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Creating Better Health Worker - Patient Interaction Using ICT; Design for Applicability and Acceptance

Arthur Bennis
HAN University
Arnhem
arthur.bennis@han.nl

Dick Lenior
HAN University
Arnhem
dick.lenior@han.nl

ABSTRACT

Case studies in three different healthcare settings were carried out to investigate the extent to which a User Centered Design approach (UCD) increases applicability and acceptance of telecare applications. These settings concerned (a) supervisory tasks, (b) domestic support for the disabled, and (c) remote healthcare diagnostics. The qualitative results of all studies were translatable into a direct positive effect on the *Performance Expectancy* and *Effort Expectancy* constructs of the UTAUT model, thereby increasing the acceptance of the application by the user. A relationship between a UCD approach and increased acceptance is shown. Better substantiation of these results is subject of on-going research.

Author Keywords

Healthcare; UCD; UTAUT; Applicability; Acceptance

ACM Classification Keywords

H.5.2 User Interfaces: User-centered design (D.2.2, H.1.2, I.3.6)

INTRODUCTION

Population aging in developed countries is progressing fast. Because of this, more healthcare will be required, which has to be delivered by a smaller, younger labor force [25]. In the near future it will thus become a necessity to be able to provide more care with less health workers. To cope with these prospects and to anticipate on other expected changes in healthcare (governments making cutbacks in expenditure for healthcare, stricter regulations), the paradigm of direct interaction between health worker and patient is not tenable. Healthcare will need to shift towards an interaction model that is more supported by ICT. ICT can offer the required extensive support and enable health workers to work more efficient.

Such an ICT system is referred to as ***telecare***, the use of telecommunication systems for care where the users are separated in space and/or time [4]. Telecare already offers widely accepted solutions for both social care and healthcare at home [18]. Telecare is also deployed in specialized homes where it enables ICT supported communication.

HCI research on telecare at home identifies barriers to the uptake of telecare [4]. One important component of these barriers is the acceptance level of health workers to use telecare systems. This level is possibly influenced by previous bad experiences with ICT systems due to insufficient training or technology with insufficient usability [20]. The design of new forms of interaction has to meet user expectations in such a way that acceptance occurs almost naturally. Such a design is only possible when users participate during the entire development process; research shows that they are actually willing to [4,13].

Because of this identified need for the introduction of suitable ICT in healthcare, and because a number of healthcare providers requested our assistance, we started an empirical research program around telecare innovations to investigate the extent to which a User Centered Design approach (UCD) increases applicability and acceptance of telecare applications [12]. This was executed in an evaluative and elaborative fashion because we wanted to stay close to practice.

To identify the shift in user acceptance, we use the Unified Theory of Acceptance and Use of Technology (UTAUT) model by Venkatesh, Morris, Davis and Davis [19]. UTAUT has shown its applicability in healthcare settings to investigate acceptance in previous studies [9, 24]. We expect faster acceptance of new technology in healthcare when using UCD because achieving the best fit of the technological means on the tasks of the health workers is central when deploying this approach. The relationship between certain project approaches and user acceptance has been investigated before [6, 23], but no research has been found evaluating acceptance after UCD with UTAUT.

In this study we deploy UTAUT to evaluate the effects of UCD on acceptance and applicability. In future work we aim to have UTAUT strengthen the UCD approach from the very start.

Following the literature review, we present the approaches and findings from three specific case studies in various areas of healthcare: (a) supervisory tasks, (b) domestic support for the disabled, and (c) remote healthcare diagnostics.

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TELECARE IN LITERATURE

Telecare has shown possibilities for not requiring patients to have a face-to-face consultation with a health worker. Positive results are shown in a study conducted in regional Western Australia [10] where rural emergency departments, only staffed by nurses, reduced the need for transfers of patients. Another Australian study [16] substantiates the cost savings claim gained by the prevention of expensive transfers. Clemins, Coon, Peck, Holloway and Min [3] found that telecare proved to be an effective mode for the provision of diabetes care to rural patients in Montana, USA. Gilmour, Campbell, Loane, Esmail, Griffiths, Roland and Wootton [7] showed the potential of telecare for dermatology cases. Based on the results, 50% of the patients could have been managed with a single video conferenced teleconsultation without any requirement for further specialist intervention. In a more recent study, Rezende, Tavares, Alves, Dos Santos and De Melo [15] showed that telecare in Brazil from 2004 till 2010 prevented the physical referral of patients in 64.2% of cases. Successful application of telecare in triage is shown by Wallace [21], be it with the comment that more research is needed. Further literature shows successful application of telecare in areas including teledermatology [22], wound care [8], teledentistry [5], and palliative care [11].

Research has been done regarding current telecare practices. Significant added value was shown, but also a number of concerns became apparent. Barlow, Singh, Bayer and Curry [1] show that, based on the evidence they reviewed, the most effective telecare interventions appear to be automated vital signs monitoring (for reducing health service use) and telephone follow-up by nurses (for improving clinical indicators and reducing health service use). The cost-effectiveness of these interventions was less certain.

Miskelly [14] shows that new technological developments in care at home are likely to make an important contribution to the care of elderly people in institutions and at home. Video-monitoring, remote health monitoring, electronic sensors and equipment such as fall detectors, door monitors, bed alerts, pressure mats and smoke and heat alarms can improve older people's safety, security and ability to cope at home. Miskelly also found that care at home is often preferable to patients and is usually less expensive for care providers than institutional alternatives

Clark and McGee-Lennon [4] state that, despite the current advantages in technology and networking in the home, telecare solutions have not yet been taken up as eagerly as might have been expected. Authors identified existing barriers to the successful uptake of telecare and derived a set of recommendations for the design and implementation of future home care / telecare technologies. These recommendations include findings like deploying a User Centered Design approach and making the technology able to cope with multiple users. A number of ethical issues were identified and included, among others, fear of technology failing and uncertainty about the security of health data. One of the most prevalent findings is that there is a clear demand for awareness raising and knowledge building on the range, scope, capabilities and acceptance of telecare.

Figure 1 illustrates a sample telecare system as presented by Turner and Maternaghan [17]. This model clearly shows the possible extensive network of technologies enclosing the telecare system. The case studies reported here are all executable within this model. We investigate the interaction of the health worker or the patient with the central box in the model – the Telecare system. Is the devised technical support acceptable?

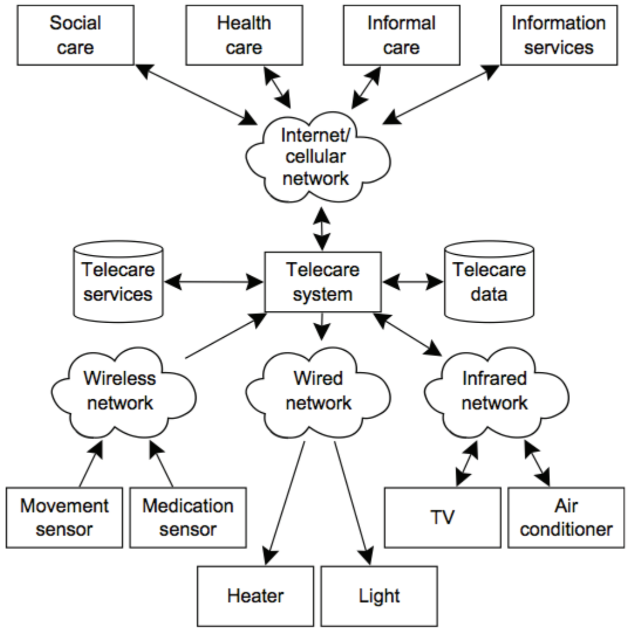

Figure 1. Sample telecare system

To be fully accepted by users, a telecare system has to meet a certain number of expectations of the users. To investigate whether or not the willingness to accept telecare has increased among our subjects, we use constructs of the UTAUT model (see figure 2). These are:

Performance expectancy (PE): The belief of a individual that the system will aid in better job performance.

Effort expectancy (EE): The believed ease of use of a system.

Social influence (SI): The perception of the opinion of important others that the individual should use the system.

Facilitation condition (FC): The belief of an individual that the organization can in fact support use of the system.

Changes in constructs 1, 2, and 3 have a direct effect on Behavioral Intention. Together with construct 4, this Behavioral Intention influences Use Behavior. During these studies we strived for representativeness in the experimental work but did not explicitly take the moderators Gender, Age, Experience, and Voluntariness of Use into account in the field studies.

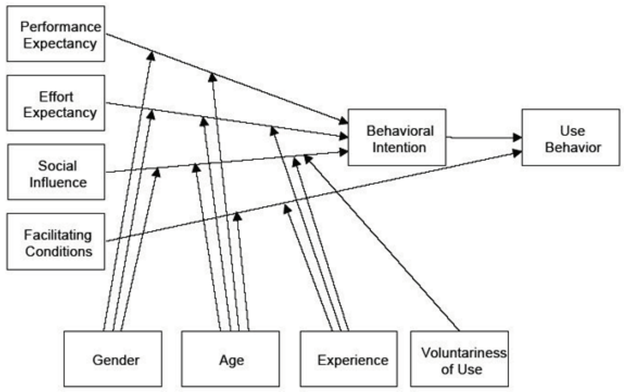

Figure 2. UTAUT model

CASE STUDIES AND RESULTS

In the case studies a UCD approach was deployed to achieve a positive effect on *Performance Expectancy* and *Effort Expectancy* from the UTAUT model, thereby directly influencing *Behavioral Intention*. In each case study the UCD approach was executed in the most conventional way, closely following Maguires interpretation [12]. After a planning phase, an iterative processes containing context of use, requirements, design solutions, and evaluation stages starts. When the solution meets the requirements, the approach is finished. In each case study a careful selection of the available usability methods was made to achieve the best results, therefore not all case studies deployed the same methods in each stage.

Case studies in the field of supervisory tasks

To determine possible technological support during supervisory tasks, and the acceptance of this technology, we investigated remote supervision in psycho-geriatric nursing home wards (living rooms). The health worker legally has to maintain continues supervision over the group, even when admitting occasional care to individuals (guided visits to the bathroom, assistance in acquiring drinks or food e.g.). Through a UCD approach we investigated the best fitting technology in consultation with the health workers.

In a first experiment we investigated sensors to assist the health worker in maintaining supervision. Currently, most deployed sensors in the field of psycho-geriatric supervision are for access control / runaway risk during daytime and for detecting bed leave during nighttime. Health workers often do not experience these sensors to have supporting value in the case of supervision. Our research further shows that these sensors are not well understood (the runaway sensor), they show no direct added value (access control), and they generate too much false positives (bed sensors).

In a laboratory setting, a ward was simulated and six actors where placed inside with a script that was deduced from real world observations. In the first experiment possible combinations of two video camera's, two microphones and two tracking systems (UbiSense and EagleVision) were tested to support in supervisory tasks. In the second experiment combinations of two webcams, a Kinect camera and a depth camera were tested.

From the evaluation with the health workers it appeared that none of the detectors offered a good solution for the supervision task. The most important conclusion deducible from these experiments is that the knowledge and the assessment of the health worker is essential when trying to recognize and interpret incidents. The behavior of patients is very unpredictable and only the health workers that have day-to-day interaction with the patients can assess whether or not a situation is, or will lead to, an incident. Automated detection of incidents by advanced technology is not only very expensive, it is also not effective yet. The interpretation of an incident should for now remain with the health worker.

We did continue to work with audio and video equipment but in a much more focused way, using technology to "extend" the eyes and the ears of the health workers. Audio levels above a certain threshold are clearly a trigger indicating a possible incident. The health worker, busy with tasks outside the ward, detects this noise via a hearing device and is offered a possibility to visually assess the situation via a mobile viewing device. Then the health worker can make a substantiated assessment whether or not to intervene.

To have health workers evaluate the results of such a system, we once again instructed actors to re-enact a number of incidents in a ward. These incident were: (1) patients having verbal and physical arguments, (2) a patient has fallen down; another patient is trying to help him to his feet, (3) a patient has dropped his cup, (4) a patient is calling the health worker because an other patient is pulling him from his chair, and (5) a patient is choking.

All incidents were successfully detected and interpreted using the system; be it with some false positives. The subjects were positive about the outcomes of the experiments and expressed an expected feeling of security and control, even when not physically present in the ward. A feeling of relief of work related stress was expected to be experienced because of the direct available information from the ward.

Case studies in domestic support for the disabled

Are patients able to work with telecare? During our research we identified and solved issues regarding technological support to patients in cooperation with two special patient groups. One of the groups consisted of patients with a mild intellectual disability and the other group was formed out of patients with acquired brain injury. Both investigations showed us that a UCD approach for interaction is indispensable, especially when working with special user groups.

Research was carried out to investigate the requirements for an application to support the acquired brain injury user group with cooking. The cooking process was completely broken down into steps and each individual step was adapted to the capabilities of the users with, among others, progress monitoring and possible alarms. Based on the findings from the various usability tests on the prototypes, development of a production ready application has been started. We observed proud patients with a regained ability to prepare a complete meal.

Deploying a similar approach, it was made possible for users with a mild intellectual disability to independently order their own supper through an application running on a special tablet. Little training on the application was found to be required. A number of open issues were identified which will be resolved to work towards a production ready application.

Both user groups experienced increased personal capabilities when preparing or ordering food by means of the developed technical aids.

Case studies in remote healthcare diagnostics

In the third kind of case studies we investigated the user needs among general practitioners (GPs) regarding a telecare system for remote healthcare diagnostics [26]. From the results of the questionnaires and interviews we can conclude that GPs are initially rather reserved about the possibilities of telecare in their practice. During the interviews, talking about examples, these opinions shifted. After the interviews still eight out of sixteen GPs stated that initial diagnostics over telecare is unrealistic. However, possibilities for follow-up consultations were mostly assessed as feasible. Most GPs feared missing vital information when questioning the patient over telecare and they felt that planning would be an issue. Supporting these reserves in suggesting professional support at the side of the patient during telecare and establishing a virtual waiting room for patients, GPs were less hesitance, but indicated that telecare would only suffice for certain patients with certain complaints. The used telecare system also contains an overview of all the health workers related to a patient; this was judged as very useful by GPs. Also, the possibility to see previous telecare occasions is deemed as very important by eleven out of fourteen GPs.

Next to the research at the GPs, we also worked with a group of health interns on better usability of the telecare application.

Finally, we conducted a small verification experiment with one GP conducting a double consultation of five patients. The experiment confirmed that telecare is usable as a remote healthcare diagnostic tool but especially for uncomplicated follow-up consultations and for intake consultations. The added value of telecare over consultation by telephone is the more personal contact because patient and GP see each other. Patients show reservation to share emotionally sensitive information via telecare.

The GP further believed that a better assessment can be made with improved image quality. In parallel, we investigated, in a more fundamental and experimental study, the effect of mediation on perceived image quality. See [2] for the results.

CONCLUSION AND DISCUSSION

The research reported here consisted of case studies in three kinds of healthcare settings combined with validation experiments in a laboratory. The three settings concerned: (a) supervisory tasks, (b) domestic support for the disabled, and (c) remote healthcare diagnostics. All three case studies showed that a UCD approach has positive impact on applicability and acceptance. All health workers showed increased confidence in task performance.

In (a) the subjects expressed expectations regarding a feeling of security and control, even when not physically present in the ward. Further, a feeling of relief of work related stress was expected to be experienced because of the direct available information from the ward. This shows a positive effect on the UTAUT constructs *Performance Expectancy* and *Effort Expectancy.*

In (b) both the user groups experienced increased personal capabilities because of the developed applications when preparing or ordering food. A positive effect on *Performance Expectancy*, *Effort Expectancy* and *Facilitating Conditions* is shown.

In (c) we observed GPs showing less hesitation to use telecare when examples were discussed or working prototypes were shown. The verification experiment with the GP showed that telecare is usable as a remote healthcare diagnostic tool but especially for uncomplicated follow-up consultations and for some intake consultations. Both these conclusions have a positive effect on *Performance Expectancy* and *Effort Expectancy*.

All our case studies show a connection between at least two of the constructs of UTAUT (*Performance Expectancy* and *Effort Expectancy*) and the organization of the development process using UCD. We did not investigate a possible relation with *Social Influence* and experienced only a minor possible relation with *Facilitating Conditions*. We do believe that these relations also exist and will focus on them in future research. Further, when *Performance Expectancy* and *Effort Expectancy* are affected in a strong, positive way, we expect a resulting positive influence on *Social Influence.*

Each of the three case studies was concluded with qualitative evaluations to assess the effect of UCD on the constructs of UTAUT. Future research should strengthen this demonstrated relation by, for example, deploying validated questionnaires to better measure acceptance effect using UTAUT. Future research should also investigate the degree of acceptance and applicability of telecare applications that are introduced without application of UCD. Are the effects that are observed through UTAUT indeed addressable to UCD?

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REFERENCES

1. Barlow, J., Singh, D., Bayer, S., & Curry, R. (2007). A systematic review of the benefits of home telecare for

frail elderly people and those with long-term conditions. Journal of Telemedicine and Telecare, 13(4), 172-179.

2. Bennis, A., Landman, R. & Lenior, D. (2014). CCTV mediated observation versus non-mediated observation: investigating perceived image quality with different test systems. To be presented at the Human Factors in Organisational Design and Management Conference in 2014
3. Ciemins, E., Coon, P., Peck, R., Holloway, B., & Min, S. J. (2011). Using Telehealth to provide diabetes care to patients in rural Montana: Findings from the Promoting Realistic Individual Self-Management Program. TELEMEDICINE and e-HEALTH, 17(8), 596-602.
4. Clark, J., & McGee-Lennon, M. (2011). A stakeholder-centred exploration of the current barriers to the uptake of home care technology in the UK. *Journal of Assistive Technologies*, *5*(1), 12-25.
5. Daniel, S. J., Wu, L., & Kumar, S. (2013). Teledentistry: A Systematic Review of Clinical Outcomes, Utilization and Costs. American Dental Hygienists Association, 87(6), 345-352.
6. Esser, P. E., & Goossens, R. H. (2009). A framework for the design of user-centred teleconsulting systems. Journal of telemedicine and telecare, 15(1), 32-39.
7. Gilmour, E., Campbell, S. M., Loane, M. A., Esmail, A., Griffiths, C. E. M., Roland, M. O., ... & Wootton, A. (1998). Comparison of teleconsultations and face-to-face consultations: preliminary results of a United Kingdom multicentre teledermatology study. *British Journal of Dermatology*, *139*(1), 81-87.
8. Gray, L. C., Armfield, N. R., & Smith, A. C. (2010). Telemedicine for wound care: Current practice and future potential. Primary Intention The Australian Journal Of Wound Management, 18(4), 158.
9. Hennington, A. H., & Janz, B. D. (2007). Information Systems and healthcare XVI: physician adoption of electronic medical records: applying the UTAUT model in a healthcare context. Communications of the Association for Information Systems, 19(5), 60-80.
10. Herrington, G., Zardins, Y., & Hamilton, A. (2013). A pilot trial of emergency telemedicine in regional Western Australia. Journal of telemedicine and telecare, 19(7), 430-433.
11. Kidd, L., Cayless, S., Johnston, B., & Wengstrom, Y. (2010). Telehealth in palliative care in the UK: a review of the evidence. Journal of Telemedicine and Telecare, 16(7), 394-402.
12. Maguire, M. (2001). Methods to support human-centred design. International journal of human-computer studies, 55(4), 587-634.
13. Martikainen, S., Viitanen, J., Korpela, M., & Lääveri, T. (2012). Physicians' experiences of participation in healthcare IT development in Finland: Willing but not able. International Journal of Medical Informatics, 81(2), 98-113.
14. Miskelly, F. G. (2001). Assistive technology in elderly care. Age and ageing, 30(6), 455-458.
15. Rezende, E. J. C., Tavares, E. C., Alves, H. J., dos Santos, A. D. F., & de Melo, M. D. C. B. (2013). Teleconsultations in Public Primary Care Units of the City of Belo Horizonte, Brazil: Profile of Patients and Physicians. Telemedicine and e-Health, 19(8), 613-618.
16. Thaker, D. A., Monypenny, R., Olver, I., & Sabesan, S. (2013). Cost savings from a telemedicine model of care in northern Queensland, Australia. The Medical Journal of Australia, 199(6), 414-417.
17. Turner, K. J., & Maternaghan, C. (2012). 2. Home Care Systems. Advances in Home Care Technologies: Results of the MATCH Project, 31, 11.
18. Turner, K. J., & McGee-Lennon, M. R. (2013). Advances in telecare over the past 10 years.
19. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS quarterly, 425-478.
20. Viitanen, J., Hyppönen, H., Lääveri, T., Vänskä, J., Reponen, J., & Winblad, I. (2011). National questionnaire study on clinical ICT systems proofs: Physicians suffer from poor usability. International journal of medical informatics, 80(10), 708-725.
21. Wallace, D. L., Hussain, A., Khan, N., & Wilson, Y. T. (2012). A systematic review of the evidence for telemedicine in burn care: with a UK perspective. Burns, 38(4), 465-480.
22. Warshaw, E. M., Hillman, Y. J., Greer, N. L., Hagel, E. M., MacDonald, R., Rutks, I. R., & Wilt, T. J. (2011). Teledermatology for diagnosis and management of skin conditions: a systematic review. Journal of the American Academy of Dermatology, 64(4), 759-772.
23. Widya, A., Bults, R. G., Sandsjö, L., Hermens, H. J., & Vollenbroek-Hutten, M. M. (2010). A scenario guideline for designing new teletreatments: a multidisciplinary approach. Journal of Telemedicine and Telecare, 16(6), 302-307.
24. Wills, M. J., El-Gayar, O. F., & Bennett, D. (2008). Examining healthcare professionals' acceptance of electronic medical records using UTAUT. Issues in Information Systems, 9(2), 396-401.
25. World Population Ageing. Retrieved March 6, 2014, from http://www.un.org/esa/population/publications/worldageing19502050/
26. Zorgplatform by Zorgservicepuntplus. Retrieved March 6, 2014, from http://www.zorgservicepuntplus.nl/