

January 2019

Amendments

February

2019

LandSAR

Supply of Wander SAR Equipment

Parameters for the Equipment

Literature Review examines the parameters being used by Land Search and Rescue to assess tracking devices used as part of a health care plan for people prone to Alzheimer's, Dementia and Autism related wandering

Executive Summary:

This is a scoped literature review looking to identify tracking devices that, when in use with other safety strategies, make life more accessible for people who have Alzheimer's, dementia or autism, and related wandering. Because tracking devices act as a fail stop to most health care strategies **the success of such tracking devices are, solely, a matter of life and death.** This review took the equipment parameters (Appendix 1), provided by Land Search and Rescue (LandSAR), and compared them to relevant peer reviewed journals to ensure continued consistency with global ethical and technological frameworks. LandSAR's Parameters were found to have one major ethical concern and one minor technical difference to global frameworks. The parameters were updated to assimilate them with recent ethical and technological developments (Appendix 2). Parameters were also labelled "Essential" or "Desirable" based on their necessity to ensure user safety. These "new" parameters have then been compared to devices that are currently in the marketplace both locally (New Zealand) and globally. Recommendations on the most suitable devices have then been made on a case of "optimal fit". Devices that failed to match all critical parameters were eliminated; the remaining devices were rated based on how many of the desired parameters were met. There is a problem in the marketplace with device makers trying to make their product appeal to multiple potential markets, leaving no real defined categories of tracking. That is most devices list vehicles, people and pets as their intended use.

Recommendations:

Product Recommendation 1 – WanderSearch system (WandaTrak / Bart Dinger Electronics products):

Currently being run by Wander Search groups throughout New Zealand, was the only system/device that was able to meet all the parameters set out by LandSAR. This system/device has to remain the go to solution for the short term (next 2-3 years). Global Positioning Systems have been proven to locate people faster, however still fail on key parameters set out by LandSAR.

Product Recommendation 2 - iTraq Nano *(available April 2019):*

A device that is tracked either online or using an app. It meets all essential and most desired parameters, however it is still too big and a little heavy at 40grms. At a cost of \$176 and a yearly cost of \$89 it is getting very close to competing with the WanderSearch system.

Product Recommendation 3 - Trackimo 3G Guardian:

Has a size and weight advantage over the iTraq Nano however no information on its robustness could be obtained. It is also tracked online or by app. At a cost of \$206 and a yearly cost of \$89 it too is getting very close to competing with the WanderSearch system.

Parameter Recommendation 1:

Ethical: Parameter 9 should be a fixed statement to leave readers in no doubt to the seriousness of its intent. It is foreseeable, that caregivers under financial pressure, would fail to understand the importance of this parameter. That is, they could inadvertently trade the safety of the user in the pursuit of a financial saving.

Parameter Recommendation 2:

Technical: Parameter 5 should be changed to 10 days. It has been shown that most organisations seek a 10 day battery life for devices with rechargeable batteries. The current figure was 7 days.

Executive Note 1:

Keep all GPS related contracts to less than three (3) years

By 2020, China will have completed its Beidou satellite navigation network (Bloomberg, 2018). The plan of this network is to eliminate Chinese reliance on the United States owned Global Positioning System (GPS). If China's system is more accurate than GPS, which is expected, GPS's monopoly on mapping and geography devices may come to an end. The Chinese government expects Beidou related technology to generate more than \$57B USD in yearly revenue (Bloomberg, 2018), GPS related technology is expected to generate \$94B USD in revenue by 2022 (Businesswire, 2016). With these market sizes at stake and in direct competition to each other, it is reasonable to expect that a wave of development will occur in the global positioning market over the next few years. It would be seen as "more favourable" to keep supply contracts of GPS equipment to a maximum of a 3 year term.

Executive Note 2:

Micro chipping Humans

LandSAR and its directors in the near future will come under increasing pressure to recommend the micro chipping of people with Alzheimer's, dementia or autism related wandering issues. There is already pocket's of people around the world where RFID micro chipping for workplace activity is a reality. "Swedes have gone on to be very active in micro chipping, with scant debate about issues surrounding its use" South China Morning Post (2018). When you combine this gradual social acceptance of micro chipping with China's technology growth around its Beidou satellite system, it is hard not to see the technology being in the marketplace soon. Carers under emotional and financial

pressure will see this technology as a silver bullet; their pressure will be turned onto LandSAR. LandSAR will be best served by developing a policy or set of guidelines around its use.

Parameter Literature Review:

Introduction:

Wandering is a condition normally associated with those who have Alzheimer's, Dementia and some forms of Autism. Caregivers, both professional and family members, recognise that when a person goes missing (wanders) it can be a stressful time for those involved until the person is located. In regards to "tracking" the individual, however, the opinions differ around the type of device to be used and the question of whether you should track or not and whose permission is needed, the family, caregiver or the individuals. This literature review will discuss the parameters provided by Land Search and Rescue (LandSAR) and compare that to current peer reviewed literature to ensure that what they are measuring against is as accurate and up to date as possible. Each parameter will be rated as either Essential or Desired in its assessment, as this allows a more thorough examination of devices on the market to take place.

Trackability:

White (2010) lead a study called Electronic tracking for people with dementia who get lost outside the home. What this study highlighted was that "Most carers preferred to use tracking as a backup to other strategies of management, particularly supervision by a carer and locked doors". When tracking was being used as a frontline strategy the carers "perceived the risk of harm from getting lost to be low" White (2010). However there are multiple technologies being used to prevent and reduce wandering by people with a high predisposition to wander. A trial conducted in Australia with Williamson et al. (2017), where participants trialed three different wearable Global Positioning System (GPS) devices over a period of 8 weeks (a pendant, a watch and a mini GPS phone), determined that the most valuable aspect of a wearable GPS is for the wearer to contact their support person with a device that allows a two-way communication, knowing where they are located and for the user of the device to feel safe when is outside of their immediate circle. Along with GPS, Radio Frequency Identification (RFID) is being widely used and studied.

A study by Zhou (2013) titled A Novel Approach for Addressing Wandering Off Elderly Using Low Cost Passive RFID Tags came to the conclusion that RFIDs are a better option for tracking people when they are indoors.

Perala, (2013) ran a study trialing and comparing a wide range of technologies. The study was broken into three parts as follows:

-  Those technologies that are operated within the home (indoor technologies):
 - Magnetic Door Alarms – Performed poorly
 - Door Alarms - With “Greater Intelligence” worked extremely well and only sent an alarm if the user left the building.

-  Those technologies are used in close proximity to the home (for example, in the garden).
 - RFID (Radio Frequency Identification) – Did not work effectively as it triggered too many false alarms
 - GSM Camera – Worked great at managing external threats

-  Technologies that are used outdoors at arbitrary distances from the home.
 - Internet based GPS -Worked well when relatives could use a web-based interface
 - Call centre monitored GPS

Based on the results of the final interviews, the installed technology had a positive impact on the participants; the technology helped to reduce feelings of insecurity, reduced anxiety and worry of relatives, and improved access control to homes (e.g. “stopping peddlers”). Overall, those technologies that operated within the premises of the living quarters, i.e. indoor technologies, tended to function more reliably than either close proximity or outdoor technologies. Location based alarm and access control technology can have a positive impact on the lives of elderly persons suffering from dementia. When chosen appropriately, technology can help to reduce or eliminate the wandering often associated with dementia. Regardless of the technology used, it should be installed when the elderly person is at the early stages of dementia; at later stages of the disease it is usually impossible for the elderly to adequately adopt the device.

An article on GPS Locator Devices for People with Dementia by Topfer (2016) highlighted four key studies and their findings:

-  A 2016 simulation study, funded by the US Department of Veterans Affairs, assessed the time to locate missing persons (role-played by researchers) under various outdoor scenarios using three commercially available RF locator devices and four GPS devices. Each device was tested three times in each of three scenarios (open, wooded, and urban). Two device tests (one with RF and one with GPS) failed to locate the missing person within 25 minutes, but overall, the GPS devices were almost twice as time-effective in finding the wanderer and performed better over larger distances. The RF devices were limited by their range; however, the study did not test the devices indoors, where RF devices may have performed better.
-  A 2012 pilot project launched by the Halifax Regional Police, called Project SOFT (Satellite Option Finding Technology), tested GPS devices in 10 people with dementia over a one-year period. A report on the study has not been published, but the principal investigator for the project noted a decrease in time and staff used in searching for missing people with dementia
-  In a UK study published in 2014, the 10 caregivers of people with dementia prioritized the improved safety of the person with dementia when using GPS devices over concerns about their privacy. They also viewed independence and freedom as an important part of their care-recipient's quality of life.
-  While GPS technology reduces searching time for lost wanderers, whether it increases overall safety has not been demonstrated. For example, GPS devices cannot alert users to dangers such as traffic, or ensure that individuals are wearing appropriate clothing for weather conditions if they wander outside.

Ethics:

Introducing a device that can be tracked raises the question of who should make the decision regarding the wearing of a device that can be tracked. Young and Kels (2016) found that the debate of tracking individuals was largely focused on the relationship between safety and autonomy. The concept of autonomy is not extinguished with the diminishment or loss of decisional capacity, although it must be balanced against the need to keep the individual safe. Family caregivers, for example, prioritize the safety of their loved ones and their support for electronic tracking is correlated with their personal responsibility for providing care. The professional caregivers are more apt to cite concerns about autonomy. A study involving older adults who lived independently and used a wrist worn monitoring device indicated that the vast majority reported feeling that the technology enabled rather than constrained them. Whilst safety and security is was one ethical consideration for caregivers Young and Kel also found that privacy and dignity, recognised as fundamental human rights, and the act of monitoring an individual's movements has privacy implications. Australian researchers have appropriately deemed privacy concerns the most significant roadblock to GPS tracking, and the government of Victoria, Australia, has taken pains to emphasize commonplace steps to preserve the privacy of individuals with dementia (Yang, Kels 2016).

Landau and Werner (2009) quote a study by *Robinson et al. (2007)*, that family care-givers mainly favoured a tracking device to locate individuals more quickly, thus reducing the risk of harm. However, they were also concerned about the effect of such devices on the individuals' autonomy and privacy and about the association of tagging devices with criminal offenders. Where individuals are unable to make a decision in regards to agreeing to be monitored, any decision made on their behalf must be made in their best interest. In such cases, even in the absence of a formal statement of wishes or an advance care plan, people's views and wishes may be used to assist in planning their support. Some health professionals argued that the person's right to autonomy should be balanced against the risk of harm both to themselves and to others *Robinson (2007)*.

Robinson (2007) also discusses the tension between the use of surveillance, through the use of tracking devices, and the person's right to privacy was also paramount, with some arguing that it was a breach of privacy (Dawkins 1998, Department of Health 2001) and others arguing that this was only the case if the person was trying to hide (Coleman 1993). *Essen (2008)* found that the majority of individuals surveyed believed that the use of electronic monitoring can indirectly protect their privacy by enabling them to continue living in their own homes rather than moving to a nursing home.

What is abundantly clear from all the research into tracking devices is that any information collected or "emitted" from the device must be protected to ensure privacy of the individual wearing it. Also the ability to track the device must be limited to those "with permission" from those involved in the health care plan of the individual wearing the device. LandSAR's parameter on Privacy (Parameter 9) has clearly defined the issues around protecting the information of the user and controlling who can track the user. The question that remains is, "If LandSAR is recommending a device should they have a definitive policy on all information gathering?" Given all that has happened with the Facebook vs. Cambridge Analytica data scandal, there can only be one answer, yes. This would bring LandSAR in line with European countries where "In an effort to give consumers greater control over how their personal details are used, Europe is set to impose sweeping changes to data laws" CNBC (2018). Caregivers under emotional and financial pressure may purchase a cheaper device, not understanding the importance of data protection and therefore put their client/user at risk. Any potential device must comply with Parameter 9 and this makes Parameter 9 Essential.

Wearability:

Wearable technology is proven to be a key issue when it comes to trackability devices, with a range of parameters that might be perceived as trivial at a first glance but can affect acceptance or willingness to use uninterrupted. As such, wearability is considered a significant issue for product designers and manufacturers alike. These wearable devices can be for external use, such as an accessory, or embedded in the user's clothing such as embedded RFID chips, GPS, and RF textile-based monitoring systems that are used on a daily basis by the cognitively impaired person without the need of activation or having to remember to carry it with them *Williamson (2017)*. They need to be secured and attached to the person but cannot be so secured that could harm those who try to pull it off repeatedly, or that can become a choking hazard.

Landau conducted a study that examined the attitudes of family and professional caregivers towards the use of advanced electronic tracking such as GPS (Global Positioning Systems) and RFID (Radio Frequency Identification) for elderly people with dementia. The study revealed 4 principal findings. First, caregiver's views range from feeling obligated to use the tracking device for the sake of the patient's safety through support of the use of the device for the caregiver's peace of mind and restricted support, to objection to the use of the device and respect of the person's autonomy. Second, family caregivers showed higher support for the use of GPS and RFID both for their own peace of mind and for the safety of the elder in their care. *Landau et al (2009)* Professionals attached higher value to respect for a person's autonomy and restricted support for using GPS and RFID. Third, both family and professional care-givers agreed that the decision on tracking dementia patients should be an intra-family issue. Fourth, family caregivers attached more importance to the tracking devices characteristics and design, thus empathising that the tracking device must be 'user-friendly'.

Landau found that the family caregivers identified a number of issues when using a device, among them were cost, technical problems, size of the device and difficulties fitting and remembering to test the batteries. *Robinson et al (2007)* found through studies and reviewing literature that family caregivers had a positive response to the tagging and/or tracking devices, either in principle or based on their experience. They also noted the following problems with the use of tracking and tagging devices that concur with those found in the Landau study. Robinson

states the issues were cost, the extensive training and technical support required, technical problems, the size of the device, difficulties fitting and remembering to test batteries, increased demand on family carers in terms of using the equipment, monitoring and searching for their relative, especially if the carer was also elderly *Landau et al. (2009)*. When chosen appropriately, technology can help to reduce or eliminate the wandering often associated with dementia. Regardless of the technology used, it should be installed when the elderly person is at the early stages of dementia; at later stages of the disease it is usually impossible for the elderly to adequately adopt the device *Perala et al. (2012)*

- 
Features - When looking through a wearability lens at the issue of tracking devices there is a clear repetitive set of features identify throughout the literature. The most recurrent demands on the devices were:
- 
Safe Monitoring - “Wearability is a key issue and at present no ideal universal solution exists for dementia disabled individuals who persist at removal attempts” Mahoney (2010) Although this quote is 7 years old it comes from a study that highlights problem with attaching devices to users with straps or necklaces that do not break under reasonable pressure. The Food and Drug Administration (FDA) was aware of 6 deaths or serious injuries from one product where the necklace had become tangled and did not break causing a choking effect.
- 
Simplicity - The device can be implemented effectively by anyone regardless of age or cognitive capabilities. This is because older adult careers often displayed difficulties when utilizing GPS technology, and if the user is already suffering from their symptoms, they will struggle to adapt to the device as demonstrated earlier by Perala. This highlights the importance of Parameter 7 in LandSAR’s guidelines. As different users have different skill sets, having devices that require no technical adjustments is highly desirable but not essential, this makes Parameter 7 a Desirable trait. “Location based alarm and access control technology can have a positive impact on the lives of elderly persons suffering from dementia. When chosen appropriately, technology can

help to reduce or eliminate the wandering often associated with dementia” *Perala (2013)*.



Battery Life - “In regard to battery life, organisations that work with people with dementia and other conditions at with risk of wandering require a minimum of 10 days of functional work without a battery recharge; but individuals expect to get less than 5 days of battery life” (*Xiao et al., 2011*). This quote points to the fact that most organisations have higher expectations of the battery life than LandSAR currently does (Parameter 5, 7 days). As technology improves, naturally, so should LandSAR’s parameters. However the remainder of Parameter 5 is founded in observed knowledge as this quote from *Williamson (2017)* can attest ‘Alerts for battery life are also considered a valuable feature for caregivers, who experienced difficulties on charging the batteries, complications with constant need of charging or concerns with no indications on when the device needed to be charged in one of the studies’. A longer battery life is always seen as more desirable, however as technology always changes and users have differing needs, Parameter 5 asking for 10 days is seen to be Desirable not Essential.



Size, Durability and Appearance - Parameters 1, 2, 3 and 4 outlined by LandSAR are well founded in best practice. Mahoney reached the following conclusion “Appearance and visibility were identified as important features to reduce social stigma. For patients with Alzheimer’s Disease, however, a portion of the caregivers would prefer if the device could be located out of reach or the design of the product does not get the attention of the wearer” What this shows is that the size, weight and appearance all play a part in the overall acceptance and therefore success of the tracking device. By providing a range of products, an optimal solution should be easier to attain for careers. Along with acceptance by the user the device should also seek to accommodate a varied and playful lifestyle. The ability to take physical shocks and survive water exposure are essential to any tracking device as highlighted by Mahoney “Shock proof technology could be proven more reliable and versatile for use of diverse population with risk of wander, depending on gadget design” *Mahoney (2010)*

Preferences on format vary from study to study, but in general, watch-like devices located in both wrist and ankle are preferable as long as the design is not childish or too bulky, and pin or pendants of jewellery appearance have also greater acceptance than products like belt clips or devices attached to shoelaces *Mahoney(2010)*. During selection of a device, it is advised to consider those with an appearance suitable for both children and adults alike, not looking to childish or clinical, as these could influence the acceptance and willingness of use.

What these studies clearly show is that anyone looking to purchase a ‘tracking device’ should have a clear focus on the device’s size and appearance. The person has to wear the device for extended periods, so having a cumbersome, weighty and non-discrete device is more likely to lead to compliance issues from the person. Having the person wearing the device for extended periods of time means the device must be compatible to daily life. It must have a capable level of water resistance, be able to take a shock from being dropped, knocked or bitten and most importantly the battery life must be user friendly. The Parameters 1, 2 and 3 provide for a variety in tastes and styles, therefore by default are Desirable traits to have in a device but not Essential. Washing hands, having a shower or doing the dishes are all daily activities where the device is likely to come into contact with water. Parameter 4, which covers water resistance, has to be considered Essential due to the variances in daily life.

The following table from *McCabe (2013)* provides an insight into how there is variation in all studies in to preferred parameters, however most are very similar to the parameters used by LandSAR.

Table 5. Recommended characteristics of a GPS device to support going out

Theme	Requirement
Style Size	Watch preferred; some favoured a necklace/pendant design Small; the size of a large watch
Colour & design	Having a choice out of a selection of subdued colours Waterproof Looking like a compass to alert the user (one participant)
Weight	Lightweight to increase comfort and wearability
Battery	2-3 days battery life to ensure regular charging while avoiding a daily task
Alerts	To be received as SMS on a mobile phone
Call or panic button	Should be present
Device removal	Divided opinion: a fixed device would not be forgotten, but more ethical concerns, and could be difficult to remove (requiring a key)

Affordability:

Affordability of a system to manage wandering is of paramount importance due to the generally limited means available to individuals with disabilities. This applies to both people with autism and the elderly who are on fixed incomes.

This means the ability to contribute financially to a tracking device and then support its upkeep, will be severely limited in a lot of high need scenarios. Any framework put in place to assist people/families in choosing a tracking device must clearly layout the purchase cost and any ongoing costs of the device. In order to track any device there is the need for a tracking receiver. If a recommendation is going to be made for a device then it is only natural a recommendation will be made for the tracking receiver. That recommendation should also clearly layout the purchase cost and any ongoing costs of the tracking receiver.

The tracking device and its receiver's success are solely a matter of life and death. This harsh reality dictates that any maintenance and aftermarket support must be highly dependable and accessible to people with limited means. It is hard to quantify how the required level of reliability could be achieved by an organisation with no representation in New Zealand. Therefore strong favouritism should be given to tracking devices and receivers supplied by organisations that are active in the New Zealand marketplace. Parameter 8 is not to be rated as either Essential or Desirable. What is important is that the full purchase cost and any ongoing costs are accurately recorded. The cost of the receiver, if one is necessary, is recorded. Lastly the supplier's location and ability to supply ongoing support is included in the rating.

Product Types in Marketplace:

Radio Frequency Identification:

“Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically-stored information. Active tags have a local power source (such as a battery) and may operate hundreds of meters from the RFID reader. Unlike a barcode, the tag need not be within the line of sight of the reader, so it may be embedded in the tracked object. RFID is one method of automatic identification and data capture” *Wikipedia (2018)*

“The WanderSearch tracking programme is currently in use in approximately 30 areas around New Zealand” *WanderSearch (2018)*. It is a RFID tracking system, that comfortably meets all the parameters set out by LandSAR. There are currently two separate and unrelated suppliers in New Zealand, WandaTrak in Canterbury and Bart Dinger Electronics in the Waikato. The WanderSearch system protects the information of the user because “Without the receiving unit and knowing the unique frequency for a particular device to be dialled into the receiving unit, no-one can track the device” *WanderSearch (2018)*. This removes a lot of the ethical problems that arise as only the Police and, in some areas, LandSAR members, when called out on search, have the receiving unit to track the missing person.

The device’s size, weight, durability, battery life and ease of use made this an ideal system to adopt throughout New Zealand. Although it does have one drawback, it has an “average find time of 60-90 minutes” *WanderSearch (2018)*. *Topfer (2016)* reported most GPS devices could find the person within 25 minutes.

Global Positioning System:

“The Global Positioning System (GPS) is a satellite-based radio navigation system owned by the United States government and operated by the United States Air Force. It is a global navigation satellite system that provides geolocation and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. Obstacles such as mountains and buildings block the relatively weak GPS signals” *Wikipedia (2018)*

The GPS device marketplace has two types of products available. There are products designed purely for tracking whatever the device is attached to, this paper will refer to those devices as “GPS Tracking”. Then there are devices designed to track whatever they are attached to plus do something extra, like heart monitor, this paper will refer to those devices as “GPS Plus”.

Literature Review Summary:

Parameter 9 has been shown to identify the problem(s) that exist around data transmission and data protection; however it was also shown to be vague on its importance. A more definite parameter leaves the reader under no illusion as to what is required. Because of the importance of protecting the user Parameter 9 must be rated Essential

Parameter 5 had a technical metric that had aged slightly. 10 days is now considered the minimum expectancy for a device with rechargeable batteries. Although 10 days is an improvement it is not necessary, because of this Parameter 5 is only considered Desirable.

Parameter 8 is vary dependant the purchasing power of the person and their family. Because of this unquantifiable variable the total purchase cost plus any ongoing cost will be used for the rating. With the reliability and support essential for any device, any device with no local supplier will be rated based on the other parameters but will not be included unless it is rated highest in several parameters.

Parameter’s 4 and 10 have been shown to be critical to the success of any tracking device being considered for people at risk of going missing due to Alzheimer's, Dementia or Autism; this therefore dictates that these two (2) parameters must be rated Essential.

Parameters 1, 2,3,6,7, are parameters that are important but may vary depending on the person using the device. The fact that slight variations will benefit different people means these parameters having a rating of Desirable.

There is a RFID system in use around New Zealand and it meets all the Parameters set out by LandSAR. However the accuracy of GPS (or a similar system) and the benefit of having the ability to contact the person through the device will probably lead to RFID being made redundant in the near future. RFID will retain some scope when tracking and monitoring people inside buildings is required.

Improved Parameters vs. New Zealand Marketplace

This table displays the devices readily available in the New Zealand marketplace that meet all the Essential Parameters. The top device listed is the WanderSearch system that uses a RFID device and tracking unit. “This is the current method used in approximately 30 areas within New Zealand” *WanderSearch (2018)* The cost of the device varies depending on charitable funding available to cover the cost. The cost of receivers (which will require replacement when they come to end of the operational life for and additional units as the uptake of the system expands is up to \$1800 for a complete unit (there are currently about 80 receivers across NZ and about 800 devices). Therefore it acts as good baseline to measure all other devices against. All figures converted to NZD, on December 6th, 2018. For a full list of devices see Appendix 3

Device	Transmission Method	Tracking Method	Meets Parameter Essentials	Size and Weight	Desirable Parameters	Purchase Price	Receiver Cost	Ongoing Costs
WanderSearch	RFID	Receiver	Yes	40h*40l*20w 20grms	3,5,6,7	\$350	Already in use	\$100
iTraQ Nano	GPS Tracking	App	Yes	52h*52l*11w 40grms	3,5,6,7	\$176	N/A	\$89
Trackimo 3G Guardian	GPS Tracking	App	Yes	47h*40l*17w 30grms	5,6,7	\$206	N/A	\$89
Pocketfinder	GPS Tracking	App	Yes	79h*41l*16w 48grms	3,5,6,7	\$235	N/A	\$191
Spytec STI GL300	GPS Tracking	App	Yes	67h*47l*21w 60grms	5,6,7	\$74	N/A	\$445
Smartsole	GPS Tracking	App	Yes	Sits in shoe	3,6,7	\$566	N/A	\$339

References:

Online:

Bloomberg 2018

Retrieved on 30/11/2018

Retrieved from: <https://www.bloomberg.com/news/articles/2018-11-25/china-s-big-dipper-satellites-challenge-the-dominance-of-gps>

Businesswire 2016

Retrieved on 30/11/2018

Retrieved from: <https://www.businesswire.com/news/home/20161018006653/en/Global-GPS-Market-2016-2022-Market-Generated-Revenue>

CNBC 2018

Retrieved on 15/12/2018

Retrieved from:

<https://www.cnbc.com/2018/05/24/facebook-must-comply-with-european-privacy-laws-in-real-life-eus-digital-policy-chief-say.html>

South China Morning Post 2018

Retrieved on 15/12/2018

Retrieved from:

<https://www.scmp.com/news/world/europe/article/2145896/thousands-people-sweden-get-microchip-implants-new-way-life>

WanderSearch 2018

Retrieved on 15/12/2018

Retrieved from:

<http://wandersearch.org.nz/about-wandersearch/>

Wikipedia 2018

Retrieved on 15/12/2018

Retrieved from:

https://en.wikipedia.org/wiki/Radio-frequency_identification

Wikipedia 2018

Retrieved on 15/12/2018

Retrieved from:

https://en.wikipedia.org/wiki/Global_Positioning_System

Journals:

- Coleman, E. A. (1993). Physical restraint use in nursing home patients with dementia. *Jama*, 270(17), 2114.
- Dawkins, V. H. (1998). Restraints and the elderly with mental illness: ethical issues and moral reasoning. *Journal of psychosocial nursing and mental health services*, 36(10), 22-27.
- Department of Health. (2001). *National service framework for older people* (pp. 30-35). STEVENSON, E., NH3171..
- Essén, A. (2008). The two facets of electronic care surveillance: an exploration of the views of older people who live with monitoring devices. *Social science & medicine*, 67(1), 128-136.
- Landau, R., Werner, S., Auslander, G. K., Shoval, N., & Heinik, J. (2009). Attitudes of family and professional care-givers towards the use of GPS for tracking patients with dementia: an exploratory study. *British Journal of Social Work*, 39(4), 670-692.
- McCabe, L., & Innes, A. (2013). Supporting safe walking for people with dementia: User participation in the development of new technology. *Gerontechnology*, 12(1), 4-15.
- Mahoney, E. L., & Mahoney, D. F. (2010). Acceptance of wearable technology by people with Alzheimer's disease: Issues and accommodations. *American Journal of Alzheimer's Disease & Other Dementias®*, 25(6), 527-531.
- Perälä, S., Mäkelä, K., Salmenaho, A., & Latvala, R. (2013). Technology for elderly with memory impairment and wandering risk. *E-Health Telecommunication Systems and Networks*, 2(01), 13.
- Robinson, L., Hutchings, D., Corner, L., Finch, T., Hughes, J., Brittain, K., & Bond, J. (2007). Balancing rights and risks: Conflicting perspectives in the management of wandering in dementia. *Health, Risk & Society*, 9(4), 389-406.
- Topfer, L. A. (2016). GPS Locator Devices for People With Dementia.
- White, E. B., Montgomery, P., & McShane, R. (2010). Electronic tracking for people with dementia who get lost outside the home: a study of the experience of familial carers. *British Journal of Occupational Therapy*, 73(4), 152-159.
- Williamson, B., Aplin, T., de Jonge, D., & Goyne, M. (2017). Tracking down a solution: exploring the acceptability and value of wearable GPS devices for older persons, individuals with a disability and their support persons. *Disability and Rehabilitation: Assistive Technology*, 12(8), 822-831.

Xiao, X., Wong, A. K. S., Woo, K. T., & Cheng, R. S. K. (2011, June). An energy-efficient elderly tracking algorithm. In *Communications (ICC), 2011 IEEE International Conference on* (pp. 1-5). IEEE.

Yang, Y. T., & Kels, C. G. (2016). Does the Shoe Fit? Ethical, Legal, and Policy Considerations of Global Positioning System Shoes for Individuals with Alzheimer's Disease. *Journal of the American Geriatrics Society*, 64(8), 1708-1715.

Zhou, M., & Ranasinghe, D. C. (2013, December). A novel approach for addressing wandering off elderly using low cost passive RFID tags. In *International Conference on Mobile and Ubiquitous Systems: Computing, Networking, and Services*(pp. 330-343). Springer, Cham.

Appendix:

Appendix 1:

To Effect the Continued Supply of Wander SAR Equipment Parameters for the Equipment

To assist with the literature review, parameters are being set to provide guidance and direction on the minimum requirements the tracking systems to be research are to have.

The parameters include:

- 1 **Size:** The size should not exceed 45mm x 30mm x 20mm for a wrist style or 40mm x 40mm x 20mm for a necklace style. Clients range in age from 3 – 100. A range of styles i.e. wrist, necklace, as one style does not suit everyone.
- 2 **Weight:** Maximum weight of 20 grams.
- 3 **Shock Proof / Robustness:** Needs to be able to withstand a drop from two meters onto concrete and able to withstand being bitten by users.
- 4 **Water Resistant:** Needs to be tested to or meet IP Code Standard - https://en.wikipedia.org/wiki/IP_Code
- 5 **Batteries:**
 - a. **Re-chargable Batteries:**
 - i. Operates for minimum of 7 days on each charge (this includes the device pulsing at a minimum of once every 5 seconds).
 - ii. Less than 2 hours recharging time
 - iii. Has a low battery alarm
 - b. **Non-Rechargable Batteries:**
 - i. Minimum of six months battery life
 - ii. Replacement batteries are easy to obtain and cost effective.
 - iii. Installation of new batteries. Who can do this so the device still retains water resistant, shock proof testing criteria.

- 6 **Pulse Rate:** Minimum of one pulse every 5 seconds or data sent at specific timeframe.

Other Considerations:

- Can the pulse rate be remotely increased / decreased i.e. doesn't need to be connected to computer, base unit etc.
- What pulse rates can the device be programmed for and how long would the battery last at these different rates.

- 7 **Ease of use:** No technical adjustments or monitoring required by the family / care-givers. The only exception is a low battery alarm to alert families / care-givers that the battery requires charging if a rechargeable battery is being used.

- 8 **Cost:**

- a. What is the purchase price and after-market / on-going costs i.e. maintenance of devices / monthly costs.
- b. If a receiver unit is used to receive the pulse, what is the cost purchase price and after-market / on-going costs.

- 9 **Privacy:** Who has access to the clients' information and who has the ability to track the client i.e. clients' freedom of movement / privacy vs their safety.

- 10 **Compliance / Levels:**

- a. Bluetooth – Class 1 level
- b. Must be compliant with Radio Spectrum Management Regulations - <https://www.rsm.govt.nz/>
- c. Must be compatible with NZ Cellular systems / technology

Other considerations to be taken into account:

1. How is the pulse received? I.e. smartphone, laptop, specific receiver unit.
2. Is there a NZ Supplier who can offer after-market support / maintenance?
3. The system is unable to be modified and SOS / Panic alarms cannot be set off by the user.

Appendix 2:

To Effect the Continued Supply of Wander SAR Equipment Parameters for the Equipment

To assist with the literature review, parameters are being set to provide guidance and direction on the minimum requirements the tracking systems to be researched are to have.

The parameters include:

- 1 **Size:** The size should not exceed 45mm x 30mm x 20mm for a wrist style or 40mm x 40mm x 20mm for a necklace style. Clients range in age from 3 – 100. A range of styles i.e. wrist, necklace, as one style does not suit everyone.
- 2 **Weight:** Maximum weight of 20 grams.
- 3 **Shock Proof / Robustness:** Needs to be able to withstand a drop from two meters onto concrete and able to withstand being bitten by users.
- 4 **Water Resistant:** Needs to be tested to or meet IP Code Standard - https://en.wikipedia.org/wiki/IP_Code
- 5 **Batteries:**
 - a. **Re-chargable Batteries:**
 - i. Operates for minimum of 10 days on each charge (this includes the device pulsing at a minimum of once every 5 seconds).
 - ii. Less than 2 hours recharging time
 - iii. Has a low battery alarm
 - b. **Non-Rechargable Batteries:**
 - i. Minimum of six months battery life
 - ii. Replacement batteries are easy to obtain and cost effective.
 - iii. Installation of new batteries. Who can do this so the device still retains water resistant, shock proof testing criteria.
- 6 **Pulse Rate:** Minimum of one pulse every 5 seconds or data sent at specific timeframe.
Other Considerations:
 - Can the pulse rate be remotely increased / decreased i.e. doesn't need to be connected to computer, base unit etc.
 - What pulse rates can the device be programmed for and how long would the battery last at these different rates.

7 **Ease of use:** No technical adjustments or monitoring required by the family / care-givers. The only exception is a low battery alarm to alert families / care-givers that the battery requires charging if a rechargeable battery is being used.

8 **Cost:**

- a. What is the purchase price and after-market / on-going costs i.e. maintenance of devices / monthly costs.
- b. If a receiver unit is used to receive the pulse, what is the cost purchase price and after-market / on-going costs.

9 **Privacy:** The device must protect the client's data and information at all times. The ability to track the client's movements is strictly limited to those persons/agents identified in users personal health plan.

10 **Compliance / Levels:**

- a. Bluetooth – Class 1 level
- b. Must be compliant with Radio Spectrum Management Regulations - <https://www.rsm.govt.nz/>
- c. Must be compatible with NZ Cellular systems / technology

Other considerations to be taken into account:

1. How is the pulse received? I.e. smartphone, laptop, specific receiver unit.
2. Is there a NZ Supplier who can offer after-market support / maintenance?
3. The system is unable to be modified and SOS / Panic alarms cannot be set off by the user.

Appendix 3:

Yearly ongoing cost is \$96sc, these products require a sim card to run, and the price of \$96 is based on Spark's plan cost for their own devices.

Device	Transmission Method	Tracking Method	Meets Parameter Essentials	Size (mm) and Weight	Desirable Parameters	Purchase Price	Receiver Cost	Yearly Ongoing Costs
WandaTrak	RFID	Receiver	Yes	40h*40l*20w 20grms	3,5,6,7	\$350*	Already in use	\$100
iTraq Nano	GPS Tracking	App	Yes	52h*52l*11w 40grms	3,5,6,7	\$176	N/A	\$89
Trackimo 3G Guardian	GPS Tracking	App	Yes	47h*40l*17w 30grms	5,6,7	\$206	N/A	\$89
Pocketfinder	GPS Tracking	App	Yes	79h*41l*16w 48grms	3,5,6,7	\$235	N/A	\$191
Spytec STI GL300	GPS Tracking	App	Yes	67h*47l*21w 60grms	5,6,7	\$74	N/A	\$445
Smartsole	GPS Tracking	App	Yes	Sits in shoe	3,6,7	\$566	N/A	\$339
Mindme	GPS Tracking	Online	No	60h*44l*14w	unsure	\$170	N/A	\$370
Angel Sense	GPS Tracking	App	No	77h*47l*20w	unsure	\$117	N/A	\$712
Trackimo 3G	GPS Plus	App	No	51h*38l*13w	5,6,7	\$206	N/A	\$89

GPS Watch				40grms				
Amon Mini Global	GPS Plus	Online	No	64h*46l*17w 50grms	unsure	\$72	N/A	\$96sc
GF07 mini	GPS Plus	Online	No	35h*20l*14w	unsure	\$25	N/A	\$96sc
4G FDD LTE MT510G	GPS Plus	App	No	89h*57l*20w	unsure	\$320	N/A	\$96sc
RF-V42	GPS Plus	App	No	45h*50l*15w	unsure	\$275	N/A	\$96sc
3G FDD LTE	GPS Plus	App	No	89h*57l*20w	unsure	\$182	N/A	\$96sc
GVT-800	GPS Plus	App	No	64h*46l*17w 60grms	unsure	\$25	N/A	\$96sc
GPT-18 Watch	GPS Plus	App	No	40h*35l*15w 40grms	unsure	\$39	N/A	\$96sc
D18s Watch	GPS Plus	App	No	46h*38l*17w 40grms	unsure	\$38	N/A	\$96sc
K30 Personal Tracker	GPS Plus	App	No	55h*40l*14w 20grms	unsure	\$28	N/A	\$96sc
Spark Spacetalk	GPS Plus	App	No	unsure	unsure	\$399	N/A	\$180