HOW TO MANAGE PATIENT WITH CHRONIC CONDITIONS REMOTELY?

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COCIR - Digitalisation of healthcare: The new normal
November 16, 2020
e-Health in Heart Failure

1. **Telemedicine** und telecare
2. Clinical information systems
3. Integrated regional and national information networks and associated e-referrals and e-prescribing
4. Disease registries and other non-clinical systems used for education, public health, patient/disease related behavior and healthcare management
5. **Mobile health (including Apps)**
6. Personalised health
7. Big Data

Telemedicine as Part of Healthcare System

- Videoconsultations
- Remote Patient Management for chronic diseases
- Doc2doc consultations/Telecouncil (e.g. virtual hospital)

Interlocking of the healthcare sectors
Concept of Remote Patient Management (RPM)

- Telemonitoring
- Education + Self-Empowerment
- Guideline-based HF-therapy

Remote Patient Management

Telemonitoring as an Element of RPM

- Non-invasive measurement of vital parameter
- Monitoring using diagnostic implantable device
- Monitoring using active implantable devices
- Smartphones

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© Abbott
© Biotronik
© Withings
## RCTs for Telemedicine in HF

### RPM with noninvasive Telemedicine

<table>
<thead>
<tr>
<th>Study</th>
<th>Publication Details</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIM-HF2</td>
<td>(Lancet 2018, Lancet Digital Health 2020)</td>
<td>1,538 patients, Germany</td>
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<tr>
<td>TIM-HF</td>
<td>(Circulation 2011)</td>
<td>710 patients, Germany</td>
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<tr>
<td>BEAT-HF</td>
<td>(JAMA 2016)</td>
<td>1,437 patients, USA</td>
</tr>
<tr>
<td>TELEREH-HF</td>
<td>(JAMA Cardiology 2019)</td>
<td>850 patients, Poland</td>
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<tr>
<td>OBSICAT</td>
<td>(EJHF 2020)</td>
<td>937 patients, France</td>
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</tbody>
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### RPM with invasive Telemedicine (Implants)

<table>
<thead>
<tr>
<th>Study</th>
<th>Publication Details</th>
<th>Participants</th>
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</thead>
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<tr>
<td>REM-HF</td>
<td>(Eur Heart J 2017)</td>
<td>1,650 patients, United Kingdom</td>
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<tr>
<td>IN-TIME</td>
<td>(Lancet 2014)</td>
<td>716 patients, Germany</td>
</tr>
<tr>
<td>CHAMPION-Trial</td>
<td>(Lancet 2011, 2016)</td>
<td>550 patients, USA</td>
</tr>
<tr>
<td>OptiLINK-HF</td>
<td>(Eur Heart J 2016)</td>
<td>1,002 patients, Germany</td>
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Summary of positive RCTs

In the recently hospitalized patients only (1/6 of the total HF-population), who were managed by a telemedical centre:

1. **Reduction of all-cause mortality** („IN-TIME“, „TIM-HF2“)
   

2. **Reduction of HF-admission rate due to HF** („Champion Trial“, „TIM-HF2“)
   
   *Abraham WT et al. Lancet. 2016 Jan 30;387(10017):453-61*

3. **Improvement of quality of life** („Champion Trial“, „TIM-HF“)
   
TIM-HF2: Study Design

Study design: multicentre RCT in Germany, 1,538 heart failure (HF) patients, hospitalised for HF maximally 12 months previously, with no major depression (PHQ-9<10) and with a LVEF ≤45% or if >45%, diuretics mandatory; Follow-up: 12-months follow-up under intervention + 12 months real-world (extended follow-up)

Primary Endpoint: % days lost due to unplanned CV hospital admissions and all-cause death

Secondary Endpoints: all-cause death, cardiovascular death, recurrent HF/CV hospital admissions, health economics, biomarkers, quality of life

Intervention: Remote Patient Management (RPM) vs Usual Care (UC)
TIM-HF2: Summary of Results

Primary outcome (% days lost due to unplanned CV hospital admissions & all-cause death)

- 20% reduction in favor of RPM (ratio 0.80, 95%, CI 0.65–1.00; \(p=0.046\)).
- 17.8 days/year vs 24.2 days/year lost for RPM and UC, respectively

All-cause death:

- 30% reduction in favor of RPM (hazard ratio [HR] 0.70, 95%, CI 0.50–0.96; \(p=0.028\)).
Main Secondary Outcomes

All-cause mortality
RPM vs. UC

HR 0.70
95% CI 0.50, 0.96
P=0.028

No. At Risk
Usual Care 773 767 756 738 716 697 681
RPM 765 755 737 724 709 688 673

## Recurrent HF hospital admissions

<table>
<thead>
<tr>
<th></th>
<th>RPM (n=765, 739.6 patient years)</th>
<th>UC (n=773, 754.4 patient years)</th>
<th>Ratio RPM vs. UC (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients with HF hosp. (%)</td>
<td>164 (21)</td>
<td>223 (29)</td>
<td>223 (29)</td>
<td>0.676</td>
</tr>
<tr>
<td>Incidence (95% CI)</td>
<td>0.441 (0.369–0.528)</td>
<td>0.653 (0.553–0.771)</td>
<td>[0.529–0.862]</td>
<td></td>
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<tr>
<td>No. of patients with HF hosp. (%)</td>
<td>280</td>
<td>405</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence (95% CI)</td>
<td>0.414 (0.345–0.498)</td>
<td>0.596 (0.502–0.707)</td>
<td>[0.541–0.894]</td>
<td></td>
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<tr>
<td>No. of patients with HF hosp. (%)</td>
<td>265</td>
<td>379</td>
<td></td>
<td></td>
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<tr>
<td>Incidence (95% CI)</td>
<td>0.414 (0.345–0.498)</td>
<td>0.596 (0.502–0.707)</td>
<td>[0.541–0.894]</td>
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IRR=Incidence rate ratio; incidence = events/100 patient years of follow-up; CV=cardiovascular; HF=heart failure; hosp.=hospital admissions

**Koehler F et al. Presentation ESC Congress, Paris, Sept 2, 2019**
All-cause Death in TIM-HF2: Main Trial & extended Follow-up combined

Kaplan Meier Survival
All-Cause Mortality

HR 0.84 (95% CI 0.66-1.06); log-rank p=0.15

Cumulative event rate (%)

0 3 6 9 12 15 18 21 24
Time (month)

Number at risk
UC 773 761 738 716 692 674 657 637 621
RPM 765 751 742 723 701 684 666 652 636

Koehler F et al. Lancet Digital Health, 2020 (2) 1: e16-e24
Remote Patient Monitoring (implanted devices) class II-B recommendation for
• Consideration of monitoring of pulmonary artery pressures with implantable haemodynamic monitoring system (CardioMems) in patients with previous hospitalization
• Consideration of multiparameter ICD-monitoring (IN-TIME approach) in HF-patients with LVEF ≤35%

Clinical practice update 2019: “Home telemonitoring using an approach that is similar to the one used in TIM-HF2 may be considered for patients with HF in order to reduce the risk recurrent cardiovascular and HF hospitalizations and cardiovascular death”\(^1\)

New guidelines planned for 2021
Digital Strategy and open questions in HF 2020

1) Research on new sensor technology

2) Upscaling of telemedical settings for usage in the real world (inclusion of artificial intelligence technologies)

3) Duration of RPM: Evidence for intervention of RPM for 12 Months - no evidence for lifelong RPM

4) (Profiling of profiting patients)

5) (No Evidence for RPM in different health care systems)
New Sensor Technologies to detect Pulmonary Congestion

Implants:

• Pulmonary artery pressure sensor – Endotronix, Inc.
• Atrial pressure sensor – V-LAP™

m-Health:

• Voice recognition systems
Digital health care solution for proactive heart failure management with the Cordella Heart Failure System: results of the SIRONA first-in-human study

Study type/patient characteristics: multicentre, open-label, feasibility study, n=15 HF patients in class NYHA III, follow-up: 90 days, NCT03375710

Primary efficacy Endpoint: Mean pulmonary artery pressure

Intervention: Implantation of Cordella Pulmonary Artery Pressure (PAP) Sensor

Results:

• No device-related complications (invasive treatment, device explant or death)
• Patient adherence to daily measurement, transmission of vital signs and PAP sensor readings: 99%
• Difference of PAP of 2.7mmHg (Cordella: 22.5±11.8 mmHg, Swan-Ganz catheter: 25.2±8.5 mmHg)

LA-Pressure Sensor – V-LAP\textsuperscript{TM}

- Left ventricular end diastolic pressure is the best pressure to use when considering left ventricular function\textsuperscript{1}.
- Left pressure measurement is second best to estimate left sided filling pressures and provides atrial rhythm analysis indirectly.

\textsuperscript{1}Peverill RE. Int J Cardiol 2015; 191:110-3
\textsuperscript{2}Guazzi M, Borlaug BA. Circulation 2012; 126(8):975-90
Development of AI-based voice analysis for the diagnostics of cardiac decompensation

Hydropic decompensation

Voice recordings

Diagnosis of decompensation

Smartphone-App for
- Voice recordings
- Project information

Analysis of voice attributes
- Extraction of voice parameters
- Deep Neural Networks
- AI-based behavioural modelling

Decision Support System at the Telemedical Centre

Supported by:
Federal Ministry for Economic Affairs and Energy
Artificial Intelligence and Telemedical Centre

Scaling up the number of patients per TMC:

a) Artificial Intelligence for prioritization of patients at the telemedical centre

b) Artificial Intelligence in new devices
Remote Patient Management for COVID-19

• Proof of benefits for Heart Failure Patients regarding mortality and morbidity
• Also possible for COVID-19 patients at home, e.g. dairy or daily measurement of oxygen saturation to detect deterioration and long-term follow-up
• RPM for Patients with Aortic Stenosis
Telemed5000- COVID-19

Telemedical longterm follow-up of recently hospitalised COVID-19 patients

**Study design:** single arm, prospective, multicentric, open, observational

**Planned study start:** Q4/2020

**Follow-Up:** 12 month for 100 patients

- Daily measurement of weight, blood pressure, SpO2, self-assessment and ECG
- Weekly: voice recording
- Monthly: 6-Minutes-Walk-Test
Conclusion

1. Remote Patient Management (RPM) is a holistic HF care intervention „add-on“ to guideline-based therapy of GPs, HF-nurses and specialists

2. Telemedicine in HF-patients could show the most robust evidence for a clinical benefit within the whole field of e-health in cardiology

3. Current proof of benefits is only for HF-patients in functional class NYHA II/III after hospitalization due to hydropic decompensation

4. Development of telemedicine technologies for HF-Patients includes the sensor technologies and telemedical centers (artificial intelligence).

5. Remote patient management with non-invasive devices has high potential for longterm follow up of COVID-19 patient, but is not reimbursed yet