Original Research Article

The Impact of Using Measurements of Electrodermal Activity in the Assessment of Problematic Behaviour in Dementia

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Keywords

Abstract

Background: A major and complex challenge when trying to support individuals with dementia is meeting the needs of those who experience changes in behaviour and mood. ***Aim:*** To explore how a sensor measuring electrodermal activity (EDA) impacts assistant nurses' structured assessments of problematic behaviours amongst people with dementia and their choices of care interventions. ***Methods:*** Fourteen individuals with dementia wore a sensor that measured EDA. The information from the sensor was presented to assistant nurses during structured assessments of problematic behaviours. The evaluation process included scorings with the instrument NPI-NH (Neuropsychiatric Inventory-Nursing Home version), the care interventions suggested by assistant nurses to decrease problematic behaviours, and the assistant nurses' experiences obtained by focus group interviews. ***Results:*** The information from the sensor measuring EDA was perceived to make behavioural patterns more visual and clear, which enhanced assistant nurses' understanding of time-related patterns of behaviours. In turn, this enhancement facilitated timely care interventions to prevent the patterns and decrease the levels of problematic behaviour. ***Conclusion:*** With the addition of information from the sensor, nursing staff could target causes and triggers in a better way, making care interventions more specific and directed towards certain times throughout the day to prevent patterns of problematic behaviours.

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Introduction

A major and complex challenge when trying to support individuals with dementia is meeting the needs of those who experience changes in behaviour and mood. These behavioural and emotional expressions, which will hereinafter be called problematic behaviours, can be expressed as agitation, anxiety or sleep disturbances, to name a few, and are often perceived as related to emotional, environmental or physiological stress. Problematic behaviours are common, and more than 90% of nursing home residents with dementia will experience problematic behaviour at some point during the course of the disease [1]. The ability to adequately assess and monitor problematic behaviours is essential in determining when interventions are needed. However, this is challenging due to factors such as nursing staff's educational level [2], the fluctuating nature of the behaviours [3], and the time available to perform systematic observations.

Measuring patients' levels of electrodermal activity (EDA) could assist nurses in assessing problematic behaviours. Existing evidence suggests that EDA can be useful in monitoring patterns of behaviour and emotional arousal [4, 5]. There are indications that EDA measurements can improve the understanding of behavioural patterns for people with problematic behaviours in nursing homes [6] and support early detection of agitation in people with dementia [7]. EDA reflects changes in skin conductivity, which is controlled by the sympathetic nervous system and may indicate stress [4, 5]. When stress stimulates the sympathetic nervous system, it also influences physiological parameters, such as muscle activity, heart rate, and pupil dilation [8]. EDA measurements have also been used to track mood changes in older people [9], assess the functional and behavioural health of people with dementia [10], investigate people with dementia's reactions to moral dilemmas [11], and compare individuals with dementia's engagement in social activities [12].

Problematic behaviours result in decreased quality of life for the individual with dementia [13] and constitute a major challenge for nursing staff and relatives [14]. The causes of these behaviours are multifaceted and complex, resulting from a unique set of casual occurrences related to the person with dementia, the caregiver, and the environment [15]. The ability to better assess and monitor problematic behaviours would help nursing staff better understand the triggers of these behaviours and, from there, better target them with care interventions. Various structured assessment tools have been developed to support nursing staff in identifying and understanding problematic behaviours [16], the most widely used and recommended of which is the Neuropsychiatric Inventory-Nursing Home version (NPI-NH) [17]. This tool is a care provider-based approach to assess 12 different problematic behaviours that are common in dementia [18, 19]. In Sweden, a quality register, the BPSD registry, has been developed to support the care of people with problematic behaviours (www.bpsd.se). The register has a clear structure that relies on outlining the frequency and severity of the behaviours per the NPI-NH, documenting current medical treatment and providing a checklist for possible causes of problematic behaviours. This structure generates an individual care plan with care interventions aimed at reducing problematic behaviours. Despite the many strengths of using the NPI-NH to understand the individual with dementia, this instrument is based on observational data, requiring a close proximity between staff and the individual with dementia over a substantial period, which can be challenging to obtain.

Developing and evaluating tools to complement the NPI-NH will enhance nursing staff's ability to assess the needs of individuals with dementia and, in turn, increase their well-being. Utilising the information from an EDA sensor may enhance nursing staff's understanding of problematic behaviours. The use of this tool needs to be further studied in a natural clinic setting to explore the way the information from the sensor impacts staff's choice of inter-

vention. Consequently, the aim of this study was to explore how an EDA sensor impacts assistant nurses' structured assessments of problematic behaviours amongst people with dementia and their choices of care interventions.

Materials and Methods

This early stage observational pilot study was designed to focus on impact in everyday practice in dementia care settings and was influenced by the framework for evaluating complex interventions outlined by Craig et al. [20]. The intervention was based mainly on two things. The first was the theoretical understanding of how wearable EDA sensors may impact structured assessments of people with dementia [6]. The second was the structured assessment and care programmes targeting problematic behaviours in individuals with dementia (www.bpsd.se) in which the NPI-NH instrument is an important tool. Structured assessments of problematic behaviours are complex and involve considerations of several influencing factors, such as the competence of involved staff along with internal and external factors affecting the individual with dementia. The present study addresses this complexity by exploring a number of factors, including the implementation process, using both quantitative and qualitative data.

Context and Participants

Twenty individuals with dementia residing in five nursing homes in northern Sweden were selected to wear the EDA sensor. They were purposefully selected in consultation with the nursing home manager and experienced staff based on the criteria that they resided in nursing homes where assistant nurses were trained in using a structured assessment and care programme for problematic behaviours in individuals with dementia prior to inclusion in the study (www.bpsd.se). The second criterion was that the person had a diagnosis of dementia and, at the time of inclusion, was considered to have problematic behaviours according to an assessment using the NPI-NH [18, 19] performed by assistant nurses. The first author, a specialised geriatric care nurse, performed an assessment with the Global Deterioration Scale [21] for each participant to determine the stage of dementia.

Each nursing home consisted of multiple wards that accommodated 10 residents who all rented their own apartments. In addition, they also included common areas, such as a day room with a TV and a dining area. The nursing homes were staffed mainly by assistant nurses working in the close care of the person with dementia, and a registered nurse and a general practitioner supported them.

In total, 33 assistant nurses who worked closely with the included individuals with dementia and, therefore, were expected to perform the structured assessment of problematic behaviours as a part of their daily work, took part in the study. Two assistant nurses usually participated in each assessment session. Prior to inclusion in the study, participating assistant nurses were involved in the daily care of the individual being assessed and had received a web-based training encompassing basic knowledge on dementia, problematic behaviours, and specific care interventions. Furthermore, one of the participating assistant nurses for each assessment session had received training in administering the NPI-NH. Of the assistant nurses who had participated in the structured assessment, 9 were recruited to participate in focus group interviews. Criteria for participation in the focus groups were willingness to participate and experience of using the EDA sensor measurements in the assessment process.

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Melander et al.: Measurements of Electrodermal Activity in Dementia

The Sensor and the System

To capture EDA, the participants used either the Discrete Tension Indicator (DTI-2) developed by Philips Research or the Empatica E4 developed by Empatica Incorporation. Both sensors are worn as a wristband, measure EDA using two electrodes placed on the skin, and have been found to reliably reflect stress levels [22, 23]. The individual with dementia wore the sensor during the day, and it was removed and charged during the night. The first author transferred the data from the wristband to an online service on a weekly basis, where it was processed and visualised. The online service visualised the measurements from the sensor on a timeline view. From this, the first author manually compiled patterns of increased EDA to be presented to assistant nurses during the structured assessment. The data collected with the sensor covered the same time period, which was also assessed with the NPI-NH.

*The Process of Assessing Problematic Behaviour*

The assessment sessions were conducted every 4 weeks as a part of the daily work in the nursing homes. In the first step, changes in behaviour during the last 4 weeks were assessed with the NPI-NH. There were usually 2 assistant nurses participating in the assessment sessions. Both participants were involved in the daily care of the individual with dementia being assessed, and 1 had received specific training in administering the NPI-NH. Screening questions for each domain within the NPI-NH were used to determine whether changes in behaviour existed. If changes were found, the frequency and severity were rated. For each of the 12 domains, the frequency scores ranged from 0 to 4, and the severity scores from 0 to 3. The product of the frequency score and the severity score gives a subscale score, and the sum of all the subscale scores formed a total score ranging from 0 to 144. Following the structure of the BPSD registry, the second and third steps of the assessment process meant that the assistant nurses documented the current medical treatment and went through a checklist of possible causes of behavioural changes. The list of possible causes included yes or no questions, such as "Enough food?", "Normal faeces?", "Good hearing (with or without aids)?", "Does the person seem pain free?", "Blood sugar – high, normal, low?", and "Is there a daily positive social contact with other people?". In the final step of each assessment session, assistant nurses suggested and evaluated care interventions to decrease problematic behaviours and, consequently, reduced the scoring according to the NPI-NH. To support this step, the BPSD registry has specified predetermined areas of interventions commonly used to decrease problematic behaviours, such as physical activity, music and singing, as well as the possibility to document a treatment plan. In each area, the assistant nurses suggested appropriate care interventions to decrease problematic behaviours. Previously suggested care interventions were revised if necessary, for example if they were deemed insufficient. The suggested and revised care interventions were documented using the assistant nurses' own wording. The first author conducted the data gathering, but was not active in the assessment sessions.

Evaluation Process

The intervention was evaluated based on:

- Change in NPI-NH scores after information from an EDA sensor was added to structured assessments;
- Changes in suggested care interventions after information from an EDA sensor was added to structured assessments; and
- Assistant nurses' experiences of using EDA sensors in assessing problematic behaviour.

The authors conducted the evaluation process between the years 2015 and 2017, and the process included NPI-NH scores from structured assessments performed by assistant nurses, the suggested care interventions, and the assistant nurses' experiences as obtained by focus group interviews. Each data collection and analysis process is described separately.

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Melander et al.: Measurements of Electrodermal Activity in Dementia
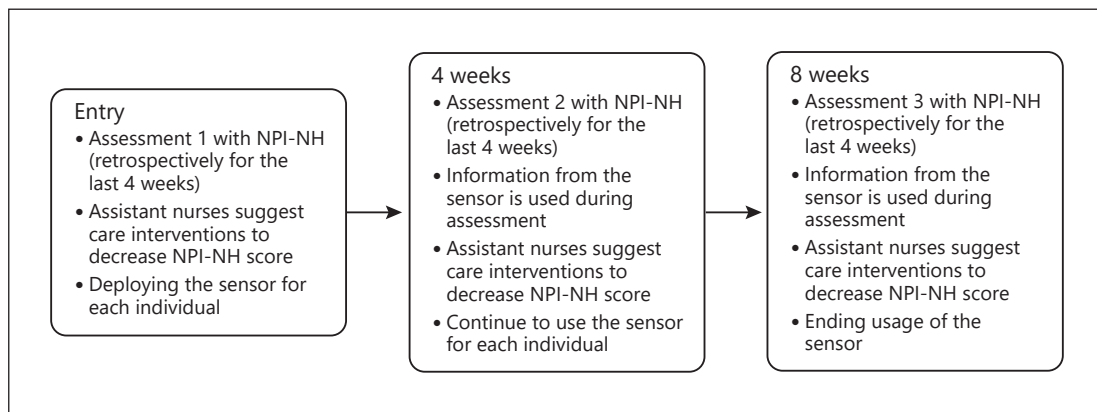
Fig. 1. Overview of the 8-week evaluation cycle in which all included participants participated. Each assessment with NPI-NH was done retrospectively, covering the previous 4 weeks. The individual wore the sensor for 8 weeks. Assistant nurses gained access to the information from the sensor during the second (4 weeks) and last (8 weeks) assessment.

NPI-NH Scoring. The NPI-NH scores from the assistant nurses' structured assessments were collected at entry and after 4 and 8 weeks for each participant (Fig. 1). Information from the sensor was presented to assistant nurses during the second (4 weeks) and last (8 weeks) assessment sessions. However, assessments with the NPI-NH were done retrospectively regarding the last 4 weeks, meaning that the second (4 weeks) assessment with the NPI-NH reflected the time between the first and second assessment, i.e. without the addition of information from the sensor. The data were collected during 2015 to 2017, and all measurements were transferred to IBM SPSS statistics predictive analytic software (version 23.0) for analysis. The analysis followed a paired design, meaning that the total NPI-NH score for each individual with dementia at the second and third assessment session was paired to investigate the differences after including the EDA sensor measurements [cf. 24]. To allow a comparison of before and after the intervention, the authors also calculated the differences between the first and second assessment for each individual in the same manner.

Care Interventions. The care interventions suggested by the assistant nurses during the last step of each assessment session, at entry and at 4 and 8 weeks, were documented and analysed with a method for content analysis [25]. Information from the sensor was presented to the assistant nurses during the second (4 weeks) and last (8 weeks) assessment sessions, and the information could be used in the process of suggesting care interventions. The first step in the analysis process was to read through the information to gain a sense of the content and the text as a whole. Each suggested care intervention was treated as a textual unit, and, in the next step, the textual units were extracted and sorted into three groups depending on the assessment session (first, second, last) in which they were conducted. The textual units within each group were then reviewed and categorised in several steps, based on similarities in content. The next step was to identify additions that were influenced by information from the sensors. In the last step, a descriptive running text was formed to convey the differences in care interventions when EDA sensor measurements were included in the assessment process. In addition, 2 authors independently coded all textual units to identify whether the care interventions included a time-related factor or not. For example, "Set the table just before she is going to eat in order to decrease stress during meals" were regarded as including a time-related factor, i.e. when the intervention was supposed to be performed during the day, as opposed to "Play her favourite CD in her apartment to prevent anxiety," where time-related

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Table 1. Characteristics of the participants with dementia at entry

Participants, *n*	14
Age, years	81.5±7.5
Gender	
Female	78.6%
Male	21.4%
GDS 6	100%
Dementia type	
Vascular dementia	50%
Alzheimer's dementia	14.3%
Frontotemporal dementia	14.3%
Mixed dementia	14.3%
Lewy body dementia	7.1%

factor was lacking. The authors compared and discussed the codings until an agreement was reached, and descriptive statistics were used to describe frequency.

Assistant Nurses' Experiences. The assistant nurses' experiences of using EDA sensor measurements were obtained using semi-structured focus group interviews held between November and December of 2017. The assistant nurses were divided into three groups, with 3 participants in each group (*n* = 9). Each interview lasted approximately 40 min. All data were audio recorded, transcribed, and analysed following Krippendorff's [25] description of qualitative content analysis. The first step of analysis was to read through the transcribed interviews several times to get a sense of the text as a whole. In the next steps, textual units were extracted and then reduced based on similarities in content. Categories were created in several steps and ended when the categories were deemed mutually exclusive and exhaustive [cf. 25]. Lastly, a running text was created with quotations to confirm the content. Trustworthiness was ensured by discussions among the authors in all steps of the process until a mutual agreement was reached, ensuring a rigorous and in-depth analysis.

Ethical Approval

The Regional Ethical Review Board for Research, No. 2013/10-31, approved the study. Due to the difficulties of obtaining informed consent, the use of sensors may affect the integrity of persons with dementia and pose a risk of intruding into the personal sphere [26]. Thus, a double-consent procedure was adopted, meaning that the assistant nurses continuously monitored every participant for signs that he or she no longer wished to participate, such as not wanting to wear the sensor, and by informing and receiving consent from a proxy [27]. All assistant nurses were given verbal and written information about the study at a common meeting, and written informed consent was obtained from the focus group participants. All data were de-identified and processed confidentially [28].

Results

Entry Data

Of the 20 included participants, 14 (70%) completed all three assessments in the 8-week evaluation cycle. Six participants dropped out and did not complete the full evaluation cycle due to severe progression of disease or death (*n* = 4), or unwillingness to wear the sensors (*n* = 2). The main characteristics of the participants with dementia at entry are presented in Table 1.

Entry measures, when included in the trial, showed a mean of a total NPI-NH score of 39.5 (*n* = 14), indicating a high level of problematic behaviour within several domains. In

Melander et al.: Measurements of Electrodermal Activity in Dementia

Table 2. Description of problematic behaviours within the sample group according to the NPI-NH scores at entry

	n	Min	Max	Mean	Std. deviation
NPI-NH total score	14	20.0	58.0	39.5	10.7
NPI-NH domains[a]					
Delusions	10	1.0	9.0	4.5	2.5
Hallucinations	5	4.0	9.0	6.2	1.8
Agitation/aggression	12	1.0	8.0	4.8	2.8
Depression/dysphoria	8	1.0	6.0	3.6	2.3
Anxiety	10	2.0	12.0	5.8	3.6
Elation/euphoria	1	4.0	4.0	4.0	
Apathy/indifference	6	3.0	8.0	5.5	1.8
Disinhibition	8	3.0	12.0	5.1	3.4
Irritability/lability	12	1.0	12.0	5.8	3.0
Aberrant motor behavior	12	2.0	12.0	8.5	3.3
Night-time disturbances	10	1.0	12.0	7.1	3.5
Appetite/eating change	3	1.0	8.0	5.7	4.0

For each of the 12 NPI-NH domains, the frequency scores (0–4), severity scores (0–3), and the product of the frequency and the severity scores give a subscale score ranging from 0 to 12. The sum of all the subscale scores forms a total score ranging from 0 to 144. [a] Of participants with NPI-NH domain scores ≥1.

comparison with statistics from the BPSD registry (www.bpsd.se), these scores are higher than the mean of all people with dementia that, at the time of this study, were assessed in the municipality in which the study was conducted (mean 28, n = 288) and the mean for all assessed in Sweden (mean 23, n = 19,956). A description of problematic behaviours according to the NPI-NH within the sample group at entry is shown in Table 2. The means and standard deviations of the NPI-NH domains are calculated for participants with NPI-NH domain scores ≥1.

The assistant nurses (n = 33) conducting the structured assessments all had a high school diploma in nursing and extensive experience working in dementia care (range 4–38 years, mean 22 years). The vast majority (97%) were women, and the mean age was 49 years (range 23–63). Most of the assistant nurses (91%) had received special training in caring for people with dementia.

Impact on NPI-NH Scores

The findings show varying patterns of NPI-NH scores for each individual with dementia between the three measurement points, but overall there was a decreasing trend in the level of problematic behaviours over the course of the trial period, indicating that the intervention had an impact on the levels of problematic behaviours.

The total NPI-NH score for each individual with dementia at the first (1), second (2), and third (3) assessment sessions are presented in Figure 2. Twelve of the 14 participants showed a decreasing trend in NPI-NH scores over the course of the trial period.

A comparison of the difference in NPI-NH scores before and after adding EDA sensor measurements, i.e. between the first and second and the second and third assessment sessions, is presented in Figure 3. A positive difference was shown for a majority of the individuals both before and after adding information from the sensor. This indicates both the impact of the structural assessment itself and the added impact of the EDA intervention. Before introducing information from the sensor, 9 of the 14 participants showed a positive difference, indicating a reduction in their NPI-NH scores. After adding EDA sensor measurements, a positive
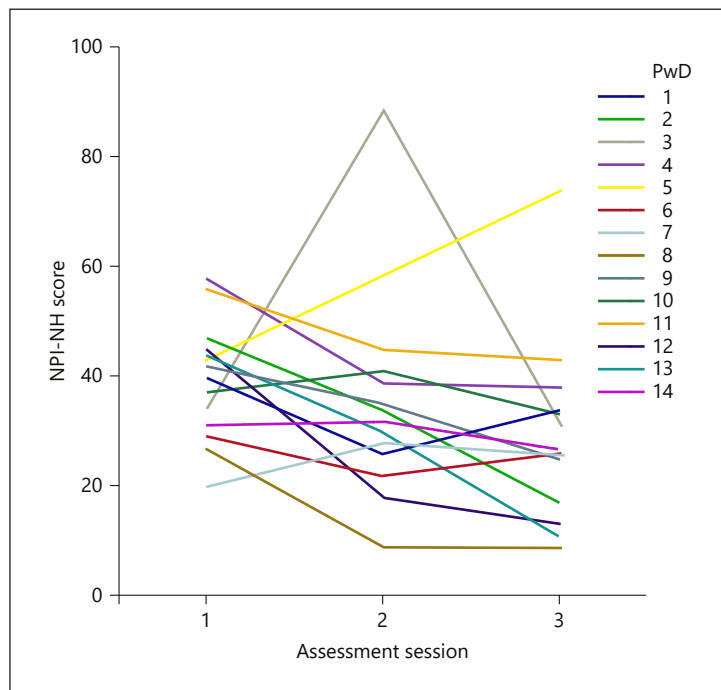
Fig. 2. The total NPI-NH score for each person with dementia (PwD) at the first (1), second (2), and third (3) assessment session. Each participant's NPI-NH score during the three assessment sessions is represented by a curve.
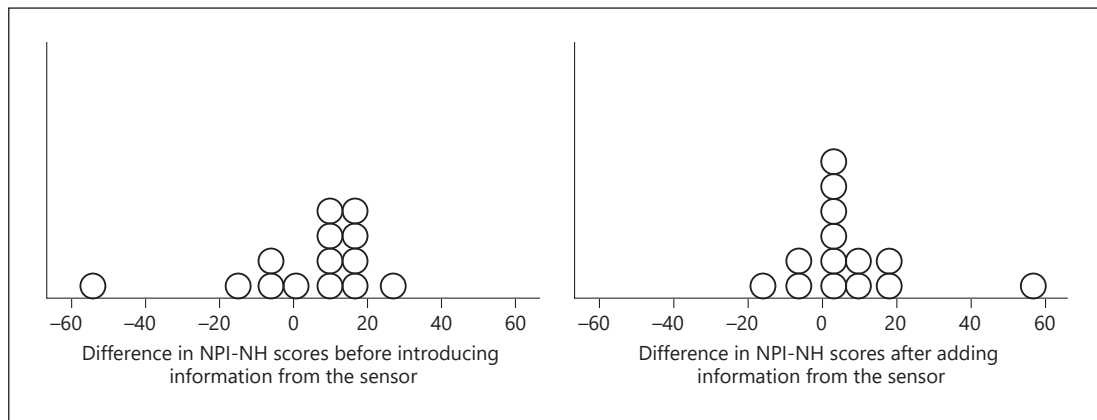
Fig. 3. Difference in NPI-NH score between two assessment sessions before and after adding information from the sensor. Each dot in the figure represents the difference for one participant. A positive score indicates a decrease in problematic behaviours.

difference was seen in the NPI-NH scores of 10 of the 14 participants, and 1 participant had no difference.

Impact on Suggested Care Interventions

The EDA sensor measurements viewed during the assessment sessions seemed to make the assistant nurses' suggest care interventions that were more specific and directed towards certain times throughout the day. The total number of care interventions successively decreased over the course of the three assessment sessions in the evaluation cycle, from 134 in the first assessment session to 90 in the third. Another trend was that the proportion of time-related care interventions increased in the second assessment session (28%), when the

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Melander et al.: Measurements of Electrodermal Activity in Dementia

Table 3. Number of assistant nurses' suggested care interventions related to specific times

Assessment session	Care interventions not related to time	Care interventions related to time	Total
First assessment session (entry)	113 (84%)	21 (16%)	134 (100%)
Second assessment session (4 weeks)	91 (72%)	35 (28%)	126 (100%)
Third assessment session (8 weeks)	67 (74%)	23 (26%)	90 (100%)

Of the total suggested care interventions per assessment session, the number of interventions related to certain times increased when adding measurements from the EDA sensor (second and third assessment sessions), compared to before adding this information (first assessment session).

information from the sensor was introduced, and this trend continued during the third assessment session (26%) compared to the first assessment when the information from the sensor was missing (16%) (Table 3).

Further analysis of the interventions revealed that time-oriented care interventions were both specific, such as guiding an individual to his/her apartment after breakfast and providing him/her with a suitable activity that he/she enjoys, and general, such as changing the ward work routine in the evening to strive for a quieter and calmer environment. The information from the sensor seemed to impact both the suggested care interventions and the time of day at which interventions were best carried out in order to prevent the onset of problematic behaviour. For example, it was shown that 1 individual with dementia had a pattern of increased EDA during lunchtime. Assistant nurses suggested serving her food first, since she became anxious and restless when having to wait. Another individual with dementia had a pattern of increased EDA during the early afternoon. To prevent this, assistant nurses suggested following him on a walk every day after lunch. The sensor information also increased the assistant nurses' suggestions of the timeliness of medications and the need for more continuous medication. For example, it was suggested to move a sedative medication 2 h forward to better meet an individual's needs and prevent problematic behaviour.

Assistant Nurses' Experiences
An Objective Tool That Contributes to the Overall Picture

As a whole, the assistant nurses experienced the objective information from the sensor as a tool that enhanced their professionalism, as they no longer had to rely solely on subjective observations and assessments. They perceived the sensor measurements as a supportive tool that made the individual's situation more comprehensive, in addition to making patterns become more visual and clear. Since the assistant nurses were not always present, sensor data could enhance continuity and contribute to their understanding of the individual with dementia's needs. The information from the sensor was perceived as not only strengthening and confirming clinical observations, but also affirming that the actions and care interventions were effective. However, the assistant nurses pointed out the importance of their understanding of the individual's needs and use the information from the sensor as a tool to aid and improve that understanding. The assessment was complex and included several factors. It was like solving a puzzle where all pieces of information were considered. In the assessment, sensor measurements provided the assistant nurses with important information, but it was only one of the many factors they used to assess the individual's needs. The nurses' knowledge of the individual with dementia was described as essential to guide in what manner the sensor data could support the assessment.

Melander et al.: Measurements of Electrodermal Activity in Dementia

Assistant nurse A: "And that's what was so good with this. When we are working pre-noon, afternoon, we are working different times. Then, we have a day off and then there are other things, we have a lot of activities and so on. So, this gives a whole [a more complete view of the person with dementia], so we clearly can see..."

Assistant nurse B: "It is really good. It becomes, I think it becomes professional. This thing [the sensor] is really good."

Visualising Time-Related Patterns of Behaviours

The assistant nurses found that the sensor measurements enhanced their focus on the triggers and starting points of problematic behaviours. The sensors helped them to visualise daily patterns, which were regarded as helpful when trying to assess possible causes and triggering factors. This visualisation also enhanced assistant nurses' understanding of when to introduce support and how to prevent the onset of problematic behaviours with timely interventions. Focusing on certain times of the day was seen as helpful, since the assistant nurses could concentrate on needs during that period of time and provide more timely and preventative care interventions.

Assistant nurse A: "Yeah, but it was this that we saw..."
Assistant nurse B: "When it increased or where it increased?"
Assistant nurse A: "Yes, that was what I thought was so good, and then we thought about what we could do right then and there if you consider a specific time, what you can change, what we can do to calm them down and ensure that they are feeling well..."

Trustworthiness in Dialogues with Team Members and Family

In dialogues with other assistant nurses, registered nurses, and general practitioners, the assistant nurses described the sensor measurements as supportive. They felt that this additional source of information made other professionals take them more seriously and listen to their input. This, in turn, led to information that might have otherwise been dismissed being better communicated and addressed. The information from the sensor led to a mutual focus within the nursing staff, which enhanced and strengthened teamwork. The sensor measurements were also regarded as a support in dialogues with individual with dementia's family, since it contributed objective information that strengthened assistant nurses' clinical observations and their line of reasoning.

Assistant nurse A: "It [the information from the sensor] becomes a compilation to talk about and discuss, this is what we need to do, we will do it better for her sake, and we can gather and try this and the next time it might not work, but we can try."

Assistant nurse C: "Yes, it [the sensor] really did [make other professionals take us more seriously]. Then the nurse saw that, it isn't just something that we are saying."

Discussion

The main findings of the study indicate that information from the wearable EDA sensor was a valuable tool in the systematic assessment of problematic behaviours in people with advanced dementia. The information enhanced assistant nurses' understanding of time-related patterns of behaviour, which facilitated both the understanding of possible triggering factors and the utilisation of timely care interventions to prevent the patterns. The findings also indicate that enhanced understanding and introduction of timely interventions reduces the level of problematic behaviours as measured with the NPI-NH.

KARGER

Melander et al.: Measurements of Electrodermal Activity in Dementia

The present findings on the sensors' impact on NPI-NH scores show trend of decreasing scores throughout the trial period and indicate a difference in NPI-NH score both before and after adding information from the sensor. However, due to the small sample size and the heterogeneity in the group, it is not possible to conclusively show that the differences were a result of the addition of the information from the sensor or of other factors. The lack of robust evidence should, however, be judged from the perspective that dementia is a disease during which functions and abilities as well as the prevalence of problematic behaviours are expected to deteriorate over time [29]. This reality means that even a small, continued reduction in NPI-NH scoring should be seen as encouraging, since it implies that the individual's situation is improving rather than deteriorating.

The findings of this study indicate that EDA sensor measurements had an impact on the number of time-related care interventions suggested by the assistant nurses. Information from the sensor clarified the starting points and patterns of increased EDA, which aided assistant nurses in determining care interventions that were timely and directed towards preventing the triggers of problematic behaviours. Cohen-Mansfield et al. [30] emphasised the importance of understanding causes and triggers to be able to address and understand problematic behaviours in people with dementia. Facilitating the identification of patterns has been established as important in supporting nursing staff's decision-making on appropriate care interventions [31]. According to McCormack [32], when aiming for a person-centred approach, it is important to develop a clear picture of the individual's situation and how he or she makes sense of what is happening. In this process, starting points and patterns of the behaviour enable the behaviour to be interpreted and understood as it occurs, and the behaviour's full context to be taken into consideration. This is important when attempting to understand the individual [cf. 32] and choose a course of action that is in line with their needs [33]. Interestingly, the number of care interventions decreased throughout the trial period, and the proportion of time-related care interventions increased when nurses received EDA sensor measurements, which may indicate that the care interventions became more customised and focused on the individuals' needs. Based on these findings, we suggest that information from an EDA sensor can support nursing staff in identifying patterns and placing behaviour in context at the time it occurred, which may strengthen the process of planning, customising, and implementing preventive support, thereby reducing the individual's stress and providing more person-centred care.

The assistant nurses in this study perceived EDA measurements to be an important objective tool that strengthened their otherwise subjective assessments and observations and enhanced continuity, which, in turn, contributed to a more comprehensive understanding of the individual's needs. Clifford and Doody [2] stress nursing staff's opportunities to spend time with individuals with dementia as an important factor that affects their ability to support those with problematic behaviours. Understanding an individual's needs is a continuous process that develops over time and facilitates more holistic decisions regarding care interventions and support based on a deeper understanding of the individual. In addition, understanding the individual has been shown to improve patient participation in the decision-making process [31], which is an important part of a good and dignified life [34]. However, spending sufficient time with each individual can be challenging in the demanding and often busy context of nursing homes and dementia care units [35]. The present study revealed that sensor information was perceived to enhance continuity in care and improve the staff's understanding of the individual with dementia and their needs, since it contributed to the information collected over time. An enhanced understanding of needs has been shown to strengthen the relationship between the nursing staff and the individual with dementia [36], which has been identified as one of the most influential factors in caregiving satisfaction [37] and shown to affect the well-being of individuals with dementia [38]. Based on the present

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Dementia
and Geriatric
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344

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Melander et al.: Measurements of Electrodermal Activity in Dementia

findings, we suggest that information from an EDA sensor can contribute to an improved assessment process with enhanced recognition and understanding of an individual's needs, which, in turn, can improve nursing staff's work satisfaction [30].

In this study, assistant nurses regarded EDA sensor measurements as one way for the individual to mediate his or her needs. However, this had to be combined with the assistant nurses' own experiences and knowledge of the individual with dementia. Nibbelink and Brewer [31] emphasised that understanding an individual's status includes a collection of informational cues, which nursing staff can then use to develop a mental model of the individual's situation. In this process, nursing staff analyse the current situation and evaluate all available information and options before making decisions regarding appropriate nursing actions [33]. The findings in this study also show that assistant nurses found the addition of the sensor information to add trustworthiness to their dialogues with other professionals. This can be seen as strengthening their confidence, which Nibbelink and Brewer [31] stress as important in communication between colleagues, since it enhances abilities such as considering options, implementing interventions and trusting one's own competence. Enhanced teamwork was noted as a consequence of adding the sensor information, and feeling supported through teamwork is essential when it comes to coping with the challenging and demanding situations [cf. 39] that are common in the everyday care of people with dementia. At its core, this study argues that the EDA sensor as a tool adds information to the nursing staff's body of knowledge, which may improve their picture of an individual's situation and, based on that, their ability to decide which nursing actions are in line with the individual's needs. The experienced trustworthiness that the sensor added to the assistant nurses' dialogue with other professionals is not only interesting, but also important, since improved teamwork impacts nursing staff's ability to cope with the challenging and often demanding context of nursing homes, as well as improve the well-being of people with dementia.

Limitations

As a pilot observational study, this research was designed to include 20 participants, but due to dropouts, only 14 participants completed the full evaluation cycle. This is a relatively small sample size, which does not allow for robust conclusions, but gives interesting indications that can guide future work. To mediate the small sample size, participants' characteristics and environmental factors needed to vary, which was achieved by recruiting participants from five different nursing homes in two different cities.

At the start of the evaluation, the individuals with dementia had a higher mean NPI-NH score compared to the mean of people with dementia nationally assessed by the BPSD registry (www.bpsd.se). This indicates that the participants had a more severe level of problematic behaviour than average, which could have allowed variances to more easily affect the NPI-NH scoring compared to less severe levels. Also complex was the nursing staff's ability to make the assessments. In a vast majority, each participant with dementia had the same rater during the trial period. However, there were occasions when the same assistant nurses could not participate in all assessment sessions. This complicating factor may affect the trustworthiness of the NPI-NH scores; still, at least 1 assistant nurse was the same during all three assessments for each individual with dementia. A limitation was that intra- and inter-rater reliability between assessments amongst assistant nurses was not examined, although it would likely reveal differences of opinion with regard to observed behaviours. The study had an observational design, and one of its strengths is that it was based on evaluating the impact of an intervention in an existing assessment routine in natural settings [cf. 40]. To reduce the risk of inconsistency during data collection, the first author participated in most of the assessment sessions to ensure that they were performed in the same manner.

Conclusion

Understanding and supporting individuals with problematic behaviours is an essential part of dementia care worldwide. Exploring complementary tools to improve the monitoring and understanding of problematic behaviours is important when trying to enhance the understanding of these behaviours. The findings of this study indicate that the use of information from an EDA sensor during assistant nurses' structured assessments had an impact on what care interventions were applied, which, consequently, decreased the level of problematic behaviours. The information from the EDA sensor provides supplementary information that can contribute to a more comprehensive picture of the individual's situation and visually reveal patterns. With the added information, nursing staff could better target causes and triggers, making care interventions more specific and directed towards certain times of the day to prevent patterns of problematic behaviours. This is a crucial element of decreasing problematic behaviours and supporting people with advanced dementia.

Future Research

This study is a small pilot study, and the findings need to be validated through further, more in-depth research that can address the many complex issues of evaluating the impact of using sensor measurements as part of the process of assessing problematic behaviours in people with dementia. An important question not addressed in this study is whether information from EDA sensors is more useful in some dimensions of problematic behaviours than others, e.g. behaviours associated with agitation, compared to depressive behaviour or apathy. Future research is also needed about developing EDA-measuring equipment to automatically identify early signs of problematic behaviour to enhance preventative measures and minimise the time needed to collect measurements before patterns can be seen.

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Statement of Ethics

The study was approved by the Regional Ethical Review Board for Research, No. 2013/10-31.

Disclosure Statement

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Melander et al.: Measurements of Electrodermal Activity in Dementia

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Melander et al.: Measurements of Electrodermal Activity in Dementia

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