eISSN 2255-0569

ORIGINAL

Use of the geographical information system integrated in smartphone to reduce transportation time for general medical care in Ibiza, Spain

Uso del sistema de información geográfica integrado en el teléfono inteligente para reducir el tiempo de transporte para la atención médica general en Ibiza, España

Hans A. Eguía[1], Franco Vinciarelli[2], Walter Curioso[3], Francisco Javier Sanz García-Donato[4], César Oliver Sotelo García[5], Carlos Sánchez Bocanegra[6]

1. MD Lægehuset Rudkøbing. Danmark. UOC researcher 2. Engineer - Master en telemedicina Senior Full Stack Developer. Italy 3. PhD Bioinformatics Vice-rector for Research - Continental University. Perú 4. MD Primary care physician - Conselleria de Sanitat Valenciana 5. MD Primary care physician - SESPA Asturias 6. PhD Head of the IT Department of the Malaga Department of Agriculture

Corresponding author
Hans A. Eguía
UOC / lægehuset Rudkøbing
Endraget 7, 5900 Rudkøbing. Danmark
E-mail: hello@hanseguia.doctor

Received: 6 - X - 2021
Accepted: 9 - XII - 2021

doi: 10.3306/AJHS.2022.37.01.86

Abstract

Introduction: Allocated time for GP out-of-hours service is scarce. Reducing transportation time is one way to increase GP-patient consultations during out-of-hours service. Geographical information systems (GIS) used to reduce response time may be a promising way to address this issue. This study aimed to compare response time between GP vehicles using GIS (from WhatsApp®) and GP vehicles using telephone-assisted driver guidance for non-acute patients who contacted a GP out-of-hours service with an unknown address.
Material & Methods: This study was a prospective observational controlled study using two groups. For each group, vehicles were dispatched simultaneously from the out-of-hours office. One group had vehicles with GIS and the other one had vehicles with telephone-assisted guidance to locate the patient. The main outcome was the response time from two different approaches.
Results: In 515 GP out-of-Hours services 63 patients did not know their location. A total of 61 non-acute patients agreed to participate. Patient age varied from 25 to 78 years with a mean of 56.6 (SD 12,86). Women comprised 28 of the patients (45,9%). The main tentative diagnoses were sore throat, otitis and superficial wound treatment. The vehicles with GIS were significantly faster ($p < 0.0001$) to reach the patient destination (mean 20 minutes) compared to vehicles using phone guidance (mean 28 minutes).
Discussion: In this feasibility study, GIS guidance seems to help reduce the transportation time of GP vehicles to patients with unknown address compared to telephone guidance.

Keywords: Out-of-hours medical care, physician, needs and demand, health services, application, tourists.

Resumen

Introducción: el tiempo asignado para visitas domiciliarias el servicio fuera de horario de atención normal de centros de salud es escaso. Reducir el tiempo de transporte es una forma de aumentar las consultas de pacientes durante el servicio fuera del horario de atención. Los sistemas de información geográfica (SIG) utilizados para reducir el tiempo de respuesta pueden ser una forma prometedora de abordar este problema. El objetivo de este estudio fue comparar el tiempo de respuesta entre los vehículos de médicos de Atención Primaria (MAP) que usan SIG (de la aplicación WhatsApp®) y los vehículos de MAP que usan la guía asistida por teléfono del paciente para llegar a su ubicación. En ambos casos sólo se valoraron pacientes no agudos que se comunicaron con nuestra clínica fuera de horario de atención normal con una dirección desconocida.

Materiales y métodos: se realizó un estudio prospectivo observacional controlado que utilizó dos grupos. Para cada grupo, los vehículos fueron despachados simultáneamente desde el centro de salud en horas fuera de horario habitual. Un grupo conducía un vehículo con SIG y el otro conducía un vehículo con la pauta dada por el paciente para llegar a su ubicación. El resultado principal fue el tiempo de respuesta con dos enfoques diferentes.

Resultados: Durante la realización del estudio 515 pacientes fueron registrados, de los cuales 63 desconocían su ubicación. Un total de 61 pacientes no agudos aceptaron participar. La edad del paciente varió de 25 a 78 años con una mediana de 56,6 (DE 12,86). Las mujeres comprendían 28 de los pacientes (45,9%). Los principales diagnósticos tentativos fueron dolor de garganta, otitis y tratamiento de heridas superficiales. Los vehículos con SIG fueron significativamente más rápidos ($p <0,0001$) para llegar al destino del paciente (promedio de 20 minutos) en comparación con los vehículos que utilizan la guía telefónica (promedio de 28 minutos).

Discusión: En este estudio de factibilidad, la guía SIG parece ayudar a reducir el tiempo de transporte de MAP hacia pacientes con dirección desconocida en comparación con la guía del paciente usando el teléfono.

Palabras clave: Atención médica fuera de horario; médico; Necesidades y Demanda, Servicios de Salud; solicitud; turistas.

Introduction

In many countries, general practitioners (GP) are responsible for out-of-hours primary care services (OOH). The OOH is a very important service[1], in particular, patients waiting time related to suboptimal use of OOH is a problem and should be reduced[2]. A central determinant that contributes to suboptimal use is patients calling OOH without knowing their address or position.

Visitors from foreign countries relatively often use OOH and in many cases due to language barriers can experience difficulties in the accessibility to their OOH[3]. These difficulties could be aggravated if the GP has to come to the patient's location. In a similar way, tourists can face difficulties, when they fell ill in foreign countries, especially if they do not speak the local language[4]. This difficulty would be worsened if the patient cannot be quickly located because they do not know which is their current address or where they are in the moment of medical need.

In Germany, it is estimated that as many as 10% of all emergency calls do not include info about the position of the patients -i.e. the OOH does not know the position of a central part of their patients[5]. Furthermore, a UK study showed that common reasons for communication difficulties comprise problems related to the missing information to the ambulance service call receiver[6], which also included the actual position of the patient. In the EU considerable time is lost by emergency services during their intervention for approximately 3,5 million calls, due to the fact that the location information provided by the caller is later found to be inaccurate[7].

Delays in all kinds of medical care are more common in rural or semi-rural areas[8]. But in case of medical emergencies, reducing the arrival time (AT) of medical care in rural or semi-rural areas play an even more important role. In cardiac arrest, reducing ambulance AT has been shown to increase the survival rate[9] even if the appearance of operational problems can delay more of the 40% of ambulance dispatches[10]. We hypothesize that smartphone technology can help reducing ambulance AT[11]. This is the reason why would be important to measure the effect of geographic information systems (GIS) by monitoring the arrival time of vehicles sent to patients who do not know their address (tourists) and also with simple pathologies, this to avoid risks for patients but obtaining data that could be extrapolated in more acute situations.

Material and methods

The present study was conducted during the summer of 2019 in a private GP clinic in Ibiza to patients (among whom were tourists) who can call for a home medical consultation. In order to be able to start with the study, an ethics committee was formed and accepted the study realization, and it was decided that to accomplish the General Data Protection Regulation (GDPR) Regulation (EU) 2016/679 on the protection of natural persons concerning the processing of personal data[12]; only the age, gender, localization, country of origin and pathology would be used in the study avoiding any way to identifying the patient with the data recorded.

A strict selection of the cases was done, no critically ill patients were selected (chest pain, breathlessness, dizziness, etc) while stable patients over 18 years old (sore throat, cold, otitis, conjunctivitis, etc) were included. Patients who knew their location, who were lodged in a hotel, were Spanish, or patients who did not use the WhatsApp application were also excluded. A total of 515 patients were eligible; if they knew their location, they were excluded (**Figure 1**).

Figure 1: Trial Flow.

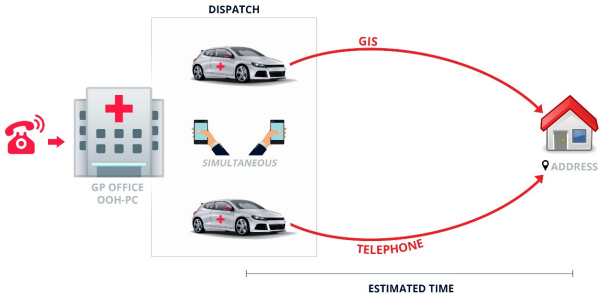
They were then asked to participate and gave oral consent. All included patients were asked to send us their location using GIS and also the directions to arrive at the place where they were. With the information obtained, two vehicles were simultaneously dispatched to the patient: "vehicle A" used the GIS data and "vehicle B" used the directions given by the patient, each vehicle was driven by a different GP, they both had the same working time on the island.

To avoid bias, both of the vehicles were parked in the same garage (one on the side of the other), both of the same brand (Nissan Micra) and date of production (2014). The mileage of each of the vehicles was written down every time before the car was dispatched and time began to be measured after the two GPs (working both

in the same clinic and they were also the drivers for the study) were seated in the cars ready to go, and a helper activated the mobile´s timing at the same time and gave it to both drivers.

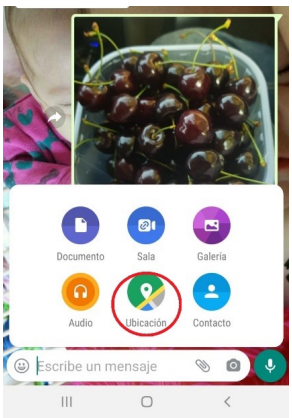
Both of the drivers were instructed on the way of driving (normal, without exceeding speed limits, or in a hurry to save time), as well as, that they had to stop the chronometer when arriving at the address (not when parking or when entering the patients' house) and write it down in a special blanket given (**Figure 2**).

Figure 2: Project process.



The WhatsApp application was selected among many other applications because it is widely used in all of Europe[13]. The app is simple to use and has an end-to-end encryption protocol that prevents any external party from having access to the messages, furthermore, only the location was sent via this application (WhatsApp), no other patient data was sent through this system. The rest of the data were obtained during the consultation with the patient. The only person to have access to the messages is the receiver as only the recipient and the sender have the special key needed to unlock and read the message[14]. Its usage is very easy, clicking over the "paperclip" icon and then selecting "my ubication" (see **figure 3**). The usage of this app is even able to reduce the response time in new communication and its efficiency in its use during the consultation, relaying quick information during clinical communication[15].

Figure 3: How to send your ubication using WhatsApp®.



Statistical analyses

This study was a prospective observational control study using two vehicles. The main outcome was to measure the response time from two different approaches.

The difference between the two groups of vehicles (A and B) was described via descriptive statistics and a graph of mean and confidence intervals. Student´s T for paired data was used for the primary outcome. We used free statistical software R 3.4.0 and WinBUGS 1.4 for the inference.

Results

The average age of all the 515 patients was 30 years old, with a mean of 56,6 years and a mode of 43. A total of 463 patients came from Europe and 52 (10%) came from countries out of the EU (Morocco, South Africa, Argentina, Russia, US, India, Ukraine, Saudi Arabia and Canada). Out of the 63 patients not knowing their location Table 01 shows that 28 patients were women (0,46) and 33 men (0,54), their age varied from 25 years to 78 years old with an age mean of 56,6 (SD: 12,86). The patients who did not know their location did not differ with regard to the home country. Overall, 80,3% came from Europe and everybody spoke English at an intermediate level.

AT range of vehicle A was between 4 and 40 minutes with a mean of 19,98 (SD: 8,1) and the range of vehicle B was between 3 and 49 minutes with a mean of 27,98 (SD: 10,21). AT of vehicle B was 8,02 minutes longer than vehicle A (see table 02).

This 8-minute difference between both of the vehicles and considering the SD of 8 minutes would result in a 95% confidence interval of around 16 minutes. We have to take into consideration that this may be due to long journeys to rural areas, the lack of knowledge of the patients of the area in which they are located or the road to reach their respective homes, and finally the reduced sample size.

Discussion

According to our knowledge, this is the first study to look into the impact of GIS on arrival time in OOH. There are data available in relation to urgent calls in the Ibiza area - average waiting time (061 – IBSalut)[16], with an arrival time of around 9 minutes which is considered adequate; However, the intention of this study is to assess whether it is feasible to reduce the arrival time for patient care (especially tourists with little command of the local language or English) and that it can be extrapolated to other geographical areas.

Our results show a significant reduction in arrival time of GPs in OOH using GIS, with a mean of 8 minutes and that many of the patients who participated were people over 25 years old (mean of 57 years old) resulting interesting that these older patients have also access to the internet and a smartphone but probably are no so trained on its use[17,18].

These results can present a pleasing alternative to the suboptimal use of OOH-GP[2] reducing both the driving time as well as the waiting time of the patient. Can also avoid the misunderstanding of an address due to the lack of language proficiency (tourists and migrants). That is the reason why our study was conducted between May and October for being the season (summer) with the highest influx of tourists in Ibiza, many renting Villas or apartments without knowing the precise address once living there.

Several limitations must be mentioned. Our study had some selection biases at baseline, which may decrease the total population generalization. Only patients who called to our clinic were included (mostly only tourists) also patients without a smartphone or internet access mobile were excluded. Another limitation was that the development of the project took place during the summer period (due to the extra influx of tourists). Patients with an acute problem or emergency were also ruled out and maybe the inclusion of them could show a different result. The use of 61 patients to develop the study could be a not significant number of patients, but we consider it as a pilot to future research. The usage of WhatsApp as GIS could be not the most accurate but it is also the most universal and could serve as a starting point for a more complete assessment (using another application or location system).

We can precise that the use of WhatsApp (or other instant messaging application with the possibility of GIS) could be very useful for medical teams' coordination because it can show actual patients localization letting the medical team arrive as fast as possible with the fastest route available. Moreover, using e-Copernicus data[7] the impact of economic resources savings in the EU could be around 467 000 hours with its equivalent in money provisions.

Table I: Description of patient's characteristics.

	min	mean	max
Age	25 years (youngest)	56,6 years (SD 12,86)	78 years (oldest)
Gender:			
Male	33 (54,1%)		
Female	28 (45,9%)		
Nationality:	Percentages		
United Kingdom	16 (26,2%)		
Germany	7 (11,5%)		
France	6 (9,8%)		
Argentina, Russia, Holland (each)	4 (6,6%) per country: 12 (19,8%)		
Italy, Belgium (each)	3 (4,9%) per country: 6 (9,8%)		
South Africa, Poland, Sweden, Norway (each)	2 (3,3%) per country: 8 (13,2%)		
Ukraine, Morocco, Austria, Wales, United States, Ireland (each)	1 (1,6%) per country: 6 (9,8%)		
Patient complaints			
Nausea	16 (26,2%)		
Cough	14 (23,0%)		
Otitis	7 (11,5%)		
Pharyngitis	7 (11,5%)		
Skin related	7 (11,5%)		
Muscle contracture	3 (4,9%)		
Viremia	3 (4,9%)		
Conjunctivitis	1 (1,6%)		
Vaginitis	1 (1,6%)		
Advice	1 (1,6%)		
Prescriptions	1 (1,6%)		

Table II: Descriptive vehicles and patient characteristics.

	Mean	Coefficient of variation	Percentile 5 (p5)	Percentile 50 (p50)	Percentile 95 (p95)
Patients age	56,6	0,23	37	55	77
Vehicle A (seconds)	19,98	0,41	5	21	30
Vehicle B (seconds)	27,98	0,36	7	28	42
Difference (seconds)	8	0,45	2	8	14

Conclusion

Our results show that it would be interesting to develop a strategy to reduce the time interval between the medical call and the arrival of help. This would contribute to the consequent saving of resources (money and time), as well as, with the greater satisfaction of the patient. In addition, it must be considered that the delays could be dangerous especially to critically ill patients.

Reducing the AT will offer the possibility of fast in-field-treatment, as well as, the prearrival notification of the medical problem to the hospital or clinic which will save more time to prepare, even with the mean arrival time avoiding the triage barrier that personal from the ambulance can sometimes become[19]. Further studies are warranted to survey GIS in the GP out-of-hours service.

Interests conflict

The authors declare no conflict of interest.

References

1. Keizer E, Maassen I, Smits M, Wensing M, Giesen P. Reducing the use of out-of-hours primary care services: A survey among Dutch general practitioners. European Journal of General Practice. 2016 Jul 2;22(3):189–95.

2. Nørøxe KB, Huibers L, Moth G, Vedsted P. Medical appropriateness of adult calls to Danish out-of-hours primary care: A questionnaire-based survey. BMC Family Practice. 2017 Mar 14;18(1):34.

3. Keizer E, Bakker P, Giesen P, Wensing M, Atsma F, Smits M, et al. Migrants' motives and expectations for contacting out-of-hours primary care: a survey study. BMC family practice. 2017 Nov 21;18(1):92.

4. Dick L. American family physician. American Family Physician. 1998 Aug 1;58(2):383.

5. Weinlich M, Kurz P, Blau MB, Walcher F, Piatek S. Significant acceleration of emergency response using smartphone geolocation data and a worldwide emergency call support system. Kou YR, editor. PLOS ONE. 2018 May 23;13(5):e0196336.

6. Higgins J, Wilson S, Bridge P, Cooke MW. Communication difficulties during 999 ambulance calls: Observational study. British Medical Journal. 2001 Oct 6;323(7316):781-2.

7. EENA Operations Document-Caller Location in Support of Emergency Services EENA asbl info@eena.org-www.eena.org is a non-for-profit association 1 EENA Operations Document Caller Location in Support of Emergency Services Title: Caller Location in Support of Emergency Services Version: 2.0 Code: 2.2.2.v2.0.Final Revision. 2014 [cited 2021 Oct 26]; Available from: www.eena.org

8. Takei Y, Inaba H, Yachida T, Enami M, Goto Y, Ohta K. Analysis of reasons for emergency call delays in Japan in relation to location: High incidence of correctable causes and the impact of delays on patient outcomes. Resuscitation. 2010 Nov 1;81(11):1492-8.

9. Pell JP, Sirel JM, Marsden AK, Ford I, Cobbe SM. Effect of reducing ambulance response times on deaths from out of hospital cardiac arrest: cohort study. BMJ (Clinical research ed). 2001 Jun 9;322(7299):1385-8.

10. Spaite DW, Valenzuela TD, Meislin HW, Criss EA, Hinsberg P. Prospective validation of a new model for evaluating emergency medical services systems by in-field observation of specific time intervals in prehospital care. Annals of Emergency Medicine. 1993 Apr 1;22(4):638-45.

11. Jaldell H, Lebnak P, Amornpetchsathaporn A. Time Is Money, but How Much? the Monetary Value of Response Time for Thai Ambulance Emergency Services. Value in Health. 2014 Jul 1;17(5):555-60.

12. EUR-Lex - 02016R0679-20160504 - EN - EUR-Lex [Internet]. [cited 2020 Jun 4]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1532348683434&uri=CELEX:02016R0679-20160504

13. Giordano V, Koch H, Godoy-Santos A, Dias Belangero W, Esteves Santos Pires R, Labronici P. WhatsApp Messenger as an Adjunctive Tool for Telemedicine: An Overview. Interactive Journal of Medical Research. 2017 Jul 21;6(2):e11.

14. Miller R, Beaumont O, McGrath S. Is it now safe to use WhatsApp for clinical messaging? The American Journal of Surgery. 2016 Nov 1;212(5):1032-3.

15. Ganasegeran K, Renganathan P, Rashid A, Al-Dubai SAR. The m-Health revolution: Exploring perceived benefits of WhatsApp use in clinical practice. International Journal of Medical Informatics. 2017 Jan 1;97:145-51.

16. Memoria 2018 RESUMEN GENERAL MEMORIA 2018.

17. Xavier AJ, D'orsi E, De Oliveira CM, Orrell M, Demakakos P, Biddulph JP, et al. English longitudinal study of aging: Can internet/e-mail use reduce cognitive decline? Journals of Gerontology - Series A Biological Sciences and Medical Sciences. 2014;69(9):1117-21.

18. Barbosa Neves B, Fonseca JRS, Amaro F, Pasqualotti A. Social capital and Internet use in an age-comparative perspective with a focus on later life. Lozano S, editor. PLOS ONE. 2018 Feb 26;13(2):e0192119.

19. Richards ME, Hubble MW, Crandall C. Influence of Ambulance Arrival on Emergency Department Time to Be Seen. Prehospital Emergency Care. 2006 Jan 2;10(4):440-6.