# Personal Emergency Response Services: Do the Benefits Justify the Cost in Seniors Housing and Care Properties?

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## Abstract

Telephone-activated personal emergency response services (PERS) were developed 30 years ago so persons experiencing adverse events could summon assistance. Little evidence exists, however, associating PERS use with improved outcomes. With growing PERS use within continuing care retirement communities, it is important to tie usage to residents' needs. The authors present data from research at Baylor College of Medicine comparing event rates, well-being scores, and sense of security between cohorts of older persons with and without PERS. Results from retrospective studies in the U.S. and Canada comparing hospitalization experience with PERS use guided an IRB-approved, randomized controlled trial of PERS use with one year of telephone follow-up. Outcome variables included frequency of health care use, functional levels measured by SF-36 scores, and self-reported sense of security. Retrospective data revealed reduced hospitalization rates among PERS users. Prospective findings revealed slight increases in emergency department use and significant increases in sensed security and SF-36 vitality and mental health component scores. PERS is most useful when relieving a sense of insecurity, and making improvements in mental well-being are indicated. Expanding PERS use among a burgeoning older population should be tailored to changes in physical and psychosocial indicators that warrant environmental prescriptions for such services, especially in long-term care settings.

## INTRODUCTION

Throughout Western Europe and North America, seniors' use of personal emergency response services (PERS) has been shown to a) decrease use of hospital stays; b) increase users' sense of personal security; and c) promote connectedness between users, their family members, local emergency response center personnel, and others in their communities, such as law enforcement officers and service agency staff members (Roush & Teasdale, 1997; Porter, 2003; Mann et al., 2005; Fallis, Silverthorne, Franklin & McClement, 2007). Early studies from Canada and France reported that overall patient survival was enhanced by telephone-facilitated monitoring similar to the PERS studied in this research (Stiell et al., 1999; Houzard et al., 1998). A recent report, however, failed to confirm that access to PERS reduced anxiety, fear of falling, or return to emergency department among older persons discharged from the emergency department (Lee, 2007). Thus, there remains uncertainty regarding the weight of evidence indicating benefits of PERS.

Conventional PERS utilize first-generation home telecare technology and are typically electronic devices worn on the wrist or as a necklace by persons deemed at risk of personal injury or acute clinical events. Manual activation of the device by the wearer signals a special in-home telephone unit to dial a central response center. This triggers a return telephone call from the response center to the user's personal telephone to determine what form of assistance is required. If communication is not achieved, the response center attempts to make contact with a prearranged set of alternate responders. If no designated responder can be contacted, emergency medical services or local police are notified.

Regardless of where use occurs, the clinical relevance of PERS use is embodied in the concept of "downtime"; i.e., that period of time a person is incapacitated and without help. Downtime can occur in a variety of residential settings, including independent living, assisted living, and indeed, congregate long-term care facilities; e.g., calling out for an onsite caregiver's help after slipping in a bathtub may have a downtime of only minutes, whereas for individuals who spend substantial periods of time alone, being unable to self-rescue from a bathtub may mean a downtime of several hours until a family member returns home. Probabilities of extended downtime increase considerably when older persons live alone, especially frequent fallers, those with prodromal conditions such as heart disease and syncope, and those with disabilities.

It is intuitive that increased length of downtime is associated with increased physiologic damage to the older individual and is concomitantly associated with post-discovery increased health care utilization, more frequent hospital emergency department visits, and longer hospital stays. Furthermore, there is strong evidence that the shorter the elapsed time from sentinel event to transport to the emergency department, the greater the likelihood that the person can be restored to health and returned to community residence (Champion, 1996; Gurley, Lum, Sande, & Katz, 1996; Roush & Teasdale, 1996).

PERS activation is designed to decrease downtime plus increase subscriber and caregiver feelings of safety. While the positive benefits of subscription to PERS services may seem obvious, relatively little empiric data have been published that specifically justify the monthly subscription fee, a commonly cited barrier to PERS use (Heinbuchner, 2010; Mann, 2005). This article recaps five years of population-based research on PERS utilization, psychometric effects associated with use of such device, and differences found between users and non-users with regard to SF-36 domains. Data from two retrospective studies and one clinical trial are reported. Discussion of newer generations of gerontechnological applications in long-term care settings with potential to mitigate the effects of disasters on older persons is also presented.

## Overview

In 1997, the authors reported the results of two retrospective studies comparing health care utilization (frequency of emergency department visits and total length of hospital stay) before and after PERS subscription in a U.S. cohort and a Canadian cohort. The authors present a brief overview of these studies for readers not familiar with this early literature in the hope that they will have a better understanding of the difference in the research design used for the present study and its recommendations for adaptation to long-term care settings.

For internal programmatic quality assurance purposes, data collection for both groups occurred independent of the investigators. The investigators were simply given access to the data from local program coordinators who were contacted by phone for assistance in resolving minor uncertainties in the data set and in confirming certain issues regarding data quality. Comparisons were made between the U.S. and Canadian sites to determine homogeneity of the overall data set. Additional comparisons were subsequently made on a before-after hypothesis-testing scenario.

Results by site are summarized here: In British Columbia, Canada, data were available for 106 subscribers. The mean frequency of one-year emergency department visits (SD) before and after access to PERS was 0.58 and 0.72 (both 1.3), respectively, yielding a non-significant difference. The mean number of hospital in-patient days per person was 14.37 (34) and 5.85 (10.9), respectively, yielding a statistically significant decline ($p = 0.01$). In Florida, data were available for 101 subscribers. The mean frequency of emergency department visits (SD) in the year before and after access to PERS was 1.13 (1.3) and 1.07 (1.4), respectively, yielding a non-significant difference. The mean per person hospital length of stay in days before and after PERS access was 10.45 (13) and 1.16 (12.2). The large confidence intervals muted the impact of a nine-day drop, yet again a statistically significant change was observed ($p = 0.01$). The two data sets were determined to be homogeneous in nature and were thus combined. Before-after comparisons on the larger data set repeated findings of the smaller samples. While the association between PERS access and emergency department visits remained uncertain, a statistically significant reduction in annual hospital in-patient days was confirmed (Roush & Teasdale, 1997). These data guided design of the subsequent prospective study reported here.

## Methods

Older persons (N = 336 oversampled subjects) residing in the greater Houston metropolitan area who fit inclusion criteria were recruited for prospective random assignment to one of three groups: (1) an experimental group receiving PERS service (intervention) for 12 months; (2) an experimental group receiving PERS service for six months followed by six months without; and (3) a control group not offered PERS service during 12 months of longitudinal follow-up.

Health care utilization measures (total hospital length of stay, number of clinic visits, number of unscheduled emergency department visits, incidence of institutionalization) and health status measures were employed to characterize subjects' experiences with and without PERS access. Null hypotheses for statistical testing were based on a "no difference" finding between groups after a 12-month follow-up period for each of these measures.

Health status measures were taken from the widely validated SF-36 Health Survey items, quality of life and coping mechanism questions. The SF-36 is a multipurpose, short-form health survey with 36 questions, yielding an 8-scale profile of functional health and well-being scores as well as psychometrically based physical and mental health summary measures and a preference-based health utility index. With more than 4,000 publication citations, experience to date from nearly 400 randomized controlled clinical trials suggests that the SF-36 is a useful tool

for evaluating the benefits of alternative treatments (see www.sf-36.org/tools/sf36.shtml).

Volunteers were screened for eligibility based on four criteria: being 70+ years of age; living alone or being alone at least six hours per day; having no apparent cognitive impairments that would impede comprehensive and appropriate use of the PERS equipment; and possessing one or more prodromal risk factors—frequent falling, recent surgery, congestive heart failure, pulmonary disease—that could potentially require emergency treatment. A person was considered at high risk of falling if they reported a history of falls or had recent orthopedic surgery.

Subjects were contacted by trained telephone interviewers to collect health status information via a structured interview using locally developed questions regarding "well-being," plus the SF-36 (Ware & Sherbourne, 1992). The SF-36 was selected since this questionnaire comprises physical and mental health components, both of which have been demonstrated to affect health and overall quality of life (McHorney, 1999). Locally developed questions focused on self-recall of scheduled and unscheduled health care utilization, plus self-reported sense of security. The security rating scale contained two questions asked of subjects at the end of their respective study period: (1) "Please rate your sense of security during the time that you had access to the PERS device"; and (2) "Please rate your sense of security during the time that you had no access to the PERS device." Group A was to have been asked to reflect back on a time prior to study initiation. Group B was to have been asked to reflect on their study periods with and without PERS access. Group C, pure control subjects never with PERS during the active study period, were not asked to report on this measure. Per IRB-approved protocol, Group C participants did receive PERS access after the study concluded; telephone interviewers were trained via didactic instruction on how to conduct the interview and completion of dummy telephone interviews with study coordinators.

The PERS device, including monthly subscription costs, were provided to study subjects free of charge by Lifeline Systems, Inc., the source of the unrestricted industry grant for the project. Contact with enrolled subjects was via telephone interview, usually conducted from the research assistants' homes.

## Statistical Approaches

Sample size calculations revealed that 248 subjects would be required for all a priori hypotheses. Subjects were recruited via multimedia announcements in accordance with institutional review board approvals from Baylor College of Medicine and the Houston Veterans Affairs Medical Center (now the Michael E. DeBakey VA Medical Center).

Analyses included robust sample description, chi-square tests on between-group frequencies, *t*-tests on between-group means, general linear multivariate models, and repeated measures analysis. The Baylor College of Medicine Institutional Review Board approved this study with human subjects.

## Findings

The sampling strategies successfully recruited the necessary number of subjects. An initial 296 subjects were enrolled, with 99 in the 12-month group (A), 98 in the six-month group (B), and 99 in the control group (C). Prior to data collection, 27 persons moved or did not want to be included, and two persons died. Thus, the final study size was 267 subjects, with only 248 needed to meet required sample size. Group A had 90 subjects, Group B had 88, and Group C had 89. Across arms of the study, sociodemographic variables presented in **Table 1** were not significantly different.

Delays in terminating PERS service after six months in Group B, plus substantial attrition of subjects in Group B, forced the research team to collapse the PERS-titrated grouping into two contrasting groups: those receiving PERS access versus those not receiving PERS access. While this prevented the authors from analyzing the impact of terminating PERS use after a six-month period of subscription, it allowed them to maximize use of existing data

**Table 1. Sociodemographic Variables.**

| Variable | Arm | | | Homogeneity |
|---|---|---|---|---|
| | Continuous | On/Off | Control | |
| **Age (mean)** | 78.78 (5.8) n = 99 | 79.79 (5.5) n = 99 | 79.38 (6.3) n = 99 | 0.325 N.S. |
| **Female Gender** | 80.8% | 74.2% | 72.7% | n/a |
| **Caucasian Ethnicity** | 91.8% | 89.8% | 88.9% | n/a |
| **Education (mean yrs)** | 9.0 (2.3) n = 99 | 11.6 (15.6) n = 98 | 11.6 (15.6) n = 99 | 0.054 N.S. |

**Table 2. Health Care Utilization.**

| | Status | Total Frequency | Per Person Mean | SD | *p*-Value |
|---|---|---|---|---|---|
| **Clinic Visits** | No PERS | 518 | 1.91 | 2.96 | 0.433 |
| | With PERS | 1055 | 2.05 | 3.42 | |
| **Emergency Department Visits** | No PERS | 518 | 0.09 | 0.61 | 0.023 |
| | With PERS | 1059 | 0.19 | 1.00 | |
| **Hospitalizations*** | No PERS | 1% | | | 0.55 |
| | With PERS | 3% | | | |

* *Measured as percentage of sample with ≥1 unscheduled overnight hospital stays.*

points by retaining the most possible number of subjects. It also improved the statistical power of the authors' tests. Thus, subsequent analyses were based on two-group comparisons (an experimental group with PERS, a control group without).

As seen in **Table 2**, no differences were observed in the frequency of scheduled clinic visits based on access to the PERS unit ($p = 0.43$). Subjects with PERS units utilized emergency departments twice as often as those without PERS access ($p = 0.02$). Interestingly, though, those additional emergency department visits did not translate into an increase in frequency of hospital admissions ($p = 0.55$). The most commonly reported reason for going to the emergency department was to relieve anxiety over feelings that "something is amiss." In geriatrics, the altered presentation of a frank myocardial infarction is often just that: a feeling that something is not right. Furthermore, all persons were being encouraged to increase their levels of health literacy. With increased knowledge about a condition, chronic or otherwise, and access (via the PERS), it stands to reason that some chose to take advantage of the opportunity. When genuine health problems are

**Table 3. Change in Well-Being by SF-36.**

| | Group with 12 mo. of PERS | | Group with 0 mo. of PERS | |
|---|---|---|---|---|
| | Delta | *p*-value | Delta | *p*-value |
| Vitality | 6.5 | 0.002 | 1.6 | 0.48 |
| Role-Emotional | 17.9 | 0.003 | 20.7 | <0.001 |
| Mental Health | 5.6 | 0.005 | 3.7 | 0.86 |
| Physical Functioning | 1.6 | 0.057 | 2.2 | 0.37 |
| General Health | 0.9 | 0.56 | 1.2 | 0.55 |
| Role-Physical | 1.6 | 0.74 | 2.5 | 0.53 |
| Social Functioning | 0.8 | 0.79 | 0.5 | 0.87 |
| Bodily Pain | 0.7 | 0.79 | 3.2 | 0.22 |

determined by proper evaluation of the patient, use of the emergency department is not only warranted but may contribute to lower health costs over time, as chances of survival and return to independent living increase with less time between an event and arrival at a site of care.

**Table 3** shows changes in SF-36 scores before and after follow-up. Significant improvements were observed in the domains for "Vitality," "Role-Emotional," and "Mental Health." The Vitality domain includes subjective measures of energy level and fatigue. The Mental Health domain includes items measuring anxiety, depression, loss of behavioral/emotional control, and psychological health. Both of these domains were significantly higher in the experimental group, indicating that PERS users experienced higher levels of well-being. The Role-Emotional domain probes for role-limitations due to mental-emotional problems. Both PERS and non-PERS groups experienced improvement in this domain, so it is probable that the reassurance that accompanies routine telephone contact was responsible for this global change.

A very strong relationship was identified between access to a PERS device and a sense of security (see **Table 4**). Using a 10-point Likert scale measuring feelings of safety (0 = not secure, 10 = very secure), the mean response for subjects with access to the device was 8.6, while the response by subjects without access was 5.7 ($p < 0.0001$).

## Discussion

Based on the findings of this study, the authors concluded that PERS access 1) significantly improved users' feelings of security; 2) may have contributed to improvement in Vitality and Mental Health scores of the SF-36; 3) was not associated with change in clinic visits; 4) was not associated with change in hospitalization rate; and 5) was associated with a modest increase in frequency of emergency department visits.

The social problem addressed by PERS is the isolation of at-risk, frail, elderly people, whether they live alone in the community, are relatively unmonitored in assisted living, or they reside in long-term care settings where the amount of monitored time fluctuates greatly based on their individual health needs. Such individuals may benefit from electronic safety monitoring affording rapid response after an adverse

**Table 4. Self-Reported Perceived Sense of Security. (n = 135)**

Subjects were asked to rate their feelings of security with and without access to a PERS device (1 = Not Secure; 10 = Very Secure).

| | Mean | SD | *p*-value |
|---|---|---|---|
| Time without PERS | 5.7 | 2.3 | <0.0001 |
| Time With PERS | 8.6 | 1.6 | |

event. PERS have the potential to minimize delay in obtaining help, a measure clearly advantageous to subscribers or to clients where this is provided by their residential facility.

Within-facility differences in functional capacity of residents was shown by ongoing research at Quinnipiac University in a Connecticut assisted living facility, which found that those in sensored assisted living units utilized hospital services three times that of age-matched residents in the IL units (Roush & Meriano, 2009). As residents age in place, one can expect some diminution of capacity due in part to the homeostasis associated with normal aging.

Results of this trial with randomized allocation of PERS subscriptions among a sample of community residing elders clearly revealed a positive association between PERS use and higher scores on vitality and mental health indices. No improvements were seen with measures of physical well-being or social functioning. Prospective cost-effectiveness data were initially sought but ultimately unavailable. The measured benefits to study subjects are conceivably applicable to family members as well, but solid studies on that conjecture remain elusive potentially because caregiver costs are only rarely reimbursable, resulting in diminished enthusiasm for such research.

The present study findings of increased sense of security during periods of time with access to PERS is not surprising, as this is the most consistently stated benefit of PERS in literature, whether measured as a sense of security or absence of anxiety. The clear and positive change in SF-36 subscales of Vitality and Mental Health among PERS users versus those without suggests tangible benefit (Mann et al., 2005). Further strengthen this by noting that 69% of their respondents reported that having the device eased family members' worries, too (Heinbuchner et al., 2010), and reported high satisfaction scores across a spectrum of service-specific and device-specific measures. Yet, more than one-quarter of subscribers never wore their device, and only two of 13 fallers who were down for more than five minutes used the device to summon help even though the device was available. The feeling that help can be summoned if eventually necessary is highly valued.

Three study measures directly addressed fiscal considerations associated with aging: frequency of clinic visits, frequency of emergency department visits, and frequency of hospital admissions. Access to PERS did not alter routine health-seeking behavior among subjects, and indeed, it should not have. PERS represents a safety net for unexpected adverse events, not a substitute for routine care. The modest increase in frequency of emergency department use is not unexpected since any true emergency perceived by the response center would trigger a call cascade for help, ending with emergency medical services. The data from Heinbuchner (2010) suggests that, in fact, subscribers are surprisingly reticent to activate the call for help.

Regarding costs to the health care industry associated with response systems, older people at such risk of adverse events that warrant having PERS

prescribed for them should not feel compunction in seeking care in the emergency department. As stated previously, frail elders often present quite differently than do younger adults with similar health conditions; thus, delay in receiving appropriate care can be costlier than the initial costs of entering the portals of health care via hospital emergency departments. And in this study, the increase in emergency department use did not result in a corresponding increase in hospitalization. One example of possible cost savings from emergency department use is that the highest rate of readmission to hospitals within 30 days is among persons with heart failure. One could argue that PERS use and home monitoring might contribute to recently discharged patients' use of early evaluation in an emergency department that results in not being readmitted.

As expected, the recurring telephone follow-up produced much anecdotal evidence from subjects and designated responders. While not formally tested nor presented here, the experience of study personnel reinforced the statistical findings that PERS use increased the sense of well-being and security among those persons concerned with being alone or who had advancing frailty. Since the present authors were among the "callers" who contacted subjects at regular intervals to administer the SF-36, many feelings of satisfaction among subjects were revealed; e.g., almost all those in the "user" group did not want the study to end; likewise, those in the control or usual care wanted to switch. One poignant story was told by the son of one of the subjects whose PERS protocol was used to contact first and second responders to an emergency medical services call that an ambulance transport to the emergency department was in progress. The son was able to be with his mother during her last few hours of life. He called the research team to express his deep gratitude that his mother had not died alone at home. Qualitative data like these reported instances of frequent communications between researchers and subjects on the perceived utility of a provided service can not be expressed in terms of probability statistics; in human emotions terms, though, they were deemed significant.

## Limitations

A central limitation of this study was the potential of bias from self-reported responses to telephone surveys. Reliability of self-reported information was not measured. The authors' telephone callers, however, were trained to probe for information inconsistencies. Frequent staff meetings held between and among the callers did not reveal any suspected cases of hyperbole or deceptive statements that would have been red flags for the team.

Dissemination of criteria identifying persons who would receive the greatest psychological and physiological yield from PERS access is necessary to improve targeting of this appropriate technology. As clinical pathways are increasingly used to conserve health resources, only groups showing clear benefit from an intervention are likely to be offered a covered or reimbursable treatment or therapy. Thus, successful expansion of PERS programs, especially into the realm of managed care, will depend on the identification of risk factors among geriatric patients, targeting individuals at highest risk of costly health events. As a consequence, individuals living independently with few functional limitations would not likely be given an environmental prescription along the lines of PERS program enrollment. Such individuals may choose to subscribe to PERS on their own, however.

Progress in gerontechnology has allowed caregivers contemplating nursing home placement to maintain elderly or disabled family members in their homes longer (Chan, 1999). While current PERS enable subjects to call for help in the event of illness, future services are likely to make use of new technologies to provide automatic sensing of emergencies as well as to predict long-term deterioration in health using subject activity profiles. Third- and fourth-generation PERS will provide innovative services via broadband communication at home through cable or wireless networks (Doughty, Cameron, &

Garner, 1996). Hamill et al. (2009) describe a successful prototype implementation of dialog-based PERS that relies on ceiling-mounted microphones and software potentially capable of circumventing the poor judgment of subscribers to not summon help. Technological advances in monitoring changes in spatial positioning and in physiological status via domotics, or "smart homes," along with GPS technologies bode well for a brighter health care future for succeeding generations of older people.

One additional relatively new use of PERS is in the area of emergency preparedness for disasters, whether natural in origin or human-caused. Via emerging bidirectional communications capacities of PERS, companies can alert congregate care and community-residing clients in advance (pre-event stage) of an impending disaster, such as a tornado or threat of terrorism, and elders can take appropriate actions to mitigate harm to themselves. Local PERS managers will know that clients have done so, but to effectively utilize the reverse-alert capability on a widespread geographical area, PERS companies and countywide emergency planners will need to share data on where vulnerable elders live and develop event and post-event communication strategies to ensure continuity of contact and targeted emergency services (Roush & Guzman, 2010).

## Conclusion

Based on the current study's findings, the authors believe that the heightened feelings of well-being and security associated with PERS use by their subjects warrant health and human services providers to recommend an environmental prescription for an emergency call system among certain community-residing elders. Deciding which elders benefit the most from such service is still troublesome. The present findings, however, suggest that individuals expressing the mental anguish of isolation, fear of falling, functional immobility (rather than physiologic immobility), and fear of personal safety, regardless of source, are all reasonable candidates.

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