Original Article

The *mHealth* in the canine assisted therapy: the proposal of a conceptual model for the wearable monitoring

Daniele Giansanti, Giovanni Maccioni

Istituto Superiore di Sanità, Rome, Italy

Contributions: (I) Conception and design: All authors; (II) Administrative support: D Giansanti; (III) Provision of study materials or patients: D Giansanti; (IV) Collection and assembly of data: D Giansanti; (V) Data analysis and interpretation: D Giansanti; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Daniele Giansanti; Giovanni Maccioni. Istituto Superiore di Sanità, Rome, Italy. Email: daniele.giansanti@iss.it; gianslele@gmail.com.

Background: We are today assisting to: an increasing interest to both the animal assisted therapy (AAT) and to the pet quality of life and health. The animal-assisted therapy is an alternative or complementary type of therapy that involves animals as a form of treatment. Among the goals of AAT there is to improve a patient's psychological and physiological condition during the rehabilitation therapies. The increasing interest into the pet quality of life and health is a direct consequence of the recognition to its contribute to the society.

Methods: Through an analysis of the literature the study investigated this field in order to derivate new models based on mHealth. Several studies showed the health benefits (psychological and physiological) for the human subject thanks to the AAT. Today, according to the new central position of the pet, the approach must be revised in a more general and bidirectional approach embedding the assessment of the health benefits contemporary for the two actors, human and pet.

Results: The study highlights that the most commonly used types of AAT is the canine-assisted therapy (CAT). Among the most used CAT applications in psychological and physiological rehabilitation there are: the (I) *co-presence* during the dynamic activity (in particular the walking) and the (II) *co-presence* in the Area of living (mainly the home). The study focused to the CAT, introduces a conceptual model for the contemporary parameters monitoring of the two actors during the two applications (I,II) and able to provide a quantification of the utility of the CAT. It is based on to two sub-systems. The first sub-systems is a wearable mobile solution with kinematic sensors for the human and the dog monitoring in (I) during walking. The second sub-system, allowing the monitoring in (II), is based on RFID technology.

Conclusions: After an analysis of the literature a new model for the CAT, based on kinematic sensors and RFID technology has been proposed and will be introduced in this field.

Keywords: mHealth; animal assisted therapy (AAT); canine-assisted therapy (CAT); model

Received: 15 May 2019; Accepted: 03 September 2019; Published: 02 December 2019.

doi: 10.21037/mhealth.2019.09.08

View this article at: http://dx.doi.org/10.21037/mhealth.2019.09.08

Introduction

The quality of life of the Pet

We are today witnessing the introduction of national and international regulations for the protection of pets, recognizing to them the great contribution to improving the quality of human life and a big value for the society. An example is the European Convention on Pet Rights promulgated in Strasbourg on 13 November 1987 (https://rm.coe.int/168007a67d) with profoundly innovative characteristics, which introduces, through a series of articles, regulations aimed at providing a complete legal structure to protect all pet animals which are finally recognized for their importance in terms of quality of life and value for

the society. Stimulated by these regulations we are now experiencing a growing interest in the quality of life and health of the pet and in the introduction of technologies for the remote monitoring of the pet animal, with particular reference to the parameters of fitness and wellness. There are today numerous examples of systems that allow monitoring in biotelemetry by means of *smartphones* or *wearable systems*. These *mobile* and *wearable devices* are able to track in some cases vital signs, such as heart rate and respiratory rate, along with wellness indicators like activity, rest, and calories burned. The following systems: *Voyce* (available up to the end of 2016), *Fitbark*, *Petpace*, *Link AKC*, *Petkit*, *Tractive Motion* can be cited as not exhaustive examples. Thanks to these systems it is possible to monitor the activity of the pet and share it on the net with the vet. We have also explored this field at the ISS and proposed a wearable device (based on accelerometers and rate-gyroscopes and described in the following) capable to monitor the dog walking and human walking together.

The canine assisted therapy (CAT)

We are today assisting to: An increasing interest to both the animal assisted therapy (AAT) and to the pet quality of life and health. The animal-assisted therapy is an alternative or complementary type of therapy that involves animals as a form of treatment. Among the goals of AAT there is to improve a patient's psychological and physiological condition during the rehabilitation therapies. Several studies showed the health benefits (psychological and physiological) for the human subject thanks to the AAT. Among the most commonly used types of AAT there is the canine-assisted therapy (CAT). The CAT is for example particularly useful in the elderly (1) or in the children (2) to improve health. In particular the identified health benefits are the following two:

- *Psychological benefit*. Improvements have been demonstrated concerning the state of anxiety, depression and other psychological disorders.
- *Physiological benefit*. Improvements in blood pressure, in certain blood parameters (cholesterol and triglycerides) on the heart and on other organs (lung) have been demonstrated.

It is well known, for example, that the walking along with a dog plays a positive role in the improvements of the two above listed health aspects both as a direct and indirect consequence of the dynamic activity. It has already been shown that dogs, play a central role in improving walking performance and consequently the related physiological and psychological parameters mentioned above (1). There are several studies focused on improving the walk thanks to the CAT based on dogs as reported in the review article (1) and consequently the physiological and physiological indicators. A first study showed, for example, evidences that people with dogs are more likely to walk through the parks of individuals who do not own dogs (3). A survey in the United States found a positive correlation between dog conduction and total amount of walking time in each session (4). In a study conducted in Colorado, it was shown that men who are accompanied by dogs walk longer distances and have lower triglycerides (5). The improvement of the ability to make exercise thanks to the walk with the dog has also been demonstrated in some individuals using a cycle-ergometer (6). Given the preponderance of the evidence, the American Heart Association has released a statement acknowledging the relationship and causality of pet ownership in the attenuation of cardiovascular disease risk (7).

The revolution of the CAT

As it has been highlighted above we are assisting to both an increasing interest into the dog quality of life and a recognition of the utility of the CAT. Researchers are today also interested on the benefic effects for the dog during the interaction with the human. They are convinced, for example, that pets may have the same benefic health psychological and physiological from the interaction with the human.

Common convincement is, for example, from a reverse point of view that:

(I) Dynamic activity (such as the walking) with the human is beneficial for the dog too.

(II) Co-presence of the human (as for example while sleeping, relaxing, having supper) improves psychological conditions in the dogs too.

As an example of (I) we can consider what it follows. All of us are aware that, year after year the dogs, are more and more affected with the same human pathologies such as for example the diabetes. As it is well known the walking can help to reduce the insulin therapy in the diabetes also in veterinary care. The love towards the dog leads the human to improve the dog's walking activity and therefore the dog's health. From the other side the walking is also useful for the human's health. Dog and human become both therapist towards each other! (*Figure 1*).

As an example of (II) we can consider that the co-presence of the human and dogs in the same room, as for example the sleeping room or the dining room improve

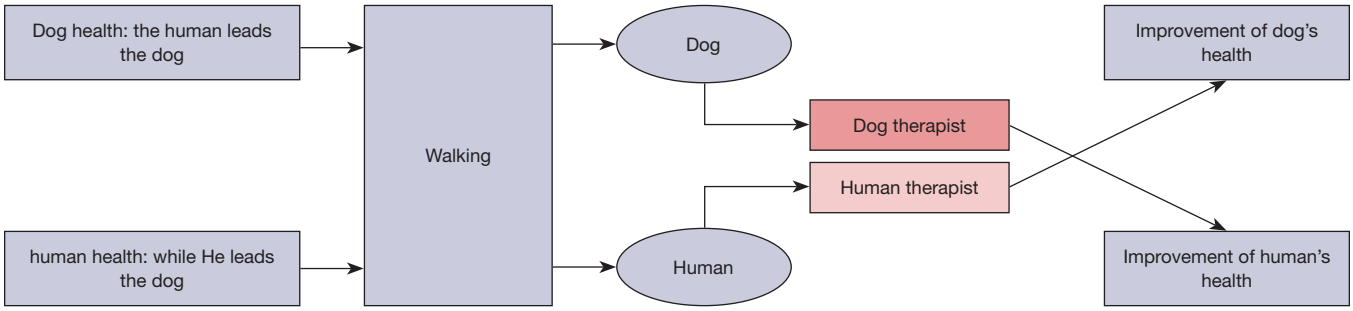

Figure 1 The walking (I) is useful both for the human and the dog.

the psychological relaxing both for the human and the dog. Scholars have the convincement on this, however needs quantitative data provided by the technology.

Purpose

Up to now the interest of the CAT shows these limits:

- It all focuses on benefits for humans and not on dogs.
- There is the need of more quantitative research data from direct monitoring (1), in particular in the two key application the CAT in (I,II): the dynamic activity with humans (walking) and the activity of *co-presence* in the area of living.
- Up to now many scientific conclusions are based on an only partially-quantitative approach.

There is thus the need of a new integrated approach to investigate the mutual health benefits involving professionals from the human medicine and veterinary medicine. Up to now this field seems to have been "a nobody's land"! To overcome this limit there is the need to design a complete approach comprehending:

- The design of appropriate mobile health technology for the contemporary assessment of parameters of the two actors (human and dog) during the two interactions (I) and (II).
- The design and application of appropriate protocols.

Methods

The methodology we followed at the ISS was based on the identification of the requirements to derive a conceptual model in mHealth

The requirements of the conceptual model

Up to now Telemedicine and in particular the mHealth has proceeded in the two separate directions of the veterinary and human mobile monitoring. Up to now, for example, there are several technological solutions of different medical complexities that allow human and animal monitoring separately. A new approach aimed at combining the two disciplines in a unitary approach is naturally complex due to the many parameters to be monitored and should tend to design systems that allow simultaneous monitoring of animal and human parameters for the resulting data-mining.

When focusing to the daily activity of the two actors (dog and human) dedicated systems should be designed allowing (I) the contemporary measurements of parameters during the dynamic activity and (II) the assessment of the *co-presence* in the area of living. These systems should allow the following features:

- A *unique diary* for the recording and storing of parameters related to daily, weekly, monthly sessions of walking activity; for the assessment of co-presence of the two actors in the area of living and for the uploading of other parameters from external periodic measurements, as for example blood parameters and pressure measurements, psychological tests, behavioral tests etc.
- A *unique tool* for analyzing and correlating activity (during interaction) of the two actors, providing diagrams, trends and motivational outputs, as for example for the fitness and wellness, information of co-presence with the possibility of the data uploading in the internet clouds.
- A *unique source* of medical knowledge useful for the both sectors of human and veterinary medicine.
- A *tool* to provide medical evidence.

The mHealth in order to achieve the objectives of the model shows several solutions from the *wearable*, *portable* and *domotic technology*.

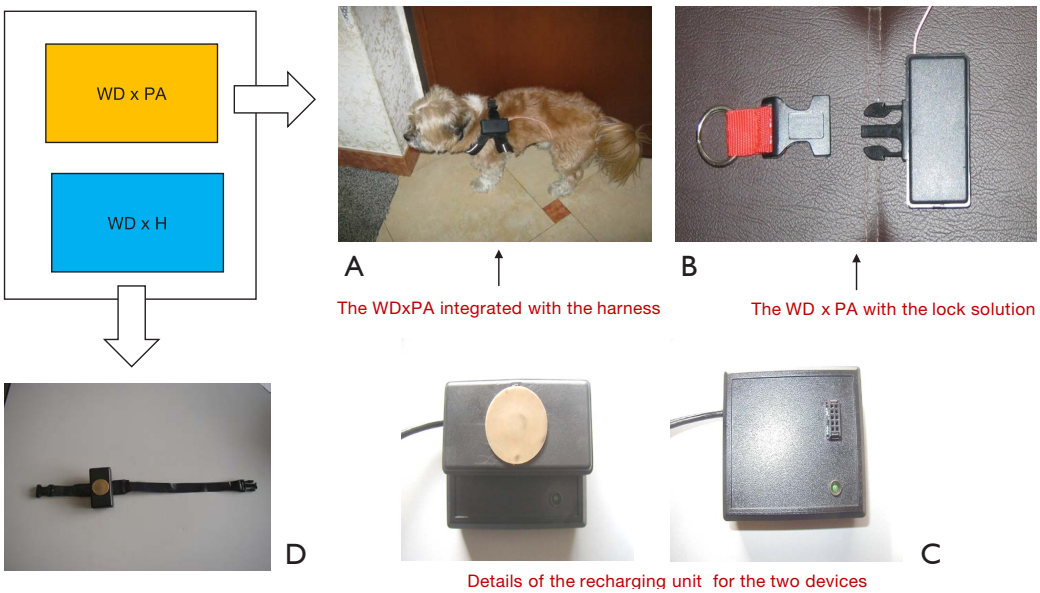

Figure 2 The components of the *wearable sensor* unit (Kit).

The conceptual model proposed at the Istituto Superiore di Sanità

At the Istituto Superiore di Sanità (ISS), the Italian National Institute of Health we are proceeding in the direction traced above.

We have proposed:

- A *telemetric system for the monitoring of the dynamic activity*, with a wearable sensor kit (with kinematic sensors) for both the human and dog, radio-linked to a *portable central unit with a domotic cockpit*;
- A *system for the co-presence monitoring in the area of living* (connectable with the same portable central unit *with a domotic cockpit)*.

Results

The outcomes are relevant to the *telemetric system for the dynamic activity monitoring*, *the portable central unit with a domotic cockpit*, *system for the co-presence monitoring in the areas of living*.

The telemetric system for the dynamic activity monitoring

Figure 2 shows the two components of the kit for the monitoring of the dynamic activity, also recalled in (8) where it is also fully described a validation in a case study. The first component has been designed for monitoring the "steps" in the human; the second component has been designed for monitoring the "steps" in the dog. The first component, the *wearable device* for the human (*WD x H*) (*Figure 2D*) is the same used in (9), i.e., a *Gastrocnemius Expansion measurement Unit* (*GEMU*). The core element of the GEMU is a Force Sensing Resistor (FSR) affixed at the calf level for the step monitoring. The second component, dedicated to the dog, is the Wearable Device for the Pet Animal (*WDxPA*). *Figure 2A* shows the affixation of the *WDxPA* on the dog-harness at the level of the scapula. *Figure 2B* shows a detail about the lock solution used in the device. *Figure 2C* shows the recharging unit, identical for the two components. The RX-TX unit used in the two transmission lines is the AUREL XTR-434H (Aurel, Italy) unit.

At the Level of the Receiving Unit there is also an A/D converter NI USB 6008 (National Instruments, USA) which, combines the two Radio-Links and converts them into digital for the Personal Computer. *Figure 3* shows the architecture of the kit. The WDxPA is based on two sensors:

- An accelerometer sensor (3031-Euro Sensors, USA) to detect the acceleration during walking. After some trials we have detected that at the level of the scapula of the dog (PA) the vertical acceleration pecks are more evident and correlated to the impacts on the ground;
- A rate-gyroscope (Gyrostar ENC-03J-Murata, Japan) to assess the rotational rate during walking, useful to

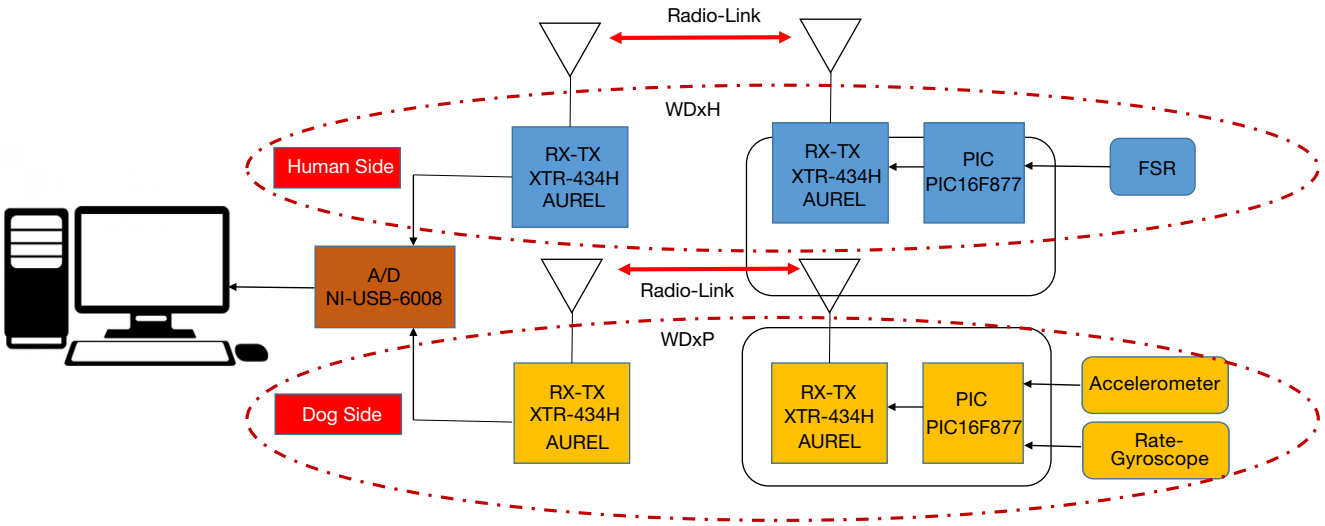

Figure 3 The architecture of the *telemetric system*.

create medical-knowledge and for correcting the step counting when the contributes of the dog-trot and dog-gallop are increasing with the speed.

The kit has been preliminarly tested in (9-11) and is integrable with other sensors for providing other useful physiological parameters. At the moment we are proceeding to the full testing and the validation in a case study.

The portable central unit in the telemetric system with the domotic cockpit

The central unit may be a desktop or portable pc with a software, it allows through the *domotic cockpit*:

(I) The management of a unique diary with the parameters relevant to the physical activity;

(II) The opportunity to upload parameters from external periodic measurements, as for example blood parameters and pressure measurements, psychological tests, behavioral tests etc. for the two actors;

(III) The timing of *co-presence* in the area of living (bedroom, living room, dining room, etc.) with the events of strong proximity (ESP) (*Figure 4*);

(IV) The opportunity of analyzing and correlating the activity of the two actors, providing diagrams, trends and motivational outputs, as for example for the fitness and wellness, timing of co-presence, with the possibility of the data uploading in the internet clouds.

At the moment the functionalities *I*, *II* have been completely implemented. We have currently designed and now are completely implementing the functionality *III* and *IV* using the low cost solutions available in domotics.

The system for the co-presence monitoring in the areas of living

We are currently implementing this system with RFID tags (TAGs) that will be worn by the two actors. The RFID detectors will be affixed (R-D) in the home area and worn by human and connected to the central unit. The R-D worn by the human will also detect the *ESP* of the dog (for example the dog more near than 1 m). The *domotic cockpit* will store and display the co-presence in an area with the related time duration; in the case of co-presence the cockpit will also records the ESPs of the dog with the time duration (*Figure 4*).

Discussion and conclusions

The study here reported was focused to the CAT and introduced a conceptual model for the contemporary parameters monitoring of the two actors (dog and human) during the (I) walking and (II) co-presence in the areas of living. The conceptual model has been individuated. It was based on to two sub-systems. The first *sub-system* is a wearable mobile solution with kinematic sensors for the human and the dog monitoring in (I) during walking.

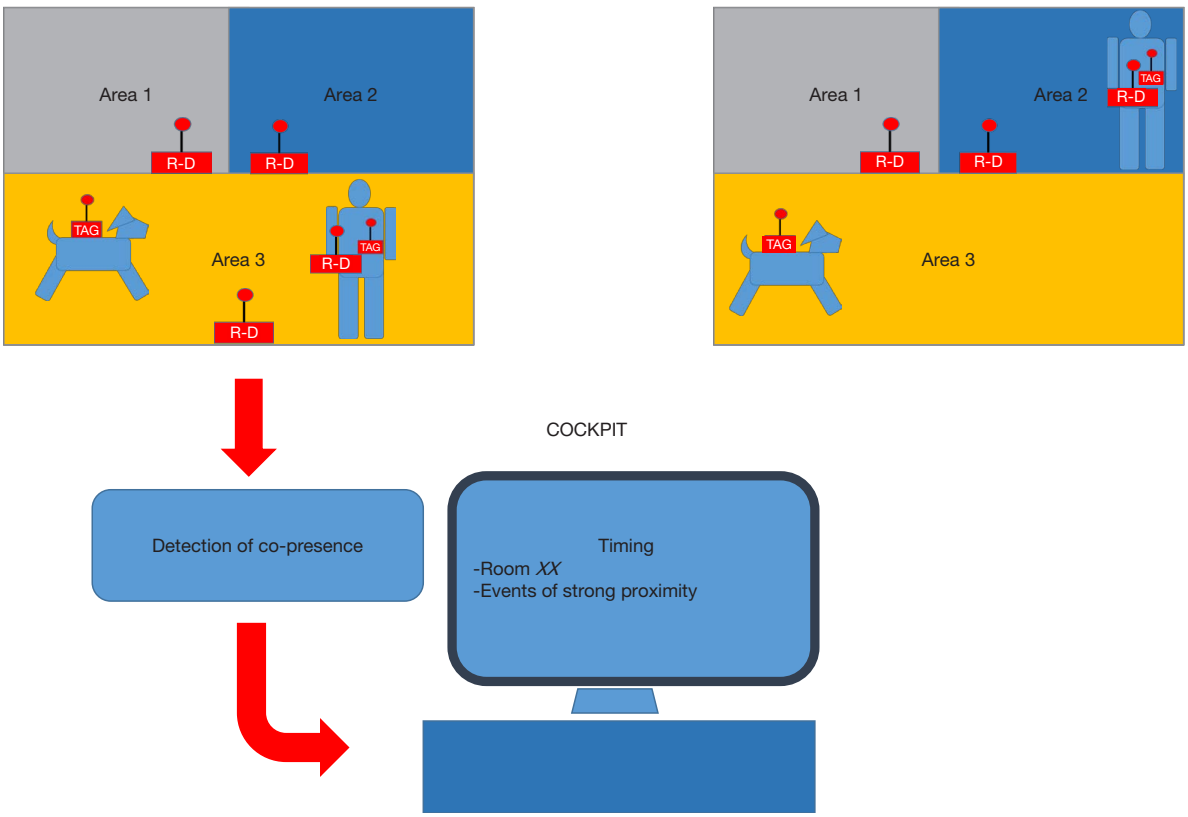

Figure 4 The monitoring of the *co-presence* and ESPs in the area of living using the RFID technology. ESP, events of strong proximity; RFID, radio frequency identifier.

The second *sub-system*, allowing the monitoring in the area of living (II), is based on RFID technology. At the moment we are fully testing and applying in a case study the first *sub-system* for the walking monitoring. The *first immediate next direction of research* will be the methodology application with properly designed protocols. This also eventually will comprehend automatic tools to automatically detect and monitor walking tests or path (10,12,13). The methodology in this phase will be applied to subjects who have already demonstrated to very well responding to the CAT (1-6): older subjects, subjects in mental rehabilitation (e.g., with depression and anxiety); subjects with heart failure; subjects with hypertension and with other risk factors (e.g., cholesterol and triglycerides). This will provide useful *medical knowledge* in this field (14,15) after a properly *data-ming*. The *second immediated next direction of the research* will be the enrichment and enlargement of the parameters to monitor in real-time, including the heart rate, the oxygen saturation and other ones.

Acknowledgments

We thank with gratitude the dog Grisou who inspired this work (b 22 Oct 2002; d 31 Dec 2018).

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Cherniack EP, Cherniack AR. The benefit of pets and animal-assisted therapy to the health of older individuals. Curr Gerontol Geriatr Res 2014;2014:623203.

2. lmacı DT, Cevizci S. Dog-assisted therapies and activities in rehabilitation of children with cerebral palsy and physical and mental disabilities. Int J Environ Res Public Health 2015;12:5046-60.
3. Temple V, Rhodes R, Higgins JW. Unleashing physical activity: an observational study of park use, dog walking, and physical activity. J Phys Act Health 2011;8:766-74.
4. Reeves MJ, Rafferty AP, Miller CE, et al. The impact of dog walking on leisure-time physical activity: results from a population-based survey of Michigan adults. J Phys Act Health 2011;8:436-44.
5. Dembicki D, Anderson J. Pet ownership may be a factor in improved health of the elderly. J Nutr Elder 1996;15:15-31.
6. Ruzic A, Miletic B, Ruzic T, et al. Regular dog-walking improves physical capacity in elderly patients after myocardial infarction. Coll Antropol 2011;35:73-5.
7. Levine GN, Allen K, Braun LT, et al. Pet ownership and cardiovascular risk: a scientific statement from the American Heart Association. Circulation 2013;127:2353-63.
8. Giansanti D, Macellari V, Maccioni G. Telemonitoring and telerehabilitation of patients with Parkinson's disease: health technology assessment of a novel wearable step counter. Telemed J E Health 2008;14:76-83.
9. Giansanti D, Maccioni G, Grigioni M. Biotelemetry for monitoring the quality of life of pets: what has changed since Laika? (in Italian) Notiziario dell' Istituto Superiore di Sanità 2017;30:3-8.
10. Giansanti D, Maccioni G, Grigioni M. Walk Tests and animal assisted Therapy: new models in Walking and health: state of the art, innovative proposals and integration into the e-health. Edited by Daniele Giansanti. (in Italian) Istituto Superiore di Sanità 2017. (Rapporti ISTISAN 17/30).
11. Giansanti D, Maccioni G, Morelli S, et al. Towards the design of automatic tools for the walking monitoring in Walking and health: state of the art, innovative proposals and integration into the e-health. Edited by Daniele Giansanti. (in Italian) Istituto Superiore di Sanità2017. (Rapporti ISTISAN 17/30).
12. Giansanti D, Maccioni G. The walking tests: from fitness to telerehabilitation. Telemed J E Health 2017;23:694-6.
13. Giansanti D, Morelli S, Maccioni G, et al. Portable kit for the assessment of gait parameters in daily telerehabilitation. Telemed J E Health 2013;19:224-32.
14. Chur-Hansen A, Stern C, Winefield H. Gaps in the evidence about companion animals and human health: some suggestions for progress. Int J Evid Based Healthc 2010;8:140-6.
15. Fabrizio B, Gualano MR, Camussi E, et al. Animal assisted intervention: A systematic review of benefits and risks. Eur J Integr Med 2016;8:695-706.

doi: 10.21037/mhealth.2019.09.08
Cite this article as: Giansanti D, Maccioni G. The *mHealth* in the canine assisted therapy: the proposal of a conceptual model for the wearable monitoring. mHealth 2019;5:51.