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Pizza HCI: Improving Medical App HCI

Meike Irene Nakovics
Swansea University
Dr.-Emil-König-Str. 3
D-69214 Eppelheim
nakovics@web.de

Harold Thimbleby
Swansea University
SWANSEA, SA2 8PP
harold@thimbleby.net

HCI recognises the "sandwich" of users/interactive systems/tasks — ideally achieving effectiveness, efficiency and satisfaction for the user — hence user centred design and other key methodologies of HCI. For medical apps this is not sufficient, as patient outcomes are more important than usability. We aim to stimulate discussion on the need for a new approach, we tentatively call "pizza HCI," which emphasises the more rounded form of HCI needed to respect the patient: patient/clinician/system/clinical task/patient. Core user-centred design methods, such as think aloud, need extending into pizza HCI by greater emphasis on stakeholders than on users in isolation.

Medical apps, HCI, Pizza HCI.

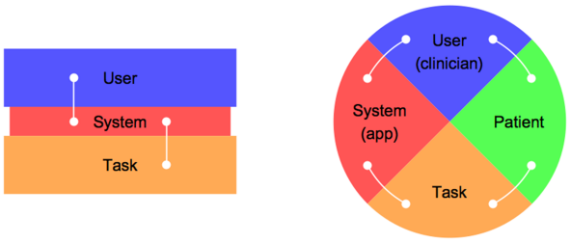
1. INTRODUCTION

Healthcare systems are characterized by rising costs and increasing demand for services (World Bank, 2018). The National Health Service (NHS, 2017) in the UK estimates that spending on health is rising from £79bn in 2006 to £126bn in 2019.

Medical apps are considered a cost-effective way to solve many health system problems (European Commission, 2014; NHS, 2014; Qiang et al., 2011; WHO, 2011). Their potential beneficial effects include reduced costs, increased quality, reduced workload, staff/patient engagement, and reaching rural areas (European Commission, 2014; Varshney, 2014). Guo et al. (2016) adds, "improvement in access to information, accuracy and efficiency, evidence-based decision making at the point of care and enhancement in performance, confidence and engagement in different contexts."

Conventional HCI rightly puts the user at the centre of design and evaluation processes. HCI developed when computer applications were predominantly systems like word processors and office systems running on personal computers: the user had a task, and it was clear that computers should be easier to use. Cairns & Cox (2008) present a good perspective on conventional HCI, and conventional HCI approaches for medical devices are covered by the NHS (2010) and the regulator, the MHRA (2017).

However, we found the HCI literature on medical apps disappointing. Our insight is that HCI needs to look beyond "the user" to consider the care of the patient. (We note that this point is made briefly in the recent Blandford *et al.* (2018) we read after doing our review.) Without improved clinical outcomes, the usability for the clinician is irrelevant. Clearly poor usability will generally be unproductive, but good usability does not ensure good patient outcomes. In fact, it may encourage the clinician, engrossed in their UI experience, to ignore the patient.



Conventional HCI sandwich (left) contrasted with the more rounded "pizza HCI," which includes the patient (more generally, other stakeholders) in the loop.

2. BACKGROUND: PRESSURE ULCERS AND MEDICAL APPS

Although there are many other examples (such as diabetes), we are working with a medical app for managing pressure ulcers.

Pressure ulcers, abbreviated PU, are "localized damage to the skin and/or underlying soft tissues usually over a bony prominence or related to a medical or other device" (NPUAP, 2016). PUs potentially affect all patients, particularly the elderly. If not treated correctly, PUs can lead to abscesses,

necrosis, and systemic infections causing death (Yarkony, 1994). Bennett et al. (2004) stated that 412,000 people in the UK are affected per year by PUs. Posnett & Franks (2008) estimate the annual cost to the UK at around £1.8-2.6bn a year; they attribute much of these costs to the additional nursing care required. The NHS recently (2018) initiated the campaign "Stop the pressure.", which shows their significance on the healthcare system. Most of PU incidence could be avoided, but regular skin-checks are not performed or not performed well (Shahin et al., 2008; Thoroddsen et al., 2013).

Health IT as a solution for PU prevention and treatment has been raised in the literature (McDonnell et al., 2010; Thoroddsen et al., 2013). The benefits of IT-enhanced wound care (reduced treatment costs, reduced number of visits and decreased healing times) for treatment of PU been confirmed by Khalil et al. (2016), particularly by improving education and documentation. Additionally, Su & Liu (2012) argue systems need to support mobility to be usable in clinical settings with patient needs. Hence, the use of a medical app for the treatment of PU seems reasonable.

3. A MEDICAL APP AND THE HCI LITERATURE

Our example of app implementation for healthcare professionals is the Offload app trialed with community nurses in a region of South Wales, initiated by the Pressure Ulcer Prevention and Intervention Service (PUPIS) and implemented by Fujitsu UK. The motivation for Offload was driven by the fact, that each week, an average of 10 cases of PU are identified in the hospital's catchment population, of which approximately 60% are already in the advanced stage of PUs (stage 3 or 4). The main objective of the app is to facilitate patients' increased involvement in the treatment and prevention of PU, to facilitate simplified and improved access to information from community healthcare professionals, as well as communication to specialist services. Hence the patient is a "user" in addition to the clinician.

Offload was evaluated in a rapid economic evaluation by the Health Economics Department, Swansea University. A majority of nurses agreed on the app's utility and 94.4% wish to use the app in the future. Nevertheless, barriers to wider adoption and implementation have to be overcome. The actual use of the app in clinical practice is low: 10 out of 18 nurses used the app only 1-4 times during a 3-month trial period. Conventional HCI evaluation found barriers to wider adoption, including low mobile technology literacy and the need to learn new technologies; also, the diverse needs and requirements of clinicians and patients was a challenging factor. These problems are typical for apps in clinical settings. In a survey of clinicians (Wyatt, 2015) only 13% assess medical apps as "essential" to their clinical work and only 12% reported usage of "several times a day".

Despite the evidence for benefits of apps in the literature, there are barriers and risks, especially in clinical settings (Aitken et al., 2017; Aitken and Lyle, 2015; European Commission, 2014; PWC, 2013; Whittaker, 2012; WHO, 2011b; Wyatt, 2015; Zhang et al., 2014; Zhang and Adipat, 2005).

A recurring problem is lack of usability evaluation and ineffective integration into the clinical task workflow. Wyatt (2015) says "there is a clear evidence that the design and usability of apps for clinicians – even those that have passed CE marking – fail to take account of well-known human factors issues." The lack of usability evaluation leads to increased error rates in hospitals (Thomas and Thimbleby, 2018). As a strategy to solve this issue, Zhang et al. (2014) and Wyatt (2015) suggest user and context-focused design with usability evaluation, which is the conventional HCI focus.

However, Fiordelli et al. (2013) argue the main part of evaluation of medical apps is to assess clinical outcomes and *not* usability. This is the missing patient-focused perspective. Fiordelli et al. (2013) also recommend to address this inappropriate use of methodologies in to early development stages. It is not sufficient to observe if a medical app is only meeting the functional requirements - so basically does the task what it should. A study by Meulendijk et al. (2014) has shown that Non-functional requirements ("attributes of or constraints on" the app (Chung and do Prado Leite, 2009)) such as Usability are more important for users than Privacy and its importance even increases with the age. Hence, all stakeholders including clinicians and patients have to be integrated at each testing stage.

Patient-focused development and design of apps are increasing in the literature – Varshney (2014) and Hamine et al. (2015). However, adoption by is a major factor for generating benefits (Varshney, 2014). A study by (Aitken and Lyle, 2015) reports that an important barrier to patient adoption of apps is if their physician is *not* using them. Especially, with increasing age, the opinion of the physician becomes more important than the Certifiability of the app (Meulendijk et al., 2014). Well-informed patients and increased patient engagement reduces the need of healthcare services, something conventional HCI misses. Nevertheless, apps cannot replace work for clinicians, since they are needed, for instance, to discuss options with the patients, to make decisions with patients, and to perform or guide the treatment.

Only if patients (and carers), who collect their data, and clinicians, who review data and use apps, then decision making can be improved — and this is critical for PU. Clinical work is complex and with

introducing further new technologies into work, the more complex it becomes (Varshney, 2014). This can lead to higher error rates (Kushniruk et al., 2004; Varshney, 2014), which could be avoided, they claim, with "context-aware", cognitive load-balancing and flexible UI designs for specific clinicians and diseases. According to Zhang et al. (2014), due to the lack of evidence about wider usability, clinicians remain unconvinced about successfully integrating apps into their tasks. Whittaker (2012) sees the need for increasing the knowledge of "what works" accompanied by stronger "collaboration with end users" and sharing information about the results.

Brown et al. (2013) state that more than 95% of medical apps have not been tested. For condition management apps, usability evaluation is usually missing for clinical practice (Aitken et al., 2017).

The current literature on medical apps concentrates on narrow evaluation (sometimes just an abstract "clinical validity"), not on their empirically assessed usability *and* patient benefit. Most of the published usability studies we reviewed investigate multi-dimensional usability, with a concentration on satisfaction, in a limited way, typically by using questionnaires, surveys, focus groups and interviews – mostly self-reported and not rigorously studied. The literature is dominated by research on health apps (i.e., apps for fitness and personal use, avoiding clinical decisions) rather than medical apps. The involvement of clinicians is low. Studies focused on usability for clinicians, especially in ecological clinical settings are lacking. One reason for that could be the administrative work and costs needed to start a project in a clinical setting. In addition, health apps are open-accessible in App Stores and don't fall under additional regulations such as for medical apps (MHRA, 2017). However, particularly, medical apps which work at the interface patient-physician need a complete and rounded assessment with the involvement of all stakeholders at every stage.

4. CONCLUSIONS

Medical apps have huge, possibly over-hyped, potential to address major problems in the global healthcare system. UI design and their usability, that is, HCI, is widely recognised as the key to their success, but medical apps must improve patient outcomes not just usability, and that requires a broader approach than "user centred design" which largely ignores (and ignores in the literature) the critical importance of patient outcome.

Medical app benefits can only be achieved if *both* patient and clinician needs are thoughtfully investigated.

We hope our paper stimulates debate on how HCI can contribute to successful medical apps.

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6. REFERENCES

Aitken, M., Clancy, B. and Nass, D. (2017), *The Growing Value of Digital Health in the United Kingdom*, IMS Institute for healthcare Informatics.

Aitken, M. and Lyle, L. (2015), *Patient Adoption of MHealth*, No. Use, Evidence and Remaining Barriers to Mainstream Acceptance, IMS Institute for healthcare Informatics.

Bennett, G., Carol Dealey and John Posnett. (2004), "The cost of pressure ulcers in the UK", *Age and Ageing*, Vol. 33 No. 3, pp. 230–235.

Blandford, A., Gibbs, J., Newhouse, N., Perski, O., Singh, A. and Murray, E. (2018), "Seven lessons for interdisciplinary research on interactive digital health interventions", *DIGITAL HEALTH*, Vol. 4, pp. 1–13.

Brown, W., Yen, P.-Y., Rojas, M. and Schnall, R. (2013), "Assessment of the Health IT Usability Evaluation Model (Health-ITUEM) for evaluating mobile health (mHealth) technology", *Journal of Biomedical Informatics*, Vol. 46 No. 6, pp. 1080–1087.

Cairns, P. and Cox, A.L. (Eds.). (2008), *Research Methods for Human-Computer Interaction*, 1 edition., Cambridge University Press, Cambridge, UK ; New York.

Chung, L. and do Prado Leite, J.C.S. (2009), "On Non-Functional Requirements in Software Engineering", in Borgida, A.T., Chaudhri, V.K., Giorgini, P. and Yu, E.S. (Eds.), *Conceptual Modeling: Foundations and Applications*, Vol. 5600, Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 363–379.

European Commission. (2014), *GREEN PAPER on Mobile Health ("mHealth")*, No. 219 final, European Comission, Brussels.

Fiordelli, M., Diviani, N. and Schulz, P.J. (2013), "Mapping mHealth Research: A Decade of Evolution", *Journal of Medical Internet Research*, Vol. 15 No. 5, p. e95.

Guo, P., Watts, K. and Wharrad, H. (2016), "An integrative review of the impact of mobile technologies used by healthcare professionals to support education and practice", *Nursing Open*, Vol. 3 No. 2, pp. 66–78.

Hamine, S., Gerth-Guyette, E., Faulx, D., Green, B.B. and Ginsburg, A.S. (2015), "Impact of mHealth Chronic Disease Management on Treatment Adherence and Patient Outcomes: A Systematic Review", *Journal of Medical Internet Research*, Vol. 17 No. 2, p. e52.

Khalil, H., Cullen, M., Chambers, H., Carroll, M. and Walker, J. (2016), "Reduction in wound healing times, cost of consumables and number of visits treated through the implementation of an electronic wound care system in rural Australia: Prospective study of wound healing times and cost in a rural population", *International Wound Journal*, Vol. 13 No. 5, pp. 945–950.

Kushniruk, A., Triola, M., Stein, B., Borycki, E. and Kannry, J. (2004), "The Relationship of Usability to Medical Error: An Evaluation of Errors Associated with Usability Problems in the Use of Handheld Application for Prescribing Medications", *Studies in Health Technology and Informatics*, Vol. 107, pp. 1073–1076.

McDonnell, C., Werner, K. and Wendel, L. (2010), "Electronic health record usability", *Vendor Practices and Perspectives: AHRQ, James Bell Associates, The Altarum Institute, Rockville*.

Meulendijk, M., Meulendijks, E., Jansen, P., Numans, M. and Spruit, M. (2014), "WHAT CONCERNS USERS OF MEDICAL APPS? EXPLORING NON-FUNCTIONAL REQUIREMENTS OF MEDICAL MOBILE APPLICATIONS", *Tel Aviv*, p. 17.

MHRA. (2017), "Human Factors and Usability Engineering - Guidance for Medical Devices Including Drug-device Combination Products", available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/645862/HumanFactors_Medical-Devices_v1.0.pdf (accessed 18 January 2018).

NHS. (2014), "App Development: An NHS Guide for Developing Mobile Healthcare Applications", NHS.

NHS. (2017), "NHS statistics, facts and figures", *NHS Statistics, Facts and Figures*, 14 July, available at: http://www.nhsconfed.org/confed18 (accessed 24 February 2018).

NHS. (2018), "Stop the Pressure | NHS Improvement", available at: http://nhs.stopthepressure.co.uk/ (accessed 24 February 2018).

NHS National Patient Safety Agency. (2010), "Design for patient safety - User testing in the development of medical devices", NHS, available at: www.nhs.npsa.uk/design (accessed 24 February 2018).

NPUAP. (2016), "National Pressure Ulcer Advisory Panel (NPUAP) announces a change in terminology from pressure ulcer to pressure injury and updates the stages of pressure injury | The National Pressure Ulcer Advisory Panel - NPUAP", *Npuap.Org*, 13 April, available at: https://www.npuap.org/national-pressure-ulcer-advisory-panel-npuap-announces-a-change-in-terminology-from-pressure-ulcer-to-pressure-injury-and-updates-the-stages-of-pressure-injury/ (accessed 24 February 2018).

Posnett, J. and Franks, P.J. (2008), "The burden of chronic wounds in the UK", *Diabetic Med*, Vol. 14 No. 5, pp. S7–S85.

PWC. (2013), *Socio-Economic Impact-of-MHealth - An Assessment Report for the European Union*.

Qiang, C.Z., Yamamichi, M., Hausman, V., Altman, D. and Unit, I.S. (2011), "Mobile applications for the health sector", *Washington: World Bank*, Vol. 2.

Shahin, E.S., Dassen, T. and Halfens, R.J. (2008), "Pressure ulcer prevalence and incidence in intensive care patients: a literature review", *Nursing in Critical Care*, Vol. 13 No. 2, pp. 71–79.

Su, K.-W. and Liu, C.-L. (2012), "A Mobile Nursing Information System Based on Human-Computer Interaction Design for Improving Quality of Nursing", *Journal of Medical Systems*, Vol. 36 No. 3, pp. 1139–1153.

Thomas, M. and Thimbleby, H. (2018), *'Computer Bugs in Hospitals: A New Killer' – IT, Cybersecurity and Risk to Patients*, Gresham College, Gresham College, available at: (accessed 26 February 2018).

Thoroddsen, A., Sigurjónsdóttir, G., Ehnfors, M. and Ehrenberg, A. (2013), "Accuracy, completeness and comprehensiveness of information on pressure ulcers recorded in the patient record: Accuracy, completeness and comprehensiveness of information on pressure ulcers", *Scandinavian Journal of Caring Sciences*, Vol. 27 No. 1, pp. 84–91.

Varshney, U. (2014), "Mobile health: Four emerging themes of research", *Decision Support Systems*, Vol. 66, pp. 20–35.

Whittaker, R. (2012), "Issues in mHealth: Findings From Key Informant Interviews", *Journal of Medical Internet Research*, Vol. 14 No. 5, p. e129.

WHO. (2011a), *Global Health and Aging*, No. Global Health and Aging.

WHO. (2011b), *MHealth: New Horizons for Health through Mobile Technologies.*, World Health Organization, Geneva.

World Bank. (2018), “Health expenditure per capita (current US$) | Data”, *The World Bank Data*, available at: https://data.worldbank.org/indicator/SH.XPD.PCAP (accessed 24 February 2018).

Wyatt, J. (2015), *Rapid Literature Review for National Information Board Workstream 1.2 - Final Report*, No. 0.797h, Royal College of Physicians.

Yarkony, G.M. (1994), “Pressure Ulcers: A Review”, *Archieves of Physical Medicine and Rehabilitation*, Vol. 75, pp. 908–925.

Zhang, C., Zhang, X. and Halstead-Nussloch, R. (2014), “ASSESSMENT METRICS, CHALLENGES AND STRATEGIES FOR MOBILE HEALTH APPS.”, *Issues in Information Systems*, Vol. 15 No. 2.

Zhang, D. and Adipat, B. (2005), “Challenges, Methodologies, and Issues in the Usability Testing of Mobile Applications”, *International Journal of Human-Computer Interaction*, Vol. 18 No. 3, pp. 293–308.