

# Vivago® Bodycode Measurement Technology

Abstracts of research and publications



**Vivago**  
*For the life we love*

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## Vivago® – an award winning telecare solution for successful and cost-efficient care.

Going far beyond any social alarm or nurse call system on the market today.

Vivago is an innovative telecare solution based on the patented Vivago Bodycode® measurement technology. The Vivago system is suitable for both home and institutional applications. Telecare enables elderly, disabled and those with long-term conditions to live safely and securely at home for a longer period of time. It also allows carers to remotely monitor the well-being of their clients' and take necessary action before a crisis occurs. The Vivago telecare solution helps to improve the quality of life of the user and reduces the cost of care. By using Vivago the need of care can be better foreseen (Figure 1).

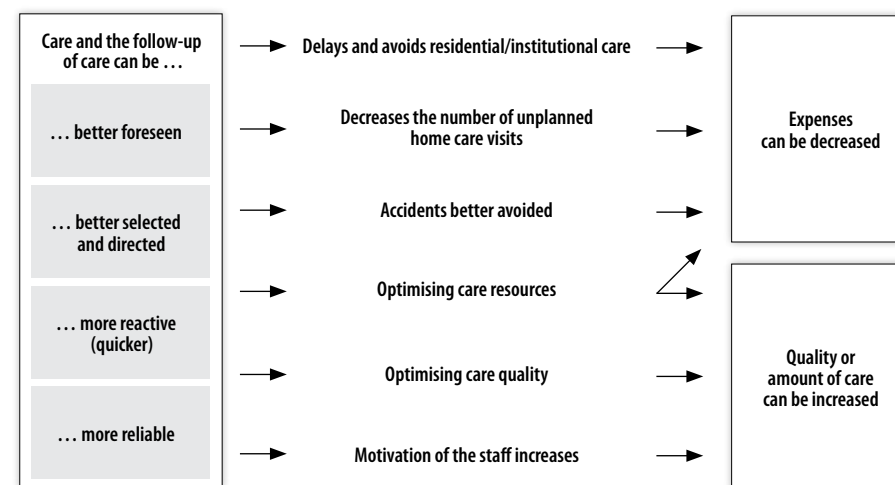


Figure 1

The Vivago watch continuously monitors the well-being of its user. If the system detects an abnormal period of immobility, or the user appears to be unconscious, an automatic alarm can be generated.

In addition to being the basis for automatic alarms, the collected activity data can also be sent to a remote recipient or viewed online in a care facility for continuous follow-up of a customer's well-being.

IST International Security Technology Oy changed its name to Vivago Oy in 2008.

Please note that all references made to WristCare and IST WristCare in these abstracts are referring to the Vivago Watch.

### Activity data is useful in health care for several purposes:

- Evaluating and detecting changes and probable developments in well-being to enable early interventions
- Planning preventative care measures, as well as
- Follow-up of treatment

### These Vivago Features will dramatically decrease the cost of care and increase the patient's well-being:

- Continuous monitoring of the user's sleep-wake pattern and circadian rhythm
- Automatic inactivity and immobility alarms
- Wrist unit usage information (watch on/off wrist)
- Wandering detection
- Automatic technical self-diagnostics
- Manual alarm trigger is naturally a feature on the watch

Over the years the system has received many awards, of which the latest is the 2006 Frost & Sullivan\* Award for product innovation within the telecare sector today. There are more than 35,000 people worldwide benefiting from using Vivago telecare solutions.

In addition to elderly care, other application areas for the Vivago technology are monitoring of long-term conditions, research and occupational health.



Vivago is developed and manufactured by Vivago Oy in Finland.  
Vivago Oy is an ISO 9001 and ISO 13485 certified company.

\*Frost & Sullivan, founded in 1961 is the world leader in growth consulting and the integrated areas of technology research, market research and economic research.

### Vivago research and related publications

The patented Vivago Bodycode measurement technology has been evaluated in several clinical studies.

#### 2003:

#### AUTOMATIC SLEEP-WAKE AND NAP ANALYSIS WITH A NEW WRIST WORN ONLINE ACTIVITY MONITORING DEVICE VIVAGO WRISTCARE®

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#### 2003:

#### IST VIVAGO® – AN INTELLIGENT SOCIAL AND REMOTE WELLNESS MONITORING SYSTEM FOR THE ELDERLY

A. Särelä<sup>1</sup>, I. Korhonen<sup>2</sup>, J. Lötjönen<sup>2</sup>, M. Sola<sup>3</sup>, and M. Myllymäki<sup>1</sup>.

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<sup>2</sup>VTT Information Technology, Tampere, Finland,

<sup>3</sup>Department of Public Health, University of Tampere, Finland

Proc of the 4th Annual IEEE Conf on Information Technology Applications in Biomedicine, UK

#### 2004:

#### CIRCADIAN ACTIVITY RHYTHM IN DEMENTED AND NON-DEMENTED NURSING-HOME RESIDENTS MEASURED BY TELEMETRIC ACTIGRAPHY

Paula Paavilainen<sup>1</sup>, Ilkka Korhonen<sup>2</sup>, Jyrki Lötjönen<sup>2</sup>, Luc Cluitmans<sup>2</sup>, Marja Jylhä<sup>1</sup>, Antti Särelä<sup>3</sup> and Markku Partinen<sup>4</sup>

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#### 2005:

#### TELEMETRIC ACTIVITY MONITORING AS AN INSTRUMENT FOR SUPPORTING THE HEALTH AND WELL-BEING OF THE ELDERLY

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#### 2005:

#### TELEMETRIC ACTIVITY MONITORING AS AN INDICATOR OF LONG-TERM CHANGES IN HEALTH AND WELL-BEING OF OLDER PEOPLE

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Gerontechnology 2005;4(2) 77-85.

#### 2005:

#### DIFFERENCES IN LIGHT SLEEP AND DEEP SLEEP MEASURED WITH IST VIVAGO® WRISTCARE

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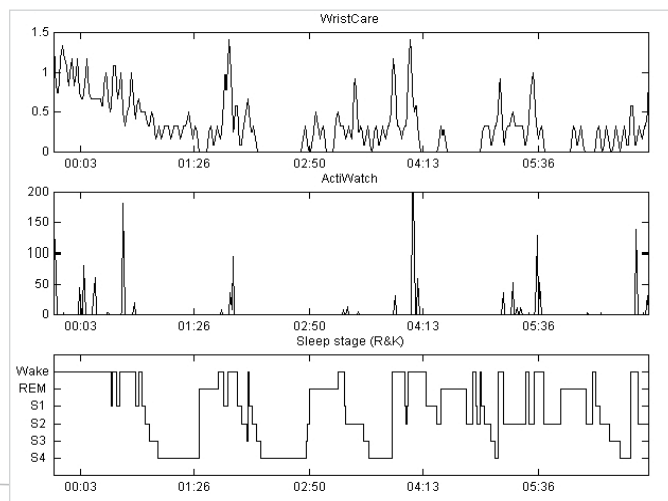
## **AUTOMATIC SLEEP-WAKE AND NAP ANALYSIS WITH A NEW WRIST WORN ONLINE ACTIVITY MONITORING DEVICE VIVAGO WRISTCARE®**

\*Jyrki Lötjönen PhD, \*Ilkka Korhonen PhD, †Kari Hirvonen MD, †Satu Eskelinen, ‡Marko Myllymäki MSc, †Markku Partinen MD  
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Vivago WristCare® is a new activity monitoring device, which allows long-term online monitoring of the activity of the user. This study evaluates the ability of the device to discriminate sleep/wake patterns during nighttime and during napping. Participants spent one night in the sleep laboratory where signals from polysomnography, actigraphy and WristCare® were acquired. In addition, actigraphy and WristCare® were used for 3-6 days for nap-analysis. Participants were 32 adults aged 26-89 years. The participants were studied in three study groups: all subjects, senior subjects (age>65 years) and middle-aged subjects (age<65 years).

Sleep/wake patterns were extracted from polysomnography, actigraphy and WristCare® for the night slept in sleep laboratory. The agreement percents between the scorings of polysomnography and actigraphy, and between polysomnography and WristCare® were about 80 % for all study groups. As total sleep time was estimated and the algorithm was optimized for this measure, the performance of the WristCare® and actigraphy were similar. Both actigraphy and WristCare® overestimated appreciably total sleep time (TST). Also in nap-analysis, actigraphy and WristCare® performed similarly as the number of naps and the length of the naps were compared.

**THE PERFORMANCE of the WristCare® can be assumed to be well comparable to actigraphy in sleep/wake studies. The study suggests that the device may be used in long-term monitoring of sleep/wake patterns with similar performance to actigraphy.**



**Figure 2** visualizes WristCare® and actigraphy signals for one subject during the PSG night as well as the corresponding PSG scoring.

## **IST VIVAGO® - AN INTELLIGENT SOCIAL AND REMOTE WELLNESS MONITORING SYSTEM FOR THE ELDERLY**

A. Särelä<sup>1</sup>, I. Korhonen<sup>2</sup>, J. Lötjönen<sup>2</sup>, M. Sola<sup>3</sup>, and M. Myllymäki<sup>1</sup>

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Proc of the 4th Annual IEEE Conf on Information Technology Applications in Biomedicine, UK

Successful application of any technology supporting independent living, such as social alarms or remote health monitoring, requires careful design and implementation of not only the technology itself but also the care provisioning process. An essential contributor to success is that the users – both elderly people and care givers – are motivated and capable to successfully use the technology in their daily living. For example social alarms are useless if the alarm device is not at hand when an emergency occurs – a common situation according to some reports. An essential feature of the IST Vivago® system is that it integrates both the intelligent social alarm system and remote wellness monitoring into a single system, which appears as a single wrist worn unit for the elderly user. Intelligence means not only the automatic passivity and inactivity alarms but also very importantly the on-wrist-detection feature, which enables the achievement of a remarkably high usage rate by allowing the care provider to monitor the true usage of the system.

The usage and alarm rates of the IST Vivago® system were evaluated in Savitaipale, Finland, over three months in 83 elderly people living at home or in assisted living facilities. During the study, the wrist unit was worn 94% of the time that the users spent within the device range. This extraordinary high usage rate as compared to those reported with traditional social alarm systems was a result of two factors. First, the true usage was monitored, and the users were actively instructed to wear the unit whenever they did not do so. Second, the manual alarm was used also as a nurse call system in the assisted living facilities, increasing the motivation to wear the wrist unit and also habituating the users to wear the alarm.

Elderly users regard the system as mainly a safety device. This motivates them to wear the wrist unit continuously. As a side product, a long-term – of months or years – follow-up of activity and circadian rhythm is provided. This data provides unique opportunities for both research and daily elderly care. Circadian rhythm and sleep/wake patterns are known to be modified e.g. due to dementia, depression, chronic pain, sudden illness, sleep syndromes, etc., which are all common in elderly subjects. Provided data is similar to the standard actigraphy, which is commonly used in sleep syndrome diagnosis and treatment follow up. This suggests that the data could be directly applied for the assessment of the need for and efficacy of sleep treatments in the elderly, e.g. in demented subjects.

**TO CONCLUDE, the IST Vivago® system provides an integrated intelligent social alarm and remote monitoring system to be used both in institutional settings and by the elderly user living independently at home. Experiences gained so far suggest that social alarms provided by the IST system perform comparably with traditional social alarm systems, while the intelligent features enable remarkably higher usage rates to be achieved. The activity monitoring integrated in the same device provides unique long-term follow up data of wellbeing through the analysis of circadian activity patterns.**

## **CIRCADIAN ACTIVITY RHYTHM IN DEMENTED AND NON-DEMENTED NURSING-HOME RESIDENTS MEASURED BY TELEMETRIC ACTIGRAPHY**

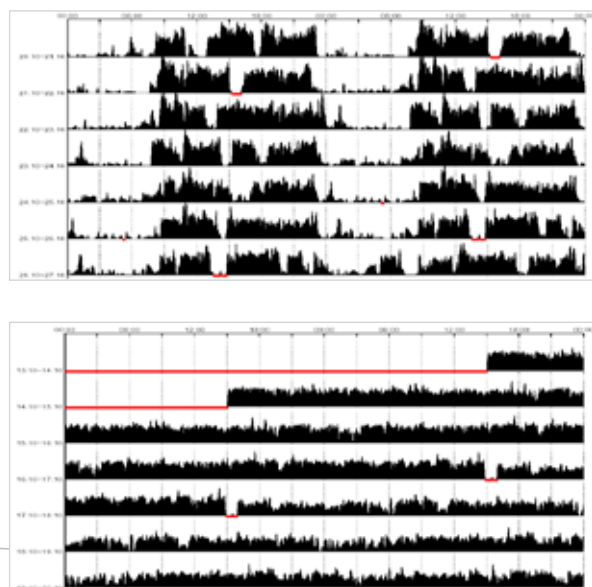
Paula Paavilainen<sup>1</sup>, Ilkka Korhonen<sup>2</sup>, Jyrki Lotjonen<sup>2</sup>, Luc Cluitmans<sup>2</sup>, Marja Jylhä<sup>1</sup>, Antti Särelä<sup>3</sup> and Markku Partinen<sup>4</sup>  
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There is a need to develop unobtrusive methods for long-term monitoring of sleep/wake and circadian activity patterns in the elderly both in nursing homes and at home settings as sleep is important for health and well-being. The IST Vivago® WristCare is an active social alarm system, which provides continuous telemetric monitoring of the user's activity. We examined how the activity signal measured by IST Vivago differed between demented and non-demented subjects living in a nursing home, and how it correlated with the subjective assessment of sleep quality and daytime alertness.

The activity signal data together with subjective assessments of sleep quality and daytime vigilance were collected from 42 volunteers (aged 56–97 years; 23 demented and 19 nondemented). The demented subjects had lower daytime activity and higher nocturnal activity than the non-demented subjects. Correlations between the activity parameters and self-assessments were weak but statistically significant. We also found correlation between functional ability and diurnal activity.

**THE RESULTS are in line with previous studies with demented and non-demented elderly subjects and suggest that the IST Vivago system provides a valid instrument for unobtrusive continuous long-term monitoring of the circadian rhythm and sleep/wake patterns in the elderly.**

**Figure 3** Examples of the activity signal in a non-demented subject with a clear circadian pattern (upper figure) and a demented subject circadian rhythm and high overall activity level (lower figure). The lines under the graph denote missing data.



## **TELEMETRIC ACTIVITY MONITORING AS AN INSTRUMENT FOR SUPPORTING THE HEALTH AND WELL-BEING OF THE ELDERLY**

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Promoting independent living of the elderly is essential in all industrial countries. Older people value their independence, and for the society the question is about the cost-efficient provision of health and social services. There is a clear trend to provide nursing services at homes instead of institutional care, and telehealth and telecare systems can be used as tools for supporting the independent living of the elderly. In this paper, we demonstrate how existing technology provides information about long-term changes in the health status and well-being of the elderly. We used the IST Vivago method (IST International Security Technology OY, Finland), which integrates telecare alarms (reactive measures) with telehealth monitoring (preventive measures) in one device. Our results suggest that continuous and ubiquitous activity monitoring can be used as a simple unspecific screening and/or follow-up tool for remote monitoring of the health status of the elderly in the institutions, but also at homes. This kind of technology may be used to monitor changes in health status and to follow up the effects of treatments and hence, to support clinical nursing and medical practices.

**CONCLUSION: Our results suggest that the IST Vivago system can be used as a simple unspecific screening and follow-up tool of the health and well-being of the elderly and hence, the system support clinical nursing and medical practices both in institutions and at home care settings, too.**

## **TELEMETRIC ACTIVITY MONITORING AS AN INDICATOR OF LONG-TERM CHANGES IN HEALTH AND WELL-BEING OF OLDER PEOPLE**

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Supporting independent living for older people is essential not only for the older people themselves, but also for the social and health care sectors. For this reason, there exists a need for unobtrusive telecare and telehealth solutions enabling independent living of the older adults. In this study, we demonstrate how telemetric activity monitoring offers a promising tool for long term monitoring to detect changes in the health status and over-all wellbeing of older people.

A telemetric activity monitoring system integrated with an intelligent social alarm system was used to monitor circadian activity rhythm of elderly nursing home residents (n=16, mean age 85.1 years, range 58-97) for several months. Changes in the activity rhythm were compared with clinical observations of health status of the subjects. The results are given as case reports. The results suggest an association between the changes in the actual health status and the circadian activity rhythm.

**CONCLUSION:** Telemetric activity monitoring systems have recently become available both for home and institutional use. The most promising feature of the method, such as embodied in the IST Vivago® system, is that it integrates the telecare alarms (reactive measures) with health monitoring (preventive measures) in one single device, which is unobtrusive to wear and which the users are motivated to use because of the alarm features. These results suggest that the method can be used to monitor changes in health status and to follow-up on the effects of treatment in elderly care institutions.

## **DIFFERENCES IN LIGHT SLEEP AND DEEP SLEEP MEASURED WITH IST VIVAGO® WRISTCARE**

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Activity monitoring is a widespread alternative to polysomnography (PSG) in studying sleep/wake patterns because it enables inexpensive long-term monitoring and does not require laboratory conditions for recording. IST Vivago® WristCare is a wrist worn activity monitoring device, which has been found to produce similar results to traditional actigraphs in sleep/wake detection. The movement sensor of Vivago® is more sensitive to low intensity movements than that of traditional actigraphs.

**CONCLUSION:** Activity measured with Vivago® is significantly smaller in deep sleep than in light sleep. The results indicate that Vivago® signals provide information on the quality of sleep. The method could be used for screening and follow-up of sleep quality.

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