Pre-hospital medical emergencies services activity over 10 years in an urban setting, in Greece.

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Abstract:
Background: Prehospital emergency medical services (PEMS) are becoming more and more sophisticated as more point-of–care advanced medical technology is available in the field. Yet, the literature around the subject is limited, as data come mainly from Northern Europe, USA, Canada and New Zealand. The aim of this analysis was to describe time trends of PEMS activity in a region of northern Greece.
Methods: Use of data retrospectively collected for PEMS usage, in the regional unit of Thessaloniki, Northern Greece from 2006 to 2015. The area of interest represents a little more than 10% of the total population of Greece.
Results: Total utilization of PEMS shows an overall l4.03% decrease over the decade; yet with an increase in the 2 last years. The mean rate of use was 69/1000 inhabitants for ambulance services and 1.5/1000 for medical interventions (MICU). Cases where the patient cancelled the request for PEMS intervention just before or after arrival of EMS team on the spot and cases where the patient refused transportation to hospital, despite EMS recommendation decreased steadily till 2013 and then increased for the last 2 years. PEMS utilization in car accidents incidents is also declining. On the contrary PEMS engagement in acute ethanol intoxication cases rose significantly. The same is true also about the obstetrical related cases during the years 2013-2015.
Conclusion: Identifying and understanding the factors behind PEMS use are essential for the organization of emergency health services in the near future. In the present study, the results can be explained either by social, financial or even administrative changes that took place over the years. However, more comprehensive analysis of a continuously recording data system needs to be considered in order to define specific needs in the dynamic environment of prehospital emergency medicine.

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Introduction:

Prehospital emergency medical services (PEMS) are becoming more and more sophisticated as more point-of–care advanced medical technology is available in the field. More specialized care is provided and education of the community is such, that, the latter is often treated both as consumer and provider of care. The presence of physicians in most European PEMS additionally impacts ambulance system organization and on-site medical management[1].

Along with the aforementioned, the number of requests to PEMS is steadily increasing in Europe over the past years. Growth and ageing of population, limited access to primary care physician, and wider public awareness of specific health problems (e.g. stroke or acute myocardial infarction) are some of the reasons provided in order to explain this trend[1-3]. Thus, there is growing public, medical and health policy interest to record and analyze the PEMS activity over time. Yet, the literature around the subject is limited. Data come mainly from Northern Europe, USA, Canada and New Zealand; while most the studies are focusing to specific aspects of PEMS (medical, social, financial, etc).

The main aim of this analysis was to describe the time trends of utilization of PEMS in a region of northern Greece from 2006 to 2015.

Material and methods:

Study design and population.

The study was based on data retrospectively extracted from National Center of Emergency Care (“EKAB”) Thessaloniki Department’s Archive Registry, from January 2006 to December 2015. The area of interest is the regional unit of Thessaloniki, which is located in northern Greece, has an area of 3.683 km^2 and the population changed from 1.057.852 in 2001 to 1.101.312 in 2011, representing a little more than 10% of the total population of Greece[4] (Figure 1).

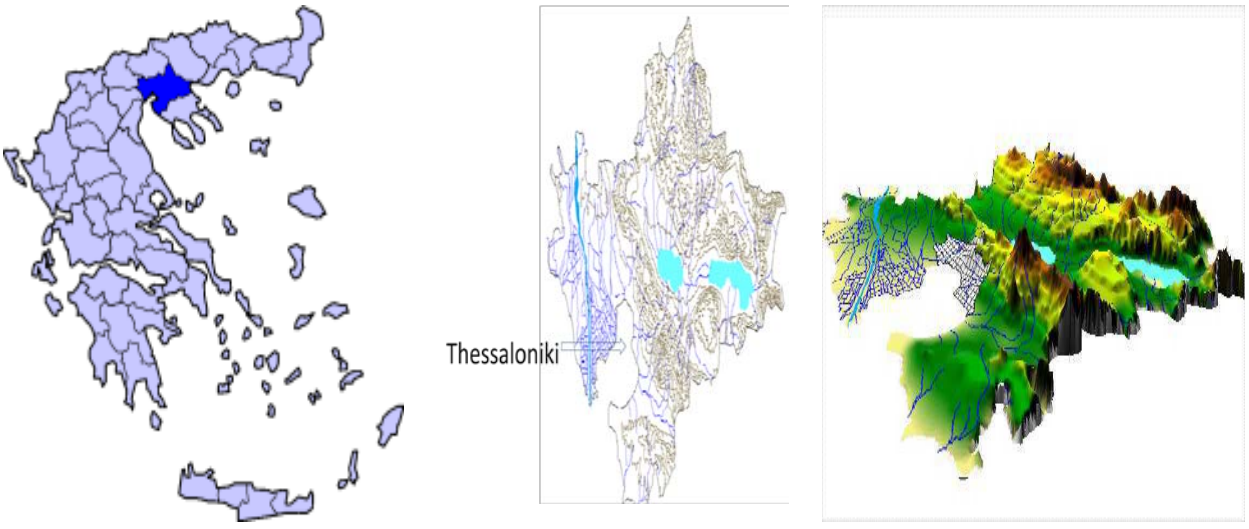


Figure 1. Area of interest of the study: right –relational position, left –topographic 2D and 3D map[5].

Description of the Thessaloniki Department PEMS.

In the area of interest, the vast majority (>95%) of the emergency calls is served by the EKAB. The funding of EKAB is governmental and all citizens within the Greek territory (both EU and non-EU citizens) have equal access to its services. On the contrary, private medical centers, which are eligible to provide ambulance services, care only for selected cases.

Thessaloniki PEMS Department (TPEMS) includes a unique emergency call center (ECC), which receives about 31000-34000 calls per month. For the morning and the afternoon 8-hour shift TPEMS has 20-24 emergency ambulances available and 1-2 rescue motorcycles, while during night shifts and weekends this number diminishes to 16-18 emergency ambulances. There is also a physician –manned emergency resuscitation vehicles (Mobile Intensive Care Units-MICU) available 24/7, while a second MICU is deployed only for 5 days/week. All ambulances' staff is EMTs, motorcycles' staff is EMTs with paramedic training and ECC staff is EMTs with additional dispatching training. Mean ambulance arrival time is 6-8 min.

PEMS requests are triaged by ECC in 3 priority groups: non emergency (transportation for planned examination/therapy or inter-hospital transportation or discharge-transportations for confined to bed patients), emergency (needs evaluation at Emergency Department), urgency (life –threatening). MICU may be sent by ECC simultaneously on site in case of cardiac arrest, major trauma, respiratory distress, coma, any other life-threatening conditions or secondary at the request of the ambulance EMTs on site.

In the area of interest seven hospitals out of eight accept emergencies. Yet, the system is organized in a manner that only one or two can accept 24hourly emergencies each day (e.g hospitals A,C in Monday, D in Thursday, H and F in Wednesday ,etc.). There is also a military hospital that accepts selected emergencies (mainly military, police, coast guard, fire departments staff and their families). No hospital serves purely as Trauma center; and there are not all the medical specialties available in all hospitals. Their geographical distribution is also inhomogeneous, as all of them are located in the city of Thessaloniki. Furthermore, 4 of the hospitals are placed centrally and the rest in each side of the city (east, south, north). Thus, there is no strict geographical area coverage for each of the two hospitals. The choice of admitting hospital for each case is based upon all the aforementioned factors (mainly distance and urgency, and then capacities of the hospital).

Variables.

Due to the retrospective character of the study selected parameters were examined: number of calls per shift/day/month/year, type of cases (Cardiac arrests, trauma, obstetrical, etc.), and utilization of MICU, faulty or cancelled calls.

Statistical analysis.

Descriptive cross-tables with number and rates or percentages were obtained for all variables. Cross examination of the PEMS data with financial and social indices were also performed. We assumed independency for all, even if it was not possible to guarantee this assumption because working on an anomymised database. Patients could have used PEMS more than once. However, we hypothesized that, due to the low frequency of these situations among the large number of cases included, this had a negligible impact on the results. All analyses were performed with Microsoft Excel 2007 and Rstudio 0.99.903.

Ethical aspects.

This study was performed on anonymously collected or anonymised health-related data; therefore there was no need of written informed consent from individual patients.

Results:

Total utilization of PEMS shows an overall l4.03% decrease over the decade for all cases (Table 1).Yet a detailed look in the data reveals a different story: Emergency cases do not show and significant trends towards any direction, even though one can recognize 2011 as flex-point among years 2008-2014 (relative decrease in emergency cases from 2008-2011 and then increase till 2014). The same seems to be valid for non-emergency cases: random results when considering the whole decade; yet, the same flex-point (year 2011) if ones considers only the period 2008-2015 (decrease in period 2008-2011 and increase in the years 2011-2015). On the contrary MICU utilization (i.e. or the intervention rate of prehospital medical physicians) shows a steady annually decrease till 2012, and thereafter, a more random trend is revealed for years 2013-2015.

Average monthly interventions rate are relative to the absolute numbers of each category; moreover, considering the phone calls ECC receives every month, it turns out that, on average, only 1 in 6-7 calls is actually being realized as PEMS intervention.

The framework of the aforementioned PEMS utilization is highlighted in Table 2. In addition to the presented information, one should notice - from September 2014- the foundation of several (14) refugees hotspots, that sustain a population of 20500 people (update August 2016).

Figure 1 illustrates the relation between the three categories of cases per month. MICU engagement is between 1.82% (2012) and 4.67% (2006), while non emergency cases are between 16.26% (2012) and 32.71% (2006) out of all PEMS cases for each year.

Distribution of cases during the year is uneven: emergency cases seem to be more between

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total	86701	77651	81805	78905	75000	66017	67841	69534	77902	76171
No /month*	7225	6471	6817	6575	6250	5501	5653	5795	6492	6348
No/1000 inhabitants	80	72	75	72	68	60	61	63	70	68
Emergency	63107	59690	60763	59044	58533	55786	57450	58007	61506	60016
Annual Δ%	NA	-5.41	1.79	-2.83	-0.86	-4.69	2.98	0.96	6.03	-2.42
No /month*	5259	4974	5064	4920	4878	4649	4787	4834	5126	5001
No/1000 inhabitants	58	55	56	54	53	51	52	52	55	54
Non-Emergency	20644	15555	18681	17738	14968	9136	9342	9971	14873	14921
Annual Δ%	NA	-24,65	20,10	-5,05	-15,62	-38,96	2,25	6,73	49,16	0,32
No /month*	1720	1296	1557	1478	1247	761	779	831	1239	1243
No/1000 inhabitants	19	14	17	16	14	8	8	9	13	13
MICU	2955	2406	2361	2123	1499	1095	1049	1556	1523	1234
Annual Δ%	NA	-18,58	-1,87	-10,08	-29,39	-26,95	-4,20	48,33	-2,12	-18,98
No /month*	246	201	197	177	125	91	87	130	127	103
No/1000 inhabitants	3	2	2	2	1	1	1	1	1	1
MICU physicians	10	10	9	7	6	5	5	8	8	8

**Rounded average values*

Table 1. Evolution of PEMS intervention between 2006 and 2015. Non-emergency=secondary transfers. MICU (mobile intensive care units) - emergency physician sent on site.

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Expenditure %GPD	9	9.1	9.8	9.8	9.9	9.5	8.9	8.7	8.3	8.2
Unemployment %	8.9	8.3	7.8	9.6	12.6	17.7	24.3	27.9	26.5	25.6
Hospital beds*	4.9	4.9	4.8	4.9	4.5	4.5	4.5	4.2	4.2	?
Acute beds*	4	4	4	4.1	3.7	3.7	3.7	3.5	3.5	?
Infant mortality*	3.7	3.5	2.7	3.1	3.8	3.4	2.9	3.7	3.8	3.6

*per 1000 inhabitants

Table 2. Selected parameters about the framework within which PEMS has occurred.

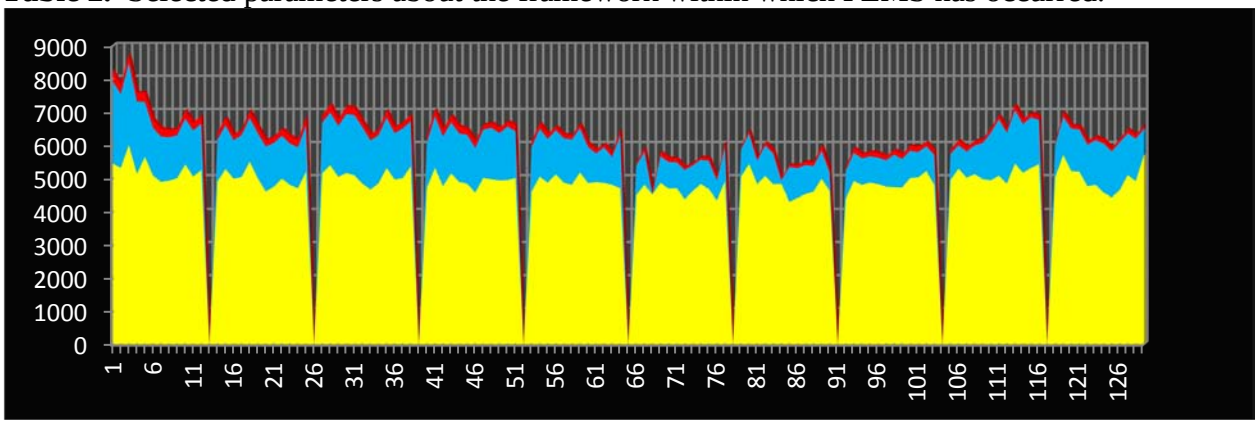


Figure 1. Relative distribution of PEMS cases/ month: yellow- emergency, blue- non-emergency, red- MICU cases.

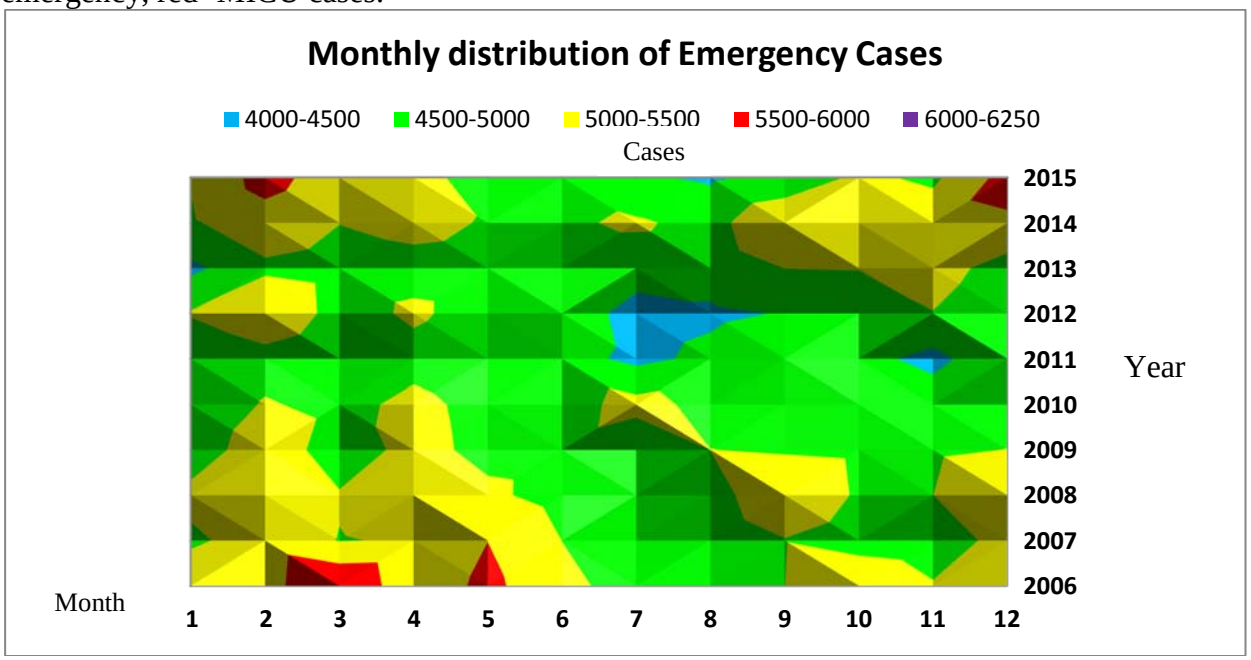


Figure 2. Graphical illustration of emergency cases per month.

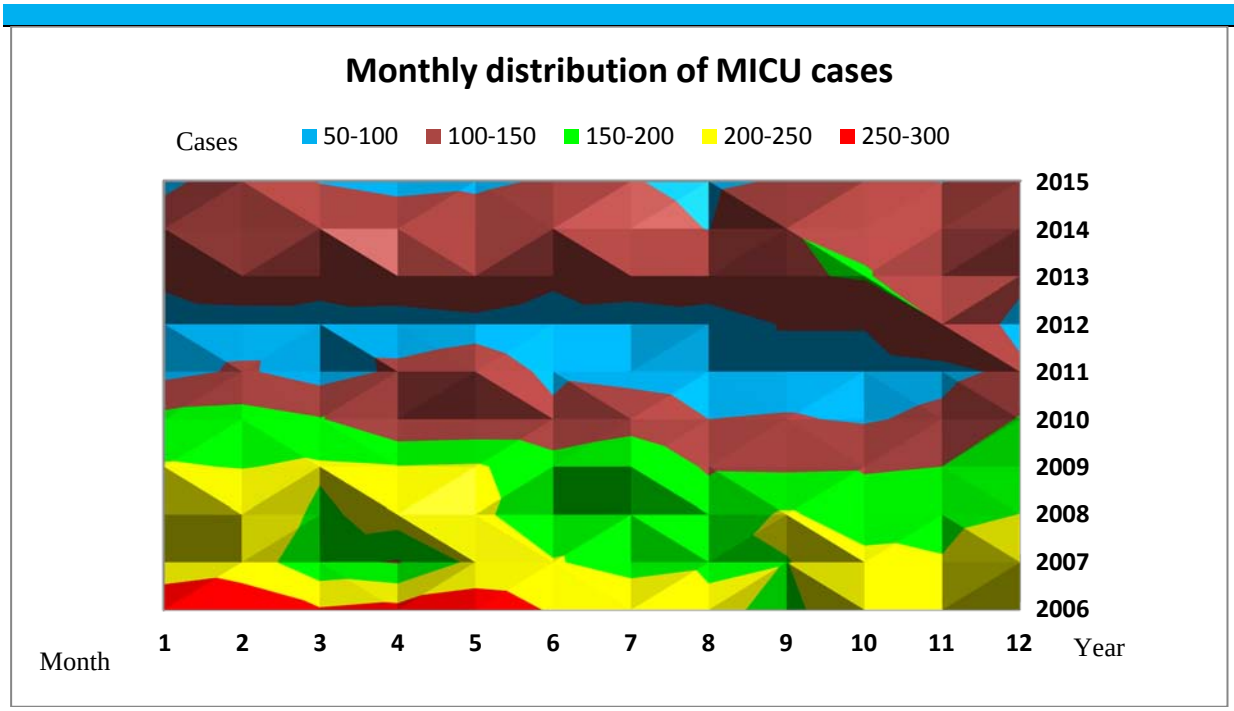
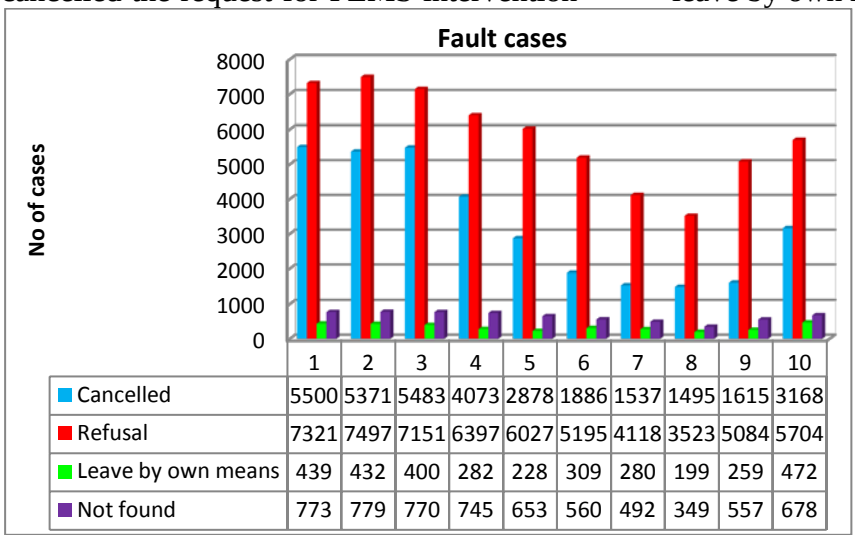


Figure 3. Graphical illustration of number of MICU cases.

December and May, while MICU cases seem to follow a more stable pattern throughout the year (Figure 2 and 3 respectively).

Another interesting point is the so-called "fault" cases, i.e. cases where ambulance mobilization did not result patient transportation. In this study, the latter were separated in a) cases where the patient cancelled the request for PEMS intervention just before or after arrival of EMS team on the spot (referred as "cancelled"), b) cases where the patient refused transportation to hospital, despite EMS recommendation (referred as" refusal"), c) cases where no patient where found (referred as "not found"); and d) cases where on arrival of EMS team, there are informed that the patient had been transported by other means (neighbors, family, friends, etc- referred as" leave by own means") (Figure 4)



	1	2	3	4	5	6	7	8	9	10
Cancelled	5500	5371	5483	4073	2878	1886	1537	1495	1615	3168
Refusal	7321	7497	7151	6397	6027	5195	4118	3523	5084	5704
Leave by own means	439	432	400	282	228	309	280	199	259	472
Not found	773	779	770	745	653	560	492	349	557	678

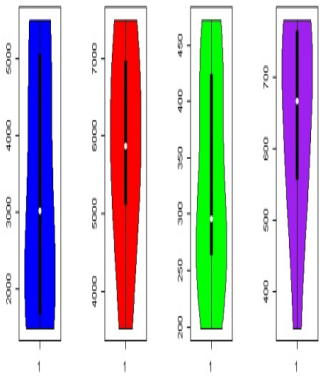
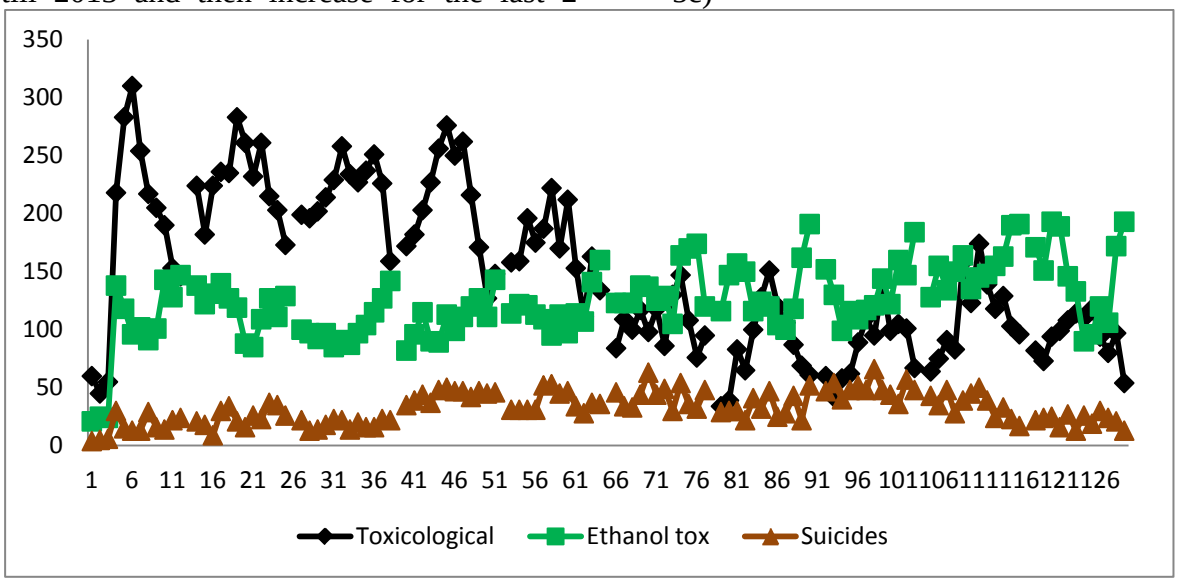


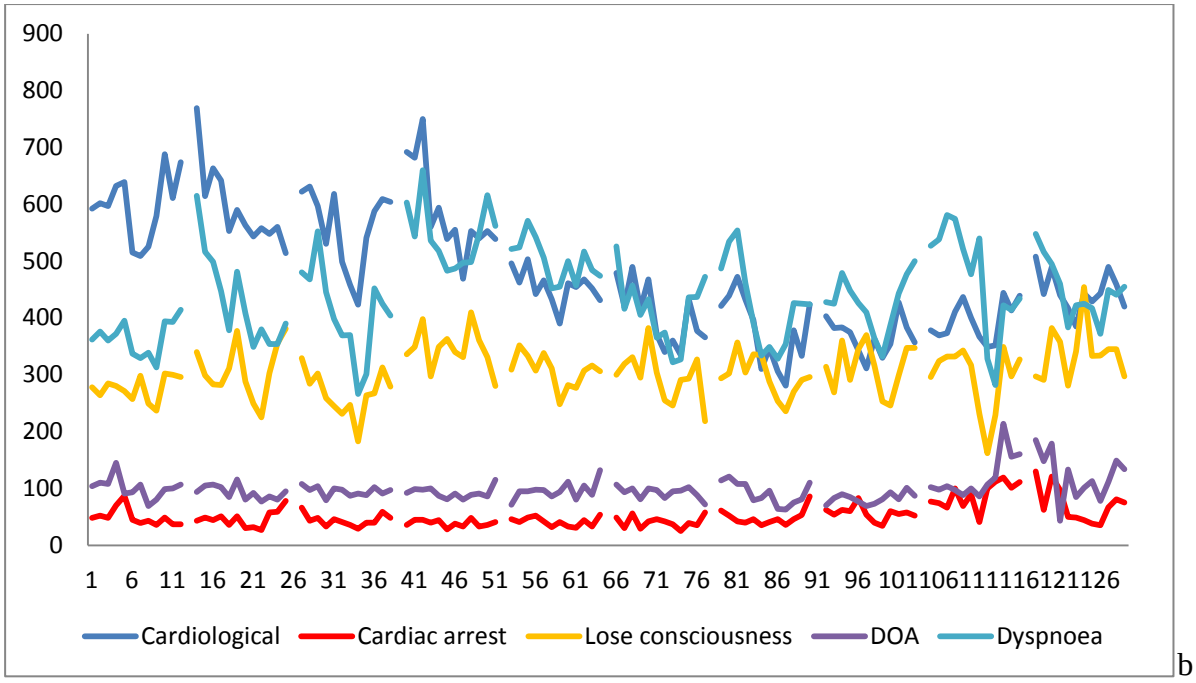
Figure 4. Relative annual distribution of fault cases over the decade (1=year 2006, 10= year 2015): blue-Cancelled, red-Refusal, green-Leave by own means, purple-Not found. Bar charts graph (up), Violinplots (down).

The number of the last two types of cases (leave by own means, not found) are constant throughout the decay of interest- 0.42% (0.29-0.62%) and 0.83% (0.5 – 1%) of total cases respectively. On the contrary, cancelled and refusal case decrease steadily till 2013 and then increase for the last 2 years. Cancelled cases are 4.25% (2.07-6.92%) of the total cases, while refusal is obtained in 7.6% (5.06-9.65%) of all cases.

Distribution analysis of selected type of cases ("case"= one patient), can also reveal several interest changes (Figure 5a, 5b and 5c)



a



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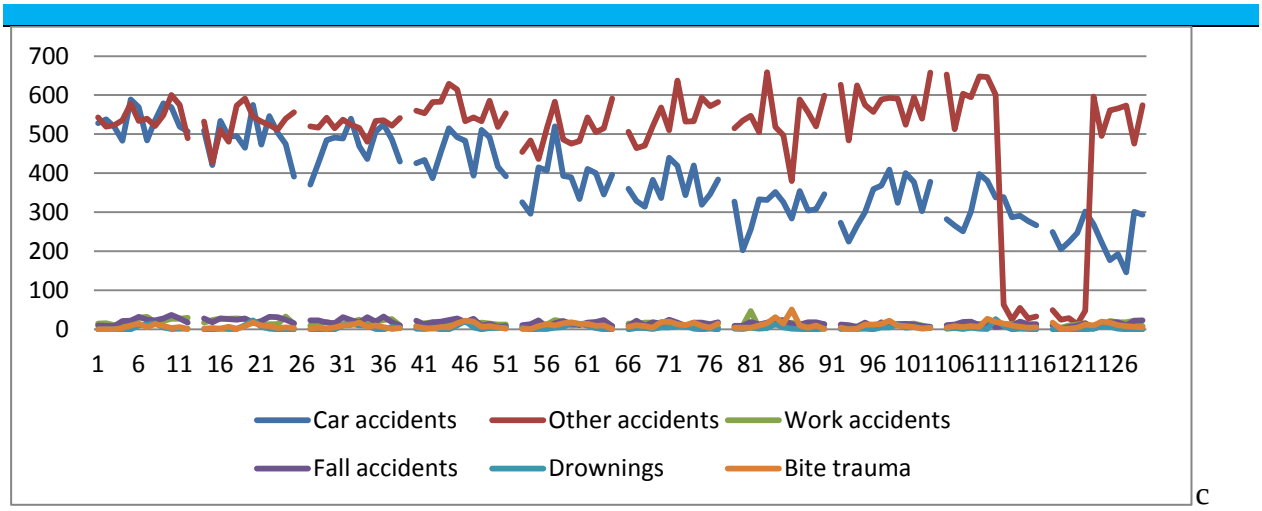

c

Figure 5. Monthly distribution of selected types of cases: a- Toxicological, mainly narcotics overdose, Suicides and Acute ethanol intoxications, b- Cardiological, cardiac arrests, DOA-dead on arrival, dyspnea and c-different kind of accidents (trauma).

Given types of cases, i.e. car accidents and "toxicological" show a discrete decreasing trend, while other, such as ethanol intoxications illustrate an augmenting trend. A moderate increase is also noticed in suicides and in cases that are categorized as DOA (dead on arrival), especially in years 2013-2015.

Finally, a noticeable increase in obstetrical/gynecological cases (defined as emergency cases needing primary assessment by an obstetrician/gynecologist, e.g. delivery, severe menstrual disorders, etc) is found from the year 2014 and on (Figure 6)

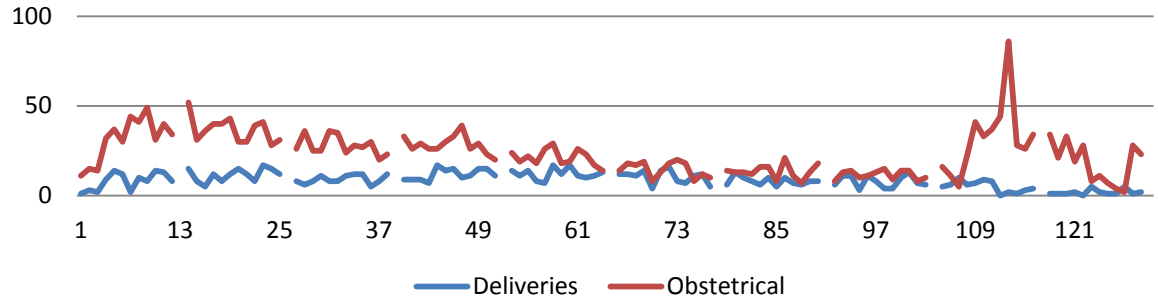

Figure 6. Monthly distribution of out-of –hospital deliveries and other Obstetrical/gynecological cases.

Discussion:

This is the first study of such type in Greece. In general, the results reflect the changes of the social and financial framework of the given area. Increased emergency utilization of PEMS services from 2010 may be seen as result of the general worsening of social and financial status of the area. The same may be concluded for the increase in methanol intoxications' or suicides cases. Refugees admission in the last 2 years may also contributed to the overall increase in emergency calls and especially to obstetrical/gynecological cases.

On the other hand, an administrative reform that took place in late 2013 and

consisted in the discontinuation of hospitals' ambulances services and the transfer of all patients' transportations under the umbrella of EKAB, may be the main reason behind the illustrated increase in non-emergency cases from that year on.

Decreasing trend in car accidents may be explained both by the legislative reforms to stricter road traffic regulations and by the worsening of the general financial status of the area (i.e. less traffic load).

On the same time, toxicological cases (mainly narcotics abuse cases) showed a decreasing trend. Yet, this is not a single – cause result; thus a more detail analysis should be done about the findings. The same is true about MICU cases trends, although the availability of medical pre-hospital physicians seem to be the main factor behind that trend.

Finally, some preliminary finding can be noticed about the attitude of the public towards PEMS services. It seems that between years 2006-2013 the public use more efficiently and PEMS; thus, the "refusal" and "cancelled" cases are steadily decreasing. The reversal of this trend during the last 2 years however, deserves more detail research, in order to define the real causes behind it (financial crisis, refugees' inflow, etc).

Although the present study has yielded some useful findings, its design is not without flaws. A number of caveats need to be noted regarding the present study. The main limitation is that the lack of prior research on the topic for the selected area and PEMS services.. No former reliable database or published articles were available for the authors to rely on. The majority of the literature come from Northern Europe, USA, Canada and New Zealand, were the organization and recourses of the PEMS system is different. The retrospective design of the study was also a problem as many of valuable data (e.g. MICU interventions, etc) were partially recorded. The lack of fully deployed electronic database system with follow-up information of the patients managed by the PEMS eliminated the ability of further analysis. Finally, due to the regional character of the study, generalization of the findings is not applicable to national level or to any other urban setting in Greece.

Apart from the aforementioned, this study was not designed to explore specific characteristics of the cases, such as ethnicity/age/sex/diagnosis distribution or relations between EMS/MICU interventions and outcome. Therefore, this kind of analysis was omitted. For the same reason, since no data analysis was made for the years prior to 2006, no assumption can be made.

Comparison with other published papers internationally on the subject may seem a logical possibility, yet we deliberately have left it out of the current study. Apart from the central premise that the same principles of healthcare quality apply to all PEMS systems, the bias involved in such comparison makes the comparison among PEMS systems and settings very difficult, since the frame within each PEMS system operates varies[9-11]. Comparison can be made only in terms of quality assessment. Performance indicators used are three types: Structure, process and outcome indicators[12-13]. Structural indicators reflect standards developed at a local, regional, or national level. Since EMS systems designs are diverse as discussed above, these indicators may not be applicable to all systems. Process data (where process= repeatable sequence of actions used across all EMS levels to produce good patient outcome) are easy to interpret, yet, in the current study, we were not able to collect the full range of data needed. The latter was even also valid for specific or overall outcome measures for the period of interest (2006-2015). Lack of key performance indicators, specific for the Greek PEMS system also contributes to the aforementioned[14].

The health information system must evolve to provide the information needed to measure, analyze, and understand the use of emergency services in order to improve their management and thus their effectiveness and efficiency. Better matching of data, with interconnectivity of different digital databases -mainly between prehospital and intrahospital ones- would help to evaluate the appropriateness of use of PEMS resources. The evolution of the professions trainings, diagnosis strategies and treatments are also important elements, contributing to the evolution and the improvement of PEMS performance. The respective contribution of each of these elements could not be evaluated in our study.

Conclusion

A thorough analysis of existing and future data shall allow a better understanding of some determinants of the evolution of the use of emergency health services. Additional assessments of certain needs (e.g. geriatric mobile units, geographical distribution of ambulances, secondary or primary air medical transport means, education of focus groups) and development of a suite of key performance indicators, will help to ameliorate designing, monitoring and providing pre-hospital emergency services and new processes of care.

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Conflict of interests:
The authors declare no competing interests.

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