Sparrow: A Smart Device for Fall Prevention

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Abstract
An interdisciplinary, inter-institutional team of engineers, professors and physicians have demonstrated Sparrow, a simple to use tool to provide nurses the information they need to lower the fall rate among the elderly. Sparrow fuses multiple sensors, a microprocessor, and internet technologies into a wheel chair accessory that communicates with any Android mobile device that has downloaded the Sparrow mobile App. The mobile Android device carried by a caregiver is sent continuous information about a wheelchair occupant's position, movement and posture. This information, combined with the experiences and observations of the caregiver, provide medical professionals or family members the opportunity to prevent a fall by returning in a timely manner to help the patient or loved one, who may soon attempt an unobserved and unattended egress from the chair.

Keywords: Fall Prevention, Smart Devices

1. Technology and Value Proposition
Sparrow was designed for the busy nursing community where nursing staff are busy with multiple administrative tasks as well as several patients. Sparrow is easy to use and requires no staff or administration training. A simple power switch flip on the Sparrow chair and a tap on the Android mobile device is all that is required to administer and use Sparrow. A Rounds feature is also incorporated into Sparrow which allows caregivers to document their visits to the occupant through a simple tap on a Rounds NFC tag mounted on the chair. Caregivers can also be notified when Rounds are overdue. Figure 1 shows an Android device running the Sparrow App.

The Sparrow system also incorporates important environmental and mechanical features. Sparrow is installed as a single unit on standard wheel chairs which remain both foldable for storage, and washable. Early development versions of Sparrow have been demonstrated to many potential customers and now, for the first time, a 4G pre-production version is ready for demonstration and field trial. 4G demonstrations in October and November have already taken place with Lawrence General Hospital and its family of nursing home affiliates in Massachusetts as well The United Methodist Residential Community elder care facilities in Michigan.

Figure 1. Sparrow App running on an Android device.

Sparrow is currently protected by provisional patent(s) and a patent attorney has completed a patent search and advised that no existing patents conflict with our technology. His review included the Mass General patent (US8203454), a concept with similar health care goals, but with very different technology, software algorithms and a much narrow range of functionality. Other active and expired patents were reviewed (eg. IBM patent (U.S. Patent No. 6,204,767). We have been advised that no conflicts with active patents are likely. No commercialized product has appeared in the market place. The intellectual property (IP) is owned entirely by ElderSafe Technologies Inc., a Delaware C Corporation whose majority shareholders are the Sparrow team members and contributors.

2. The Problem we Solve
Nurses need information, information that tells them that an unattended unobserved high fall risk wheelchair occupant needs to be visited, now. "Now" may mean that the patient has been unattended too long, perhaps far beyond institutional rounds standards for high fall risk patients, or "now" may mean that the occupant has begun to reposition himself or herself in the chair in a manner that the nursing staff, if aware, would believe that an attempt at an unassisted egress is imminent. There are no products on the market that have taken a systems approach to closing this information gap in health care. So prior to the advent of Sparrow, "now" often was too late.

978-1-4673-9795-7/15 $31.00 © 2015 IEEE
DOI 10.1109/CSCI.2015.82

Surprisingly the primary technologies applied to the fall problem are over 50 years old. The pressure cushion and lanyard are still widely used on wheel chairs even though they are largely ineffective in preventing falls. Three well known problems exist with these devices. They frequently set off "false alarms", which eventually inoculate care givers from even hearing the alarms. When nurses do hear the audio alarms, caregivers often are unable to quickly determine the precise location or patient in an alarm state. When they do, it is often too late.

By contrast, the medical professionals who are providing reference letters as well as many others believe Sparrow has the potential of becoming a standard of care for high fall risk seniors, of whom, there are millions today and whom will be an ever increasing percentage of tomorrow's population.
It is best to hear from them. As Dr. Neil Meehan, Medical Director or Lawrence General Hospital has stated:

"Healthcare is under great pressure to adopt evidence based health care practices. The Sparrow system will provide automated, reliable data such as rounding intervals and other evidence based activity that will drive quality improvement and better outcomes for patients."

And,

"The Sparrow fall mitigation product has potential to be of great benefit to nurses and caregivers who care for the elderly in skilled nursing facilities (SNFs) and rehabilitation hospitals. Providing remotely located caregivers with real time status on their high fall risk patients seated in wheel chairs should significantly reduce fall rates in facilities that specialize in care for the elderly."

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The Sparrow system mounted on wheelchairs is shown in Figure 2. A video demonstration also can be found at:
https://www.youtube.com/watch?v=t4RtuSHF8ig&feature=youtube

Each year, a typical nursing home with 100 beds will officially report 10 to 20 falls/month but it is known that many falls go unreported [10]. Most nurses and their nursing directors told us that they experience a 20-25% fall rate/month and that 25% of these falls are serious. They volunteered that eliminating 2 falls/month would make Sparrow a success.

If a typical 125 bed staffed nursing facility experiences 25 falls/month, of which 5-6 are serious, the hospitalization cost [6] for each will average $35,000. Physician fees, post fall rehabilitation costs and higher levels of long term post-acute care can easily double the total cost for each of the falls to $70,000, especially if a hip fracture or traumatic brain injury is involved [6]. At these medical cost levels ten Sparrow systems could easily be leased for an entire year from the savings of preventing *just a few* serious falls.

Figure 2. The Sparrow system mounted behind the wheelchairs. It consists of three subsystems. 1. The removable wheel chair accessory, 2. Internet based server software and finally 3. The mobile Android application.

In addition to movement alerts, the Rounds feature of Sparrow will help nurses reduce fall rates even further. Medical facilities with patient-centered rounds who are able to maintain daily goals sheets do experience improved safety [13]. Sparrow will automate do this important, but difficult to maintain health care practice. Sparrow will automatically produce weekly administrative aggregate summaries of alert levels, response times, rounds history as well as patient and nurse specific health care outcomes. These reports will not impose any administrative burden on the staff. The cost of providing evidence based medical care outcomes will be covered in the monthly lease charge. The monthly lease also covers maintenance and software upgrades, but not any new features.

3. Market Potential

Falls are the leading cause of injury and death among the elderly. Approximately 1 out of 3 seniors will fall each year [1]. In Europe and America, seniors currently represent over 20% of the 1 Billion residents [2][3]. By 2020 it is estimated that 28% of the population in Europe will be classified as seniors [9]. Over 70 million seniors in Europe and America fall annually and approximately 4-5 million will visit an emergency room [1]. 30% of these seniors will be hospitalized [1]. Many will not live independently again and will spend their days in a wheel chair.

Within five years, approximately 9% of 200 million seniors be living in skilled nursing facilities (SNF) or receiving daily home health care services [7][8]. These 18-20 million seniors will reside in over 100,000 nursing homes and innumerable private residences in America, Europe and

Japan [11][12]. We estimate that 4 to 5 million of these seniors will be rated as high fall risk [1][4][5][6]. These seniors need to be observed by Sparrow whenever they are seated in a wheel chair.

Caregivers working in staffed nursing facilities as well as home health care workers will be the users of Sparrow. They need technology to do what they cannot do. During the day-shift, a 25 patient ward will typically be serviced by 2 nurses and 5-6 semi-professional caregivers. Their patient care work load is high and they cannot constantly keep their high fall risk patients in view.

We have talked to many caregivers. They are the author of the ideas incorporated into Sparrow mobile device. Without exaggeration one can say they are truly the inventors of Sparrow. In the interest of brevity we will omit Sparrow's extensive features list. Nevertheless, it is worth mentioning, these future users emphasized Sparrow must reach a new level of technological achievement in areas of simplicity, administrative efficiency and self-learning systems design. We believe Sparrow has met these challenges.

4. Commercialization Plan

With the completion of the Sparrow pre-production version we now are turning our attention to the commercialization challenges which includes conducting large scale validation trials to establish broad statistical evidence of system efficacy. To achieve this goal, a GMP manufacturing team is being trained and a facility put in place in Sterling, MA to support the trial and limited pre-production activities.

5. The Challenges of Growth

The manufacturing center will also become the support center for repair and maintenance. Sparrow is designed to be removable for return and repair and customer installable upon delivery. The Sparrow mobile app is downloadable from the web. Sparrow is designed for indirect distribution, internet sales and no on-site support once trials are completed.

References

[1] Center for Disease Control and Prevention (CDC), Falls Among Older Adults: An Overview. *Home and Recreational Safety*, (September 2014) http://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html Retrieved October 6, 2014.

[2] Center for Disease Control and Prevention (CDC), Falls in Nursing Homes. *Home and Recreational Safety*, (September 2014) http://www.cdc.gov/homeandrecreationalsafety/falls/nursing.html Retrieved Oct. 6, '14.

[3] Center for Disease Control and Prevention (CDC), Hip Fractures Among Older Americans, *Home and Recreational Safety*, (September 2013) http://www.cdc.gov/homeandrecreationalsafety/falls/adulthipfx.html Retrieved Oct., '14.

[4] U.S. Department of Health and Human Services (USHHS), Administration for Community Living, Administration on Aging (AoA), *A Profile of Older Americans* (Dec. '11) http://www.aoa.gov/Aging_Statistics/Profile/2011/4.aspx Retrieved Oct. 6, '14.

[5] Gavin-Dreschnack Deborah, Nelson Audrey, Fitzgerald Shirley, Harrow Jeffrey, Sanchez-Anguiano Aurora, Ahmed Shahbaz, Powell-Cope Gail, "Wheelchair-related Falls: Current Evidence and Directions for Improved Quality Care", Journal of Nursing Care Quality V20 n2 p119-127 April/June 2005

[6] Nyberg L, Gustafson Y. Using the Downtown Index to predict those prone to falls in stroke rehabilitation. Stroke 1996; 27: 1821-4

[7] Lars Nyberg, Yngve Gustafson, "Patient Falls in Stroke Rehabilitation A Challenge to Rehabilitation Strategies". Stroke 1995; 26: 838-42

[8] Shobha S. Rao, "Prevention of Falls in Older Patients". American Academy of Family Physicians, Vol 72 no 1 July 1 2005 pp81-88

[9] Teasell R, McRaeM, Foley N, Bhardwaj A. The incidence and consequences of falls in stroke patients during inpatient rehabilitation: factors associated with high risk. Arch Phys Med Rehabil 2002; 83: 329-3

[10] Granek E, Baker SP, Abbey H, et al. Medication and diagnosis in relation to .falls in a long-term care facility. J Am Geriatr Soc 1987; 35: 503-11

[11] Moyer VA. Prevention of Falls in Community-Dwelling Older Adults: U.S. "Preventive Services Task Force Recommendation Statement". Annals of Internal Medicine 2012;157(3):197–204.

[12] Noury, N, Fleury, A., Rumeau, P., Bourke, A, Laighin, G., Rialee, V., Lundy,J. "Fall Detection – Principles and Methods". Proceedings of the 29th Annual International Conference of the IEEE Engineering in Medicine and Biology (EMBS). Aug. 23-26 2007 pp. 1663-1666.

[13] US Patent Sparks, Patent No. US 2,204,767 B1 Date March 20, 2001 Chair Monitor Brian J Sparks, Milwaukee, WI