Managing My Bladder Dictates My Daily Routines

A Model for Design and Adoption of mHealth in Lower Urinary Tract Symptoms Management

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Introduction and Background

Lower urinary tract symptoms (LUTS) are prevalent urological health issues estimated to currently affect 2.3 billion people worldwide [1]. Conventional aids to counteract these symptoms predominantly contain unhygienic and cumbersome attributes [2]. Mobile health (mHealth) solutions have the potential to significantly improve both the quality of life and care of those suffering from LUTS [3]. The number of mHealth solutions and the amount of respective research are quickly growing [4]. However, mHealth regularly lacks in user acceptance and fails when entering the market [5]. Designing mHealth with the objective to ensure later user adoption needs further guidance and structure [6].
In this study, we present a model for the adoption of mHealth solutions by patients suffering from LUTS and derived principles for designing such mHealth. We developed and evaluated the model along *inContAlert*, an mHealth device to support patients suffering from LUTS in their daily routines and prevent harmful incidents.

Method

At the outset, we conducted a systematic literature review to build an *ex-ante* adoption model of factors that positively affect the intention of patients suffering from LUTS to adopt the intended mHealth solution. Subsequently, we applied an action design research (ADR) approach [7] to revise the adoption model and develop an mHealth solution, which noninvasively determines the filling level of the urinary bladder and displays the filling level to a digital end-device. Equally split in the α- and β-cycle, we conducted 20 semi-structured interviews with patients suffering from LUTS and 12 with selected experts in various LUTS-related fields. To evaluate our constructs in a larger setting, we conducted a confirmative survey with 387 patients and care assistants as the last part of the β-cycle. We concluded with the *ex-post* adoption model that we call the *Chronic Disease mHealth Adoption Model* (CDmHAM) and derived principles for designing such mHealth.

Results

As a result of the literature review, we identified factors affecting the intention of potential users to adopt mHealth solutions in general. Our *ex-ante* adoption model consisted of 5 superordinate categories (i.e., *User Factors*, *Perceived Benefits*, *Hard- and Software*, *Data Factors*, and *Environment*) and 21 sub-categories. Building upon the generic *ex-ante* model, we developed the α-version of the sensor system. Within the α- and β-cycle of our ADR approach, we specified our perspective on LUTS patients and practitioners. We confirmed the 5 categories and enhanced them to conclude in 28 sub-categories. The *ex-post* adoption model (i.e., the CDmHAM) in Figure 1 depicts the interrelations between the categories, the adoption intention, and the design of mHealth devices.

In the following, we provide an overview of the identified sub-categories and list them adding their mean scores obtained from the survey to illustrate the relevance of each:

1) ***User Factors***: *Accessibility* (5.96), *Customization* (6.12), *Initial User Briefing* (6.20), and *Constant User Consulting* (5.78).
2) ***Perceived Benefits***: *Usefulness* (6.14), *Autonomy* (6.38), *Convenience* (6.37), *Comfort* (6.30), *Mobility* (6.54), and *Unobtrusiveness* (6.23).
3) ***Hardware and Software***: *Safety* (6.39), *Reliability* (6.52), *Performance* (6.32), *Durability* (6.28), *Hardware Fixation* (5.60), *Design* (4.78), *Interoperability* (5.23), and *Connectivity* (5.26).
4) ***Data Factors***: *Generation and Integration* (5.14), *Storage and Access* (5.13), *Analysis* (5.27), *Feedback on Usage* (5.66), *Transfer* (5.19), and *Privacy* (5.73).
5) ***Environment***: *Ongoing Maintenance* (6.01), *Costs* (5.89), *Health Insurance Involvement* (6.19), and *Provider Involvement* (6.12).

Resulting from the β-cycle, the final version of the sensor system comprises an mHealth sensor device, a monitoring app, and an additional drinking protocol app. Furthermore, we derived a catalog of 26 design principles guiding future developments of mHealth for LUTS and other chronic health issues:

1) Design principles addressing **hardware** comprise *Miniaturization*, *Flexibility*, *Soft Materials*, *Lightweight Construction*, *Smooth Surface*, *Wireless Device*, *Transparency*, *Washability*, *Biocompatibility*, and *Durable Components*.
2) Addressing both **hard- and software**, *Plug-and-Play*, *Reduction of Manual Input*, *Clearness*, *Voice Assistant*, *Multiple Interfaces*, *Energy Efficiency*, *Internal Data Storage*, and *Cost-Effectiveness* are relevant.
3) In terms of **software**, *Readability*, *Intuitive Operating Steps*, *Appropriate Language*, *Graphic Visualization*, *Mobile-Friendly Software*, *Cloud Computing*, *Alert Mechanism*, and *Learning Algorithm* are pivotal determinants to be considered.

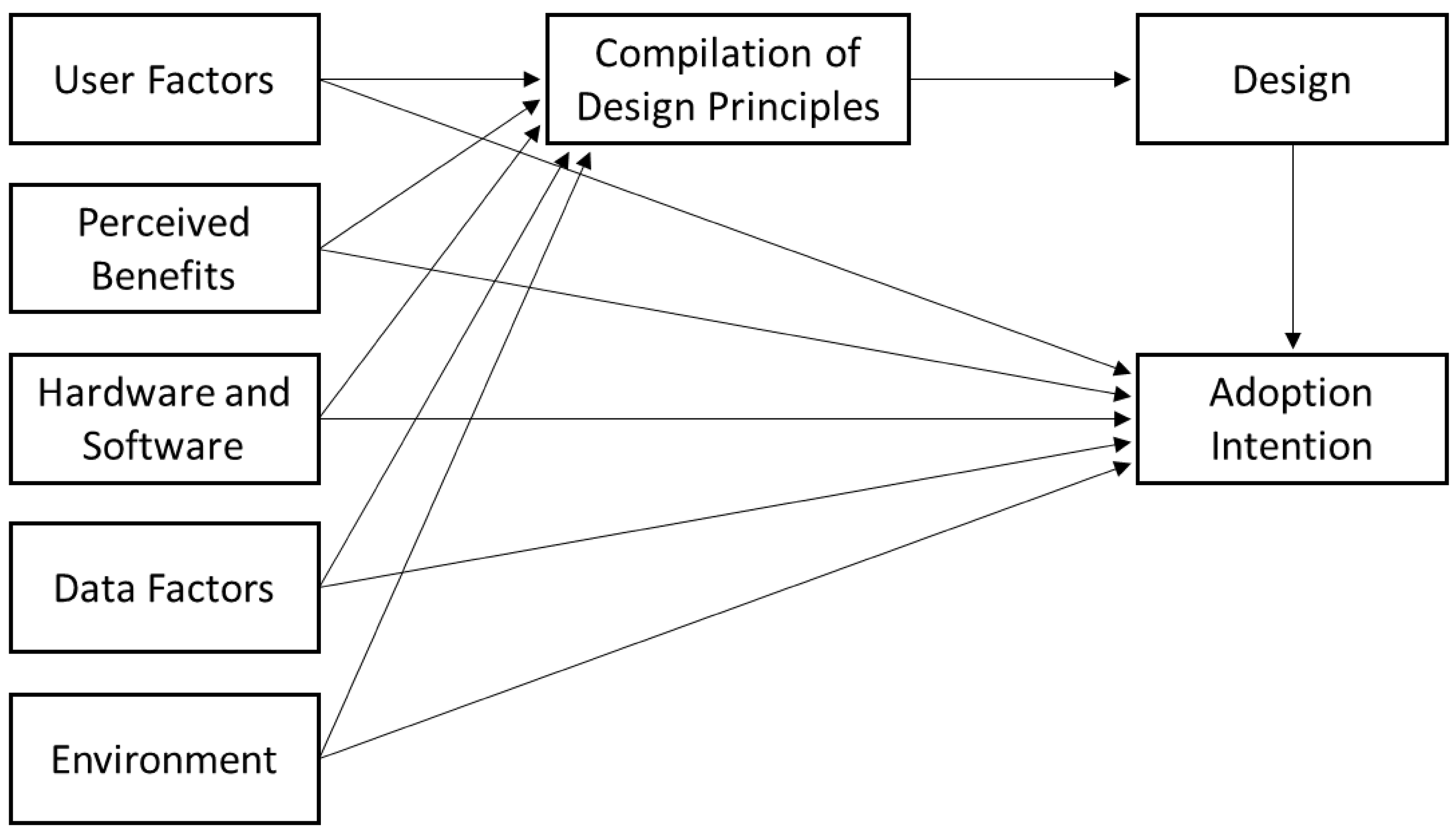

Figure 1. The Chronic Disease mHealth Adoption Model

The CDmHAM contributes to understanding the intention of (potential) users to adopt mHealth applications. Furthermore, it serves as foundation for developing mHealth devices. Figure 2 illustrates the interaction between the CDmHAM, the adoption intention of users, and the design of mHealth solutions..

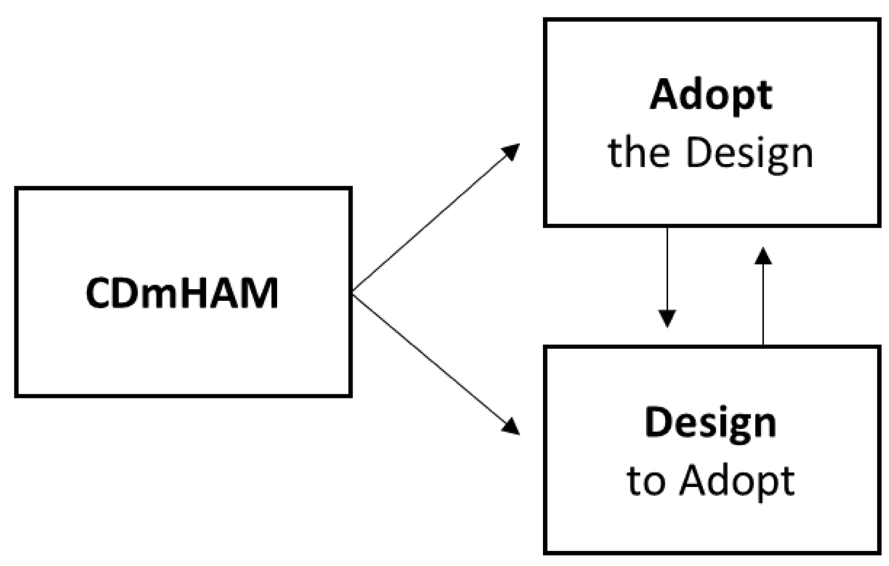

Figure 2. Interaction between the CDmHAM, the Adoption Intention of Users, and the Design of mHealth Solutions

Discussion and Conclusion

As research provides little knowledge on mHealth adoption with urological health issues, we followed a multi-method approach to build both the CDmHAM and a catalog of design principles. Integrating patient and expert interviews, we ensured the applicability of our generic model for the specific case of LUTS. Our study, thereby, contributes with a comprehensive model of mHealth adoption.
Our study faces limitations as we investigated neither dependencies between factors nor the influence of moderating variables. Hence, we invite future studies to investigate whether the factors depend on each other, to identify specific moderating variables, and to probe their effect within the CDmHAM and on the catalog of design principles. Since potential users assessed the relevance of the adoption factors, we suggest focusing on the most relevant ones while investigating mHealth adoption and developing mHealth devices.

Concluding, we obtained an adoption model as well as a catalog of design principles specifically applicable in LUTS management and supposed to apply to other chronic diseases as well. The comprehensiveness of factors and principles and the proven applicability for LUTS are valuable for research. We invite researchers to build upon our findings and validate and enhance both the model and the catalog.

References

1. Irwin, D.E., Kopp, Z.S., Agatep, B., Milsom, I., Abrams, P.: Worldwide prevalence estimates of lower urinary tract symptoms, overactive bladder, urinary incontinence and bladder outlet obstruction. BJU international 108, 1132–1138 (2011)
2. Toye, F., Barker, K.L.: A meta-ethnography to understand the experience of living with urinary incontinence: 'is it just part and parcel of life?'. BMC urology 20, 1 (2020)
3. World Health Organization: mHealth. New horizons for health through mobile technologies. World Health Organization, Geneva (2011)
4. Silva, B.M.C., Rodrigues, J.J.P.C., La Torre Díez, I. de, López-Coronado, M., Saleem, K.: Mobile-health: A review of current state in 2015. Journal of biomedical informatics 56, 265–272 (2015)
5. Krebs, P., Duncan, D.T.: Health App Use Among US Mobile Phone Owners: A National Survey. JMIR mHealth and uHealth 3, e101 (2015)
6. Bernard, S., Boucher, S., McLean, L., Moffet, H.: Mobile technologies for the conservative self-management of urinary incontinence: a systematic scoping review. International urogynecology journal 31, 1163–1174 (2020)
7. Sein, M.K., Henfridsson, O., Purao, S., Rossi, M., Lindgren, R.: Action design research. MIS Quarterly 35, 37–56 (2011)