A telemedicine framework for collaborative pacemaker follow-up

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Current State of Pacemaker Follow-ups in Austria

- **Burden** for elderly patients (transportation and waiting times)
- **Wasted resources** at pacemaker centres
- **Patient numbers** increase
- **Lack of integrated therapy management** (quality assurance loop not closed)
Pacemaker Follow-up

- Identify problems at the earliest possible stage
- Basic follow-up: function test (up to 4 times per year)
  - Check basic function and battery state (magnet - effect)
    → ECG, general condition of the patient
    → can be done by General practitioner

- Extended follow-up: Basic follow-up + adjustment of specific parameters (after implantation and every 18-24 months)
  - Manufacturer dependent pacemaker programming device needed
  - → available only in specialised pacemaker centres
  - → can be done only by specialised Cardiologists
Telemedicine Framework

General practitioner
(basic exam. + ECG recording during magnet application)

Feedback via SMS

Telemedicine Service Centre
(Signal processing, electronic patient record)

Hospital
(Diagnostic findings)

Proposed results
Mobile Pacemaker Follow-up System

- Login / Identification
- Enter basic examination data
- ECG recording during temporary magnet application
- Data transmission via UMTS network
- Feedback via SMS
Telemedicine Service Centre

- **eHealth platform**
  - Electronic Pacemaker Patient Record
  - User management
  - Interface to mobile pacemaker follow-up client
  - Web portal

- **ECG signal processing unit**
  - „OK“: Begin Of Life
  - „NOTOK“: Elective Replacement Indicator / End Of Life
  - „UNDEFINED“: no appropriate magnet effect sequence found
Preliminary Report / Cardiologist Review

- Patient data
- Results of previous follow-ups
- Results from signal analysis
- Visualization of the recorded ECG
- Suggestion for the next follow-up date

- Final report after cardiologist review
- Stored to EPPR
Pilot Study

- Pacemaker follow-up centre of the Medical University of Graz
- Immediately prior to routinely scheduled pacemaker follow-up
- Separate room, no feedback to the cardiologist
- Automated data and signal processing
- Immediate feedback via SMS

Patients
- 24 consecutive patients (10 f, 14 m) on four consecutive days
- 17 different pacemaker models
- 6 different pacemaker manufacturers
Results

- Follow-up duration
  - ca. 15 min per follow-up
  - preparation, recording, transmission, analysis and feedback

- Results of automated signals analysis

<table>
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<tr>
<th>result</th>
<th>Prospective</th>
<th>Retrospektive¹</th>
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<td>17</td>
</tr>
<tr>
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<tr>
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¹ after updating the pacemaker database

- Results of “normal” follow-up by the cardiologist
  - all pacemakers were classified as „OK“
Summary

- Telemedicine framework for collaborative therapy management
- Manufacturer independent basic pacemaker follow-ups
- Feasibility proven in a pilot study
  - Some pacemakers were not in our database
    - Update pacemaker database
  - Some spikes could not be detected
    - Increase sample rate from 256Hz to 1000Hz
  - For about 2/3 of the cases submission to the specialised pacemaker clinic would not have been necessary
Conclusions

- The developed pacemaker follow-up framework
  - provides a tool for patient centred management of pacemaker therapy data
  - allows to manage all therapy related data in an Electronic Pacemaker Patient Record

- Pacemaker therapy in the future
  - higher efficiency and quality
  - lower burden to the patients

from indication via implantation to follow-ups