 607 | 14.0 | 0.53 |
|  | Stroke | 290 | 7.7 | 303 | 8.7 | 320 | 8.5 | 276 | 7.9 | 0.40 | 344 | 7.2 | 304 | 7.1 | 355 | 7.5 | 294 | 6.8 | 0.60 |
| Bystander CPR | 2344 | 62.6 | 2264 | 64.9 | 2527 | 67.1 | 2352 | 67.5 | <0.01 | 2398 | 49.9 | 2192 | 51.0 | 2529 | 53.5 | 2346 | 54.0 | <0.01 |
| Tiered response system |  |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | <0.01 |
|  | Single-tiered | 3474 | 92.7 | 2519 | 72.2 | 1948 | 51.7 | 1368 | 39.3 |  | 4476 | 93.1 | 3088 | 71.9 | 2456 | 52.0 | 1755 | 40.4 |  |
|  | MTR with ambulance | 268 | 7.2 | 746 | 21.4 | 1544 | 41.0 | 1902 | 54.6 |  | 329 | 6.8 | 942 | 21.9 | 1886 | 39.9 | 2301 | 53.0 |  |
|  | MTR with fire engine | 5 | 0.1 | 226 | 6.5 | 274 | 7.3 | 215 | 6.2 |  | 5 | 0.1 | 266 | 6.2 | 385 | 8.1 | 285 | 6.6 |  |
| Primary ECG |  |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | <0.01 |
|  | VF/pulseless VT | 919 | 24.5 | 961 | 27.5 | 1025 | 27.2 | 1038 | 29.8 |  | 474 | 9.9 | 451 | 10.5 | 518 | 11.0 | 488 | 11.2 |  |
|  | PEA | 584 | 15.6 | 578 | 16.6 | 663 | 17.6 | 635 | 18.2 |  | 442 | 9.2 | 408 | 9.5 | 494 | 10.5 | 482 | 11.1 |  |
|  | Asystole | 2244 | 59.9 | 1952 | 55.9 | 2078 | 55.2 | 1812 | 52.0 |  | 3894 | 81.0 | 3437 | 80.0 | 3715 | 78.6 | 3371 | 77.7 |  |
| Response time interval, min |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | <0.01 |
|  | 0-3 | 313 | 8.4 | 222 | 6.4 | 220 | 5.8 | 137 | 3.9 |  | 438 | 9.1 | 253 | 5.9 | 298 | 6.3 | 197 | 4.5 |  |
|  | 4-7 | 1850 | 49.4 | 1823 | 52.2 | 2090 | 55.5 | 1810 | 51.9 |  | 2319 | 48.2 | 2343 | 54.5 | 2621 | 55.4 | 2273 | 52.4 |  |
|  | 8-11 | 1029 | 27.5 | 936 | 26.8 | 947 | 25.1 | 972 | 27.9 |  | 1309 | 27.2 | 1066 | 24.8 | 1179 | 24.9 | 1201 | 27.7 |  |
|  | 12+ | 555 | 14.8 | 510 | 14.6 | 509 | 13.5 | 566 | 16.2 |  | 744 | 15.5 | 634 | 14.8 | 629 | 13.3 | 670 | 15.4 |  |
|  | Median (IQR) | 7 (5-10) | 7 (5-9) | 7 (5-9) | 7 (5-10) | <0.01 | 7 (5-10) | 7 (5-9) | 7 (5-9) | 7 (5-9) | <0.01 |
| Scene time interval, min |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | <0.01 |
|  | 0-3 | 99 | 2.6 | 35 | 1.0 | 42 | 1.1 | 60 | 1.7 |  | 116 | 2.4 | 34 | 0.8 | 48 | 1.0 | 64 | 1.5 |  |
|  | 4-7 | 829 | 22.1 | 340 | 9.7 | 272 | 7.2 | 289 | 8.3 |  | 1138 | 23.7 | 360 | 8.4 | 326 | 6.9 | 353 | 8.1 |  |
|  | 8-11 | 1445 | 38.6 | 1223 | 35.0 | 1074 | 28.5 | 843 | 24.2 |  | 1919 | 39.9 | 1563 | 36.4 | 1405 | 29.7 | 1070 | 24.6 |  |
|  | 12+ | 1374 | 36.7 | 1893 | 54.2 | 2378 | 63.1 | 2293 | 65.8 |  | 1637 | 34.0 | 2339 | 54.4 | 2948 | 62.4 | 2854 | 65.7 |  |
|  | Median (IQR) | 10 (8-13) | 12 (9-16) | 13 (10-18) | 14 (10-19) | <0.01 | 10 (7-13) | 12 (9-16) | 13 (10-18) | 14 (10-18) | <0.01 |
| Transport time interval, min |  |  |  |  |  |  |  | 0.22 |  |  |  |  |  |  |  |  | 0.02 |
|  | 0-3 | 649 | 17.3 | 577 | 16.5 | 654 | 17.4 | 577 | 16.6 |  | 806 | 16.8 | 772 | 18.0 | 809 | 17.1 | 836 | 19.3 |  |
|  | 4-7 | 1598 | 42.6 | 1497 | 42.9 | 1512 | 40.1 | 1448 | 41.5 |  | 2086 | 43.4 | 1862 | 43.3 | 2017 | 42.7 | 1798 | 41.4 |  |
|  | 8-11 | 758 | 20.2 | 731 | 20.9 | 778 | 20.7 | 726 | 20.8 |  | 963 | 20.0 | 809 | 18.8 | 937 | 19.8 | 899 | 20.7 |  |
|  | 12+ | 742 | 19.8 | 686 | 19.7 | 822 | 21.8 | 734 | 21.1 |  | 955 | 19.9 | 853 | 19.9 | 964 | 20.4 | 808 | 18.6 |  |
|  | Median (IQR) | 6 (4-10) | 6 (4-10) | 7 (4-11) | 6 (4-10) | 0.45 | 6 (4-10) | 6 (4-10) | 6 (4-10) | 6 (4-10) | 0.12 |
| Prehospital airway |  |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | <0.01 |
|  | ETI  | 198 | 5.3 | 253 | 7.2 | 299 | 7.9 | 281 | 8.1 |  | 234 | 4.9 | 243 | 5.7 | 341 | 7.2 | 297 | 6.8 |  |
|  | SGA | 918 | 24.5 | 1303 | 37.3 | 1898 | 50.4 | 2022 | 58.0 |  | 987 | 20.5 | 1436 | 33.4 | 2244 | 47.5 | 2338 | 53.9 |  |
|  | BVM | 2631 | 70.2 | 1935 | 55.4 | 1569 | 41.7 | 1182 | 33.9 |  | 3589 | 74.6 | 2617 | 60.9 | 2142 | 45.3 | 1706 | 39.3 |  |
| EMS resuscitation  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | EMS defibrillation | 1213 | 32.4 | 1235 | 35.4 | 1303 | 34.6 | 1288 | 37.0 | <0.01 | 804 | 16.7 | 777 | 18.1 | 867 | 18.3 | 814 | 18.8 | 0.06 |
|  | Fluid resuscitation | 336 | 9.0 | 686 | 19.7 | 1194 | 31.7 | 1338 | 38.4 | <0.01 | 329 | 6.8 | 698 | 16.2 | 1300 | 27.5 | 1497 | 34.5 | <0.01 |
|  | IV medication | 63 | 1.7 | 266 | 7.6 | 517 | 13.7 | 587 | 16.8 | <0.01 | 74 | 1.5 | 277 | 6.4 | 605 | 12.8 | 688 | 15.8 | <0.01 |
|  | EMS mechanical CPR | 9 | 0.2 | 27 | 0.8 | 101 | 2.7 | 151 | 4.3 | <0.01 | 14 | 0.3 | 39 | 0.9 | 94 | 2.0 | 211 | 4.9 | <0.01 |
| Level of ED |  |  |  |  |  |  |  |  | <0.01 |  |  |  |  |  |  |  |  | <0.01 |
|  | Level 1 | 455 | 12.1 | 424 | 12.1 | 721 | 19.1 | 677 | 19.4 |  | 495 | 10.3 | 418 | 9.7 | 794 | 16.8 | 753 | 17.3 |  |
|  | Level 2 | 2027 | 54.1 | 1928 | 55.2 | 1767 | 46.9 | 1738 | 49.9 |  | 2393 | 49.8 | 2147 | 50.0 | 2109 | 44.6 | 1953 | 45.0 |  |
|  | Level 3 | 1265 | 33.8 | 1139 | 32.6 | 1278 | 33.9 | 1070 | 30.7 |  | 1922 | 40.0 | 1731 | 40.3 | 1824 | 38.6 | 1635 | 37.7 |  |
| Post–resuscitation care |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | PCI | 150 | 4.0 | 157 | 4.5 | 165 | 4.4 | 158 | 4.5 | 0.67 | 43 | 0.9 | 57 | 1.3 | 51 | 1.1 | 67 | 1.5 | 0.03 |
|  | TTM | 116 | 3.1 | 144 | 4.1 | 127 | 3.4 | 136 | 3.9 | 0.07 | 79 | 1.6 | 52 | 1.2 | 66 | 1.4 | 79 | 1.8 | 0.10 |
|  | ECMO | 44 | 1.2 | 48 | 1.4 | 36 | 1.0 | 40 | 1.1 | 0.43 | 19 | 0.4 | 19 | 0.4 | 10 | 0.2 | 21 | 0.5 | 0.15 |
| Outcomes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Prehospital ROSC | 466 | 12.4 | 566 | 16.2 | 680 | 18.1 | 698 | 20.0 | <0.01 | 171 | 3.6 | 206 | 4.8 | 295 | 6.2 | 287 | 6.6 | <0.01 |
|  | Survival to discharge | 416 | 11.1 | 472 | 13.5 | 504 | 13.4 | 533 | 15.3 | <0.01 | 155 | 3.2 | 161 | 3.7 | 170 | 3.6 | 178 | 4.1 | 0.16 |
| 　 | Good CPC | 292 | 7.8 | 320 | 9.2 | 340 | 9.0 | 364 | 10.4 | <0.01 | 95 | 2.0 | 80 | 1.9 | 102 | 2.2 | 89 | 2.1 | 0.79 |

IQR, interquartile range; CPR, cardiopulmonary resuscitation; MTR, multi-tiered response; ECG, electrocardiogram; VF, ventricular fibrillation; VT, ventricular tachycardia; PEA, pulseless electrical activity; ETI, endotracheal intubation; SGA, supraglottic airway; BVM, bag-valve mask; EMS, emergency medical service; IV, intravenous; ED, emergency department; PCI, percutaneous coronary intervention; TTM, target temperature management; ECMO, extracorporeal membrane oxygenation; ROSC, return-of-spontaneous circulation; CPC, cerebral performance category

Supplemental table 2. Characteristics of multi-tiered response system

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Number of vehicles | Total | Single-tiered | MTR with ambulance | MTR with fire engine |
| 　 | N | % | N | % | N | % | N | % |
| Total |  | 32663 | 100.0 | 21084 | 100.0 | 9918 | 100.0 | 1661 | 100.0 |
| Ambulance | 0 | 22335 | 68.4 | 20765 | 98.5 | 0 | 0.0 | 1570 | 94.5 |
|  | 1 | 9882 | 30.3 | 318 | 1.5 | 9473 | 95.5 | 91 | 5.5 |
|  | 2 | 430 | 1.3 | 1 | 0.0 | 429 | 4.3 | 0 | 0.0 |
|  | 3 | 15 | 0.0 | 0 | 0.0 | 15 | 0.2 | 0 | 0.0 |
|  | 4 | 1 | 0.0 | 0 | 0.0 | 1 | 0.0 | 0 | 0.0 |
| Fire engine | 0 | 29249 | 89.5 | 21048 | 99.8 | 8201 | 82.7 | 0 | 0.0 |
| 　 | 1 | 3414 | 10.5 | 36 | 0.2 | 1717 | 17.3 | 1661 | 100.0 |

MTR, multi-tiered response