Evaluation of a Telemergency Service for Older People Living at Home: A Study Protocol.

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Abstract— **Ageing is a critical challenge for public health and healthcare systems worldwide, as it is associated with an increased risk of falls, disability, cognitive impairment, and comorbidities. Among strategies to reduce negative fall outcomes, fall detection devices, such as Personal Emergency Response Systems (PERS), seem to be beneficial tools. PERS enable the detection and reporting of potentially dangerous situations in and outside home. However, more studies are needed to understand who can best benefit from these devices, as most did not associate alert data with user health information. For this purpose, a retrospective cohort study is being conducted to describe two years of alerts activation and the characteristics of users, distinguishing between those who privately pay for the service and those who receive a fund from public local authorities.**

Keywords— fall detection device, Personal Emergency Response System, homecare, aged, nursing.

I. Introduction

Falls are the main cause of admission to emergency departments and hospitals in older people [1], [2]. An estimated 684000 fatal falls worldwide occur each year in individuals older than 60 years [3]. Falls outcomes in older adults are both physical and psychological, with significant consequences on social life [3], [4]. Recurrent falls are associated with a decrease in older adults' independence, anticipating admission to nursing homes [5].

Falls have a high cost to healthcare systems worldwide. The average cost of hospitalization for a patient aged 65 years or older who suffered a fall-related injury ranges from US$ 6,646 in Ireland to US$ 17,483 in the United States. This will increase to US$ 240 billion annually in 2040 [3].

New technologies, such as fall detection devices, can be beneficial tools to detect and send an alert in potentially dangerous situations. These devices help to gain faster access to health services, aiding in the request for support [6], [7]. Among the devices currently on the market, the most commonly used and user-friendly are Personal Emergency Response Systems (PERS) [8]. These devices have three specific features: (a) a red button to call to (b) a 24-hour emergency response centre and (c) a home communication system [7]. These devices may reduce fall anxiety and increase security, thus improving confidence in performing activities [5], [9]. In addition, PERS are easy to use, quickly accepted by both the user and caregiver, and low cost [6], [10].

Over the years, these devices have been integrated with the Global Positioning System (GPS), tracking the person's location in the event of an emergency outside the home. Furthermore, with an accelerometer and a gyroscope, the call is automatically dispatched in the event of a bump and the person's inability to press the button [6].

Although PERS was developed for fall detection, these devices can provide support in many situations. Agboola et al. [11] found that only 43.2% of the alerts sent in 5 years of observation were related to falls. People often ask for support for physical or psychological symptoms, such as fever, dyspnoea, dizziness, and anxiety. In other cases, they needed the nurses' support information about medications, or household problems (6,5%). In a small percentage of calls (2%), people only needed somebody to talk to. Most alerts related to physical or psychological symptoms required emergency transportation, compared to those related to falls ($RR = 2.41$; $p < 0.001$) [11].

Similar data also emerged from the study by De San Miguel et al. [12], who showed differences in the risk profile of falls between those who purchased or not a PERS. Although the two groups were comparable for fall histories or comorbidities, those who decided not to purchase the device were younger, less independent, and with little or no social network compared to those who purchased it. [12]. The former sent more alerts, experiencing a higher number of emergencies [12].

To our knowledge no studies have associated alert data with users' health information. Furthermore, most published studies involve people who pay privately for the service, leaving out those for whom the service is funded by public local authorities [11], [12]. These data could be useful not only

to improve the quality of care provided but also to understand whom most benefit from these devices.

A retrospective analysis of data from a telemergency service offered by the Social Cooperative Ass.I.S.Te could help shed light on the use of PERS. The service is provided privately, through a monthly fee, or in agreement with public local authorities that partially or fully finance the cost. In addition, users' health status data, such as comorbidities, medications, and social networks, are collected at the service activation.

II. AIM

The aim of this paper is to describe the number, type and cause of the alerts activation and describe the characteristics of the users, distinguishing between those who privately pay the telemergency system offered by Ass.I.S.Te Cooperative and those who receive a refund.

III. MATERIAL AND METHODS

A. Setting

Telemergency is provided to people living at home who require or need remote monitoring. Data on device use and alerts are sent to the coordinating centre, located at the Ville Roddolo Nursing Home (Torino, Northern Italy). For the purpose of the research, the data collected will be analysed at the Department of Public Health and Pediatrics (Torino, Northern Italy).

B. Elegibility

All users who sent an alert from December 2020 to March 2023 were included.

C. The Telemergency Service

The Telemergency service provided by Ass.I.S.Te company offers frail people assistance in emergencies, including falling, limiting the time spent on the ground without rescue. This service has been in operation for more than ten years.

The service is managed by the Telemergency Operations Centre (T.O.C.), active during the twelve daytime hours; during the night-time hours, the service is contracted to an outside firm. Trained lay personnel work in the Telemergency centre.

The company provides two types of PERS. An indoor device, with a radio transmitter, connected to a wearable one around the neck. This device is designed for home use. An outdoor device that can be clipped to the belt or a watch, equipped with G.P.S. All devices are equipped with a phone SIM card, which can contact T.O.C. only. The alert can be generated:

- Automatically by the device, thanks to the presence of an accelerometer.
- By the person pressing the red button on all devices.

From the workstation, the T.O.C. staff can display on the screen the type of alert, from which device was sent, and the user's data (name, surname, age, residence, and health data). After assessing the user's condition, the calls are classified as: true alert, user error, information request, conversation call or test call. The assessment is made with a short unstructured interview asking the reason for the call. In case of an emergency or a fall, the staff reports in the free field 'Notes' the dynamics of the event, the possible cause, and the resolution of the alert. Based on the user's needs, the public safety answering point (112), on call Doctor, General Practitioner (GP) or caregiver can be contacted.

The service also includes the T.O.C.'s twice-weekly calls to ascertain the user's general health condition to detect possible risk situations such as fever, general discomfort etc. These calls are not recorded in the software. Every fortnight, users are asked to generate an alert to verify the functioning of the device (test call). These alerts are coded by the staff on the software as evidence of device functioning. Help interventions or calls to the caregiver are performed in the event of an alert, if problems are identified during conversation/company calls, and if the person is unreachable.

D. PERS devices: Assist 4 and Personal Tracker 3.0

Assit4 and Personal Tracker 3.0. are PERS designed by the Urmet ATE company, that enable to send an alert after a fall. The first device is designed for home use, while the second is equipped with GPS, to geolocalise the person after a fall. The technical characteristics of the devices are summarised in Table 1.

Following an impact, the fall detection system evaluates the change in height and rotation of the device, as well as if the user is on the ground. Thereby the device sends an automatic call to the T.O.C. To avoid false alerts, on both devices it is possible to turn off call forwarding. In Assist4, the forwarding call can be disabled by pressing the green button within 15 seconds, while the distress call alert is not sent if the person gets up within 15 seconds of the impact for the Personal Tracker 3.0.

If the user does not t

TABLE I. DEVICE CHARACTERISTICS

	Type of devices		
	Assist4	***Fall device***	***Tracker 3.0***
Size	222x155x55 mm	49.5 x 90 x 23 mm (without clip)	-
Power supply	Switching power supply 9Vdc 600mA max	-	Rechargeable
Battery type	Lead gel accumulator 6V 1,2Ah	CR2032	3.7 V 1150 mAh LiPo battery
Battery life	48 h	12 months	-
Transmission vector	PSTN telephone network	-	-
Frequency	869.25 MHz (class I) Social Alarm Freq. Compliance	869.20 MHz – 869.25 MHz Social Alarm Frequency Compliance	Quadri-band GSM/GPRS modules 850/900 - 1800/1900 MHz

Compared to the outdoor device, Assist4 enables:

- monitoring of the power grid sending alert in case of prolonged power failure.
- Anti-radio interference circuit: alerts the central unit in case of radio interference between Assist4 and the remote control.
- checking the battery level of the terminal and remote control and reporting it to the Central Unit.

- local self-diagnosis system, with watch-dog, to regularly alert the Central Unit on the proper functioning of the equipment and connections.

Furthermore, Assist4 has a remote control, wearable on the wrist or neck, with a survival control function and a micro-movement sensor. The remote control can send an automatic alert in case of no motion for a pre-defined time (in days or hours). This allows to know whether the user is wearing the remote control or not.

E. Service cost

PERS are leased to users upon a deposit of 100 euros, which is returned at the service's interruption. The connection fee is 50 euros, plus a monthly fee of 25 euros. Replacement of the remote control for damage costs 25 euros, while the entire replacement in case of breakage costs 100 euros.

F. Outcomes

The median time of service utilization for each group will be reported, giving reasons for deactivation, together with the total number of alerts sent. The alerts were classified as follows:

- True alert: reports of falls, near falls, physical symptoms (fever, dyspnoea, pain, bleeding, etc.) and psychological (anxiety).
- False alert: alerts sent by mistake, such as accidental button press, device fall, etc.
- Users request: calls to speak with a caregiver or social worker.
- Test alert: regular alert sent by users for the maintenance of the PERS.
- Technical alert: an alert sent automatically by the device, for example for low battery, or sent by the users to communicate malfunctions.
- Not coded: cases where no event description can be traced from the notes section.

The interventions after a true alert will be described, specifying who was contacted. In addition, the average time to help's arrival and intervention completion will be calculated. The incidence of falls, near-falls, and cumulative one-year incidence of falls for private and contracted users will be described. The odd and hazard ratios of falls in the two groups will also be calculated. The time, causes and outcomes following the fall for each group will also be reported.

G. Statistical methods

Data will be analysed using STATA version 17 statistical software. Continuous variables with a normal distribution will be presented through mean and standard deviation (SD). The median and interquartile range (IQR) will be used for continuous variables that are not normally distributed. Absolute and relative frequencies will express categorical variables. Differences between the two groups will be shown with t-tests for continuous variables or chi-tests for categorical variables. The logistic regression model will test the association between the variables found to be different between the two groups and fall and near-fall.

IV. PRELIMINARY AND EXPECTED RESULTS

This is the first study that includes people receiving support from public local authorities that partially or fully finance the cost. Most studies in fact did not include people whose health insurance or other type of financial support covered the cost of the service [11].

Over the 2 years, 717 users sent at least one alert. Data of the private and non - private groups are not yet available. From December 2020 to March 2023, users sent 65276 alerts, of which 17447 were sent by companies. The Telemergency service is, therefore, offered to companies or stores, such as pharmacies. Analysis of the 'Notes' section of these alerts showed that PERS can be used as a tool to increase worker safety.

Consistent with the results found by Agboola et al. [11], most were test alerts for the maintenance of the PERS (Table II). A substantial number of alerts concerned technical interventions to resolve device malfunctions (41.83%) and low battery (39.43%). A small percentage of the alerts were true, reporting falls and emergencies, namely events that required the intervention of health care workers or a caregiver to rescue the user. However, 2.3% of the alerts were requests for information or any kind of support, such as medication intake, for transport, or to talk with a caregiver/T.O.C. staff, implying that the PERS is useful also in non-emergency situations. This point will be examined in depth to better understand the needs of users.

TABLE II. ALERT SENT BY USERS

	N	*%*
Total	**65274**	-
Test alert	**24789**	**38**
Technical alert	**9293**	**14.2**
Technical interventions	3887	41.8
Low battery	3664	39.5
Technical notifications	1742	18.7
False alert	**5376**	**8.2**
Accidental Press	4060	75.5
Alert misuse	1316	24.5
Users request	**1479**	**2.3**
Support request	828	55.9
Listening service	651	44.1
True alert	**672**	**1**
Emergencies	427	63.5
Falls	245	36.5

The main expected result is to underline the differences in the need and use of the device between the two groups of users, to possibly promote the PERS use in home care with the aim of improving the quality of the services offered and increasing patients' safety.

In this way, even those who are not supported by a social network could more easily access to essential services, such as health system, meeting people needs.

The usefulness of the service will be based on the number of alerts made, which would not have been made in the absence of the device. From the dynamic of the fall event, we will assess how many times the person would have been unable to call for help.

V. Ethical and Privacy Issues

A study approval request was sent to the Bioethics Committee of the University of Torino. When signing up for the service, people have consented to process the information collected by the telemergency system for research purposes. Therefore, the company will provide the data to the research team anonymously.

VI. Conclusions

Understanding the potential benefit of these devices for fall detection helps shed lighter on their effectiveness, highlighting the main criticalities in a real context, and providing elements for integrating the devices into daily care practice. The involvement of the Social Cooperative Ass.I.S.Te provides data on a tangible reality in a real context.

Conflict of interest

The authors declare no conflict of interest. The study is part of the agreement signed between the Ass.I.S.Te Social Cooperative and the Department of Public Health and Pediatric Sciences, to establish a PON Research and Innovation doctoral fellowship. As required by Ministerial Decree 1061/2021, the doctoral project must be carried out in collaboration with the company. Therefore, the sponsor's support will be to make data available for the evaluation of the telemergency service.

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