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Fusion of dispatching centres into one entity: effects on performance

T. Määttä[1], M. Kuisma[1], T. Väyrynen[1], M. Nousila-Wiik[2], K. Porthan[3], J. Boyd[1], J. Kuosmanen[1] and P. Räsänen[4]
[1]*Emergency Medical Service, Helsinki University Central Hospital, Helsinki, Finland,* [2]*Emergency Response Centre, Helsinki, Finland,* [3]*Helsinki City Rescue Department, Helsinki, Finland and* [4]*Finnish Office for Health Technology Assessment at the National Institute for Health and Welfare, Helsinki, Finland*

Background: Dispatching centres were fused into one of the 112 entity, which caused concerns regarding whether the medical calls could be processed effectively also in the new centre. We evaluated the effects of the reform on key performance criteria in medical calls.
Methods: This observational study in the Helsinki Dispatching Centre consisted of two periods: Period I 2 years before the reform and Period II 2 years after. The main outcome measures were answering and call processing times, accuracy of risk assessment and appropriate use of ambulances.
Results: In Period I ($n = 574{,}276$), 92.2% of all incoming phone calls were answered within 10 s and in Period II ($n = 758{,}022$) 82.8% ($P < 0.0001$). Time to dispatch a first responding fire unit increased from 98 to 113 s ($P < 0.0001$) and an advanced life support unit in category A calls increased from 73 to 84 s ($P < 0.0001$). In Period I 47.7%, 34.8% and 17.5% of phone calls were completed in <3, 3–5 and >5 min and in Period II 29.8%, 36.1% and 34.1% ($P < 0.0001$). The number of three studied non-transportation call types and unnecessary lights-and-siren responses increased significantly ($P < 0.0001$ and 0.0001, respectively). Neither the accuracy of risk assessment in the three studied call types nor the rate of telephone-guided cardiopulmonary resuscitation changed.
Conclusions: The reform increased the total number of ambulance dispatches, prolonged answering and call processing times and had a negative effect on the appropriate use of ambulances. The accuracy of risk assessment was not affected. Evidence-based data should be the basis for the future as dispatching centre processes are shown to be vulnerable during organisational reforms.

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The dispatching centre is the key link in the chain of emergency care. However, access of citizens to the system, system structure, processes and staff qualifications vary considerably.[1] Police, fire service and ambulance services may all have separate emergency phone numbers, two of the services may have a common number or all may have one common number. The common centre may process the phone call from the very beginning to the end or act only as a call-taker and then forward the call to the centre of the appropriate authority. Regardless of the system, the calls should be answered without delay, processing should be prompt and accurate and finally, ambulance resources should be used wisely.

Decisions concerning reforms in dispatching services have been made based merely on expert opinions, finance and politics rather than on evidence-based data. In Finland, the model in which all emergency phone calls (police, fire, ambulance and, to some extent, acute social care) are handled by one centre was only piloted outside the Helsinki Metropolitan area. The analysis of pilot results was focused on the overall costs and savings in the number of personnel rather than the performance itself. Later, the municipal dispatching centre for fire and medical emergencies (112) and police alarm centre (10022) in the capital city were fused into one governmental 112 entity.

The purpose of the study was to evaluate the effects of the dispatching centre fusion on system performance criteria related to answering and processing emergency medical calls, the accuracy of risk assessment in certain critical call types and the use of ambulance resources. Our hypothesis was that the key performance criteria would not be affected by the reform.

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Material and methods

Study setting and type

The study was conducted in the Helsinki dispatching centre (i.e. emergency medical communication centre) and in emergency medical service (EMS). The study plan was approved by the institutional review board of Helsinki University Central Hospital. In this observational and controlled study, we compared the key performance criteria before and after the dispatching centre reform. The key performance criteria used were chosen based on their routine use for quality management purposes or on the medical literature (Table 1).

Emergency medical phone call processing

Each emergency phone call is processed by one dispatcher from the beginning to the end. The dispatcher identifies the medical need, decides on a priority and defines a response or makes a do-not-dispatch decision. Emergency medical calls are prioritised into four urgency categories from A (highest) to D (lowest). A more detailed description of the medical priority dispatching model used and its safety has been published elsewhere.[2,3] Dispatching of an ambulance or a first responding fire unit (FRU) should be done within 90 s from the time the call is answered in high-risk A and B calls. Call processing times and time intervals are defined in Table 2.

Table 1

Key performance criteria of the ambulance dispatch centre.

Area	Criteria
Access of citizens to the system	Time to answer an emergency phone call
Call processing times	Time to dispatch an FRU
	Time to dispatch an ALS unit
	Time to close the call
Accuracy of risk assessment	Cardiac arrest
	Stroke
	STEMI
Telephone-guided first aid	Telephone-guided CPR
The use of ambulance resources	Non-transportation ambulance calls
	Unnecessary lights-and-siren ambulance calls
	All ambulance dispatches

The table describes the key performance criteria according to the area used in the study.
FRU, first responding unit; ALS, advanced life support; STEMI, ST-elevation acute myocardial infarction; MICU, mobile intensive care unit; CPR, cardiopulmonary resuscitation.

Table 2

Definitions.

Calls	*Definition*
Phone call	An emergency phone call received and processed in the dispatching centre
Ambulance call	An emergency phone call resulting in dispatching ambulance service. One or more units may be dispatched to take care of a single ambulance call
MCI call	Multiple casualty incident e.g., traffic accidents and residential fires with several injured, requiring a simultaneous response from fire service, police and EMS
Time	*Definition*
Income	Time when the phone call is first registered in the computerised system i.e., time zero
Answer	Time when the phone call is answered by the dispatcher
Dispatch	Time when the dispatching decision has been made and the dispatcher sends a computerised message to a unit/units. When more than one unit is dispatched the time may be the same for all units or there may be several times
End	The time when the phone call is finished
Time intervals	*Definition*
Answering time	Time from phone call income to answering
EMD response interval	Time from phone call income to dispatching of first unit (an ambulance or an FRU), ALS unit or MICU
Total call processing time	Time from phone call income to the end of the call

Definitions for calls, phone call processing times and time intervals. The time accuracy is 1 s.
EMS, emergency medical service; EMD, emergency medical dispatching; FRU, first responding unit; ALS, advanced life support; MICU, physician staffed mobile intensive care unit.

EMS

Helsinki EMS is three tiered, and the services for urgent (A, B and C) calls are provided by the Rescue Department. The first tier consists of basic life support ambulances and fire engines used as FRUs. FRUs are only used in A and high-risk B calls if there is no ambulance immediately available nearby. The second tier consists of advanced life support (ALS) ambulances and one medical supervisor unit. One physician-staffed mobile intensive care unit (MICU) makes up the third tier. Patients who are not transported to emergency departments (ED) have a 10-point classification for non-transportation decisions.

Dispatching centre reform

The dispatching centre reform took place in Helsinki Metropolitan Area. The municipal dispatching centre for fire and medical emergencies (112),

and police alarm centre (10022) were fused into one governmental 112 entity. Before the reform, the dispatching centre served Helsinki (population 560,000) and six neighbouring cities and municipalities (population 467,000), whereas the police alarm centre served only the city of Helsinki. After the reform, the new centre served only the city of Helsinki, but in addition to emergency medical and fire calls, it handled all police phone calls as well. Before the reform, medical calls were processed by qualified emergency dispatchers and after the reform either by qualified emergency dispatchers or by police officers.

Data collection

The data only contain medical phone calls (out-of-hospital acute medical conditions and trauma), except for answering time analysis, in which all incoming emergency calls were included. Data were collected from the electronic database, where all critical time-intervals, codes, urgencies and level of response are automatically registered. Additional data were retrieved from EMS cardiac arrest and ST-elevation acute myocardial infarction (STEMI) registries. Cardiac arrest data collection was performed according to the Utstein style.[4] In 2008, after the end of study period II, Utstein guidelines for reporting on emergency medical dispatch when conducting research in emergency medicine were published.[5] These guidelines were followed when writing this report, if appropriate.

We divided the study into two time periods. Period I (1 October 2003–30 September 2005) was the time before the reform and Period II (1 October 2005–30 September 2007) the time after the reform. For some of the data, we subdivided the two groups into 1-year periods to determine possible trends within the groups.

Statistical analysis

Statistical analysis was performed using SPSS for Macintosh version 16.0 statistical software (SPSS Inc., Chicago, IL). For normally distributed continuous variables, mean and standard deviation are presented and an independent-samples *t*-test was used as a test of significance. Median and interquartile range (IQR) are presented for non-normally distributed data and the Mann–Whitney *U*- or the Kruskal–Wallis test was used as a test of significance. All categorical variables were analysed using a χ^2 test or Fischer's exact test. All significance tests were two-tailed, with $P \leq 0.05$ considered statistically significant. Continuous values with large *n* values (i.e. answering time and the total phone call processing time) were categorised to facilitate statistical analysis.

Results

Access of citizens to the system

Answering time. Period I included 574,276 and Period II 758,022 incoming emergency phone calls with complete data available. The calls without complete data were excluded (3.8% and 9.1% in Periods I and II, consequently). The median answering time interval increased from 2 s (IQR 2–3 s) in Period I to 3 s (IQR 2–6 s) in Period II. In Period I, 92.2% and in Period II 82.8% of the phone calls were answered within 10 s ($P < 0.0001$).

Call processing times

Time to dispatch an FRU. In potentially life-threatening calls, an FRU was dispatched 2002 times during Period I and 2404 times during Period II. The median time to dispatch an FRU increased from 98 s (IQR 63–147) to 113 s (IQR 70–169) between periods ($P < 0.0001$).

Time to dispatch ALS. In urgency category A calls, an ALS unit or MICU was dispatched either simultaneously with an FRU or later during the call processing 5185 times in Period I and 6858 times in Period II. The median time to dispatch an ALS unit increased from 73 s (IQR 49–109) to 84 s (IQR 56–125) between periods ($P < 0.0001$).

Dispatching times in cardiac arrest. Both time to dispatch a first vehicle and the MICU in verified cardiac arrest calls were lengthened after the reform ($P < 0.0001$ and 0.0001) (Table 3).

Table 3

Dispatching times in cardiac arrest.

Parameter	Period I	Period II
Time to first unit (s)	72 (47–106)	82 (57–126)
Time to MICU (s)	152 (89–221)	168 (105–266)

The table reports time (s) to dispatch a first unit (an ambulance or an FRU) and the MICU in cardiac arrest calls ($n = 1160$). EMS-witnessed cardiac arrests are not included. Times to dispatch the MICU are presented only for calls that were dispatched in A priority primarily ($n = 899$). Data are presented as medians (IQR).
FRU, first responding unit; MICU, mobile intensive care unit; IQR, interquartile range.

Time to dispatch EMS in multiple casualty incidents (MCIs). There were 82 MCIs . The time to dispatch EMS was 110 s (IQR 72–160) during Period I and 105 s (IQR 78–151) during Period II ($P = 0.860$).

Total phone call processing time. The total median time used for processing an emergency medical phone call ($n = 195{,}989$) was 3 min 5 s in Period I and 4 min 2 s in Period II. The median times for call processing are presented in 3-month periods in Fig. 1. Immediately after the reform, the total call processing time was significantly increased, and at the same time, it became more variable. In Period I 47.7%, 34.8% and 17.5% of phone calls were completed in <3, 3–5 and >5 min and in Period II 29.8%, 36.1% and 34.1% ($P < 0.0001$).

Accuracy of risk assessment

Cardiac arrest. Cardiac arrest was recognised by the dispatcher in 280 cases of 401 (69.8%) in Period I and in 291 cases of 418 (69.6%) in Period II ($P = 1.000$). A small minority of cardiac arrest calls were assigned to C or D urgency categories, i.e. 3.7% ($n = 15$) during Period I and 3.6% ($n = 15$) during Period II ($P = 1.000$).

Stroke. The proportion of calls classified as any other code but stroke, but transported from the scene to ED as suspected stroke (negative quality indicator) after emergency medical technician or paramedic evaluation, remained at the previous level, $P = 0.249$ (Table 4). Patients who received an urgency category C response (no lights and siren) in the dispatching phase but were transported to ED in urgency category B (lights and siren) as candidates for stroke thrombolysis comprised approximately 15% of all transported stroke patients in both periods, $P = 0.452$.

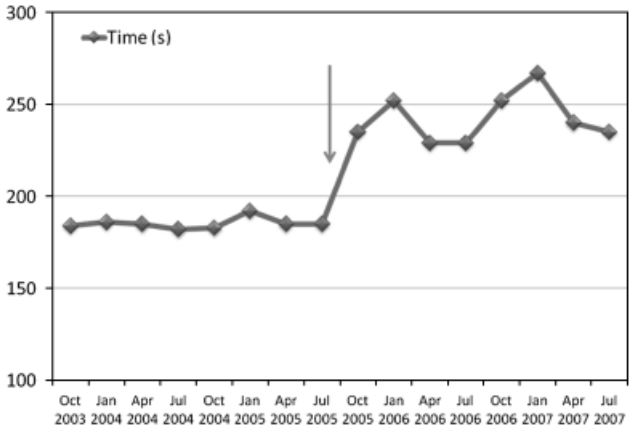

*Fig. 1. Median phone call processing times (s) presented in sixteen 3-month periods (*n *= 195,989). The first period begins 1 October 2003 and the last period ends 30 September 2007. Each 3-month period is named according to the first month and the year. The time of dispatching centre reform is marked with an arrow.*

Table 4

Risk assessment in stroke calls.

Parameter	Period I, *n* (%)	Period II, *n* (%)
Transported as stroke	713 (100)	639 (100
Transported as stroke but dispatched with other code	324 (45.4)	270 (42.2)
Dispatched with C urgency but transported with B		
Urgency as a candidate for stroke thrombolysis	116 (16.3)	94 (14.7)

The table reports the accuracy of risk assessment in stroke calls, B urgency, emergency, with lights and siren, C urgency, urgent, without lights and siren.

STEMI. Out of all calls with on-scene verified diagnosis of STEMI, 46.9% ($n = 99$) were primarily classified as urgency A in Period I and 47.9% ($n = 104$) in Period II, $P = 0.847$. In the rest of the cases, a secondary request for the MICU or a medical supervisor unit had to be made. The median (IQR) arrival time of the MICU or a medical supervisor unit at the patient's side was 25 (15–38) min in Period I and 24 (15–37) min in Period II, $P = 0.73$.

Telephone-guided first aid

Cardiopulmonary resuscitation (CPR). Confirmed cardiac arrests recognised by the dispatcher that had complete data on telephone-guided CPR were included in the analysis. The dispatchers gave telephone-guided CPR instructions in 39.3% of the cases (117 of 298) during Period I and in 43.7% of the cases (128 of 293) during Period II ($P = 0.279$).

The use of ambulance resources

Number of non-transportation calls. Out of the 10 codes for non-transportation causes, we focused on the codes in which no need for a transport was found on scene, no patient was found or the call was cancelled before the ambulance reached the scene. The number of all these three codes increased significantly after the reform, $P < 0.0001$ (Table 5). There was no statistically significant change in the combined number of other seven non-transportation codes between the study periods, $P = 0.280$.

Unnecessary lights-and-siren response. In high-risk calls, the lights-and-siren response was classified as unnecessary if no need for an ambulance transport was found, no patient was found on scene or the call was cancelled before the ambulance reached the scene. There was a statistically significant increase in those calls after the reform, $P < 0.0001$ (Table 6).

Number of ambulance dispatches. In order to place the dispatching centre reform and its effect on call volume into a wider time perspective, we reported the annual number of all ambulance dispatches in categories A, B and C from 2001 to 2009 (Fig. 2). The number of annual dispatches remained constant until the end of year 2005 and was markedly elevated after the reform.

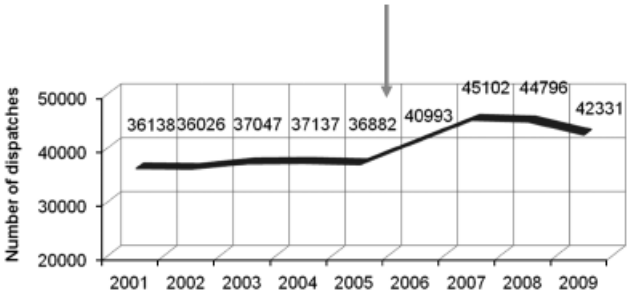

Fig. 2. Urgent ambulance dispatches (categories A–C) from 2001 to 2009. The time of the dispatching centre reform is marked with an arrow. The number of all ambulance dispatches is higher than the call volume used in other parts of the article as more than one unit may have been dispatched to take care of one individual call.

Discussion

Principal findings

After the dispatching centre reform, the number of ambulance calls increased substantially, critical times and time intervals in answering and processing emergency phone calls were lengthened and calls were overtriaged, leading to the overuse of ambulance resources and to potential traffic safety hazards. None of these changes was anticipated by the planners of the reform. The change in the formal qualifications of a dispatcher, the increased turnover rate of dispatchers and unmanageable simultaneous rush hours in police and medical phone calls are possible explanations for these results. Considering advancements in technology, dispatching and call processing times should have been shorter in Period II and not vice versa as they were.

There was no change in the amount of ambulance working hours that obliged the system to work at the upper level of its capacity. It is generally accepted that risk assessment over telephone will result in overtriage. However, there is no consensus of its acceptable level. In the worst case, overtriage will lead to the depletion of ambulance resources and inability to respond to other simultaneous emergencies. Overtriage may also frustrate providers, medical directors and EDs.[6] High overtriage rates have been reported in unconscious patients and cardiac emergencies.[6,7] Overtriage is not specific for dispatching centres, and it exists at all levels of emergency care.[8,9] After the end of Period II, ambulance resources had to be increased permanently because the demand remained constantly high. In our opinion, reference levels for both overtriage and undertriage should be urgently set.

We noticed no significant change in the accuracy of risk assessment of the three studied call categories but the time required for risk assessment was prolonged. Risk assessment findings are probably explained by the fact that the content of the orientation given to new dispatchers was focused on

Table 5

Non-transportation calls.

Parameter	Period I, *n* (%)	Period II, *n* (%)
Non-transported		
# No need	11,005 (73.8)	14,150 (71.7)
# Patient not found	1534 (10.3)	2183 (11.1)
# Call cancelled	2374 (15.9)	3394 (17.2)
Subgroup total	14,913 (58.5)	19,727 (62.5)
*Other non-transportation calls**	10,561 (41.5)	11,822 (37.5)
All non-transported	25,474	31,549
Transported to ED	35,923	38,094

The table reports ambulance calls resulting in a non-transportation decision.
*Including seven non-transportation codes: prehospital death, patient given to police's custody, patient remains waiting for home attending physician of other service, other mode of transportation to ED, patient refusal, no need for transportation after on-site emergency care and ambulance malfunction preventing driving. ED, emergency department.

Table 6

Unnecessary lights and siren response.

Parameter	Period I, *n* (%)	Period II, *n* (%)
Light-and-siren response		
Unnecessary	5641 (21.8)	8335 (26.5)
Necessary	20, 269	23, 137
All	25, 910	31, 472

The table reports ambulance calls with an unnecessary lights and siren response. Many lights-and-siren calls included more than one unit.

protocols that were readily available during call processing to support the risk assessment. Decision making i.e., choosing appropriate resources to be dispatched promptly or withhold dispatching seem to have been more difficult than following the risk assessment pathway itself. The rate of providing telephone-guided CPR remained unchanged.

Relation of results to other studies

We found a cardiac arrest recognition rate of 70% in both study periods. This is comparable to the 71% rate in a recent report from the Netherlands,[10] but even higher rates (77–79%) have been reported in Australia and in a subpopulation found in ventricular fibrillation.[3,11] The positive predictive value in detecting cardiac emergencies by telephone triage has turned out to be poor.[6,12] Risk assessment protocols are not meant to be diagnostic tools but they should support appropriate allocation of limited ALS resources to patients with true cardiac emergencies. In this study, we specifically looked at patients with a final diagnosis of STEMI. The MICU was dispatched primarily in these cases in approximately half of the cases during both study periods. Secondary dispatch results in prolonged time to start prehospital thrombolysis or pharmacological pretreatment for primary coronary intervention.

A report from Los Angeles confirmed previous results that stroke recognition by dispatchers is suboptimal.[13] Only 45% of ambulance-transported patients with a final diagnosis of stroke received a stroke code by dispatchers. Similar results were found in a study from UK.[14] We did not track the final diagnoses but instead we used the results of field clinical examination for comparison. Out of patients meeting field criteria to be a stroke suspect, the same proportion received a stroke code by dispatchers before and after the reform.

The risks associated with lights-and-siren calls have not been considered appropriately. A recent editorial pointed out that sending ambulances and fire engines liberally without adequate medical justification endangers the life of emergency workers as well as the public.[15] In the United States, the annual occupational fatality rate is 12.7/100,000 EMS workers, and during a 10-year period, ambulance crashes killed 357 people.[16,17] It is noteworthy that many lights-and-siren calls may include more than one unit, increasing the risk considerably per one call. In this study, the dispatching centre reform increased the number of unnecessary lights-and-siren calls and thereby the likelihood of ambulance crashes.

Relevance of the study results

The substantial increase of calls in which the answering time is >10 s, prolongation of the total call-processing time by one-third and especially overuse of ambulance resources have direct clinical implications. During rush hours, some callers have waited for an answer up to some minutes, which has delayed the start of emergency care. When call-processing times are long, dispatchers may not able to answer to new phone calls, and when ambulances are busy with overtriaged calls, they may not be available to respond to real emergencies. Even a modest absolute increase in dispatching times may become clinically relevant when added to the currently increasing ambulance driving times caused by traffic congestion.

Our study results highlight that evidence-based medicine should be an integral part of decision making also in dispatching centres. Before nationwide changes are implemented, piloting is needed in rural, suburban and metropolitan areas. Solutions that are found to be good elsewhere may not necessarily work in busy metropolitan areas.[18] Based on our results and experiences, we can say that dispatching centre reforms require comprehensive advance planning, piloting and commitment of all authorities and stakeholders.[19] A formal degree in emergency dispatching should be required from all dispatchers.

Limitations

We failed to retrieve data from unanswered emergency phone calls. If an emergency call is not answered promptly, some callers hang up and redial 112. In those calls, the system registers answering time only from the last call not including the queuing time from previous calls. The evaluation of the accuracy of risk assessment is limited by the fact that we only included three codes. However, the selected three codes represent patients who are likely to benefit from a correct and timely risk assessment. One limitation is the use of only three non-transportation codes as a surrogate for an unnecessary ambulance call. The decision to dispatch an ambulance based on the information received from the caller has inevitably been correct in part of these calls during both study periods. Therefore, the trend in

the proportion of these calls between periods is more important than the actual figures.

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Address:
Dr *Markku Kuisma*
Helsinki University Hospital
PO Box 440
FIN-00029 HUS
Helsinki
Finland
e-mail: markku.kuisma@hus.fi