Personal Emergency Response System (PERS) with Optimized Automatic Fall Detection Shows Greater Effectiveness than PERS Alone

How reliable, prompt reporting of falls could help in the management of healthcare costs in growing senior population

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Summary

With 1 in 3 seniors falling each year in the US,[1] falling is a major health issue for older adults who want to maintain health and independence as well as for healthcare organizations under constant pressure to manage large at-risk populations. Personal emergency response systems provide a solution that can help improve outcomes and lower healthcare costs. A retrospective, quantitative analysis of over 400,000 PERS users based on reported fall rates registered by an emergency response center showed that PERS with highly accurate and reliable automatic fall detection technology reports more than twice as many falls[2] as would be reported with a standard personal emergency response system that requires a button push. More reporting on falls can lead to better outcomes, including faster transport to the hospital, shorter hospital stays, and interventions prompted by knowing a senior has fallen.

High cost of falls for a growing elder population

With a rapidly increasing population of older adults using more healthcare per capita than any other age group, facilitating healthy aging or aging in place is an important factor in controlling healthcare costs.[3-5] One major health problem among seniors is falling: In 2013, the direct medical costs – not accounting for long-term effects such as disability and increased dependence on others – of older adult falls were $34 billion.[6]

A prospective study on falls in elders residing in the community has shown that 1 in 3 adults aged 65 and older falls each year.[1] Investigation of a trauma registry from a US hospital indicated that of those who fall, 30% suffer moderate to severe injuries in this age group.[7] Serious injuries, admission to hospital, and subsequent moves into long-term care are strongly associated with lying on the floor for a long time.[8] The mortality rate from falls is 67% when lie times were more than 72 hours, compared to 12% when lie times were less than 1 hour.[8]

Personal emergency response systems (PERS), also called medical alert services, can provide seniors who fall with immediate access to appropriate help. PERS enable users to press a button, usually worn as a pendant or wrist strap, which transmits a signal to a response center representative, who contacts appropriate help. The average time for users of Philips Lifeline PERS to connect to the response center is 22 seconds.

Without PERS, the time it takes for individuals who are incapacitated to receive emergency services ranges from a median of 2–72 hours, depending on who calls the emergency medical service: 2 hours if the senior calls; 4.5 hours if a friend calls; 9 hours if a family member calls; and 72 hours if a landlord calls.[8]

The benefits of immediate access to appropriate help provided by PERS are well known, and include significantly reduced inpatient admissions, hospital days, and mortality.[9,10] However, seniors with PERS who fall may not press their help buttons for a variety of reasons. In the best case, the senior is fine and doesn't need additional help. But the senior may not want to press the button because it would place a burden on caregivers, or may forget to the press the button due to cognitive impairment. In the worst case, the senior can't press the button because of incapacitation due to such conditions as unconsciousness or stroke.

The addition of optimized automatic fall detection technology to PERS provides a potential solution for unreported falls among seniors: A call for help is automatically signaled if a fall is detected; no button push is required. To verify and quantify the added benefit of this technology, Philips performed a retrospective, quantitative analysis of the number and type of falls (including recurrent events) reported to a medical alert service response center.

Study design and methods

The automatic fall detection technology analyzed in this study, AutoAlert offered by Philips, met key criteria for an accurate and reliable service, including high rate of detection of falls from a standing position (over 95%), low false alarm rate, and ability to recognize when a user immediately stands up after a fall. (For a detailed look at the criteria, see Appendix A.)

To understand the benefits of fall detection, we analyzed over 400,000 records of seniors equipped with a standard medical alert service or a medical alert service with AutoAlert between January 2012 and June 2014. The analysis showed the subgroup of 145,315 direct-to-consumer, private-pay users was ideal for the comparison of these service solutions. A choice between a help button with and without automatic fall detection technology is always offered to this group, and extensive profiling showed no systematic differences between seniors using a standard PERS and seniors using AutoAlert.

This study provides a detailed analysis of the difference in fall incidence rates in 69,430 standard PERS users vs 75,885 AutoAlert users. (For more detail on methodology, see Appendix B.) A fall incidence rate is the number of falls per user per year in a given population. The fall incidence discussed in this study was calculated based on the over 70,000 falls that occurred between January 2012 and June 2014, a period of 2.5 years. The findings of the quantitative analysis are supplemented with user experience stories derived from a qualitative product study in 2014.[11]

Twice as many falls recorded

The rate of recorded falls among users in the study population segment using automatic fall technology was 0.71 falls per year, as presented in Figure 1. In users not using the AutoAlert service, the reported fall rate was only 0.34 falls per year.
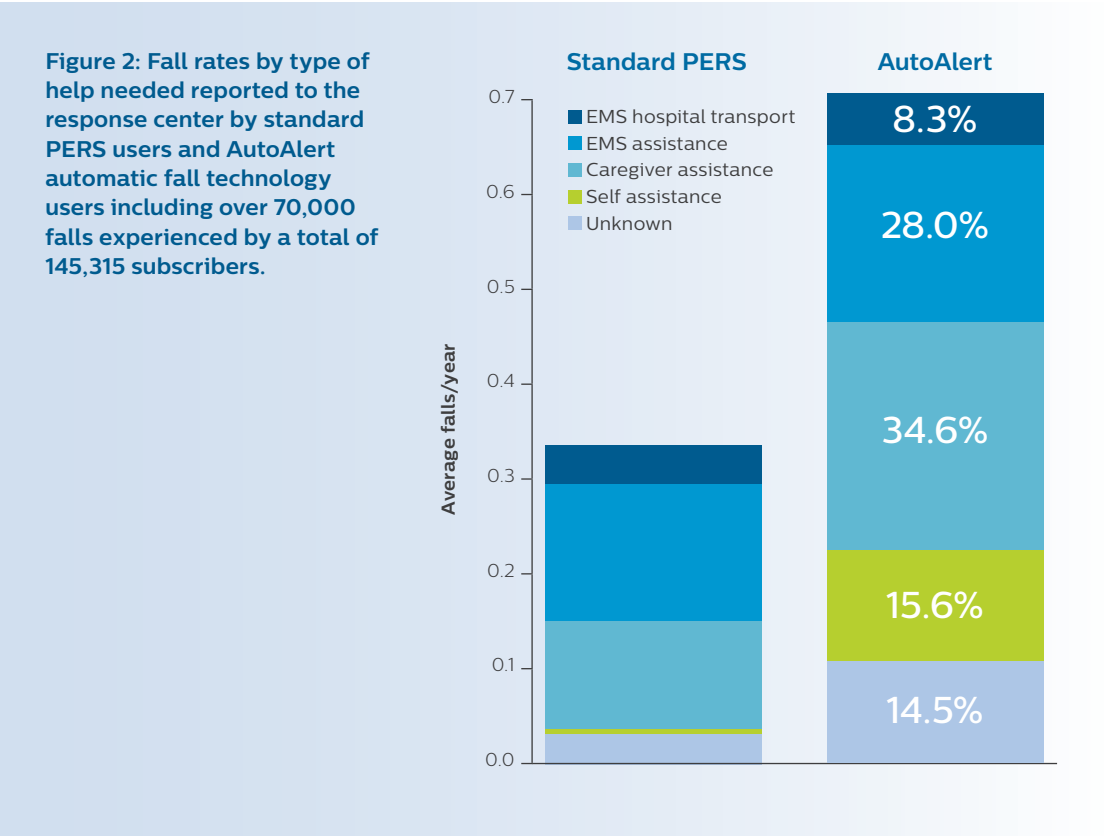
In a population with similar demographic characteristics and self-reported medical conditions, a similar actual fall rate would be expected. Yet twice as many falls are reported to the response center by subscribers using AutoAlert as by those without the AutoAlert feature. This means that in the event of a fall, standard PERS subscribers press their help buttons only half of the time. In the other 50%, the fall is not reported to the call center and no action is taken or follow-up evaluation performed.

Figure 1: Rate of falls reported to response center with standard PERS vs AutoAlert automatic fall detection technology derived from 2.5 years of data including over 70,000 falls.
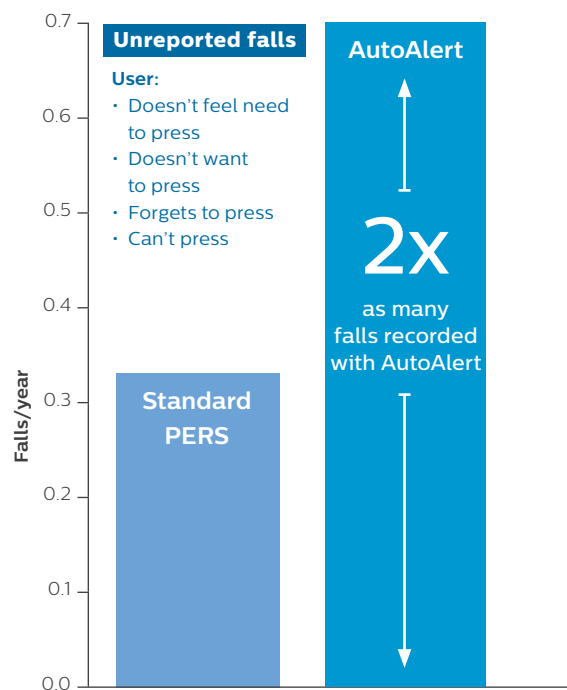
Fall rates and types of help needed

When a call for help enters the response center, the situation is evaluated and an appropriate follow-up action is selected and executed. In urgent and critical situations, emergency medical services (EMS) are sent to the home of the senior. EMS provides acute care on the scene and transports the senior to the hospital if necessary. In less critical situations, a caregiver such as a family member, friend or neighbor is informed and sent to assist the senior. Figure 2 presents the reported fall rates in users of PERS with and without AutoAlert subdivided by the type of help that is needed.
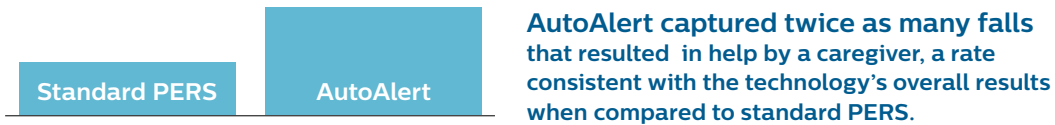
Figure 2: Fall rates by type of help needed reported to the response center by standard PERS users and AutoAlert automatic fall technology users including over 70,000 falls experienced by a total of 145,315 subscribers.

Standard PERS / AutoAlert

Average falls/year

- EMS hospital transport
- EMS assistance
- Caregiver assistance
- Self assistance
- Unknown

AutoAlert:
- 8.3%
- 28.0%
- 34.6%
- 15.6%
- 14.5%

EMS Hospital Transport

When compared to standard PERS services, AutoAlert captured over 30% more falls that resulted in EMS hospital transport. Since similar fall rates are expected in both groups, this implies a significant group of users experience falls that require EMS transport but since the users do not push the standard help button, they don't receive such help. An automatic fall detection service could be lifesaving in these events.

Standard PERS   **AutoAlert**

AutoAlert captured over 30% more falls
that were severe enough to require
EMS assistance.

Caregiver assistance

The reported rate of falls that resulted in a caregiver giving assistance is 100% higher with AutoAlert than without AutoAlert. Sending a caregiver in time might prevent the situation from escalating in severity to one that will require an ER visit, or may prompt the caregiver to make the senior's home safer.

Standard PERS   **AutoAlert**

AutoAlert captured twice as many falls
that resulted in help by a caregiver, a rate
consistent with the technology's overall results
when compared to standard PERS.

"I was coming down the stairs and I fell like three steps, and I just laid there and I wasn't hurt or anything but I had to compose myself. Then all of a sudden I got a call asking if I was all right which was really nice. I was shook up and I forgot that I had it on, so I probably wouldn't have pressed the button anyway, but it sensed that I had fallen, and when I said that I was alright, they called my children anyway."

Self-assistance

Without AutoAlert, less than 5% of the falls in which seniors can assist themselves are reported to the call center. Since the senior says he or she is okay, these falls pose no immediate threat. Yet if caregivers and healthcare providers do not know about these events, they may misjudge the health status of the senior. By reporting all falls detected to the call center, AutoAlert provides a better view into the actual fall rate. This detailed information could be acted on by caregivers to prevent future and possibly more serious falls, and by physicians and other healthcare professionals to assess possible changes in health status.

Standard PERS   **AutoAlert**

Standard PERS catches only 5% of falls
when the subscriber doesn't need help.

Who benefits most from AutoAlert?

When a senior is enrolled in the medical alert service, information that is relevant for optimal service delivery and evaluation of incoming emergency calls – such as specific diseases and medical conditions – is collected.

More than 70% of the AutoAlert subscribers report at least one medical condition at service enrollment and 20% of subscribers report 5 or more conditions (Figure 3). Reported conditions at service enrollment include severe chronic diseases as well as risk factors such as high blood pressure, high cholesterol, and balance problems/unsteady gait. While the conditions are self-reported and do not reflect a complete medical diagnosis, they provide valuable information to derive insights on fall rates, severity, and outcomes related to disease profiles.

Frequency of self-reported medical conditions

20%
5 or more medical conditions

27%
0 medical conditions

25%
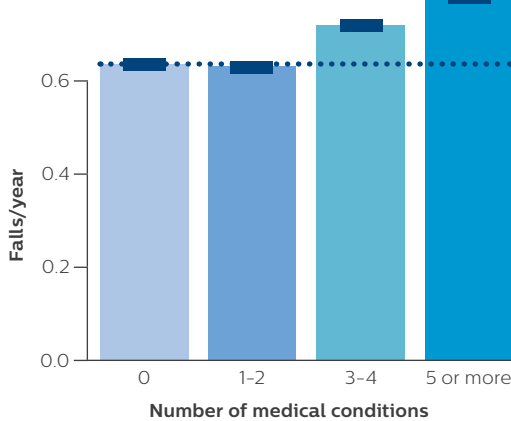3–4 medical conditions

27%
1–2 medical conditions
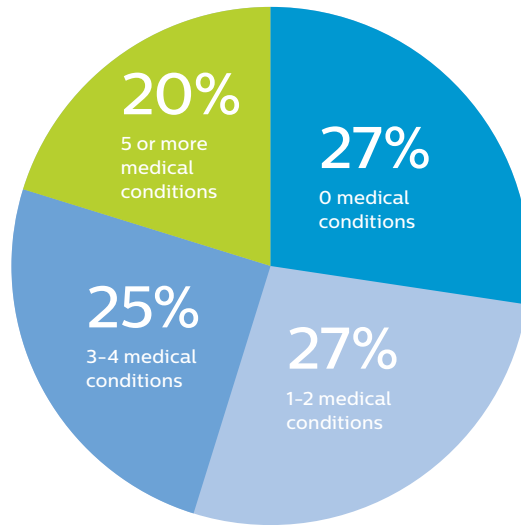
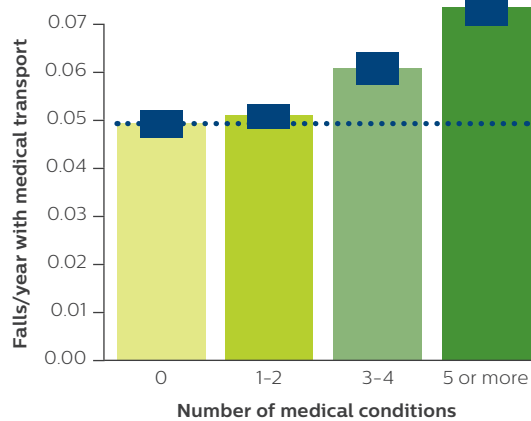**Figure 3: Number of reported medical conditions reported by AutoAlert users.**

Fall rates and number of reported medical conditions

A significant increase in the fall rate occurs when 3 or more conditions are reported. The increase is even greater for the falls that result in emergency transport. Seniors reporting 3 or more conditions have 15% to 40% more falls that are severe than seniors reporting no medical conditions (see Figure 4), so those with more conditions could potentially benefit from the automated fall technology more than their peers with fewer conditions.

All Falls

Falls with hospital transport

Figure 4: Overall fall rate (a) and fall rate with hospital transport (b) of AutoAlert users reporting different numbers of medical conditions. Additional bars represent 95% confidence intervals.

Seniors with 5 or more medical conditions report

40%more falls

that require emergency transport to a hospital than those with no conditions.

Fall rates and type of reported medical conditions

Some of the frequently reported conditions include heart conditions, diabetes, cognitive impairment, COPD, osteoporosis and Parkinson's disease. Seniors reporting these 6 chronic conditions all have a significantly higher severe fall rate compared to seniors reporting no conditions, shown in Figure 5. **Parkinson's disease and cognitive impairment have the most significant correlation with the number of severe falls experienced by seniors with AutoAlert.** A senior with Parkinson's is 2 times more likely to fall and need hospital transport than a senior with no conditions, and a senior with cognitive impairment, 1.5 times more likely.
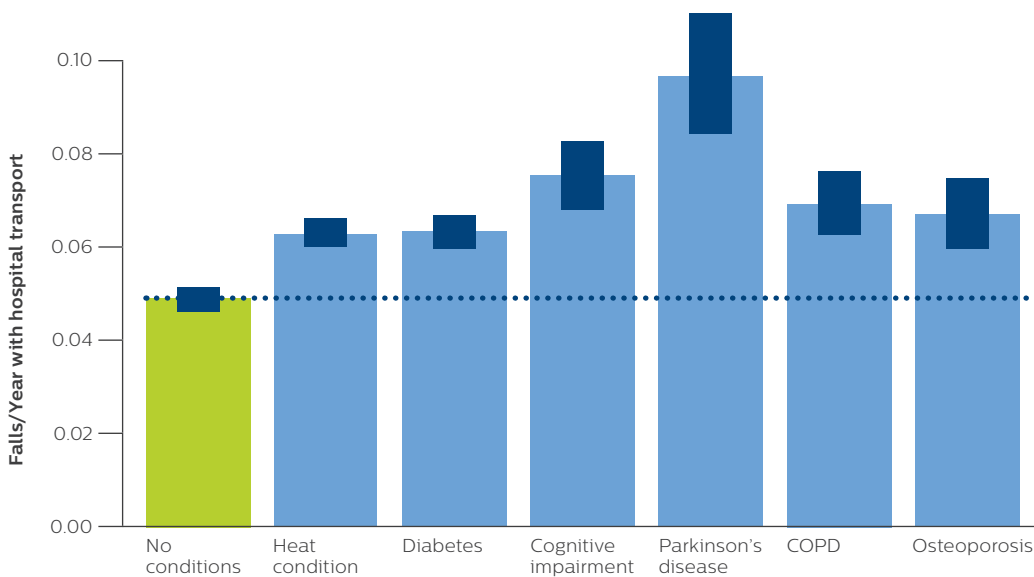
Figure 5: Fall rate with hospital transport of AutoAlert users by reported medical condition. Additional bars represent 95% confidence intervals.

Conclusion

Quantitative analysis of a large database of personal medical alert users shows AutoAlert, a PERS with highly reliable and accurate automatic fall detection technology, detects twice as many actual falls as reported with a standard PERS solution alone and 30% more falls that require hospital transport. This significantly higher reporting of falls offers potential benefits to seniors, caregivers and managed care organizations, which may include:

- **Delivery of prompt urgent care**. Fast access to professional help when it is needed most can improve health outcomes and manage costs related to direct medical assistance, loss of independence and transitions to long-term care.
- **Avoidance of unnecessary care**. By making caregivers aware of more falls, automatic fall detection technology may prevent hospital transport, ER visits and hospitalization resulting from complications of long lie times.
- **Prevention of future falls**. With a fuller picture of what is happening to seniors in their homes, caregivers can take proactive steps to improve safety.
- **Enabling proactive care**. Recording almost all falls, even minor ones, gives physicians added information that can help them assess seniors' health status and make adjustments to care when needed.

The clear value of adding optimized automatic fall detection technology to a standard medical alert system suggests such technology should be considered as the safety standard in the medical alert industry for seniors.

"... she would not be able to stay in her house without it, honestly. Because I don't know that she would push the button, even though we've shown her how to do it, we've talked to her about how to do it... I think **AutoAlert is what's allowing us to keep her in her home**."

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11. Philips qualitative research study of AutoAlert users, January 2014.

Appendix A:
Optimized Technology Used in Study

The PERS solution with automatic fall detection cited in this study, marketed as Lifeline Medical Alert Service with AutoAlert, has been used by over 300,000 seniors in North America since its release in 2010.

Philips Lifeline Medical Alert Service with AutoAlert meets criteria for accuracy and reliability:

- **High rate of detection of falls from a standing position**. Falls involve instant drops to a lower level. The technology evaluated in this study has a detection rate of over 95%, verified by testing that involved real falls as well as simulated falls using crash dummies prior to introduction to the market. The line between heavy falls with potentially severe outcomes and less critical situations like gentle slides to the floor is set with a precisely optimized algorithm for usability, helping to ensure safety while helping to minimize false alarms. In certain situations, such as a gradual slide from a seated position, the technology may not detect a fall.

- **Low false alarm rate**. A false alarm is defined as the system responding as though there was a fall when no fall happened. The technology used in this study averaged 1 false alarm every 2 months per user based on user perception, so includes instances where the user fell but did not want or need help and did not acknowledge the fall. This rate is well accepted by users; an occasional false alarm is not bothersome and assures them the system is properly working and will provide access to help.

- **Ability to recognize when a user immediately stands up after a fall**. This feature allows seniors to recover from falls not serious enough to require help. Extensive analysis of service data has shown that button pushes after a fall with immediate standing up, called revocation, are rare: when a PERS user gets up after a fall, they rarely need help and if they do they are able to push the button. The technology studied in this analysis does not automatically generate a call if revocation is detected within 30 seconds after a fall, minimizing perceived false alarms.

Appendix B:
Study Population Characteristics

The authors analyzed the demographics (age, gender and medical condition) and service characteristics (e.g., living conditions, type of equipment used and length of subscription to the service), of 400,000 seniors equipped with a standard medical alert service or automatic fall detection service. A sub-analysis of the 2 groups is presented in Table 1.

In both groups the median age at service enrollment is 83 and over 50% report 2 or more medical conditions. Furthermore, the proportion of subscribers reporting conditions that may affect fall risk or outcome after a fall such as heart failure, chronic obstructive pulmonary disease (COPD), osteoporosis and Parkinson's disease, is very similar in both populations.

The user comparison analysis ensures that the direct to consumer business channel provides a subpopulation in which the difference in service and effectiveness between standard PERS and PERS with fall detection technology can be objectively compared. The final study population was derived from this group based on the availability of data on falls.

Table 1. Characteristics of direct-to-consumer, private-pay subscribers of standard PERS (>100,000) and AutoAlert (>100,000)

	Standard PERS	AutoAlert
Age at enrollment – Mean	81.1	81.5
Age at enrollment – Median	83	83
Gender (% Female)	77%	76%
Living condition		
% Living alone	98%	98%
Amount of self-reported medical conditions		
% Reporting at least one	68%	70%
Average number	2.2	2.3
Median number	2	2
Type of self-reported medical conditions		
· High blood pressure	24.7%	24.8%
· Diabetes	14.4%	14.7%
· Heart condition	22.4%	24.7%
· COPD	5.0%	4.8%
· Parkinson's disease	1.5%	1.8%
· Osteoporosis	3.6%	3.1%
Fall risk	15.7%	17.1%
Gait assistance device (cane, crutches, walker)	15.2%	17.2%