Technology and therapy control for geriatric patients

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Ö Landeskrankenhaus Hochzirl
Anna Dengel-Haus

ERA-AGE FORUM Meeting
Wien, 1.3.2011
Aging – associated with impairments and diseases

Technology and therapy control

Studies

Application for geriatric patients
Functional and cognitive impairment

- Immobility
- Incontinence
- Instability
- Isolation
- Insomnie
- Irritable Colon
- Immunodeficiency
- Impaired eyes, ears
- Intellectual impairment
- Impecunity (Mittellos)
- Iatrogenic Problems (Polypharmacy)
- Impotence
Aging - disability and disease
percent of the population with diseases and disabilities
Germany 2003
TECHNOLOGY

Monitoring of disease

Monitoring of therapy
  - efficacy, safety
  - medication (adherence, interaction, side effects)

Safety (prevention of falls...)

Tools

HELP to live independently

Sensors

Data recorders

Communication networks
Examples of in situ monitoring technologies for geriatric patients
(Kang et al, JAGS 2010)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Risk Monitoring System</th>
<th>Interventional, Alert System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable</td>
<td>Heart rate, Blood pressure, Activity monitor, Oximetry, Glucose monitor, Sociometer, Portable telephone</td>
<td>Mobility monitoring in patients with Parkinson`s disease, Warning for unsafe behaviours in patients with dementia, Cuing of gait for rehabilitation</td>
</tr>
<tr>
<td>Environmental</td>
<td>Motion sensor, Instrumented carpet, Refrigerator door sensor, Toilet flush sensor</td>
<td>Video, Acute fall detection, Electronic pill box</td>
</tr>
</tbody>
</table>
Health Information Systems (HIS)

• **TELEMONITORING**
  – Heart disease (heart failure, arrhythmias, pacemaker)
  – Hypertension (therapy control and adaption)
  – Diabetes mellitus (glucose control, therapy adaption, prevention of hypoglycaemia)
  – Pulmonary disease (oxygenation, aspiration)
  – Epilepsy
  – Prevention of falls
  – Malnutrition: calory intake
  – Dehydration: Fluid intake
  – Anticoagulation (ESCAT=early self controlled anticoagulation trial)
  – Sleep monitoring

• **ORIENTATION** (light, sounds..)

• **TELERHABILITATION**

• **DRUG INTERACTION** (E-medication)
Heart disease

Heart failure

Atrial fibrillation

Pacemaker/Cardioverter/Defibrillation
  self-monitoring
  remote-monitoring
  retro-monitoring
Cardiovascular disease in Europe

- Total CVD: 19%
- CHD: 9%
- Stroke: 5%
- Other CVD: 5%
- Neuropsychiatric Disorders: 25%
- Injuries: 12%
- Cancers: 15%
- All Other Causes: 29%

Estimated Disability-Adjusted Life Years Lost (DALYs) for the Top Causes of Burden of Disease in Europe, 1990

TELE-CARDIOLOGY

Diagnosis and monitoring of arrhythmias

Implanted defibrillators, and pacemakers cardioverters

Atrial fibrillation

Heart failure
Cochrane analysis
(Inglis et al, 2010)

25 studies

9500 patients

3-18 months

Telemonitoring of patients with heart failure reduces

the rate of death from any cause by 44%

the rate of heart-failure related hospitalization by 21%
Telemonitoring in patients with heart failure
(Chaudhry et al, N Engl J Med 2010)

1653 patients with heart failure (age 51-73 years) – recently hospitalized
826 with telemonitoring, 827 with usual care
Telemonitoring: telephone-based interactive voice response system:
Tel-Assurance (Pharos Innovations), commercial system
daily calls to the system (series of questions about heart failure symptoms),
responses by telephone keypad; review every weekday
Primary end point: re-admission or death from any cause

Outcome – no difference between both groups (180 days after enrollment)

<table>
<thead>
<tr>
<th></th>
<th>telemonitoring</th>
<th>usual care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary end point</td>
<td>52.3%</td>
<td>51.5%</td>
</tr>
<tr>
<td>Re-admission</td>
<td>49.3%</td>
<td>47.4%</td>
</tr>
<tr>
<td>Death</td>
<td>11.1%</td>
<td>11.4%</td>
</tr>
</tbody>
</table>
Wireless pulmonary artery haemodynamic monitoring in chronic heart failure: a randomized controlled trial
CHAMPION stuy
(Abraham et al, Lancet 2011)

Centralised electronic system (wireless implantable haemodynamic monitoring)=treatment group (n=270) vs. Control (n=280)
NYHA III
Daily measures of pulmonary artery pressure

Age: 61±13 years

After 6 months:
Heart failure related hospitalizations: 83 in the treatment group vs. 120 in the control group
In total 39% reduction vs. Control group
Telemedical Interventional Monitoring in Heart Failure (TIM-HF), a randomized, controlled intervention trial investigating the impact of telemedicine on mortality in ambulatory patients with heart failure: study design. (Kohler et al, Eur Heart Fail 2011)

Recruitment of 710 heart failure patients

Follow-up 12-21 months

Daily remote device: electrocardiography, blood pressure, body weight

End-points. Mortality, hospital admission
Reliability of an external loop recorder for automatic recognition and transtelephonic ECG transmission of atrial fibrillation
(Mueller et al, J Telemed Telecare, 2009)

Conventional 24-h electrocardiogram
Telemonitoring with an external loop recorder – bluetooth – mobile phone

24 patients with atrial fibrillation, 24 patients with sinus rhythm

Atrial fibrillation was detected immediately in 23 of 24 patients with persistent atrial fibrillation

High sensitivity for detecting bradycardiac and tachycardiac atrial fibrillation
Implanted cardioverter - defibrillation

**Home – Monitoring – System:**
Retro-Monitoring, modified mobile telephone results from the ICD by GPRS to the telemedical center (Biotronik GmbH)
Physician observes the data via internet
Event: cardioreport by mail, SMS or telephone call

**Housecall-plus-System:**
Interactive system, telephone call patient – center, patient places telemetric transmitter to the ICD

**Carelink System:**
Similar to housecall system, physician controls the data via internet
## Implant Cardioverter Defibrillator Systems

*(Sommer et al., Herzschrittmachertherapie & Elektrophysiology 2010)*

<table>
<thead>
<tr>
<th></th>
<th>Biotronik</th>
<th>Boston Sc.</th>
<th>St. Jude</th>
<th>Medtronic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>name</strong></td>
<td>Biotronik Homemonitor</td>
<td>Latitude</td>
<td>HousecallPlus/ Merlion.net</td>
<td>CareLink Network</td>
</tr>
<tr>
<td><strong>Centers/patients</strong></td>
<td>36,600 German patients</td>
<td>150,000 US patients</td>
<td>1103 centers 36,000 patients</td>
<td>2,900 centers worldwide &gt;320,000 patients</td>
</tr>
<tr>
<td><strong>start</strong></td>
<td>December 2001</td>
<td>October 2005</td>
<td>December 2003</td>
<td>January 2002</td>
</tr>
<tr>
<td><strong>form</strong></td>
<td>control</td>
<td>Control and distant care</td>
<td>Control and distant care</td>
<td>Control and distant care</td>
</tr>
<tr>
<td><strong>Data transfer</strong></td>
<td>GSM network</td>
<td>telephone</td>
<td>GSM and telephone</td>
<td>telephone</td>
</tr>
<tr>
<td><strong>Data record and administration</strong></td>
<td>Automatical Bio Servicecenter</td>
<td>by patient and automatical BSX server</td>
<td>by patient and automatical PHTS Servicecenter</td>
<td>by patient and automatical MDT server</td>
</tr>
<tr>
<td><strong>controls</strong></td>
<td>daily</td>
<td>Defined period and event</td>
<td>Defined period and event</td>
<td>Defined period and event</td>
</tr>
</tbody>
</table>
ICD-Studies

REFORM study
150 patients
usual care (3-monthly ambulatory control) vs.
telemonitoring

TRUST study
1312 patients
design according to REFORM study

RESULTS:
Telemonitoring safe for patients – compared with usual care
Hypertension

Hypertonie Prävalenz – USA 1997

Antihypertensive medication – results from clinical practice

Patients with known, treated and controlled hypertension

(%) cross sectional German study 1997–2001; (n= 3304)

BBK +  known, treated controlled = A
BBK -  known, treated, uncontrolled = B
BB -  known, not treated = C

Blood pressure tele-monitoring
(Midekke, Praktische Telemedizin in Kardiologie und Hypertensiologie, 2009)

Blood pressure self control

Bluetooth mobile phone

Transfer to physician – short message service

Therapeutic recommendations (24 hour efficacy and safety)
Chronotherapy improves blood pressure control and reverts the nondipping pattern in patients with resistant hypertension

(Hermida et al, Hypertension 2008)
Telemonitoring and self-management in the control of hypertension (TASMINH2): a randomised controlled trial (McManus et al, Lancet 2010)

24 UK general practices
527 participants, age 35-85 years
Usual care vs. Self-monitoring of blood pressure, self-titration of antihypertensive medication, telemonitoring
Primary end point: change in systolic blood pressure after 6 and 12 months

<table>
<thead>
<tr>
<th></th>
<th>telemonitoring</th>
<th>usual care</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 m:decrease in SBP</td>
<td>12.9 mm Hg</td>
<td>9.2 mm Hg</td>
</tr>
<tr>
<td>12 m:</td>
<td>17.6 mm Hg</td>
<td>12.2 mm Hg</td>
</tr>
</tbody>
</table>

No difference with respect to side effects
## Telemonitoring and self-management in hypertension (McManus et al, BMC Cardiovasc Disorders 2009)

<table>
<thead>
<tr>
<th>Study</th>
<th>N (age)</th>
<th>BP measurement</th>
<th>outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friedmann et al (1996)</td>
<td>267 (77 years)</td>
<td>Telephone system</td>
<td>Small drop in DBP</td>
</tr>
<tr>
<td>Mehos et al (2000)</td>
<td>36 (59 years)</td>
<td>Monthly telephone call</td>
<td>No difference</td>
</tr>
<tr>
<td>Rogers et al (2001)</td>
<td>121 (61 years)</td>
<td>Transmission of BP down phone line, monthly reports</td>
<td>Reduction of MAP of 3 mm Hg</td>
</tr>
<tr>
<td>Artinian et al (2001)</td>
<td>26 African Americans</td>
<td>Transmission of BP down phone line weekly with automated feedback to patients, additional feedback via nurse</td>
<td>Pilot study</td>
</tr>
<tr>
<td>Zarkne et al (1997)</td>
<td>31 (55 years)</td>
<td>Self directed adjustment of therapy</td>
<td>Lower mean MAP</td>
</tr>
</tbody>
</table>
Role of home blood pressure monitoring in overcoming therapeutic inertia and improving hypertension control: a systematic review and meta-analysis (Agarwal et al, Hypertension 2011)

- Meta-Analysis of 37 trials
- 9446 patients
- Telemonitoring compared to usual care resulted in
  - Lower SBP: -2.63 mm Hg (95% CI: -4.24, -1.61)
  - Lower DBP: -1.68 mm Hg (95% CI: -2.58, -0.79)
Diabetes mellitus

Prevalence of diabetes in men and women in US population >20 years
Diabetes and elderly patients

2/3 of all diabetics are older than 65 years

Education programs, therapeutic goals and therapy have to be adapted to the individual situation

Hypoglycaemia is harmful (falls, cognitive function, heart problems...)

Diabetic foot problem
Hypoglycaemic coma requiring hospitalisation is more common in elderly people with type 2 diabetes

Retrospective medical record review of individuals with diabetes who were admitted with DIHC or developed DIHC during hospitalisation.

Diabetes mellitus

Glucose self measurements

Therapy control

Functional insulin therapy

Telephone call - GlucoTel

E-Mail

AIMS:

Improvement of glycaemic controls

Prevention of acute complications (hypoglycaemia, hyperglycaemia)

Diabetic foot - Teledermatology
Active Care management supported by home telemonitoring in veterans with type 2 diabetes: the DiaTel randomized controlled trial (Stone et al, Diabetes Care 2010)

137 Veterans of the VA Pittsburgh Healthcare System
Age: <80 years
Active care management with telemonitoring OR Monthly care coordination telephone call

Both groups received monthly calls for diabetes education and self-management review

Active care management: transmission of blood glucose, blood pressure, body weight to a nurse practitioner using the Viterion 100 Tele Health Monitor; adjustment of medication

Measures obtained at baseline, 3 months and 6 months

Significant reduction of HbA1c in the group receiving active care management
A comparison of in-person home care, home care with telephone contact and home care with telemonitoring for disease management (Bowles et al, J Telemed Telecare 2009)

Diabetes Guideline Checklist

What is the most recent HbA1c?
Was it obtained in the last three months?
Is the patients aware when hypoglycaemic?
Teach them how to recognize hypoglycaemia and what to do

Is fasting glucose < 110?
Is 2 hour postprandial glucose < 140?

Examine the patient’s feet
What is the patient’s blood pressure
Antihypertensive medication?
Lipid profile?
Eye exam in the past year?

Counsel the patient on diabetic diet
Glucose control

Check the flow chart for appropriateness of your patient’s therapy
A comparison of in-person home care, home care with telephone contact and home care with telemonitoring for disease management (Bowles et al, J Telemed Telecare 2009)

**Phone call guide for diabetes management**

Do you wake up frequently in the night to urinate?
Do you feel thirsty?
Do you feel nervous or glittery?
Are you checking your blood sugar at home? When?
What was your latest blood sugar?
Have you been able to stay on the diet?
Are you getting any exercise?
Are you feeling blue or sad?
Are you taking your medication as ordered?
Blood glucose monitoring – detection of hypoglycaemia

Tagesverlauf
1 Woche bis zum 17.02.2009

[Graph showing blood glucose levels over a period of time]
Herunterladen von Daten einfach per Mausklick

4. Analyse von Blutzuckermustern an Fallbeispielen | Seite 59
Hildegard Huber 21.06.1942 ID: Kasuistik_01
Gesamtverlauf - BZ - Alle

Voreinstellungen | Einblenden/Ausblenden

Darstellung „Gesamtverlauf“ über 4 Wochen
- gute, aussagekräftige Messfrequenz
- häufige Hyperglykamien
- wenig Hypoglykamien

4. Analyse von Blutzuckermustern an Fallbeispielen | Seite 60
Continuous subcutaneous insulin infusion versus multiple daily insulin injections in patients with diabetes mellitus: systematic review and meta-analysis

K. Jeitler · K. Horvath · A. Berghold · T. W. Gratzer · K. Neeser · T. R. Pieber · A. Siebenhofer

Received: 12 September 2007 / Accepted: 5 February 2008 / Published online: 20 March 2008
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Continuous Glucose Monitoring and Intensive Treatment of Type 1 Diabetes

The Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group*
Type 1 diabetes

- Changes of HbA1c (12 studies)

<table>
<thead>
<tr>
<th>Study</th>
<th>weight (%)</th>
<th>Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berg 1998</td>
<td>7,90</td>
<td>-0.92 (-1,64; -0,20)</td>
</tr>
<tr>
<td>Ciavarella 1985</td>
<td>4,46</td>
<td>-3,19 (-4,43; -1.93)</td>
</tr>
<tr>
<td>DeVries 2002</td>
<td>10,17</td>
<td>-0,81 (-1,28; -0,35)</td>
</tr>
<tr>
<td>Ziegler 1990</td>
<td>9,67</td>
<td>0,16 (-0,35; 0,68)</td>
</tr>
<tr>
<td>Oslo-Studie 1987</td>
<td>7,90</td>
<td>-0,29 (-1,01; 0,43)</td>
</tr>
<tr>
<td>Chiasson 1984</td>
<td>7,21</td>
<td>0,33 (-0,47; 1,13)</td>
</tr>
<tr>
<td>Hanaire-Broutin 2000</td>
<td>10,41</td>
<td>-0,56 (-1,00; -0,12)</td>
</tr>
<tr>
<td>Home 1982</td>
<td>6,62</td>
<td>-0,84 (-1,72; 0,04)</td>
</tr>
<tr>
<td>Hoogma 2006</td>
<td>12,35</td>
<td>-0,22 (-0,40; 0,04)</td>
</tr>
<tr>
<td>Saurbrey 1987</td>
<td>8,60</td>
<td>0,00 (-0,64; 0,64)</td>
</tr>
<tr>
<td>Schiffrin 1982</td>
<td>8,10</td>
<td>-0,41 (-1,10; 0,28)</td>
</tr>
<tr>
<td>Schmitz 1989</td>
<td>6,62</td>
<td>(-0,87; -0,22)</td>
</tr>
</tbody>
</table>

meta-analysis - effects on HbA1c

nach: Jeitler K et al.: Diabetologia 2008; 51:941-951
Type 2 diabetes

• Hypoglycaemia

![Graph showing hypoglycaemia rates per week for ICT and CSII treatments.](nach: Jeitler K et al.: Diabetologia 2008; 51:941-951)
## Meta-Analysis – HbA1c

### Type 2 diabetes (only 2 studies)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>n</th>
<th>age</th>
<th>DM duration</th>
<th>Change in HbA1c</th>
<th>% of patients with hypo</th>
<th>Severe hypo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herman 2005* offen parallel 52 Wochen</td>
<td>CSII (Lispro) vs. ICT (Lispro/ Glargin)</td>
<td>53</td>
<td>67</td>
<td>17</td>
<td>8,4% → 6,7% (-1,7%) 8,1% → 6,5% (-1,6%)</td>
<td>81%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54</td>
<td>66</td>
<td>15</td>
<td></td>
<td></td>
<td>90%</td>
</tr>
<tr>
<td>Raskin 2003** offen parallel 24 Wochen</td>
<td>CSII (Aspart) vs. ICT (Aspart/ NPH)</td>
<td>66</td>
<td>55</td>
<td>14</td>
<td>8,2% → 7,6% (-0,6%) 8,0% → 7,5% (-0,5%)</td>
<td>54%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>61</td>
<td>56</td>
<td>12</td>
<td></td>
<td></td>
<td>59%</td>
</tr>
</tbody>
</table>

* Herman WH et al.: Diabetes Care 28 (2005); 1568-1573
** Raskin P et al.: Diabetes Care 26 (2003),
nach: Jeitler K et al.: Diabetologia 2008; 51:941-951
**JDRF - Stdy**

Results after 6 months

- **Use of sensor techniques in different age groups**

  patients (%): use of sensor > 6 days in 26 weeks

  - > 25 J.: 83%
  - 15 - 24 J.: 30%
  - 8-14 J.: 50%

  Reduction in HbA1c

  - > 25 J.: -0.50%
  - 15 - 24 J.: -0.18%
  - 8-14 J.: -0.37%

Sensor supported insulin pump therapy – prevention of hypoglycaemia

• Prediction of hypoglycaemia

Dassau E et al.: ADA 2008
Prevention of hypoglycaemia

Stop of insulin infusion

Dassau E et al.: ADA 2008
Closed-loop-Algorhythm

Zisser H et al.: ADA 2008
Closed loop- simultaneous administration of insulin and glucagon
Clinical effects of home telemonitoring in the context of diabetes, asthma, heart failure and hypertension: a systematic review
(Pare et al, J of Med Internet Res 2010)

62 studies between 1966 and 2008
MEDLINE, Cochrane Library, INAHTA (International Network of Agencies for Health Technology Assessment)

**Diabetes:** better glycaemic control with home monitoring (n=24)

**Asthma:** no significant improvement (n=8)

**Hypertension:** reduction of systolic and diastolic blood pressure with home monitoring (n=13)

**Heart failure:** equivocal findings in the evaluated studies (n=17)
E-mediation
Lowering the risk of drug interaction

Polycharmacy
Side-effects
Drug interaction
Cognitive impairment – problems and complications

• **Orientation**
  – E-Shoe
  – elektronic Systems
  – chip

• **Activities of Daily Living**
  – burning – sensor systems (bathing room, kitchen)
  – immobility – emergency call
  – falls

• **Medication**
  – reminder systems
Training of cognitive functions

- Which day of the week?
- Month?
- gaims
- 100 minus 7 ......
- Drawing of figures
Prevention of falls

• Sensor systems
• Alarm systems – change of position (acoustic, light)
• E-Shoe (Gait)
• Support systems for walking

A wearable system for pre-impact fall detection
(Min et al, J Biomech 2008)

Torso and thigh wearable sensors (3D accelerometer, 2D gyroscope

Assessing elderly persons fall risk using spectral analysis on accelerometric data – a clinical evaluation study
(Marschollek et al, 2008)
Pro Act: Real time localization

WLanPager
TAGs (patient, scout)
PC
Concerns

Information overload for clinicians

Guidelines, licensure, regulation

Financing

Reimbursement

Concerns on technical issues (communication infrastructure, safety)

Concerns of ethics of monitoring (threat to autonomy, privacy)
Geriatric medicine –
different individual situation and needs
Thank you !