

Rehabilitation Risk Management: Enabling Data Analytics with Quantified Self and Smart Home Data

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Bachelor

- 2012
- Economics
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Master

- 2014
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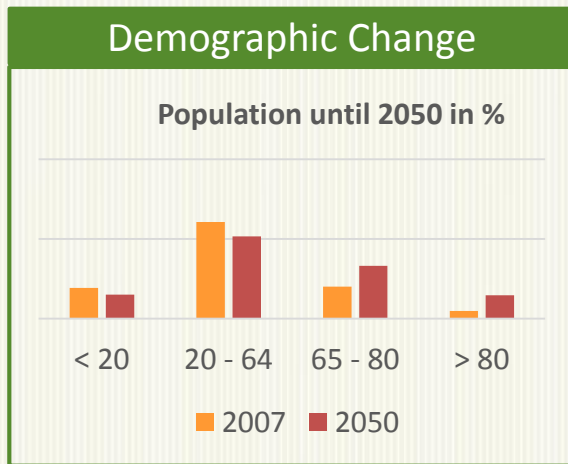
PhD

- Since October 2014
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- | **Introduction**
- | **Background**
- | **Technologies for Rehabilitation Monitoring**
- | **Implications & Limitations**
- | **Discussion**

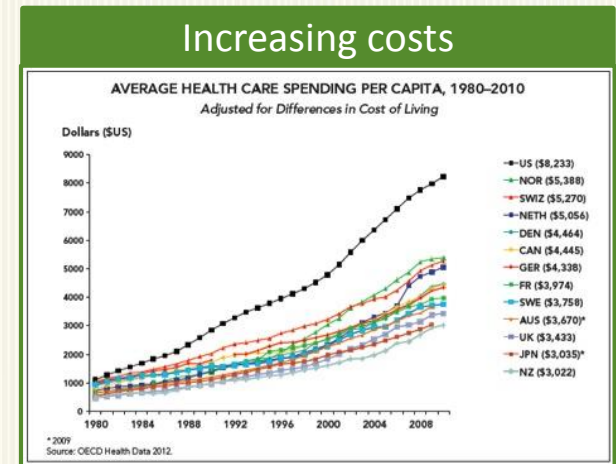
- 30% of the increase in total health expenditure of the inpatient hospital sector is reflected in the cost of hospitals
- Internal costs* (raises and lack of trained professionals) + *external influences* (inflation, demographic changes)



Medical Advances

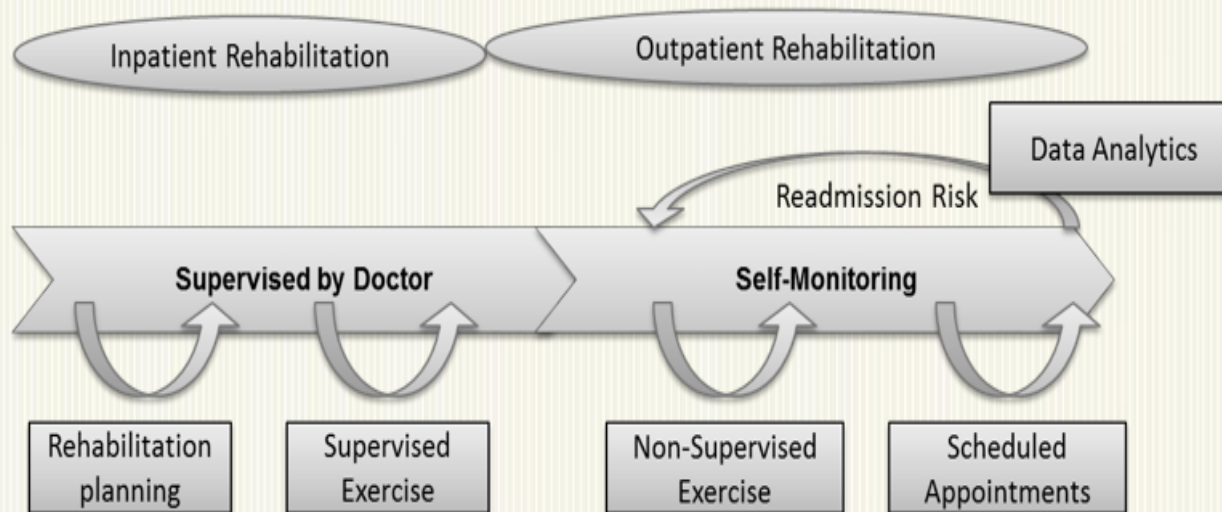
Research: Genome sequencing, Stem Cell, advanced medications and targeted therapies

Technologies: minimally invasive procedures, better IT support and medical equipment

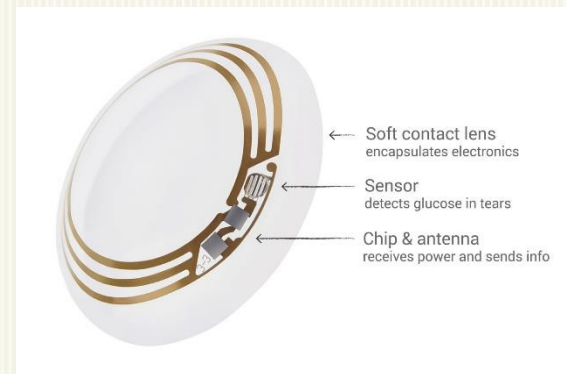


- Disease management and rehabilitation for individual care are less than optimal
- **incomplete** or **delayed information sharing** between stakeholders, **heterogeneous sources** for disease-related data, and lack of **individually created support concepts**

- Rehabilitation is key for a variety of **acute** and **chronic diseases**
- After discharge, patients are challenged to continue the prescribed measures (e.g. exercise programs, nutrition plans) **on their own**
- The success of self-care application depends to a large extent on the patient's **adherence to the rehabilitation plan** and the **exercise quality**
- Studies show that readmissions within 30 days can be **reduced by 50%** when patients are engaged

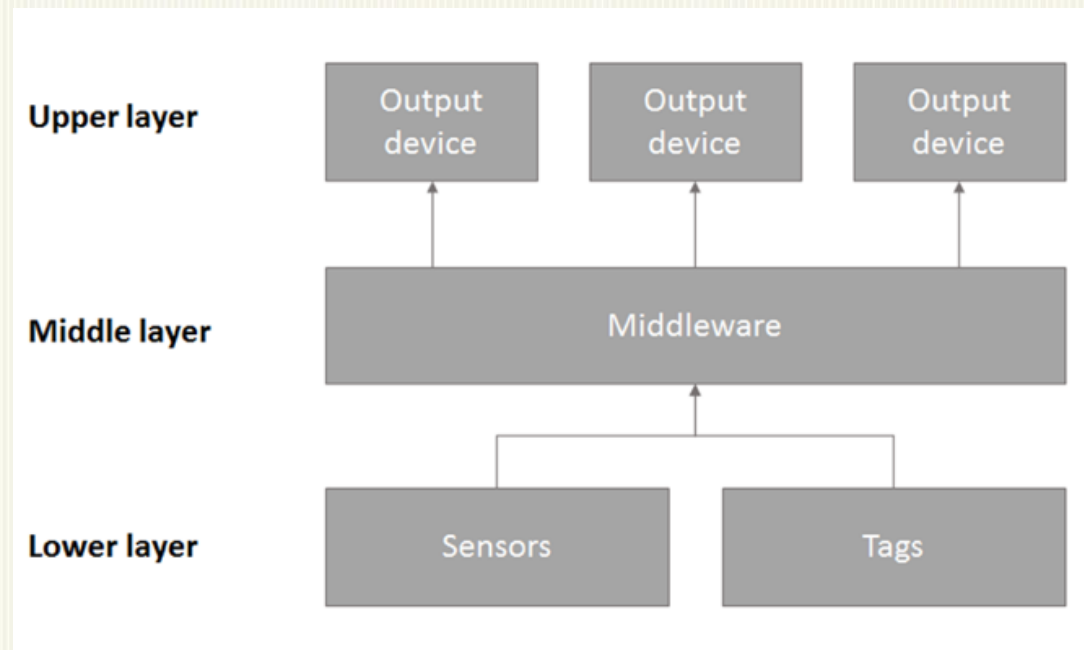


- Patients with chronic diseases account for the biggest part of readmissions
- *Renal failure, Septicemia, diabetes, psychotic disorders, airway disease and cardiac disease*
- The monitoring of **simple values** can heavily support the pre-emptive detection of patient deterioration.
- The collection of data to support monitoring these diseases at home can range from simple devices, such as **digital scales** (e.g. to track fluid fluctuations with renal disease), more advanced, non-invasive sensors for **blood sugar measurement** (e.g. through contact lenses) to more complicated or invasive measures, e.g. testing for inflammatory markers.



How can **consumer technologies** be used to enable the *simple* and *automatic* collection and storage of *rehabilitation* and *monitoring data* to **optimize available information** for all involved professional actors and family members.

Ambient Assisted Living systems provide *sensitive, adaptive* electronic environments that **communicate** and **interact** with people and objects to gain insights and provide the aggregated *information* and *services* to different stakeholders

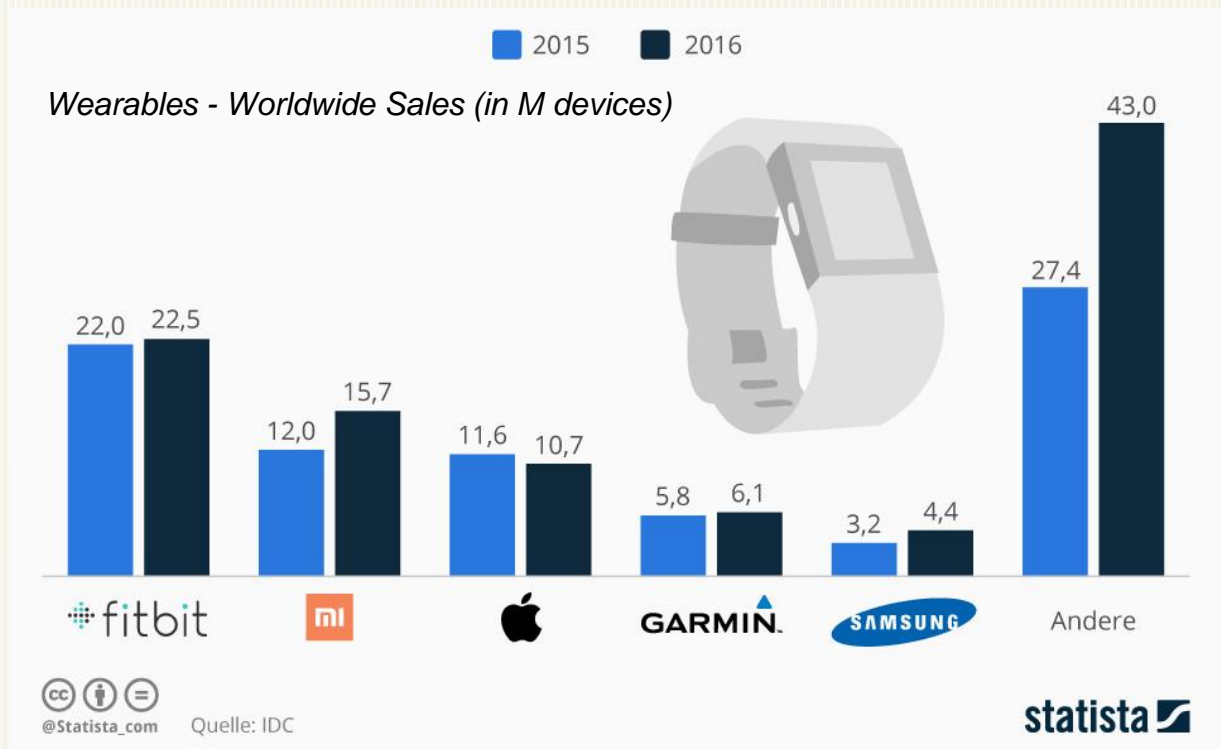


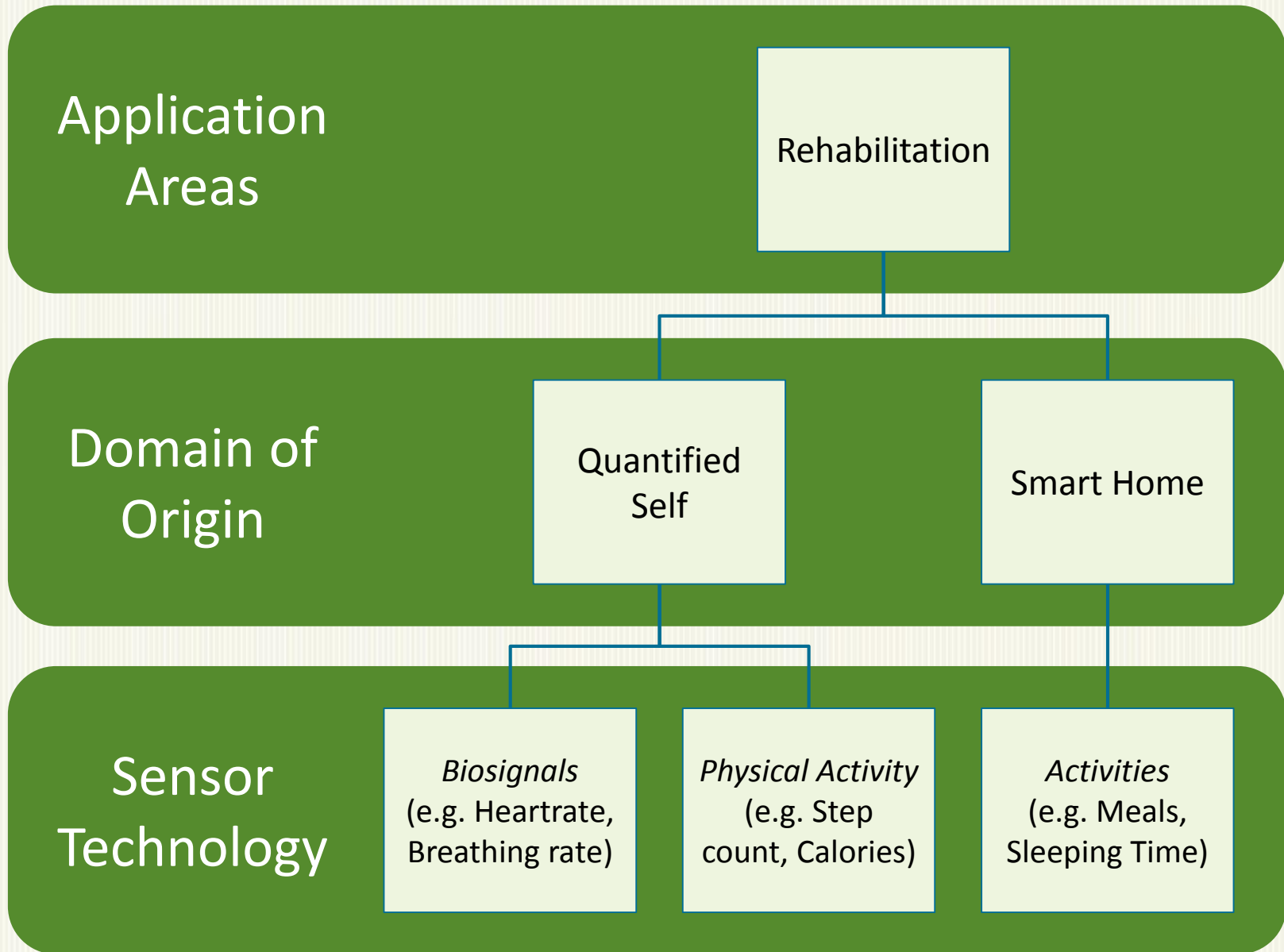
Telemedicine

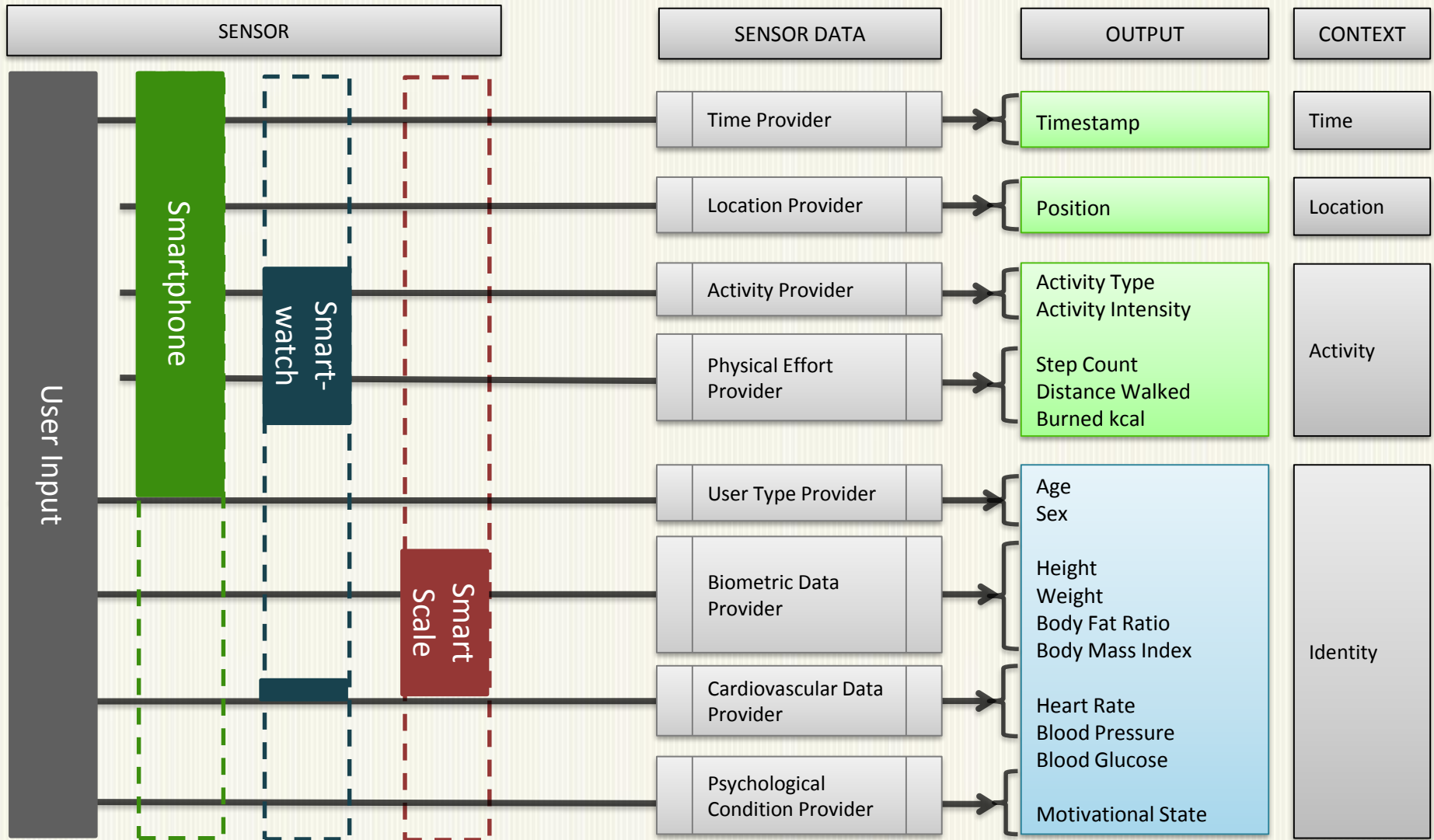
*Outpatient
Care*

Smart Home

Quantified self
consistently tracking movement data as well as health related information
through wearable sensory







- **Implications for research and practice**

- *Research*

- “All in one approach” to integrate the management of various risks simultaneously
- Extendable modular sensor framework

- *Practice:*

- Improve healthcare value through an enriched data collection
- Early identification of issues can lead to fewer unnecessary readmissions and timely interventions

- **Limitations**

- Data security and data interoperability have to be considered as important factors in this context
- Responsibilities and quality of measurements for more complex diseases need to be tested and evaluated

- M. Bick, T.-F. Kummer, and W. Rössig, Ambient intelligence in medical environments and devices: Qualitative Studie zu Nutzenpotentialen ambienter Technologien in Krankenhäusern. Berlin: European School of Management, 2008.
- Nilmini Wickramasinghe, Delivering value-based patient centred care with the Point of care system.
- Bundesagentur für Arbeit, Der Arbeitsmarkt in Deutschland –Altenpflege. [Online] Available: <http://statistik.arbeitsagentur.de/Statischer-Content/Arbeitsmarktberichte/Branchen-Berufe/generische-Publikationen/Altenpflege-2014.pdf>. Accessed on: Jul. 20 2016.
- BMFSFJ, Möglichkeiten und Grenzen selbständiger Lebensführung in stationären Einrichtungen (MuG IV): Demenz, Angehörige und Freiwillige, Versorgungssituation sowie Beispielen für „Good Practice“. [Online]. Accessed on: Jul. 20 2016.
- HealthQuest. [Online] Available: <http://www.healthquest.org/>. Accessed on: Jul. 20 2016.
- C. Nugent, A. Coronato, and J. Bravo, Ambient assisted living and active aging: 5th International Work-Conference, IWAAL 2013, Carrillo, Costa Rica, December 2-6, 2013, Proceedings. Berlin: Springer, 2013.
- C. Tunca, H. Alemdar, H. Ertan, O. D. Incel, and C. Ersoy, “Multimodal wireless sensor network-based ambient assisted living in real homes with multiple residents,” (eng), *Sensors* (Basel, Switzerland), vol. 14, no. 6, pp. 9692–9719, 2014.
- E. Aarts and R. Wichert, “Ambient intelligence,” in *Technology Guide*: Springer Berlin Heidelberg, 2009, pp. 244–249.
- Fraunhofer, Mobile EFA-Reha-App. [Online] Available: <http://www.efa.fraunhofer.de/de/efa-anwendungen/mobile-efa-reha-app.html>. Accessed on: Jul. 20 2016.
- 3D4Medical, Rehabilitation for Lower Limbs. [Online] Available: http://applications.3d4medical.com/rehabilitation_lowerlimbs. Accessed on: Jul. 20 2016.
- AmbiGate, e-Reha. [Online] Available: <http://www.ambigate.com/e-reha/>. Accessed on: Jul. 20 2016.
- P. Georgieff, Ambient Assisted Living: Marktpotenziale IT-unterstützter Pflege für ein selbstbestimmtes Altern. Stuttgart: MFG-Stiftung Baden-Württemberg, 2008.
- L. C. de Silva, C. Morikawa, and I. M. Petra, “State of the art of smart homes,” *Advanced issues in Artificial Intelligence and Pattern Recognition for Intelligent Surveillance System in Smart Home Environment*, vol. 25, no. 7, pp. 1313–1321, 2012.

- F. J. Fernandez-Luque, F. L. Martínez, G. Domènech, J. Zapata, and R. Ruiz, “Ambient assisted living system with capacitive occupancy sensor,” *Expert Systems*, vol. 31, no. 4, pp. 378–388, 2014.
- J. Bizer et al, *Technikfolgenabschätzung Ubiquitäres Computing und Informationelle Selbstbestimmung*. [Online] Available: https://www.datenschutzzentrum.de/taucis/ita_taucis.pdf.
- M. Mulvenna et al, *Visualization of data for ambient assisted living services: Institute of Electrical and Electronics Engineers (IEEE)*, 2011.
- Apple, *Apple HealthKit - iOS8*. [Online] Available: <http://www.apple.com/ios/health/>. Accessed on: Jul. 20 2016.
- Google, *Google Fit - Platform Overview*. [Online] Available: <https://developers.google.com/fit/overview>. Accessed on: Jul. 20 2016.
- M. Swan, “Sensor mania! the internet of things, wearable computing, objective metrics, and the quantified self 2.0,” *Journal of Sensor and Actuator Networks*, vol. 1, no. 3, pp. 217–253, 2012.
- C. Zigel, A. Hamper and F. Bodendorf, “SmartHealth for Senior Self-Monitoring: Nutzenpotenziale von Smartwatches für die Überwachung des Gesundheitszustands von Senioren,” 2014.
- B. X. Chen, “The iPhone 6 Goes Big, as Apple Aims Small With a Smartwatch,” *The New York Times*, 2014, 2014,
- A. Rütten, K. Abu-Omar, W. Adlwarth and R. Meierjürgen, “Sedentary lifestyles. Classification of different target groups for the promotion of health-enhancing physical activities,” *Gesundheitswesen*, vol. 69, no. 7, pp. 393–400, 2007.
- Apple, *Apple Watch - Features*. [Online] Available: <https://www.apple.com/watch/features>. Accessed on: Jul. 20 2016.
- J. O. Prochaska and W. F. Velicer, *The transtheoretical model of health behavior change*. [S.l.]: [s.n.], 1997.
- A. Hamper, “A Context Aware Mobile Application for Physical Activity Promotion”, 2015 48th Hawaii International Conference on System Sciences (HICSS), vol. 00, no. , pp. 3197-3206, 2015
- T. Horbach, *Expert Interview on a Service Portfolio for Health Services*.
- Anika L. Hines, Ph.D., M.P.H., Marguerite L. Barrett, M.S., H. Joanna Jiang, Ph.D., and Claudia A. Steiner, M.D., M.P.H.: *Conditions With the Largest Number of Adult Hospital Readmissions by Payer*, 2011. Hg. v. Agency for Healthcare Research and Quality.
- Oddone, Eugene Z.; Bosworth, Hayden B.; Weinberger, Morris (Hg.) (2006): *Patient treatment adherence. Concepts, interventions, and measurement*. ebrary, Inc. Mahwah, N.J: Lawrence Erlbaum Associates Publishers.



Thanks for your attention!

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