ABSTRACTS

Fourth European Congress on eCardiology and eHealth
Berlin 2017

Index by Title (Alphabetical)
(Hyperlinked titles – mouse-over and [ENTER] to navigate;
to locate an author - [CTRL][F], type in the surname, [ENTER])

A mobile application for heart failure management. Vodopija A., Baert A., Pardaens S., Clays E., Lustrek M.

A multidisciplinary smartphone based virtual clinic to support patients with Acute Coronary Syndromes: A qualitative study on healthcare providers’ perspectives. Bashi N., Varnfield M., Walters D., Karunanithi M.

A proposal for a German nation-wide vaccination system: Empowering patients through digital involvement. Knahl C., Samarah M.

A review of eHealth technologies for the management of patients with pulmonary arterial hypertension. Gonzalez-Garcia M., Farhad F., Ding H., Varnfield M., Karunanithi M., Yang I., Feenstra J.


Can we have confidence in oscillometric methods for non-invasive measurement of blood pressure? Celler B., Ahmadreza A., Le P., Ambikairajah E.

Characterisation of hypertension based on pulse wave velocity, stress, obesity and physical activity from real-life data collected by connected devices. Bellahsen O., Nikzad N., Chieh A., Roitmann E., Steinhubl S., Modena B.

Do the positive effects of a telemedical care program on mortality and hospital readmissions in chronic heart failure patients persist in the long-term? Wouters D., Verboven A-S., Vanderlinden L., Welten M., Frederix I., Dendale P.

ECG quality assessment of dry-electrode cooperative sensors. Rapin M., Ferrario D., Pellaton C., Haenni E., Dasen S., Châtelat O.

ECG-derived expiration-triggered sinus arrhythmia is a strong risk predictor in survivors of acute myocardial infarction. Steger A., Dommasch M., Sinnecker D., Maller A., Barthel P., Laugwitz K-L., Schmidt G.

Effectiveness and cost-effectiveness of a novel cardiac rehabilitation program for obese patients with coronary artery disease or atrial fibrillation. Study protocol of the OptiCare-XL study. Tenbult-Limpt, Van N., Uijl, Den I., Hoeve, Ter N., Kraal J., Kemps H., Berg, Van Den-Emons R.
Effectiveness of serious games’ design features to promote engagement and improve learning outcomes in healthcare professionals and students: a systematic review protocol. Maheu-Cadotte M-A., Cossette S., Duba V., Fontaine G.

Effects of internet-based exercise training compared with supervised group exercise training in patients with type 2 diabetes: a randomized controlled study. Akinci B., Yeldan I., Satman I., Razak Ozdincler A.


Exploring physical activity behavior, needs for and interest in a technology-delivered home-based exercise program among patients with intermittent claudication. Cornelis N., Buys R., Fournier I., Dewit T., Cornelissen V.


Heartbeat classification using LSTM recurrent neural networks. Wegrzynowicz P.

Incidence, risk factors and prognostic of atrial high rate episodes detected by telecardiology of 1226 defibrillator patients. Surget E., Guâ., Don- Moreau L., Finat L., Kyheng M., Kouakam C.


Multimodal sensor-based technologies for fall detection and risk factor assessment. Schutz N., Urwyler P., Saner H., Nef T.


Occlusion in anomalous coronary arteries: a parametric computer-based simulation. Formato G.M., Auricchio F., Frigiola A., Conti M.

OCULUS study: three-dimensional movie as a new solution to the problem of poor patients’ compliance. Balsam P., Borodzicz S., Malesa K., Puchta D., Tyminska A., Ozieranski K., Koltoowski L., Peller M., Grabowski M., Opolski G.


PPG versus single lead ECG for the diagnose of atrial fibrillation. Vandenberk T., Pelckmans C., Vanschelvergem G., Van Der Auvera J., Thijs I., Storms V., Vandervoort P., Grieten L.

Risk prediction by cyclic variation of heart rate and sleep-disordered breathing assessed from Holter ECGs in post-infarction patients. Cao X., Mâller A., Barthel P., Schmidt G., Sinnecker D.

SAFE2SCREEN - Can patient initiated kiosk-based self-screening provide an opportunity to identify Atrial Fibrillation within a GP waiting room environment? Crockford C., Mitchell A., Kaba R., Rudland S., Fay M., Nangalia V.
Simultaneous truth and performance level estimation for R-wave detectors in continuous ECG monitoring. Deserno T.M., Kashif M., Jonas S.

Smartphone application as a follow-up tool for cardiac patients after cardiac rehabilitation: a feasibility study. Lunde P., Bye A., Kvãrner K., Bergland A., Nilsson B.B.


Telecardiology as a diagnostic support to Emergency Care Units (UPA 24h) based on two years experience in Rio de Janeiro. Farah S., Grisolia A.M.M., Andrea B.R.


Unsupervised Telemonitoring of blood pressure at home - conclusions from the Australian CSIRO National Telehealth trial. Argha A., Celler B.G.

Utilization of mobile short message service to enhance uptake of focused ante natal care among rural women. Gitonga E., Nyamari J., Warutere P., Wanyoro A.

Validation of a wrist-worn device for the assessment of energy expenditure in patients with chronic heart failure and coronary artery disease. Herkert C., Kraal J., Kemps H.

Value-based assessment of blood pressure telemonitoring in hypertensive patients. Ionov M., Yudina Y., Kurapeev D., Kuzmina Y., Zvartau N., Konradi A.

Your own doctor can motivate you best to learn remotely! Kirn B., Frederix I., Kokalj S., Dendale P.
PATHway: User validation of a technology-enabled behaviour change intervention for patients with cardiovascular disease

Pattyn N., Claes J., Cornelis N., Dewit T., Cornelissen V., Buys R.
KU Leuven, Heverlee, BELGIUM

Background
Long-term adherence to a physically active lifestyle after completion of phase II cardiac rehabilitation (CR) is poor. PATHway (Physical Activity Towards Health) is a technology-enabled CR intervention designed to enhance patient self-management of cardiovascular diseases through adherence to exercise and other health behaviours. As a last step in the development of PATHway and before evaluating its (cost-) effectiveness, the platform was user validated and patient feedback was gathered.

Methods
Ten cardiac patients participating in phase III CR participated in a try-out session with PATHway. They were guided through the pre-final Dutch PATHway prototype to elicit feedback. Participants completed 1) lifestyle assessment and goal setting, 2) health and fitness assessment, 3) an ExerClass and ExerGame, 4) an outdoor activity recording and 5) a multi-player session. All feedback was recorded in real time and assessed by means of the adapted Technology Usage Questionnaire, the System Usability Scale (SUS), the User Experience Questionnaire (UEQ), the Fun questionnaire and open questions.

Results
All participants (90% male, age 71±6 y) were regular internet users (90% daily) on a personal computer (100%), tablet (60%) and/or smartphone (50%). Patients participated in 2.5 weekly CR sessions (range 1-3), with a median Borg score of 13 (range 12-14). Seventy percent of the patients used a HR monitor (50%) and/or accelerometer (50%) while exercising. Only one patient had tried an active computer game before.

Technical errors that occurred during the usability testing were logged and communicated to technical partners. Mean score on the SUS was 59 (range 43-78), which was below the cut-off for good usability of 68.

The UEQ is divided in 6 subscales; a value of ≥0.8 is considered as a positive evaluation. Attractiveness, efficiency, stimulation and novelty scored positively, while perspicuity and dependability scored below average. The median pragmatic quality score (task related quality) was 0.79, while median hedonic quality score (non-task related quality) was 1.10 on average. (Figure 1)

Fun questionnaire results showed a high interest to use PATHway in daily life (100%). Only 1 patient found PATHway difficult to use; 40% made mistakes while working with the program this first time. All patients reported they would feel safe using PATHway at home. However, only 20% preferred PATHway over community based CR. Most patients (60%) would prefer to use PATHway in addition to CR, for reasons of social interaction and peer support.

Conclusion
Our results from a single try-out with the pre-final PATHway prototype highlighted important aspects for improvement, which were mostly related to technical errors that
are solved in the current version. These errors might partly explain the somewhat lower scores on SUS and dependability subscale of UEQ. Future work will report on system usability following 6 months of PATHway use.

Back to Contents
PPG Versus Single Lead ECG for the diagnose of atrial fibrillation

Vandenberk T.,¹ Pelckmans C.,¹ Vanschelvergem G.,¹ Van Der Auwera J.,² Thijs I.,¹ Storms V.,¹ Vandervoort P.,¹ Grieten L.²
¹ Mobile Health Unit, Faculty of Medicine and Life Sciences, Hasselt University, Hasselt, Belgium; ² FibriCheck, Hasselt, BELGIUM

Background
Atrial Fibrillation (AF) is the most common heart rhythm disorder with a prevalence of 1-2% of the world population. AF has many health consequences, such as stroke and heart failure, leading to increased hospitalisation mortality. The diagnosis of AF is nowadays confirmed by the cardiologist based on the 12-lead electrocardiogram. Unfortunately, due to the paroxysmal nature of the disease, it is difficult to diagnose all patients on the moment of a doctor’s appointment. Here mobile monitoring solutions could assist the detecting of AF outside face-to-face visits. By using a smartphone with a custom-made application, the cardiac pulse rate can be measured by the PPG-signal in the tip of the finger using the smartphone camera.

Purpose
Diagnosis of Atrial Fibrillation based on the visual interpretation of a PPG signal results in a high clinical accuracy compared to single lead ECG and the current gold 12-lead ECG-standard.

Methods
A double-blind, randomized, prospective study was performed. The visual signal of simultaneous measured PPG and one-lead ECG were selected for diagnosis by a cardiologist. These files included AF, sinus rhythms, bad signal (bad quality of PPG or/and ECG signal) and other arrhythmia measurements. The PDF-files were randomly mixed and divided over two bundles. Four doctors (one cardiologist, one electrophysiologist and two assistant cardiologists) were asked to review one of the bundles. The diagnosis of the PPG and one-lead ECG signals were compared to the diagnosis of the 12-lead ECG.

Results
344 pairs of PPG, one-lead ECG and 12-lead ECG signals were reviewed by cardiologists. Out of the 12-lead ECG files, 173 were diagnosed as AF. Averaged results showed a PPG sensitivity rate of 83.5% and a specificity rate of 92.4% compared to a sensitivity rate of 93.1% and a specificity rate of 95.9% for the one-lead ECG. After eliminating other arrhythmias and bad signals, further data-analysis was done. Sensitivity and specificity rates increased to 96.3% and 99.1% for PPG compared to 95.6% and 98.4% for one-lead ECG. Considerable differences between reviewers were found for sensitivity rates.

Conclusion
The use of a smartphone application for AF patients results in a good accuracy for the diagnose of this heart rhythm disorder. Although potential problems could arise round education and training for cardiologist. After enabling data-analysis, sensitivity and specificity rates increase to very high accuracy corresponding 12-lead ECG. Algorithms could be important to process PPG measurements to adjust the quality of the data. This study concludes the potential to detect and diagnose AF in patients using a smartphone.
Utilization of mobile short message service to enhance uptake of focused ante natal care among rural women.

Gitonga E., Nyamari J., Warutere P., Wanyoro A.
Kenyatta University, NAIROBI, KENYA

Background
The Sustainable Development Goals targets a global maternal mortality ratio not greater than 70 maternal deaths per 100 000 live births by 2030. In Kenya, the maternal mortality ratio is high at 362 maternal deaths per 100,000 live births. Focused ante natal care approach recommends four targeted visits in which individualized care. Focused ante natal care increases the level of skilled birth attendance which reduces maternal mortality and morbidity. Mobile health has been known to improve outcomes in several health conditions.

The purpose of this study is to assess the influence of mobile phone short message service on uptake of focused ante natal care and its outcomes among women in Tharaka Nithi County, Kenya.

Methodology
A single blind randomized controlled trial was carried in selected rural health facilities. The sample size was 118 respondents for each arm. Random allocation through a computer application to interventional or control arm was done. The interventional group was sent one text message per month from booking to delivery while the control group was not. The short message services had content reminding the women of their next ante natal clinic appointment. Structured questionnaires and key informant interview guide were used in data collection. Chi square and multiple logistic regression were used to draw inferences.

Results
The utilization of focused ante natal care for the respondents was 57%. The uptake in the intervention group was 75% versus 10% in the control group. The chances of utilization of focused ante natal care was 27 times more among the intervention group compared with the control group (odd ratio = 27, P<0.001). The intervention also influenced the outcomes of focused ante natal care; namely place of delivery with 98% of the women in intervention group delivering in health facilities versus 78% of the control group (odds ratio 16, P<0.001). Completion of ante natal profile in intervention group was 81% versus 53% in the control group (odds ratio 3.9 p<0.001). The use of health promotion practices was 68% versus 27% in the control group (odds ratio 5.6, p<0.001).

Conclusion
Mhealth can improve the uptake of focused ante natal care among rural women through timely reminders.

Back to Contents
Multimodal sensor-based technologies for fall detection and risk factor assessment

Schutz N.,¹ Urwyler P.,¹ Saner H.,² Nef T.¹
¹University of Bern/ARTORG, Bern, SWITZERLAND; ² University Clinic of Cardiology, University Hospital Bern, Inselspital, Bern, SWITZERLAND

Introduction
In our aging society, prolonged independent living is a question of individual preference in addition to an economical one. Recent studies have shown that increasing home care in comparison to institutionalization, may have a significant effect in lowering health-care cost projections. To realize this vision, major threats of healthy aging in the elderly such as falls and fall-related injuries have become a central challenge in recent research. Existing systems that rely on single sensor-based detection or manual interaction fail to produce efficient and reliable results. Moreover, current fall detection technologies work well under laboratory conditions but it is still problematic to produce reliable results when these technologies are applied to real life conditions. Multimodal sensor-based technologies can provide an objective alternative to existing systems.

Purpose
In this study, we will investigate if multimodal sensor technology can promote healthy aging through the automatic detection of falls as well as assess an individual’s risk factors for falls.

Methods
Participants (N=46, age > 70 years) living alone in a community have been recruited for physiological and activity data measurement using ambient and wearable sensors for 12 months. Wearable sensors include a mobile ECG (Preventice Health-Guardian) and a Fitness Watch (FitBit) for one half of the participants and the other half involve an armband (Biovotion Everion) and an accelerometer (Axivity AC3). Ambient sensors include motion and door sensors (Domo-Safety System) as well as a bed sensor. Simultaneously, questionnaires and limb strength measures are recorded, while local care givers visit the participants twice a week to get information about lifestyle changes, accidents and other unforeseeable events.

We plan to combine different algorithms such as activities of daily living detection (ADL), stress- recognition or anomaly detection towards building patient-specific models that can effectively evaluate the current health state, limitations and ideally give predictive information about risk factors. The data will also be used to detect medical emergency situations such as falls and trigger timely responses.

Conclusions
Multimodal sensor-based technologies may provide accelerated response to fall and reduce rescue times to a fall which are linked with reduced negative medical impacts. Sensor-based technologies along with monitoring the physical behaviour can be a powerful tool for the detection of falls and increase the safety of those prone to falling.

Back to Contents
A proposal for a German nation-wide vaccination system: Empowering patients through digital involvement

Knahl C., Samarah M.
Florida Polytechnic University, Lakeland, UNITED STATES

Introduction
Vaccination is an integral part of disease prevention in Germany. However, recent measles outbreaks have shown that not enough people are immunised to ensure herd immunity. Also, poor data quality does not allow reliable vaccination insights. Therefore, this paper proposes a framework for a national vaccination register in Germany that aims to increase vaccination rates by creating transparency for patients over their vaccination status. With a user interface explicitly coded for mobile devices and an expandable database and architecture design, it promotes mobile health while giving patients stewardship of their data. Moreover, it offers medical providers and researchers reliable population health insights that can help discover new ways to enhance vaccination rates and the population’s wellbeing.

Methods
First, the current way of documenting vaccinations in Germany and legal requirements were studied. Then, the existing and future German health telematics infrastructure was reviewed and lessons-learned and best practices for vaccination systems in other countries were examined.

The solution utilizes methods from software engineering, advanced database systems and data analytics with emphasis on adaptable metadata, open connectivity and easy universal access.

Results
The application is built using four main principals:
1. Patient first: Allowing patients to review and manage their vaccination status
2. Universal secure sharable access: Patients, providers, clinicians and administrator use the same interface
3. Vaccination advocacy: Medical providers gain access to regional and national insights to increase vaccination rates
4. Open, extensible data model: The system holds core metadata to track a patient’s vaccination record and allows extensibility to receive automatically verifiable updates from medical providers

It actively involves patients and medical providers in the process of keeping vaccination rates up and could replace existing paper-based documentation. Certain security features are required to comply with legislation. Therefore, two-factor authentication is enforced and the front and back-end systems communicate via a secure channel. At the same time, all data are stored in a secure database employing encryption-at-rest. The system is accessed securely from any device. In the future, an integration interface allows automatic transfer of data from a medical practice to the system. This avoids manual data entry and reduces risk for erroneous data.

Conclusion
While extensive testing and validation of the security features is pending and more doctors and patients need to be polled to receive feedback about the concept, the application helps to increase vaccination rates by raising awareness for vaccination and giving transparency over the vaccination status of an individual and the entire population. Thus, the solution serves as a blueprint for building nation-wide vaccination systems that give patients stewardship of their health data.
Occlusion in anomalous coronary arteries: a parametric computer-based simulation

Formato G.M.,¹ Auricchio F.,¹ Frigiola A.,² Conti M.¹
¹ University of Pavia, Pavia, ITALY
² IRCCS Policlinico San Donato, San Donato (mi), ITALY

Objectives
Although anomalous origin of coronary arteries represents one of the most dangerous pathologies for young athletes, being related to sudden death, the underlying mechanisms are still to be elucidated. The present study aims to better understand how the lumen of the anomalous coronary (AAOCA) may narrow during aortic expansion. (Figure 1)

Methods
To this aim, we created a parametric geometrical model of the aortic root and anomalous coronary, performing a static finite element analysis (FEA). In particular, we have analysed nine models with different take-off angles and intramural penetration, showing the functional effect of these geometrical features of the anatomical anomaly. Firstly, we created a fully parametric geometrical model of an idealized aortic root with AAOCA using the CAD software Rhinoceros v. 5.0 working with the plug-in Grasshopper v. 2014 (McNeel and associates, Seattle, Washington, USA) - Figure 2.
The model has twenty-three free parameters that allow obtaining an aortic root with the desired geometry and simulating the AAOCA varying the position of the coronary along the root, its take-off angle, the amount of intramural penetration and the length of intramural course. Secondly, we built the model by setting the parameters using typical values encountered in the literature, selecting studies on individuals subjected to prolonged physical efforts whenever possible. All parameters were fixed except: a) the angle formed by the coronary axis and the plane tangential to the external surface of the root in the intersection point and b) the amount of intramural penetration of the coronary lumen. Nine models were selected for the finite-element based structural simulation performed with Abaqus Standard solver (Dassault Systèmes, Providence, RI, USA). Taking into account a pre-tensioning of the model, hydrostatic pressures of 100 mmHg and 15 mmHg were then applied to the internal surfaces of the aortic root and coronary to simulate the systolic pressures during exercise. As boundary conditions, the extremities of the aortic root were prevented to translate longitudinally and planar rotate, but allowed to move radially to follow the dilatation of the root.

Results
FEA revealed that a) aortic expansion leads to coronary occlusion and b) there is a dependence of coronary occlusion on both take-off angle and intramural penetration. Figure 3 relates the percentage reduction of the minimum radius along the coronary to intramural penetration, evidencing that the more is the intramural penetration the more is the coronary occlusion.
Figure 4 shows that acute take-off angles lead to a reduction of the coronary lumen at the ostium level.
Figure 3. Percentage reduction of coronary radius at different wall penetrations. The reduction increases with intramural penetration.

Figure 4. Percentage reduction of coronary radius at different wall penetrations. The reduction increases with intramural penetration.

**Conclusions**

This preliminary study reveals that a possible mechanism of coronary occlusion can rely on biomechanical reasons. Further studies should be made with more physiological pressures and boundary conditions to better understand this phenomenon.
Effects of internet-based exercise training compared with supervised group exercise training in patients with type 2 diabetes: a randomized controlled study

Akinci B.,1 Yeldan I.,2 Satman I.,3 Razak Ozdincler A.2
1 Biruni University, İstanbul, TURKEY; 2 Istanbul University, Faculty of Health Sciences Division of Physiotherapy and Rehabilitation, Department of Physiotherapy and Rehabilitation, Istanbul, TURKEY; 3 Istanbul University, Istanbul Faculty of Medicine, Department of Internal Medicine, Division of Endocrinology and Metabolic Diseases, Istanbul University, Istanbul, TURKEY

Background
Increased Type 2 Diabetes Mellitus (DM) prevalence is strongly associated with unhealthy lifestyle behaviours in all over the world. The literature includes Internet-based studies aimed at Type 2 DM patients developing a healthy lifestyle which includes physical activity. However, there were no studies compared the effectiveness of internet-based structured exercise training with supervised exercise training programs in Type 2 DM.

Purpose
The aim of this study is to compare the effects of internet-based aerobic and resistance exercise training on glycemic control, physical fitness, functional capacity, physical activity level and quality of life with supervised exercise training group in patients with Type 2 DM.

Methods
Sixty-five patients were included in the study and divided randomly into three groups as Group A, Group B, Group C. Group A- Control Group (n=22): Received once physical activity counselling via a brochure. Group B-Supervised Clinical Exercise Training Group (n=22): Physiotherapist led supervised aerobic and resistance training group exercise training 3 times in a week for 8 weeks. Group C: Internet Based Exercise Training Group (n=21): Continued the same program with videos from a website named “www.diyabetvehareket.com”. Sociodemographic features, HbA1c, fasting blood glucose, HDL, LDL, triglyceride, cholesterol levels and medication usage were recorded. We used dynamometer for lower and upper extremity muscle strength, 6 minutes walking test for functional capacity, bioelectrical impedance analysis and waist to hip measurements for body composition and pedometer for physical activity level, Euro-Quality of Life-5 Dimension for the quality of life assessment. The continuity of the patients to the program in the internet-based exercise training group was followed up by researcher physiotherapist via internet-based exercise reporting system. All assessments were repeated after 8 weeks.

Results
After treatment, there were no significant differences in any parameter over time in Group A. Significant improvements in glycemic control, physically fitness, functional capacity, physical activity, quality of life and medication usage doses were found in Group B and Group C (p<0.05). Improvements in Group C were similar with Group B except for some physical fitness parameters. There was no superiority between Group B and Group C (p>0.05)

Conclusion
The results of the study demonstrated that the gains provided with internet based combined exercise training are similar with supervised group exercise training and it can be used as an alternative rehabilitation service in Type 2 DM.

Back to Contents
Non-Invasive anatomical and functional cardiac imaging using Artificial Intelligence applicative in cardiology during stable chest pain evaluation from ARTICA Co-operative database.

Mazzanti M.,¹ Pugliese F.,² Rossi A.,³ Goda A.,⁴ Pottle A.,¹ Hasimi E.,⁴ Gjergo H.,⁴ Shirka E.,⁴ Dent N.,¹ Mackay N.,¹ Deane S.E.,¹ Underwood R.¹
¹ Royal Brompton and Harefield Hospital, LONDON, UNITED KINGDOM; ²Barts Heart Centre, London, UNITED KINGDOM; ³ Humanitas Clinical Institute, Milano, ITALY; ⁴ Mother Teresa Hospital, Tirana, ALBANIA

Background
The increasing published evidence in cardiology results in cognitive overload, particularly when interpreting big data, leading to costly diagnostic errors. Artificial Intelligence has several applications in clinical cardiology as implementing Clinical Decision Support System (CDSS) to increase appropriateness.

Purpose
To analyze Non-Invasive anatomical and functional imaging approaches using CDSS vs standard care (STD).

Methods
174 subjects, 132 males and 42 females; (61.4±8.1 years) underwent Non-Invasive imaging tests following Stable Chest Pain evaluation at three different hospitals. A computerized automated CDSS and a human cardiologist STD were applied during the same day visit. Pre-test likelihood of CAD was based on Diamond-Forrester and Clinical score + CACS. All subjects underwent Coronary Artery Calcium Scoring (CACS) and Computerized Tomography Coronary Angiography (CTCA) defining significant Coronary Artery Disease (CAD) as >50% coronary stenosis.

Results
Population was divided into two groups: GROUP 1 and GROUP 2 as shown in table. In GROUP 1, 140/144 (97%) subjects have normal CTCA ± Functional Imaging at STD; 137 of them were suggested of having No further test by CDSS. In GROUP 2, 15/34 (44%) have normal CTCA ±Functional Imaging by STD procedure. All 15 showed normal studies by CDSS when prescribed and only 2 subjects were allocated to Non-further test in the remaining 19. CDSS and STD strongly correlated well in both groups, especially for negative results of CDSS (Pearson r=0.78).

Conclusions
Automated CDSS applicative is strongly accurate to rule-out significant CAD when compared to STD. Artificial intelligence by CDSS may represent a valuable measure to correct clinical appropriateness and apparently a cost-saving method in subjects undergoing stable chest pain evaluation.
Exploring physical activity behavior, needs for and interest in a technology-delivered home-based exercise program among patients with intermittent claudication

Cornelis N., Buys R., Fourneau I., Dewit T., Cornelissen V.  
KU Leuven, Leuven, BELGIUM

Background
Intermittent claudication (IC) is a debilitating symptom in peripheral artery disease (PAD) patients, which has a significant impact on functionality and quality of life. Supervised walking is recommended as a first line therapy, however uptake of supervised programs and compliance to a physically active (PA) lifestyle is low. Home-based exercise seems an appealing alternative to supervised exercise especially since technological advances allowing tele-coaching and tele-monitoring may facilitate and support PAD patients to adopt a PA lifestyle. However, to guide the development of such an intervention, it is important to identify barriers towards (PA) and the needs and interests for technology enabled exercise therapy in this patient group.

Purpose
To assess PA levels, to identify barriers for PA and to explore the needs and interests towards technology enabled home-based exercise therapy in patients with PAD.

Methods
PAD patients with IC were recruited at the vascular center of the University hospitals Leuven (Belgium). A questionnaire assessing PA (SF-International Physical Activity Questionnaire), barriers to a PA lifestyle and interest in technology-supported exercise therapy (Technology Usage Questionnaire) was completed. Descriptive and correlation analyses were performed.

Results
One hundred patients (77 men; mean age 69yrs) completed the survey. Ninety-three were classified as Rutherford 1-3, with one fourth treated conservatively. PA level was low in 48%, moderate in 29% and 23% was considered highly active. Claudication was the most important barrier to PA, with almost all patients reporting pain (92%), need for rest (91%) and obstacles worsening their pain (73%) as barriers. Most participants (93%) owned a mobile phone and three quarter had access to the internet, mostly via a personal computer (91%). Eighty-eight reported the need for an exercise program, with 67% showing interest in tele-coaching to support exercise. When technology would be available, two third stated to be interested in home-based tele-coaching using the internet (preferably e-mails 86%) and 51% by their mobile phone, with text messages (85%) once or twice a week (50%) as the desired communication tool. (Figure 1). Both were related to age ($r_{pb}=-0.372$ and $r_{pb}=-0.264$, $p<0.01$) but not to educational level or gender. Next to exercise promotion, a large group of patients perceived health advice related to stress (67%), healthy eating (78%) or smoking cessation (85%) as at least somewhat useful. Acquaintance with elastic bands or gaming platforms was moderate (54% and 50%), but patients were interested in using them as alternative training modes (84% and 42%). Interest in platforms was age-dependent ($r_s=-0.489$, $p<0.01$).

Conclusions
PAD patients show significant interest in a technology-delivered exercise, offering future possibilities to develop a guided home-based exercise program.

This project received funding from the EU Horizon 2020 Programme, no. 643491.

Back to Contents
The first ACS e-registry in Scotland

Morris T.,1 Zhang R.,2 Papworth R.,2 Hillen N.,2 Mangion K.,2 Shield S.,1 Mcconnachie A.,2 Mccowan C.,2 Findlay I.,3 Berry C.2

1 AstraZeneca UK Ltd, Luton, UNITED KINGDOM; 2 University of Glasgow, Glasgow, UNITED KINGDOM; 3 NHS Greater Glasgow & Clyde, Glasgow, UNITED KINGDOM

Background
Acute coronary syndrome (ACS) is a leading cause of emergency hospital admissions and death. The Myocardial Ischemia National Audit Project (MINAP) supplies participating UK (not including Scotland) hospitals records of their management of heart attacks to monitor and improve the quality and outcomes of their services. While reducing the public health burden from ACS is a key focus for the National Health Service (NHS) Scotland, Scottish hospitals do not submit data to MINAP. Therefore, we lack the evaluative feedback on service delivery and the opportunity to improve patient outcomes.

Aims
To implement secondary care electronic record linkage for patients hospitalised with ACS in a complex regional healthcare system in Scotland and evaluate this e-Registry in terms of patterns of service delivery and 1-year outcomes. A secondary objective was to create a minimum dataset to allow comparisons against MINAP without the need for manual data entry.

Methods
We linked existing electronic records from (1) a patient administration system, (2) invasive cardiovascular procedure referrals, (3) a catheter laboratory record and (4) Scottish mortality data to develop a secondary care ACS e-registry (Figure 1). Data was extracted for admissions (1 October 2013 – 30 September 2014) with an ICD-10 diagnosis of ACS and analysed in an NHS data Safe Haven. Spells of care were categorised into care pathways and evaluated in terms of patient characteristics, as well as service delivery metrics and outcomes including mortality. The collated data for each episode of care for the ACS registry was also mapped to the MINAP minimum datasets for ST-segment elevation myocardial infarction (STEMI) and non-STEMI (NSTEMI) events.

Results
2327 patients had 2472 spells of care. The diagnoses for each patient’s first hospitalization within the study period and additional results are presented in Table 1. Six care pathways were observed. (Figure 1). The collated data was successfully used to create either a MINAP minimum dataset STEMI or NSTEMI record. Not all fields in the wider STEMI and NSTEMI datasets were directly mappable.
Table 1. Selected results of ACS registry.

<table>
<thead>
<tr>
<th></th>
<th>STEMI</th>
<th>NSTEMI [Low/High GRACE*]</th>
<th>Unclassified MI</th>
<th>Unstable Angina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients (N, %)</td>
<td>585 (25.2%)</td>
<td>1068 (45.9%)</td>
<td>146 (6.3%)</td>
<td>527 (22.6%)</td>
</tr>
<tr>
<td>Male (%)</td>
<td>68.9</td>
<td>57.1</td>
<td>52.1</td>
<td>47.1</td>
</tr>
<tr>
<td>All-cause death at 30 days (%)</td>
<td>9.0</td>
<td>3.0 [0.3/1.2]</td>
<td>31.5</td>
<td>0.6</td>
</tr>
<tr>
<td>All-cause death at 1 year (%)</td>
<td>11.9</td>
<td>11.6 [0.6/6.2]</td>
<td>45.9</td>
<td>5.7</td>
</tr>
<tr>
<td>Angiography (%)</td>
<td>86.0</td>
<td>63.5 [98.2/94.6]</td>
<td>0</td>
<td>4.2</td>
</tr>
<tr>
<td>Percutaneous Coronary Intervention (%)</td>
<td>80.2</td>
<td>33.1 [47.9/50.4]</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*GRACE was only available for NSTEMI patients intended for intervention.

**Conclusions**
The e-registry has enabled analysis of ACS hospitalizations in a complex healthcare system with implications for both quality improvement and research. Patient episodes identified as STEMI or NSTEMI were successfully mapped to MINAP minimum datasets with ongoing work looking to expand the data collection to completely replicate the MINAP dataset.

Back to Contents
Your own doctor can motivate you best to learn remotely!

Kirn B.¹, Frederix I.,² Kokalj S.,¹ Dendale P.²
¹Primarius C.J., Ljubljana, SLOVENIA; ²Department of Cardiology, Jessa Hospital, HASSELT, BELGIUM

Objectives
In eLearning, medically and scientifically sound videos with (para-) medical caregivers are used to teach patients of their medical condition in the post-discharge setting. In the videos doctors from the clinic are recorded and displayed to their patients or alternatively generic videos of unfamiliar teams are used. Use of generic videos however might reduce content uptake because patients are not familiar with the acting doctors.

Purpose
The purpose of this substudy was to investigate the impact of doctor familiarity on cardiac patients’ eLearning uptake behaviour.

Methods
387 coronary artery disease patients were enrolled in eLearning in two different clinics A and B (251 and 136 respectively). Upon discharge, they both received a one-month access to a secure and commercially available eLearning platform with exactly the same content. The 20 eLearning units contained videos in which only (para-) medical caregivers from clinic A were recorded. Platform usage was captured during whole study period by means of number of logins, number of units viewed, time spent on the platform while logged in and time spent viewing the units. Independent t-tests were used to compare observed values between patients from clinic A and B.

Results
In clinic A 120 (48%) and in clinic B 74 (54%) patients logged in at least once. The number of units viewed, time spent on the platform while logged in and time spent viewing the units were all significantly (p<0.05) larger in the clinic A vs. B (11.7±11.8 vs. 7.5±6.8; 56±78min vs. 34±47min; 42±53min vs. 25±40min, respectively). Average number of logins (mean ± SD) were 2.2±1.7 and 1.9±1.6 for clinic A and B respectively and the difference was not significant.

Conclusion
This substudy showed that cardiac patients’ eLearning use is reduced by 40% if generic videos are used instead of the doctors who were treating them in the clinic.

Back to Contents
Physical activity telecoaching for adults with congenital heart disease. Preliminary results from the Start2Sport study

Buys R., Claes J., Cornelissen V., Troost E., Goetschalckx K., Budts W.
1 KU Leuven, Leuven, BELGIUM; 2 University Hospitals Leuven, Leuven, BELGIUM

Objectives
Adult congenital heart disease (ACHD) patients have a suboptimal physical activity level. Hence preventive strategies and education should not only focus on the heart problem, but also on promoting a healthy lifestyle including physical activity. Therefore, the Grown Up Congenital Heart Disease working group of the European Society of Cardiology (ESC) introduced a recommendation for individualized exercise prescription for ACHD patients. To establish scientific evidence on the usability and effectiveness of individualized exercise prescription as recommended by the ESC, we developed and evaluated the Start to Sport (Start2Sport) program for ACHD patients.

Methods
Patients were randomized (2:1) to Start2Sport or usual care. Start2Sport consisted of a motivational interview with an exercise specialist, followed by a tele-coached progressive exercise program. The patient was coached on how to implement the exercise prescription in daily life and gradually increase the exercise duration to 3–4.5 hours per week within the prescribed exercise intensity range based on heart rate and perceived exertion. Exercise intensity and duration were monitored by Garmin Forerunner 335 and data were uploaded on the Garmin Platform for review. Patients in the usual care group received the normal advice to be physically active. Cardiopulmonary exercise testing was performed at baseline and 3 months to assess the primary outcome of change in percentage of predicted peak oxygen uptake (pVO\textsubscript{2}). Intention to treat analysis was performed and paired and independent t-tests were used.

Results
So far, 47 (31 Start2Sport, 16 usual care; 24 men, mean age 35.5±11.5 years) patients could be included in the analysis. Two patients dropped out from the Start2Sport group (pregnancy, n=1; lack of time, n=1). Enrolled patients had different underlying heart defects, from simple lesions such as closed atrial septal defect to complex cardiopathies. Therefore, no exercise restriction (n=7), restriction to high intensity static exercise (n=15), restriction to high intensity static and dynamic exercise (n=19), restriction to high intensity dynamic and moderate-high static exercise (n=4), and restriction to all moderate-high intensity exercise (n=2) was set according to the ESC recommendation. At baseline, pVO\textsubscript{2} averaged 72±19% for usual care and 76±20% for Start2Sport group (p>0.05). Patients in the Start2Sport group exercised a median of 3 hours/week (range 1.5–10h) within their prescribed heart rate zone. At follow-up, pVO\textsubscript{2} in the Start2Sport group had increased with 11.5±11%, which was significantly more than the increase of 0.7±13% in the usual care group (p=0.017). (Figure 1) No exercise related adverse events occurred.

Conclusions
Implementation of the ESC exercise prescription recommendation seems feasible and safe. Moreover, these preliminary results show its effectiveness through telecoaching for improving pVO\textsubscript{2} of ACHD patients.

Back to Contents
Unsupervised Telemonitoring of blood pressure at home - conclusions from the Australian CSIRO National Telehealth trial

Argha A., Celler B.G.
University of New South Wales, Sydney, AUSTRALIA

The CSIRO National Telehealth trial is the largest trial of telehealth services for the management of chronic disease in the community ever attempted in Australia.

Objectives
Here we provide basic demographic data and BP distribution for the patient cohort and analyse the time course of blood pressure (BP) changes over time. We also report on patient compliance, over the duration of the study and quality issues arising from unsupervised monitoring of BP at home.

Methods
BP data was collected at home using a commercially available NIBP device from Telemedcare Pty Ltd. This study was only carried out on the 60 (out of 113) patients who were monitored for at least 6 months. Subjects were asked to record their BP every morning just prior to taking their medications. A typical panel of data collected is shown in Figure 1.

![Example NIBP data processed waveforms](image)

Figure 1. Example NIBP data processed waveforms

Signal processing algorithms were used to identify measurement artefact, noise or arrhythmia and records excessively perturbed by noise were rejected.

Results
Of the subject cohort 19 (31.7%) were female. The average age was 71.4±8.9 years. A total of 16,855 recordings were analysed, representing on average of 281 recordings for each patient and an adherence rate of 81.9% (64.6-94.3%). Of these, 1504 (17.4%) recordings were rejected as being excessively corrupted by noise, arrhythmia or other measurement artefact. Only 1,865 or 11.1% of the original recordings were not disturbed by measurement noise or ectopic beats, demonstrating the difficulties encountered in self-administered NIBP recordings.

Adherence to the daily schedule of measurements was initially 79.5% (77.1-81.1%) and fell to 76.4% (76.1-78.2%) after 3 months and 74.8% (73.7-78.2%) after 6 months. At the start of intervention, the median systolic and diastolic pressures for all subjects were 137.1 (130.4-142.7) and 69.7 (64.5-76.7) mmHg respectively, with a median heart rate of 74.8 (66.4-84.0) bpm. Of these 35% had stage I hypertension with systolic pressures between 140-160mmHg and 3.3% had stage II hypertension with systolic pressure exceeding 160mmHg. For hypertensive patients, the median systolic pressure at the start of monitoring was 144.4 (141.5-146.2) mmHg, which fell significantly (P=0.006) at the end of 3 months to 138.8 (132.6-145.4) mmHg, and after 6 months (P=0.0127) to 139.1 (130.8-146.0) mmHg.
Conclusion
The recording of unsupervised BP measurements at home by elderly subjects with chronic conditions is challenging because of a high proportion of subjects with cardiac arrhythmia and the occurrence of signal noise and measurement artefact. Adherence to this measurement schedule was generally high, and was well maintained over 6 months. Hypertensive patients experienced a significant fall in their systolic pressure over 3 months which was sustained through to the end of 6 months of monitoring. Telemonitoring methods focused on the control of BP, supported by highly trained care coordination are likely to be effective in reducing BP among hypertensive subjects.
ECG-derived expiration-triggered sinus arrhythmia is a strong risk predictor in survivors of acute myocardial infarction

Steger A., Dommasch M., Sinnecker D., Muller A., Barthel P., Laugwitz K-L., Schmidt G.
Klinikum rechts der Isar / TU Munchen, Munchen, GERMANY

Background
The phenomenon of expiration leading to a heart rate decrease and inspiration leading to a heart rate increase is commonly known as respiratory sinus arrhythmia. The undulating activity of the Vagus nerve in response to the respiratory phases is the main engine of respiratory sinus arrhythmia. Expiration-triggered sinus arrhythmia (ETA) is a parameter that distinctively addresses the expiration-driven increase of vagal activity leading to a heart rate deceleration. ETA is a strong and independent predictor of mortality in survivors of acute myocardial infarction. For the assessment of ETA, simultaneous recordings of respiration (via chest belt) and ECG are required. Therefore, practicability in daily clinical practice will be limited.

Purpose
The main goals of this study were: 1) the development of an algorithm suitable for the correct reconstruction of respiration curves from high resolution ECG without the need of a chest belt and the calculation of ETA on this basis (ETA_{ECG}); 2) the evaluation of ETA_{ECG} in risk stratification of post-MI patients using the reconstructed respiratory signal.

Methods
Simultaneous recordings of ECG and respiratory chest excursions were performed in 941 survivors of acute myocardial infarction. A mean follow-up of 5 years was achieved. Using a 200 Hertz high-pass filter in all three ECG channels (X, Y, Z), myopotentials from auxiliary respiratory muscles were visualized and respiratory curves were reconstructed. ETA_{ECG} was quantified by means of phase rectified signal averaging as previously described for ETA (unit: ms).

Results
ETA can easily be derived from high resolution surface ECGs alone. The correlation is excellent and there is no systematic bias between ETA and ETA_{ECG}. The optimum dichotomy of ETA_{ECG} for the prediction of all-cause mortality was 0.36 ms. The area under the ROC curve for the prediction of 5-year mortality was 0.70 (95%-CI 0.63-0.75) for ETA and 0.74 (95%-CI 0.68-0.80) for ETA_{ECG}. (Figure 1)

Conclusion
1) ETA_{ECG} does not require chest belt signals for the detection of expiration induced and vagally mediated heart rate deceleration. 2) ETA_{ECG} is a strong and independent risk predictor in post-MI patients. Therefore, ETA_{ECG} is a promising parameter easily to implement in clinical routine.

Figure 1. Receiver operating characteristics of ETA and ETA_{ECG} for the prediction of 5-year mortality in survivors of acute myocardial infarction.
Do the positive effects of a telemedical care program on mortality and hospital readmissions in chronic heart failure patients persist in the long-term?

Wouters D., Verboven A-S., Vanderlinden L., Welten M., Frederix I., Dendale P.
Hasselt University, DIEPENBEEK, BELGIUM

Objectives
As shown by the original Telemonitoring in the Management of Heart Failure (TEMA-HF) study, telemonitoring in chronic heart failure (CHF) appears to reduce time to death and number of days lost to hospitalization during the monitoring period. The TEMA-HF 1 Long-Term Follow-up Study assessed whether this tendency persists in the long-term, after the initial 6-months telemonitoring (TM) intervention had been stopped.

Methods
After the multi-center, randomized controlled telemonitoring trial (TEMA-HF 1, starting at time point $t_0$); 142 CHF patients (65% male; age: 76 ± 10 years; EF: 36 ± 15%; NYHA Class 3.0 ± 0.5) were alive and entered the follow-up study (time point: $t_1$) with a final evaluation at 79 months (minimum 68 – maximum 89 months) (time point: $t_2$). Both TM and usual care (UC) group patients received standard heart failure care only during the follow-up study (time points: $t_1 - t_2$). The primary endpoint was all-cause mortality. Secondary endpoints included days lost due to heart failure readmissions.

Results
No reduction in all-cause mortality was shown for the TM intervention patient group (hazard ratio: 0.83; 95% confidence interval, 0.57 to 1.20; $p = 0.32$) when compared to UC patients in the long-term. The number of days lost due to heart failure readmissions was significantly lower in the TM group (7.3 ± 12.6), compared to the UC group (11.8 ± 18.6) ($p = 0.04$).

Conclusion
While an initial 6-month telemonitoring program was not associated with reduced all-cause mortality in CHF patients during the follow-up period after termination of monitoring, the significant reduction in heart failure readmissions indicates promising possibilities. Future research is necessary to investigate whether a prolongation of the telemonitoring period can induce more extensive long-term health benefits within this patient population.

Back to Contents
OCULUS study: three-dimensional movie as a new solution to the problem of poor patients' compliance

Balsam P., Borodzicz S., Malesa K., Puchta D., Tyminska A., Ozieranski K., Koltowski L., Peller M., Grabowski M., Opolski G.
1st Chair and Department of Cardiology, Medical University of Warsaw, Warsaw, POLAND

Introduction
Poor compliance of patients with atrial fibrillation (AF) is associated with high risk of stroke. The three-dimensional (3D) movie is suggested to be play a significant role in e-medicine.

Purpose
The purpose of the OCULUS study was to assess the efficacy of the 3D movie in teaching patients about the consequences of AF and pharmacological prevention of stroke. Previous results consisted of 1 week follow-up data. Now we have extended the follow-up to one year.

Methods
The single center prospective study was based on the questionnaire, designed by the authors of the study and included 100 consecutive patients (38% women). The survey contained questions about previous AF history, knowledge about consequences of AF and the role of oral anticoagulants (OAC) in prevention of stroke. Subsequently, the 3D movie was displayed using the oculus glasses and a smartphone. The movie was illustrating the mechanism of stroke in AF and was defining the possibilities of its prevention by using the OAC. Immediately after the projection several other questions were asked according to the movie’s plot. One week and one year afterward similar questions were asked during the telephone conversations with patients.

Results
A previous history of AF was reported in 62% of patients. Before the projection 22% of patients declared stroke a dangerous consequence of AF, 83% immediately after (p<0.0001), 78.7% a week after (p<0.0001 in comparison to the knowledge before watching the movie) and 73% one year after the projection (p<0.0001 when compared to the knowledge before watching the movie). As the drugs reducing the risk of stroke OAC were chosen by 68% of patients before watching the movie, 95.7% a week after (p<0.0001) and 92.2% one year after the projection (p<0.0001 in comparison to the knowledge before watching the movie). 3D movie was approved as an interesting tool to inform about the consequences of AF by 98% of patients. 99% of patients responded, that they would like to watch similar movies concerning other various diseases. 97.9% of patients declared taking prescribed OAC in the future according to the knowledge of AF consequences.

Conclusions
The OCULUS study reveal, that 3D movie is useful in transferring the knowledge about the consequences of AF and the role of OAC in prevention of stroke. It is suggested, that 3D movie may become a solution to the problem of poor patients’ compliance.
A mobile application for heart failure management

Vodopija A., Baert A., Pardaens S., Clays E., Lustrek M.

1 Jožef Stefan Institute, Ljubljana, SLOVENIA; 2 Ghent University, Ghent, BELGIUM

Background
Self-management in chronic disease such as congestive heart failure (CHF) is increasingly seen as critical for the patients’ health and quality of life. It has been shown that an appropriate and consistent self-management helps to maintain clinical stability, and reduces mortality risk and hospital admission. However, it requires a big commitment from the patients as they are obliged to monitor their symptoms and physiological parameters such as blood pressure, and - even more importantly - adhere to their medication, diet and exercise regimes, etc. Mobile health technologies have emerged as a way to simplify this task and actively engage patients in self-management. Several mobile applications have recently been developed for this purpose. Their main functionality is to track the information relevant for the patients’ health, while the guidance they provide is general and usually relatively simple. In addition, as far we know, no existing application includes all topics relevant for CHF management; most of them focus only on one or two problems (e.g. medication adherence, physical activity, etc.).

Purpose
The main purpose of this study was to build a mobile application for the self-management of CHF, which includes all the relevant topics and provides an appropriate guidance to the patients.

Methods
A systematic review was conducted regarding models predicting mortality/hospitalization and quality of life in CHF patients. This information was synthesized with existing guidelines for the treatment of CHF and expert opinions, and translated into decision models and content to be administered through a mobile application.

Results
Using the described method, we were able to select five important topics concerning self-management for CHF patients, which are also included in our application: physical activity, medication, nutrition, monitoring of symptoms and physiological parameters, and environment management. The application has access to the patient’s health record, is connected to a monitoring wristband, and keeps a record of the user’s past actions. The guidance it provides is thus personalized based on the patient’s data. For example, the exercise programme depends on the patient’s physical capacity and current heart rate, while the nutrition education is adapted to the patient’s comorbidities (diabetes etc.) and focuses on topics the patient has difficulties with.

Conclusion
Although there are several mobile applications for CHF management on the market, none provide compressive guidance to all relevant self-management topics identified through the literature review, and they do not offer a significant degree of personalisation. With our application, we hope to address these shortcomings. Its decision models and content have been validated by medical experts, while the application is still in development and has to be validated in real-life situations.
A multidisciplinary smartphone based virtual clinic to support patients with Acute Coronary Syndromes: A qualitative study on healthcare providers' perspectives

Bashi N., ¹ Varnfield M., ¹ Walters D., ² Karunanithi M. ¹
¹ CSIRO, Brisbane, AUSTRALIA; ² Queensland Health, Brisbane, AUSTRALIA

Background
Post discharge interventions are limited for patients with Acute Coronary Syndromes (ACS) due to few scheduled visits to outpatient clinics and travel from remote areas. Smartphones have become viable lifestyle technology to deliver educational and health interventions following discharge from hospital.

Purpose
The purpose of this study was to identify the needs of delivering a mobile health interventions for post-discharge management of ACS patients through a multidisciplinary team focus group.

Methods
We conducted a focus group among healthcare professionals (N=10) from a large metropolitan hospital in May 2017. These participants from a multidisciplinary team contributed to a one hour discussion by responding to eight questions relating to applicability of a smartphone-based educational and health interventions. Descriptive statistics of the focus group data were analysed using Statistical Package for the Social Sciences (SPSS) version 21 for Windows (SPSS Inc., Chicago, IL, USA). The qualitative data were analysed according to relevant themes extracted from the focus groups’ transcription and using a qualitative description method NVivo 11 software program.

Results
The mean age of participants was 47 years (SD: 8); 3 were cardiologists; 2 nurse practitioners; 2 clinical nurses; 2 research scientists and; 1 physiotherapist. Of these participants, 70% had experience using eHealth intervention during their professional practice. Four major themes and their subthemes emerged from the qualitative analysis. Healthcare providers indicated that comprehensive education on diet particularly providing daily meals’ plan is critical for ACS patients. In terms of ACS symptoms, a strong recommendation was focused on educating patients instead of daily monitoring of chest pain and shortness of breathing due to subjectivity and insufficient information for clinicians. Findings also suggested that monitoring health measures such as blood pressure and weight may result in increased awareness of patient physical health, yet may not be sufficient to support ACS patients via the smartphone-based intervention. Therefore, monitoring pain and emotional status along with other health measures was recommended. Real-time support via face time or video conferencing was indicated as motivational and supportive for patient engagement and self-monitoring. The general demography of ACS patients being older, having low educational level and lack of computer skills were identified as potential barriers for them to engage with the smartphone-based intervention.

Conclusions
A smartphone-based program that incorporates the identified educational materials and health interventions would be able to motivate ACS patients to engage with the multidisciplinary intervention and improve their health outcomes after discharge from hospital.

Back to Contents
Can we have confidence in oscillometric methods for non-invasive measurement of blood pressure?

Celler B., Ahmadreza A., Le P., Ambikairajah E.
University of NSW, Sydney, AUSTRALIA

Blood pressure can be measured invasively or estimated non-invasively. However, non-invasive (NIBP) methods are more popular because of ease of use, reduced risk and reduced patient discomfort and the use of automated electronic blood pressure measurement devices is rapidly increasing. A number of automated devices are available to measure blood pressure by both auscultatory and oscillometric techniques but most NIBP monitors used for at-home telemonitoring are based on oscillometric techniques where the systolic and diastolic pressures are empirically determined, based on the mean arterial pressure, by reading the value of the cuff pressure when the oscillation amplitude is at some fraction of its maximum amplitude.

This method is employed in most automated NIBP devices but is incapable of highly accurate BP estimation, and has been found to be not suitable for use in many clinical applications.

**Objectives**

To review the evidence for the accuracy of oscillometric NIBP monitors with reference to both classical sphygmomanometry and intra-arterial pressure recorded via an indwelling catheter and to propose a new measurement modality for NIBP measurement, based on new sophisticated algorithms which allow us to identify the reason for the large errors in oscillometric NIBP measurements relative to an auscultatory method similar to classical sphygmomanometry.

**Methods**

We recorded 16,850 NIBP oscillometric and auscultatory recordings from 113 patients over a period of 6-12 months. Of these, we randomly selected 512 records that were not disturbed by measurement noise or ectopic beats. We were then able to analyse these recordings simultaneously using both a standard fixed ratios oscillometric method ($RS = 0.55$, $RD = 0.55$) and a new method based on the analysis of the energy of the Korotkoff sounds.

**Results**

The Bland-Altman plots for systolic pressure, comparing our algorithmic auscultatory method to the oscillometric method is shown below.
Conclusion
For the fixed oscillometric ratios chosen for this comparison, the error in the mean difference between the oscillometric method and the auscultatory method was 2.0 mmHg, the sum of squares error (SSE) was 6.3 mmHg, the r² value was 0.79 and the Reproducibility Coefficient (RPC=1.96*SD) was 12 mm Hg or 8.5%. This means that > 5% of measurements was in error by > 12 mmHg. For Diastolic pressure, the results are substantially worse, with a systematic bias of 3.4 mmHg, SSE of 7.2 mmHg and r² = 0.4974. The RPC was 13 mmHg or 19%.
34.5% of systolic pressure estimates based on the oscillometric method were in error by more than ± 5 mmHg. In many cases the systolic pressure selected via the oscillometric ratio bore no relationship to the first Korotkoff sound observed. Additional research is required to validate the auscultatory methods presented in this study against intra-arterial measurements and to identify the reasons for errors exceeding ±10mmHg observed in a significant number (8.4%) of oscillometric measurements. The methods presented could also be used to standardize the testing and calibration of NIBP devices.

Back to Contents
SAFE2SCREEN - Can patient initiated kiosk-based self-screening provide an opportunity to identify Atrial Fibrillation within a GP waiting room environment?

Crockford C., Mitchell A., Kaba R., Rudland S., Fay M., Nangalia V.
1 Cardiocity Limited, Lancaster, UNITED KINGDOM; 2 Jersey General Hospital, Jersey, UNITED KINGDOM; 3 St Peter's Hospital, Chertsey, UNITED KINGDOM; 4 Stowhealth Limited, Stowmarket, UNITED KINGDOM; 5 Westcliffe Medical Centre, Shipley, UNITED KINGDOM; 6 Royal Free Hospital, London, UNITED KINGDOM

Introduction
Atrial fibrillation (AF) remains undiagnosed in many patients in the community. We explored the use of a new electrocardiogram (ECG) screening technique to identify patients with AF who were attending GP surgeries for routine appointments.

Methods
The SAFE2SCREEN study deployed 25 novel kiosk ECG screening systems into GP surgery waiting rooms across the United Kingdom. (Figure 1) GP practices were recruited through communications with the Atrial Fibrillation Association and the Anti-Coagulation Europe organisations. The patients visiting the GP practices operated the kiosk systems autonomously and no clinical assistance in their usage was offered. The kiosks used a touch screen to allow the subject to navigate their way through the screening experience, which lasted approximately 60 seconds during which a 30-second Lead I ECG rhythm strip was obtained with electric potential sensors located under the thenar eminence of each hand. Subject information was inputted by the patient. Abnormal ECGs were independently examined by a trained professional.

Results
28,340 GP surgery visitors were screened. The kiosks rejected 2809 readings (9.9% rejection rate) where subjects could not follow the video instructions on how to use the system. 194 confirmed cases of AF were diagnosed (0.68%).

Conclusions
SAFE2SCREEN provided a unique insight into the public perception of screening technology as well as the usability of unattended medical equipment for screening. Every participating GP practice found cases of AF but there was a considerable amount of variation with not only the location for the deployment of the kiosks, the average age of the user but also the practice's ability to receive the data back in and to follow up. Attitudes to the concept of patient-led screening were found to vary considerably. With an AF detection rate of only 0.68%, we question the viability of unattended mass opportunistic screening for the identification of AF but identify that potential exists to extend the role of unattended screening kiosks to allow for a single patient experience to yield more physiological measurement data that can then be cloud verified to provide screening beyond just Atrial Fibrillation which may well be more suited and better received by the GP.
**Long-term continuous ECG telemonitoring in the detection of atrial fibrillation in elderly population: Non-Invasive Monitoring for Early Detection of Atrial Fibrillation - “NOMED-AF” project**

Konka A.,¹ Sredniawa B.,² Zdrojewski T.,³ Kazmierczak J.,⁴ Opolski G.,⁵ Grodzicki T.,⁶ Jedrzejczyk-Patej E.,⁷ Boidol J.,⁷ Stolarczyk P.,¹ Kalarus Z.²

¹ Silesian Park of Medical Technology Kardio-Med Silesia, Zabrze, POLAND; ² Medical University of Silesia, Katowice, POLAND; ³ Medical University of Gdańsk, Gdańsk, POLAND; ⁴ Pomeranian Medical University, Szczecin, POLAND; ⁵ Medical University of Warsaw, Warszawa, POLAND; ⁶ Jagiellonian University Medical College, Kraków, POLAND; ⁷ Silesian Center for Heart Diseases, Zabrze, POLAND

Project NOMED-AF, co-financed by National Center for Research and Development, is conducted by Polish interdisciplinary consortium (4 medical universities, 2 scientific research bodies, 1 business partner) under auspices of Ministry of Health.

**Objective**

The objective of the project is to create and implement into clinical practice long-term non-invasive system of ECG monitoring, enabling early detection of atrial fibrillation (AF), especially asymptomatic (silent) AF across large cohort population aged >65 years. AF is the most common arrhythmia; its prevalence grows with age. It increases risk of ischemic stroke (IS) by 5-fold and is suspected to be responsible for 30% of all IS. Exact percentage of AF patients, especially elderly is still investigated in many countries. Although silent AF is considered to be the same risk factor for IS as symptomatic arrhythmia, data on its prevalence is limited. Standard methods of ECG monitoring fail to diagnose AF in patients at AF risk due to limited or not continuous monitoring time.

**Methods**

This 48-months project started in 2015. In its first stage long-term system for recording and teletransmission, consisting of mobile long-term ECG vest, recorders, docking station and monitoring platform comprising dedicated automatic ECG analysis software was constructed (Figure 1).

Figure 1. Elements of the vest ECG solution.

In the second phase the system was validated. The third ongoing stage is epidemiological study with total number of 3000 patients aged > 65 years, randomly chosen from 6 age cohorts: (65-69, 70-74, 75-79, 80-85, 85-90, >90). Acquired by vest ECG signal (up to 30-days monitoring) is transmitted every 24-hours to the platform. After immediate automatic analysis is visualized in the telemonitoring center and assessed by qualified medical staff to confirm AF episodes. 12-month follow-up of enrolled patients will be performed to evaluate adverse events and antithrombotic treatment in particular in patients with newly AF detection. The last stage assumes preparation of the system for commercial use.

**Results**

The vest recorder system with teletransmission and automatic ECG analysis platform was constructed. The vest system and ECG analysis software were validated according to the project protocol. Fulfilling the validation criteria: > 70% sensitivity of AF detection and the ratio of real signal acquisition time to scheduled time no less than 90%, it was approved for use in epidemiological study. Telemonitoring center has been launched. Since March 2017 epidemiological study has been conducted: ECG transmissions have been acquired and assessed. By June 15th 2017, 640 patients were enrolled into the study.
Conclusions
The project should improve the field of long-term telemonitoring in detecting newly diagnosed AF, especially silent. In elderly, this can prove the reason of unexplained IS. Moreover, such early AF detection can reduce IS incidence.

Back to Contents
**Smartphone application as a follow-up tool for cardiac patients after cardiac rehabilitation: a feasibility study**

**Lunde P., ¹ Bye A., ¹ Kværner K., ² Bergland A., ¹ Nilsson B.B. ³**

¹ Oslo and Akershus University College of Applied Science, Oslo, NORWAY; ² Centre for Connected Care, Oslo University Hospital, Oslo, NORWAY; ³ Institute of Health and Society, Faculty of Medicine, University of Oslo, Oslo, NORWAY

**Objective**

To investigate the feasibility and satisfaction of using a smartphone-application (app), promoting life style changes, after completed cardiac rehabilitation (CR).

**Methods**

Patients were recruited during their last week in CR. They got access to the app, Vett®, for three months. (Figure1) Vett® is an individualized and interactive training method for goal achievement. A supervisor (specialized physical therapist) has access to an admin-interface (figure2) where the patients’ activities are logged and can be viewed. The supervisor can give individualized feedback and the patients may send questions to the supervisor at any time. Before the patients started to use the app, they received one hour of counselling and guidance in setting adherence-related goals with related tasks. During the study, individualized feedback was provided once a week and motivational messages one to three times weekly. If questions were forwarded the supervisor, answer was provided within two working days. Time spent for the supervisor to follow-up the patients were consecutively logged throughout the study. Data on adherence to provided tasks and problems experienced with the app was retrieved from the app-database. User-satisfaction was measured by The System Usability Scale (0-100), weekly goal-achievement weekly registered in the app with a VAS-scale (0-100) and Quality of Life was evaluated with COOP/WONCA and EQ-5D.

**Results**

Fourteen patients, ten men and four women, aged 42-68 years were recruited. The baseline characteristics are given in table 1. All patients used the app for reminders regarding physical activity, exercise and diet. In addition, three had goals and tasks regarding emotional challenges and one used it to quit smoking. All patients received one to three motivational messages each week in addition to weekly feedback through e-mail, and all patients used the app for three months. Weekly follow-up time by the supervisor was in average 88 minutes; six minutes on each patient. In addition, in average seven minutes each week was spent answering patient e-mails and nine minutes to talk to the
service provider for bug fixing and application update needs of the app. Additional results will be available from July 2017 and can be presented at eCardiology in Berlin, November 2017.

Table 1. Baseline characteristics of subjects.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Disease/treatment</th>
<th>Smoker</th>
<th>Years of education after high school</th>
<th>Weekly exercise last year</th>
<th>Exercise capacity ( \text{VO}_{2\text{peak}} )</th>
<th>Goals in the app</th>
<th>Tasks in the app</th>
<th>Weekly reminders in the app</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woman 42</td>
<td>PCI</td>
<td>Earlier</td>
<td>0</td>
<td>3</td>
<td>37,4</td>
<td>3</td>
<td>4</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Man    66</td>
<td>PCI</td>
<td>Never</td>
<td>5</td>
<td>0</td>
<td>35,6</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Man    64</td>
<td>PCI</td>
<td>Earlier</td>
<td>1</td>
<td>1,5</td>
<td>29,4</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Man    55</td>
<td>PCI</td>
<td>Earlier</td>
<td>4</td>
<td>0,5</td>
<td>28,1</td>
<td>2</td>
<td>4</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Man    45</td>
<td>PCI</td>
<td>Never</td>
<td>2</td>
<td>1,5</td>
<td>36,3</td>
<td>2</td>
<td>5</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Woman 68</td>
<td>Cardiac arrest, ICD</td>
<td>Earlier</td>
<td>0</td>
<td>0</td>
<td>16,1</td>
<td>2</td>
<td>4</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Woman 62</td>
<td>PCI</td>
<td>Earlier</td>
<td>5</td>
<td>1</td>
<td>26,6</td>
<td>2</td>
<td>5</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Woman 66</td>
<td>Spasmingina</td>
<td>Earlier</td>
<td>0</td>
<td>0</td>
<td>27,6</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Man    66</td>
<td>CABG</td>
<td>Earlier</td>
<td>0</td>
<td>0</td>
<td>19,7</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Man    68</td>
<td>PCI</td>
<td>Never</td>
<td>7</td>
<td>7</td>
<td>25,4</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Man    52</td>
<td>PCI</td>
<td>Never</td>
<td>4</td>
<td>2</td>
<td>28,1</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Man    66</td>
<td>Myocardial infarction, conservatively treated</td>
<td>Current</td>
<td>3</td>
<td>0</td>
<td>19,7</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Man    62</td>
<td>Valvular surgery + CABG</td>
<td>Earlier</td>
<td>3</td>
<td>0</td>
<td>28,2</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Man    60</td>
<td>Atrial fibrillation, pacemaker</td>
<td>Never</td>
<td>1</td>
<td>4</td>
<td>27,5</td>
<td>2</td>
<td>4</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion**

The personalized and interactive training method Vett® seems to be well-accepted app for long-term follow up after participating in CR program. The management was easy, time spent on follow-up was only six minutes per patient a week, and only minor problems appeared during the study. The effect of the app regarding modifiable risk factors such as physical fitness, cholesterol, triglycerides and blood pressure, need to be assessed in a powered randomized trial.

Back to Contents
ECG quality assessment of dry-electrode cooperative sensors

Rapin M.,¹ Ferrario D.,¹ Pellaton C.,² Haenni E.,¹ Dasen S.,¹ Châtelat O. ¹
¹ CSEM SA, Neuchâtel, SWITZERLAND; ² Hôpital neuchâtelois - Pourtalès, département de médecine, service de cardiologie, Neuchâtel, SWITZERLAND

ECG has been routinely measured for many years with adhesive gel electrodes connected with shielded cables to the centralized ECG electronic device. One of the limitations that prevented alternative solutions better suited for wearables—such as textile electrodes—to replace the classical technology was signal quality that were not demonstrated as sufficient.

In order to solve the issue, we developed and patented active dry electrodes called “cooperative sensors” embedded in a vest.

Since cooperative sensors use a different transducer (dry instead of gel electrodes) and a different way of application (vest instead of adhesive), tests cannot be limited to compliance to medical standards (e.g., IEC60601-2-47 or IEC60601-2-25): a qualitative assessment in a real setting is necessary. This paper presents such assessment.

The developed prototype is able to measure 12 leads of ECG from cooperative sensors embedded in a vest. (Fig 1)

The cabling consists of a bus of two unshielded wires integrated in the textile of the vest. Sensors are located according to the Mason-Likar system. They are clipped in the vest by stud snaps. All sensors have a stainless-steel dry electrode. The vest is simply put on naked skin (no skin preparation) and zipped. The measured signals are streamed by Bluetooth from one of the sensor and displayed in real time on a computer or a smartphone where they are recorded for further analysis. Lead II is displayed as a continuous wave below the 12-lead complexes.

The assessment was performed on one healthy subject (so far). A commercial 12-lead ECG system (Schiller CS-200) was used as reference. (Figure 2)

The electrodes were placed at locations as close as possible to those of cooperative sensors. The protocol was 1) a few minutes in resting, supine position, 2) exercise stress test on bicycle (25W-steps, each 2 min long, from 50W and up to subject’s capability), 3) recovery. Figure 3 shows signals obtained from the reference (black) and from the dry-electrode cooperative sensors (red) during the three phases of the protocol.
The two signals are very similar. When there is some noise on the signals, it appears on both of them simultaneously (which means that the electrical artefact is already present on the body). When there are large differences in shape, they are due to the electrode locations that cannot be exactly the same for the reference and cooperative sensors. This is particularly visible in figure 4 that shows a ventricular ectopic beat captured during the recovery phase.

Figure 4. Ventricular ectopic beat seen from lead II (top), V2 (middle), and V5 (bottom). Note that the differences in morphology comes from the impossibility to place the cooperative sensors (red) and the reference (black) adhesive electrodes at exact.

Figure 5 shows that the baseline wandering is similar for both systems.
The performed assessment showed that the dry-electrode cooperative-sensor technology provides signals—at rest and during exercise stress tests—of quality at least equivalent to conventional 12-lead ECG systems.

Figure 5. Comparison of baseline wandering during motion. Cooperative sensors (red) behave slightly better (no other filter than the basic 0.05 to 150 Hz first-order band-pass filter of the medical standards) than the reference (black).
Validation of a wrist-worn device for the assessment of energy expenditure in patients with chronic heart failure and coronary artery disease

Herkert C., Kraal J., Kemps H.
Máxima Medical Centre, Veldhoven, NETHERLANDS

Background
Cardiac rehabilitation (CR) has proven to reduce repeated cardiac events and cardiovascular mortality. One of the goals of CR is improving physical fitness and physical activity levels. Currently, exercise training programmes are usually centre based and evaluation or monitoring of physical activity is not routinely applied. In order to monitor and promote physical activity in cardiac patients successfully, accurate and non-obtrusive devices to assess physical activity need to be available. The aim of the present study is to validate a wrist-worn activity tracker (Fitbit Charge 2), for the assessment of energy expenditure in two patient categories: patients with chronic heart failure and patients with coronary artery disease. So far this device has only been validated in healthy individuals. However due to impaired exercise tolerance and use of heart rate lowering medication (betablockers), these results cannot be extrapolated to cardiac patients.

Objectives
The primary objective of the present study is to determine the accuracy of a commercial wrist-worn activity tracker (Fitbit Charge 2) for the assessment of energy expenditure in patients with chronic heart failure or coronary artery disease. The secondary endpoint is to determine the accuracy of a wrist-worn activity tracker (Fitbit Charge 2) for the assessment energy expenditure during cycling and walking activities.

Methods
This is a single centre validation study with a comparative design. Energy expenditure assessed by the Fitbit Charge 2 will be compared to energy expenditure calculated from oxygen uptake assessed by breath-to-breath analyses using a mobile device (Oxycon Mobile, CareFusion B.V.) during an activity protocol. During the protocol, low-to-moderate-intensity activities representative for daily physical activity are performed. The Fitbit will be studied in two patient groups: patients (minimum age of 18 years) with stable chronic heart failure with reduced left ventricular ejection fraction (< 40%), New York Heart Association (NYHA) Class II or III; and patients with stable coronary artery disease with preserved left ventricular ejection fraction. A total of 38 patients will participate in the study.

Results
The results are expected in September 2017.

Back to Contents
Heartbeat classification using LSTM recurrent neural networks

Wegrzynowicz P.
Consonance sp. z o. o., Kraków, POLAND

A deep learning approach for the heartbeat classification in the electrocardiogram is presented. The development of learning methods and the availability of distributed cloud computing allows the use of recurrent neural networks for ECG analysis. Recent achievements in the field of the speech recognition prove that the use of deep learning has tremendous potential in pattern classification of time series. A recurrent neural network with the Long Short-Term Memory (LSTM) architecture is applied to classify each of the heartbeats. A simple baseline wandering correction is used as a pre-processing step. The proposed method does not contain the feature extraction stage. Two ECG leads are utilised as the input of the neural network. The use of internal memory units allows to exhibit the temporal nature of the ECG signal. The LSTM architecture prevents errors from vanishing and exploding gradients in the backpropagation learning. The data is split into training and testing datasets. The learning dataset contains approximately 65 000 different heartbeats. Recognized types can be grouped into normal beats, ventricular ectopic beats, supraventricular ectopic beats, fusions and paced beats. The proposed method is validated on the MIT-BIH arrhythmia database and it yields an overall accuracy of 98.7%. The subject-oriented evaluation scheme is also examined. It is performed in the leave-one-out cross validation strategy. Achieved classification performance is comparable to state-of-art results. The application of deep learning methods in ECG analysis allows to obtain satisfactory results. Applied algorithms can be individually adapted to new patients. The developed method is a part of the ECG processing system provided as a cloud computing service.

Back to Contents
Can digital pre-consultation save medical time and improve outcome in cardiology?

Jamal F., Garrier O., Leroux P.-Y., Dementhon J., Lamartine S., Zouaghi O., Staat P., Sanchez I., Champagnac D., Lienhart Y.
Cardiologie Tonkin, Villeurbanne, FRANCE

Waiting time for cardiology consultations is constantly increasing and can compromise the diagnosis and treatment of urgent cases. Pre-entering patient data using digital e-health tools may optimize and modify the care path and potentially increase the available medical time.

**Objectives**

Our goal was to get the patient’s information before the medical appointment (symptoms, cardiac risk factors, previous cardiac tests results. (Table 1)

Table 1. Pre-consultation list and data availability. In addition to the feasibility assessment, we aimed: (1) to estimate the average time saved for each consultation, (2) to test whether this digital data could modify the medical decisions.

**Methods**

We used a web-based interface allowing patients to report their data and calculate a risk score. Sixty-one consecutive new patients scheduled in our outpatient clinic were included. The total list of questions was composed of 48 items. (Table 1) For this study, the referent cardiologist: (1) timed the duration of each questionnaire, (2) marked the number of answered questions, and (3) reported if the early analysis of patient’s information would change the healthcare path (identification of a possible urgent case or prescription of an additional test prior to the scheduled consultation).

**Results**

Patient age averaged 53 years (SD +/- 10 years) and 64% were men. Data availability is summarized in Table 1. For each patient, an average of 27 questions was reported (56% +/- 10% of total). The time necessary for each patient’s questionnaire was 5 min 20 sec (+/- 1 min 15 sec). For an average of 1800 consultations/year/cardiologist, this potentially represents 160 hours of extra medical time, and 320 extra consultations per year and per cardiologist.

Furthermore, the early data analysis allowed the referent cardiologist to identify in this population 17 patients (28%) who would benefit from an additional test prior to consultation, including 4 high risk patients with suspected coronary disease. However, the majority of patients needed assistance to complete the requested information.

**Conclusions**

(1) Digital pre-consultation can significantly reduce each medical examination and increase the available medical time. (2) If available and analyzed beforehand, this data combined with artificial intelligence algorithms can change the care path and may influence prognosis. (3) Improved ergonomics, interface and user experience are important issues to ensure effective use of e-health platforms and data quality. (4) if not sufficient, the pre-consultation process may be coupled and enhanced using complementary tele-consultation.

Back to Contents
**Risk prediction by cyclic variation of heart rate and sleep-disordered breathing assessed from Holter ECGs in post-infarction patients**

Cao X., Mäller A., Barthel P., Schmidt G., Sinnecker D.
Technical University of Munich, München, GERMANY

**Aims**
Sleep-disordered breathing (SDB) is common among patients with heart disease. The role of SDB as an independent risk predictor after myocardial infarction (MI) is unclear. SDB is associated with cyclic variation of heart rate (CVHR), and can be detected from Holter recordings with a positive and negative predictive accuracy of 86% and 100%, respectively. The aim of this study was to apply this detection algorithm to Holter recordings from a large cohort of survivors of acute MI to assess the value of SDB and CVHR for mortality prediction after acute MI.

**Methods**
1538 survivors of acute MI in sinus rhythm were prospectively enrolled and followed for 5-year all-cause mortality. Standard Holter ECGs were recorded at a median of 5 days after MI. RR interval plots were generated from nocturnal (00:00-06.00 am) segments. Only normal-to-normal intervals were used for the subsequent analysis by a previously-described algorithm (1). Briefly, CVHR was defined as ≥3 successive HR increases (arousals) of at least 6 bpm and at least 10 seconds duration, with ≤2 min between two successive arousals. According to a pre-specified cutpoint, SDB was assumed if CVHR was present in ≥ 36 of the first 180 minutes of the recording.

**Results**
SDB was present in 39% of the patients. 5-year mortality in these patients (8.4%) was not significantly different from the remaining patients (11.5%; p=0.07). However, when treated as a continuous variable, the overall percentage of time with CVHR was associated with mortality. The area under the receiver-operating characteristic (ROC) curve was 0.59 (95% CI 0.54–0.65). Interestingly, patients with a low frequency of CVHR episodes had an increased mortality risk: the optimum dichotomy according to Youden’s index was ≤9.5 minutes within the first 3 hours. Such a low amount of CVHR was present in 9.5% of the patients. In these patients, 5-year mortality was 17.8%, compared to 7.3% in the remaining patients (p<0.001). In univariable Cox analysis, the hazard ratio for CVHR ≤ 9.5 minutes was 2.57 (95% CI 1.87–3.53, p <0.001). CVHR ≤ 9.5 minutes remained a strong and independent risk predictor in multivariable Cox analysis considering also LVEF ≤35%, severe autonomic failure, and mean nocturnal respiratory rate, with a hazard ratio of 1.85 (95% CI 1.33–2.57, p<0.001).

**Conclusion**
SDB, assessed from nocturnal Holter recordings as CVHR in ≥ 36 of the first 180 minutes, was frequently found in survivors of acute MI. Its presence was not significantly associated with mortality. However, a very low amount of CVHR (≤9.5 minutes of the first 180 minutes), which was present in roughly ten percent of the patients, was an independent predictor of 5-year all-cause mortality.

**References**

Back to Contents
Characterisation of hypertension based on pulse wave velocity, stress, obesity and physical activity from real-life data collected by connected devices

Bellahsen O.,1 Nikzad N.,2 Chieh A.,1 Roitmann E.,1 Steinhubl S.,2 Modena B.2

1 Nokia Digital Health, Issy-les-Moulineaux, FRANCE; 2 Scripps Translational Science Institute, La Jolla, UNITED STATES

Objectives
Hypertension and elevated pulse wave velocity (PWV) are important, independent risk factors for the development of cardiovascular disease. Yet, the development of cardiovascular disease is complex, and there is increasing evidence that lifestyle factors such as psychological stress, sedentary time, and sleep also play important roles. Hypertension remains difficult to diagnose and treat. The physician office visit provides limited opportunity to assess baseline blood pressures and motivate patients regarding lifestyle changes. Patient compliance with anti-hypertensive medications, for a variety of reasons, remains low. PWV is not being universally measured yet, and the assessment of lifestyle factors is limited. Using new digital health tracking devices at home, blood pressure (BP), PWV, and lifestyle factors can now be assessed accurately and more often.

Methods
In this home-based study, 295 users of commercially-available health tracking devices were consented and enrolled using a mobile app. BP, PWV, heart rate and weight were measured twice weekly for 17 weeks using a blood pressure monitor and a weight scale that measures PWV. Activity trackers recorded physical activity and sleep patterns. Surveys collected by the mobile app were used to report medical history, stress levels and medication usage.

Results
Nearly 60% of enrollees measured PWV and BP at least twice weekly for 12 weeks, resulting in 22888 BP and 22475 PWV measurements. Approximately 1/3 of our cohort reported high perceived stress, 17% had excessive alcohol usage. Roughly 24% of enrollees were diagnosed and treated for hypertension, of which 32% had uncontrolled disease. Enrollees treated with anti-hypertensives had higher age (53 vs. 45 years, p=3.4E-06), BMI (32 vs. 28, p=8.5E-05), PWV (7.8 vs. 7.4, p=2.7E-03), took significantly fewer steps (5776 vs. 7043, p=2.2E-03), and were less likely to have high stress levels (17% vs 34%, p=0.025). Of the remaining, untreated enrollees, 31% had undiagnosed hypertension, defined as an average blood pressure over 12 weeks greater than 135/85mmHg. These participants had higher BMI (32 vs. 26, p=2.6E-11) and PWV (7.9 vs. 7.3, p=4.9E-06), but not a fewer number of steps.

Conclusions
Our platform provides a scalable, accurate, and cost-effective means to assess PWV, blood pressure control and other lifestyle factors at home, providing care providers a holistic picture of individual’s health and cardiovascular risk factors. Our data provides strong evidence that hypertension is commonly undiagnosed or uncontrolled despite treatment. Sedentary time/physical activity and obesity had the strongest relationship with hypertension, while high-stress individuals were less likely to take medication to manage their hypertension. Our new platform allows care providers the ability to better inform and motivate patients, and suggest personalized lifestyle interventions.
Effectiveness and cost-effectiveness of a novel cardiac rehabilitation program for obese patients with coronary artery disease or atrial fibrillation. Study protocol of the OptiCare-XL study

Tenbult-Limpt, Van N.,¹ Uijl, Den I.,² Hoeve, Ter N.,² Kraal J.,³ Kemps H.,¹ Berg, Van Den-Emons R.²
¹ Department of Cardiology, Máxima Medical Centre, Eindhoven/ Veldhoven, NETHERLANDS; ² Capri Cardiac Rehabilitation, Rotterdam, NETHERLANDS; ³ FLOW Centre for rehabilitation and prevention in chronic disease, Máxima Medical Centre, Eindhoven/ Veldhoven, NETHERLANDS

Introduction
Obese patients with coronary artery disease (CAD) currently participate in regular cardiac rehabilitation (CR) programs. However, effects of CR appear smaller than in non-obese patients, and are rarely sustained over time. In addition, obese patients with atrial fibrillation (AF) often do not receive any CR. However, weight loss reduces the burden of AF and therefore CR is expected to be beneficial for AF patients.

Aim
We study the clinical- and cost-effectiveness of a new patient-oriented cardiac rehabilitation program, OPTICARE XL, specially developed for obese CAD and AF patients.

Method
In this multicentre randomised controlled trial, 200 cardiac patients will be included. Participants will be randomized 1:1 to regular CR or an intervention group. In the first three months patients in the intervention group receive 20-24 sessions of exercise training in a set group with other obese cardiac patients. In addition, they receive 12 interactive sessions about healthy weight, four sessions about active lifestyle management, and other regular CR sessions such as psychosocial therapy and stress management. Between three months and one year, the intervention group receives six follow-up meetings, and access to a mobile chat with dietician and other participants. The control group receives regular CR for three months. The main endpoint is health related quality of life, secondary endpoints are physical fitness, body composition, other cardiac risk factors, physical activity levels and costs, assessed at baseline, three months, nine months (control group), 12 months (intervention group) and 18 months after inclusion. Initiator in the OPTICARE XL study is Capri Cardiac Rehabilitation Rotterdam. This work received funding from the Dutch Organisation for Health Research and Development (ZonMw, Grant number 843001702).

Results
The first results are expected in 2019.

Conclusion
This OPTICARE XL study will provide insight in (cost-) effectiveness of a novel cardiac rehabilitation program for obese patients with coronary artery disease or atrial fibrillation. We expect that a tailored program for obese cardiac patients results in improved outcomes compared to regular CR.
Effectiveness of serious games’ design features to promote engagement and improve learning outcomes in healthcare professionals and students: a systematic review protocol

Maheu-Cadotte M-A., Cossette S., Duba V., Fontaine G.
Université de Montréal, Montréal, CANADA

Background
Serious games are interactive electronic applications used within a pedagogical context that promote learners’ engagement through entertainment. Previous reviews have identified the effectiveness of serious games in improving knowledge acquisition and competencies development in healthcare professionals and students. However, serious games’ design features have been found to be highly variable across studies. Design features refer to aspects (e.g. storytelling, graphic) and mechanics (e.g. leaderboard, progress bar, in-game hints) of the serious game. Therefore, we need to systematically assess which serious games’ design features are the most effective in promoting engagement and improving learning.

Purpose
The aim of this systematic review is to assess the best available evidence regarding the effectiveness of serious games’ design features to promote engagement and improve knowledge acquisition, competencies development, and task performance in healthcare professionals and students.

Methods
A systematic search of the literature will be conducted with the assistance of a librarian. The combination of the terms “serious game”, “healthcare professionals”, and “students” will be used to search the following databases: Cumulative Index of Nursing and Allied Health, EMBASE, ERIC, PsycINFO, PubMed and Web of Science. We will also search the reference lists of relevant publications. We will include experimental and quasi-experimental studies assessing serious games for training healthcare professionals and students, published in English or French, and since 2000. Two authors will independently perform study selection and disagreements will be resolved through consensus. Assessment of the risk of bias of included studies will be performed using the Cochrane Collaboration Risk of Bias Tool. Data regarding serious games’ design features will be synthesized qualitatively. Depending on the availability and quality of data, a meta-analysis will be performed.

Results
The review is currently underway. We retrieved 1369 unique references in the searched databases. During this presentation, the protocol of this systematic review will be presented according to the PRISMA-P statement. Preliminary results will also be presented.

Conclusion
To our knowledge, this will be the first systematic review to examine serious games’ design features. The results of this review will guide the development of serious games to promote engagement and to improve the learning outcomes of healthcare professionals and students.

Back to Contents
Simultaneous truth and performance level estimation for R-wave detectors in continuous ECG monitoring

Deserno T.M.,¹ Kashif M.,² Jonas S.²
¹University of Braunschweig - Institute of Technology, Braunschweig, GERMANY; ²RWTH Aachen University, Aachen, GERMANY

Simultaneous truth and performance level estimation for R-wave detectors in continuous ECG monitoring

Objectives
Pushed by smart textile producers and wellness industry, continuous monitoring of ECG will shortly be available but the signal quality will be reduced as compared with Holter monitoring, where the electrodes are placed carefully. Being able to record ECG continuously, real-time processing and analysis is required, aiming at predicting serious adverse events. We aim at improving existing R-wave detectors that fail on noisy, bad quality signals and corrupted measures.

Methods
We applied the simultaneous truth and performance level estimation (STAPLE) algorithm (IEEE Trans Med Imaging 2004;23(7):903-21) to ECG signals. Adopted from image processing, a STAPLE-estimated segmentation is a consensus of all methods and can be used as a reference standard (ground truth). At the same time, STAPLE assesses the performance of different algorithms. We applied STAPEL to 9 R-wave detection methods: Pan & Tompkins (1985), Chernenko (2007), Arzeno et al. (2008), Manikandan et al. (2012), Lentini et al. (2013), Sartor et al. (2014), Liu et al. (2014), Arteaga-Falconi et al. (2015), and Khamis et al. (2016). Experiments are performed on the (i) MIT-BIH database 48 recordings with 2 leads, 300 Hz, and 109,404 beats in total; (ii) TELE database with 250 recordings, single lead, 500 Hz, and 6,708 beats in total; (iii) PTB database with 549 recordings, 12 leads, 1,000 Hz and 72,586 beats in total where 10,655 of this figure is labeled as recorded from healthy subjects, and (iv) 24/7 Holter monitoring of multi-morbid subjects with 60 recordings, 12 leads, 1,000 Hz, and about 37 million beats in total. In the experiments, we have applied precision (also called positive predictive value) and recall (sensitivity). Specificity was not used because of the high number of true negatives. Comparison is based on the F-measure as a harmonic mean of precision and recall.

Results
All measures excellently perform on healthy subjects but the performance significantly drops down when analyzing the 37 million R-waves of multi-morbid subjects. STAPLE improves existing approaches and yields a relative (but not absolute) scale to compare algorithms’ performances. The overall best method was that of Khamis (IEEE Trans Biomed Eng 2016; 63(7):1377-88).

Conclusions
Robust R-wave detection methods are required to analyze continuous data captured with consumer hardware and/or from pathological subjects. Adopted from image to signal analysis, the STAPLE approach improves the results obtained on large, incomplete, and noisy data without manual ground truth. However, better methods still are needed to cope with ECG recordings in future.

Back to Contents
Incidence, risk factors and prognosis of atrial high rate episodes detected by telecardiology of 1226 defibrillator patients.

Surget E., Guā., Don-Moreau L., Finat L., Kyheng M., Kouakam C.
Lille University Hospital, Lille, FRANCE

**Background**
Atrial high rate episodes (AHRE) detected by implanted pacemakers or deï¬’brillators are common. They are associated with systemic embolism and ischaemic stroke.

**Objectives**
To analyze incidence, risk factors and treatment of AHRE detected by telecardiology of defibrillator patients in Lille University Hospital.

**Methods**
1226 patients implanted of defibrillators in Lille University Hospital between January 2009 to December 2016 with telemedical monitoring were included. The primary endpoint was AHRE detection by telecardiology. AHRE were defined by atrial rates of >190 beats for at least 5 min. Exclusion criteria were a history of AF and false detection episodes.

**Results**
Of the 1226 patients included, AHRE occurred in 5.14% of patients. The median age of the first recorded AHRE was 66 ± 15 years. The mean interval from defibrillator implantation to AHRE detection was 67 months. AHRE were asymptomatic in 79.4% of cases. For the other 20.6%, the main symptom was dyspnea. Precipitating factor was usually an infective episode. Obstructive sleep apnea syndrome was not associated with nocturnal AHRE. Risk factors for AHRE were thyroid dysfunction ($P = 0.0047$) and left atrial enlargement ($P = 0.032$). But none of these factors were associated with an increase in AHRE burden. There was no significant effect of systolic left ventricular dysfunction on the presence of AHREs. Regarding heart failure treatment, beta-blockers ($P = 0.070$), angiotensin-converting enzyme inhibitor/angiotensin receptor blocker ($P = 0.82$) or mineralocorticoid receptor antagonist ($P = 0.94$) didn’t significantly reduced AHRE. Median CHA$_2$DS$_2$-VASc score was 2.64 ± 1.38. Anticoagulation was initiated in 88.7% of patients (56.82% VKA, 6.82% dabigatran, 15.91% rivaroxaban, 18.18% apixaban, 2.27% low-molecular-weight heparin). Systemic embolism incidence was 1.6% with one nonfatal stroke 4 months after AHRE detection. Bleeding incidence on anticoagulation was 8.5% with mostly major bleeding (one patient died because of a brain haemorrhage).

**Conclusions**
AHRE are common. They are favoured by thyroid dysfunction and left atrial enlargement. Their thromboembolism risk is low. Initiation of anticoagulation is based on thromboembolism risk assessment; its indication should be reassessed regularly because bleeding complications are common.

Back to Contents
Telecardiology as a diagnostic support to Emergency Care Units (UPA 24h) based on two years’ experience in Rio de Janeiro.

Farah S.,1 Grisolia A.M.M.,1 Andrea B.R.2
1 Universidade do Estado do Rio de Janeiro - UERJ, Rio de Janeiro, BRAZIL; 2 Instituto Estadual de Cardiologia Aloysio de Castro, Rio De Janeiro, BRAZIL

Objectives
Report on the application of telecardiology as a diagnostic support for patients with chest pain admitted at twenty-two Emergency Care Units (UPA 24h) of Rio de Janeiro State.

Methods
Descriptive and retrospective study, based on information in the database of the Cardiology Consultancy Nucleus (CCN) of the Health Secretariat of Rio de Janeiro State. We analysed data of patients admitted with chest pain from January 1, 2012 to December 31, 2013. This was the peak period of CCN activity. A cardiologist was available 24h a day for an interactive teleconsultation. The CCN routinely performed daily calls to all UPA 24h in order to update data of previous consulted admitted patients or search for new cardiologic admissions. The data of each teleconsultancy were organized in Excel worksheets. Teleconsultancy was based on phone contact about initial patient details such as age, gender, date of admission, main symptoms, initial diagnosis and the patient’s relevant medical history. The UPA 24h staff was asked to describe their clinical impression based on anamnesis and physical examination. Electrocardiograms (ECG) were submitted by fax and immediately analyzed by the CCN. Laboratory results and chest radiographies were also evaluated. After teleconsultancy, UPA 24h staff were advised to transfer the patient to cardiology intensive care unit or discharge.

Results
In this 2-year period there were 9,692 subjects undergoing telecardiology consultancies by the CCN. Of this total, chest pains were identified in 5,816 (60%) apparently associated to cardiological cause. On comparing the initial diagnosis made in the UPA 24h with the subsequent diagnosis made by the specialized telecardiology consultants, 1,593 (27.39%) resulted in amended diagnoses. Of this total, initial UPA 24h diagnosis indicated 1,477 patients (92.72%) with acute non-ST elevation myocardial infarction (NSTEMI), 74 (4.65%) with acute ST elevation myocardial infarction (STEMI), 40 (2.51%) with acute lung edema and 3 (0.19%) with tachyarrhythmia. After telecardiology, the diagnoses indicated 89 patients (5.59%) with acute NSTEMI, 174 (10.92%) with acute STEMI, 289 (18.14%) with congestive heart failure, 212 (13.31%) with acute lung edema, 20 (1.26%) with tachyarrhythmia, 385 (24.17%) with unstable angina, 152 (9.54%) with hypertensive emergency, 5 (0.31%) with valvular diseases, 26 (1.63%) with myopericarditis, 113 (7.09%) with chronic kidney failure, 89 (5.59%) with pneumonia and 39 (2.45%) with sepsis.

Conclusions
Telecardiology contributed to better classify chest pain in patients with NSTEMI, STEMI, unstable angina, congestive heart failure, pulmonary edema, myopericarditis, tachyarrhythmias, hypertension and valvular diseases. Therefore the application of telecardiology is feasible, resulting in better identification and classification diagnosis, which might impact in morbi-mortality, hospitalization rates and healthy care costs.

Back to Contents
Tailoring a patient-oriented and resources-based communication plan for long-term follow-up of post-percutaneous coronary interventions patients.

Anwer S.,1 Elbakery A.,1 Moharem-Elgamal S.,1 Ismail M.,2 Kazamel G.,1 Seleem M.,1 Ragy H.,1 Zarif B.1

1 National Heart Institute, Cairo, EGYPT; 2 Médecins Sans Frontières (Doctors Without Border), Cairo, EGYPT

Introduction
Patients undergoing percutaneous interventions (PCI) requires close follow-up. In this study, we established a Post-PCI patient-oriented communication plan; tailored to centre’s resources to maintain and study adherence to management and follow-up plan.

Objectives
We have designed a Post-PCI patient-oriented communication plan; tailored to centre’s resources to ensure patients’ adherence to management and follow-up plan; allow early detection and management of complications. Also to study impact of demographics and disease-related factors on adherence to follow-up.

Methods
We communicated to our post-PCI patients every 3 months, by voice calls and text messages, focusing on patients’ current symptoms, life style, adherence to medications, and reminders to perform laboratory work up and visit our centre for follow-up. Accordingly, we performed an initial data analysis on our registry, from March 2012 to March 2013, and the follow-up outcomes till April 2017.

Results
In terms of demographics, 494 (69.4%) of our patients were males and 218 (30.6%) females. Whole group age ranged from 29 to 80 (Mean ±SD: 53 ± 11) years. Risk factors history analysis showed that 327 (46%) had hypertension 289 (41%) had diabetes mellitus, and 259 (36%) had dyslipidaemia. 131 patients had two or more risk factors. According to indications to undergo PCI, 324 (45.5%) patients were indicated on top of STEMI, 280 (39.3%) acute coronary syndrome (ACS), and 108 (15.2%) chronic stable angina. Table 1 shows sub-analysis of different factors affecting over-all response rates.

<table>
<thead>
<tr>
<th>Methods of communication</th>
<th>Factors</th>
<th>Response rate (%)</th>
<th>Significance</th>
<th>Responsiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice calls</td>
<td></td>
<td>67.8%</td>
<td>P &lt; 0.0001</td>
<td>Higher to voice calls</td>
</tr>
<tr>
<td>Text messages</td>
<td></td>
<td>38.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td>71.8%</td>
<td>P = 0.02</td>
<td>Higher among male patients</td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td>69.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate or Basic education</td>
<td></td>
<td>45.7%</td>
<td>P &lt; 0.0001</td>
<td>Higher among higher education</td>
</tr>
<tr>
<td>High school and above</td>
<td></td>
<td>54.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geographical distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same governorate</td>
<td></td>
<td>55.7%</td>
<td>P &lt; 0.0001</td>
<td>Higher among same governorate residents</td>
</tr>
<tr>
<td>Outside governorate</td>
<td></td>
<td>48.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td>54.5%</td>
<td>P &lt; 0.0001</td>
<td>Higher among urban areas residents</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td>48.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple risk factors</td>
<td></td>
<td>57.5%</td>
<td>P &lt; 0.0001</td>
<td>Higher among patients with multiple risk factors, or DM alone.</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td></td>
<td>53.5%</td>
<td></td>
<td>Lower among those with single risk factor, hypertension or dyslipidemia.</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td>50.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td></td>
<td>50.9%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The average patients' response rates over the five-year follow-up was 68% for calls, and 38% for messages. Currently, we are able to maintain voice calls communication with 92.1% of our patients, excluding who passed away. Figure 1 shows the average response rate during the 5-year follow-up period.

According to patients’ responses about their clinical condition during the follow-up period, we were able to detect 8 out of 13 (61.5%) patients who had in-stent restenosis (ISR), 1 out of 10 (10%) who had a new coronary lesion, all 7 patients (100%) who required re-hospitalisation for progressive signs of heart failure, and 1 out of 4 patients (25%) with recent atrial fibrillation.

**Conclusions**

Our communication plan improved patients’ adherence to their medications, follow-up plan, and awareness of their health status. Voice calls were superior in reaching out to our patients when compared to text messages. Demographic factors, as gender and education; and risk factors, as diabetes and hypertension, can affect patients’ responsiveness. Presence of dedicated staff that directly communicates with patients allowed early detection and proper management of complications that patients may not have been aware of. Eventually, initial results allowed us to maintain our communication plan, and set up our long-term objectives.

Back to Contents
Value-based assessment of blood pressure telemonitoring in hypertensive patients

Ionov M., Yudina Y., Kurapeev D., Kuzmina Y., Zvartau N., Konradi A.
Federal State Budgetary Institution, V. A. Almazov Federal North-West Medical Research Centre, of the Ministry of Health of the Russian Federation., Saint - Petersburg, RUSSIAN FEDERATION

Objectives
Blood pressure telemonitoring with remote counselling (BPTM) confirmed to be effective to improve blood pressure control in hypertension (HTN). However, studies assessing efficacy of telemonitoring from value-based perspective are lacking.
To investigate whether BPTM fits all three principles of value-based approach: clinical benefit, cost-effectiveness and improved patient reported outcome/experience measures (PROMs/PREMs).

Methods
The study included 90 ambulatory patients (52 males/38 females, mean age 49.6±17 years) referred to federal cardiology center due to uncontrolled HTN during 2016. They were randomized to BPTM group (60 patients) and usual care group (UC, 30 patients). Duration of follow-up constituted 3 months with 2 mandatory clinic visits (baseline and end-of-study) in both groups. Between visits BPTM patients used simple, secure web-platform allowing physician-patient communication, storage and blood pressure (BP) and medication data exchange. Clinical efficacy endpoints included BP changes and BP control rate. Economic evaluation settled in Euro currency consisted of cost of illness (COI), incremental cost-effectiveness ratio (ICER), while cost-utility analysis (CUA) was performed using generic PROM (SF-36). PREMs collection was made via PEQ chart.

Results
BPTM group characterized by significantly larger decrease in BP level compared with UC (-16±6 mmHg for SBP; p=0.005; -8.4±3.4 mmHg for DBP; p=0.02) (Figure 1) while the number of antihypertensive drugs remained mostly unchanged (+0.3 drugs in BPTM group; p=0.15).

COI was 2.36 times higher in BPTM (196.9 € vs 83.5 €, p<0.005) and ICER was 8.45 €/mmHg (95% CI 4.9 € to 12 €) per patient. BPTM improved QoL evaluated by PROMs (+2.9 for physical component SF-36, p=0.04) with 0.06 quality adjusted life years (QALYs) gained per patient. The resultant CUA for BPTM was 2698 € per QALY per patient at a willingness-to-pay threshold of 20383 € per 1 QALY gained. (Figure 2)
As for PREMs there was a clear benefit in BPTM group (PEQ +10 points, p=0.01). UC group showed minor changes in QoL (+1.3 for SF-36 PH, p=0.56; +6 points PEQ, p=0.03). No association was noticed between BP and QoL results (P=0.5 for all group comparisons).

**Conclusions**
BPTM being cost-effective and cost-saving tool incorporates both clinical benefits with the patient-perceived value.

Back to Contents

Fontaine G., Cossette S., Maheu-Cadotte M-A.
Montreal Heart Institute, Montreal, CANADA

Objectives
Reducing cardiometabolic risk through brief behavior change counseling (BBCC) is a priority to decrease the morbidity and mortality related to cardiovascular diseases and diabetes. While e-Learning platforms provide benefits for nurses’ training in BBCC in terms of accessibility, intelligent learning environments (ILE) could improve nurses’ learning efficiency, enjoyment and engagement. This pilot study aimed to assess the appreciation of the content, pedagogical approaches and user interface design of an e-Learning platform for BBCC as a first step to guide the development of an ILE.

Methods
We conducted a single-group, pre-post pilot study involving 31 cardiovascular nurses. The e-Learning platform for BBCC consisted of two sessions lasting 30 and 20 minutes. Both sessions included a theoretical introduction to BBCC followed by role-modeling videos showing nurse-client interactions. Clinical situations targeted smoking, medication adherence, physical activity, and diet. Appreciation of the e-Learning platform was assessed at 30 days after the first session using a modified version of the Technology Acceptance Model for e-Learning.

Results
Nurses greatly appreciated the clinical content (mean 6.26, SD 0.59; scale 0–7) and the user interface design (mean 6.22, SD 0.58; scale 0–7) of the e-Learning platform. However, the 3 items that received the lowest scores were related to learning effectiveness compared to other training methods (mean 5.30, SD 1.2; scale 0–7), learning efficiency (mean 5.48, SD 1.05; scale 0–7), and enjoyment while using the e-Learning platform (mean 5.59, SD 1.15; scale 0–7). Nurses also suggested to provide more flexibility by taking into account their prior knowledge and preferences regarding clinical situations.

Conclusions
E-Learning is an ever-expanding field in health sciences education. However, fostering engagement in e-Learning interventions continues to be a challenge. Results of this pilot study build on previous evidence and show the need for real-time adaptation of the e-Learning platform in BBCC to optimize nurses’ learning efficiency, enjoyment and engagement. Artificial intelligence techniques can integrate nurses’ knowledge, goals and preferences and provide personalized learning paths. The development of an ILE in BBCC could then allow for real-time adaptation of the content, navigation, presentation, multimedia and tools of the training to nurses’ needs, potentially optimizing nurses’ knowledge and competence in BBCC.

Back to Contents
A review of eHealth technologies for the management of patients with pulmonary arterial hypertension

Gonzalez-Garcia M., Farhad F., Ding H., Varnfield M., Karunanithi M., Yang I., Feenstra J.

1 Australian E-Health Research Centre, CSIRO, Brisbane, AUSTRALIA; 2 Faculty of Medicine, University of Queensland, Brisbane, AUSTRALIA

**Background**

In the era of new therapies, Pulmonary Arterial Hypertension (PAH) may be considered a chronic disease. New technological advances in smartphone and Internet-based technology offer promise in supporting the management of patients with other chronic conditions such as congestive heart failure or chronic obstructive pulmonary disease. We hypothesize the use of a new smartphone and Internet-based solution for the management of patients with diagnosed PAH can be effective, but with further verification.

**Objectives**

The purpose of this study was to review current evidence in the literature supporting the use of telehealth systems in patients with diagnosed PAH, highlighting possible existing gaps in this field.

**Methods**

Reviewer 1 searched Pubmed, CINAHL and Embase with a combination of controlled vocabulary and free text keywords pertaining to pulmonary arterial hypertension and e-health, such as “Pulmonary Hypertension”, “telehealth”, “telemedicine”, “telemonitoring” or “mobile smartphone applications”. Retrieved records were exported to an EndNote library and duplicates were removed. During the screening at title/abstract level, only clinical studies (involving patients) were selected by Reviewer 1, excluding any other type of communications/studies. On the resulting selected abstracts, two independent reviewers (Reviewer 1 and 2) assessed inclusion criteria for further full-text reviewing (English language literature and peer review article including any of the referred free text key words), which was finally completed by Reviewer 1.

**Results**

Our broad search strategy resulted in 1432 articles (1 duplicate). After screening from Reviewer 1, a total of 33 abstracts were selected to be assessed by Reviewer 1 and 2. Of them, only

![Figure 1. Study flow diagram on literature review “telemonitoring/e-health and PAH”](image-url)
2 papers met inclusion criteria for full text reviewing, which concluded that none of them was specifically designed for the management of PAH patients. (Figure 1).

The covered areas in the current literature circumscribe to wireless assessment of functional capacity (6-minute-walk test) and Pulmonary Artery pressure (hemodynamic monitoring of the Pulmonary Artery pressure through Cardiomems® device).

**Conclusion**
The results of this review showed that the practice of e-Health-based technology towards PAH management is absent. The development and implementation of comprehensive Internet and smartphone-based technology (Apps) for PAH management is an innovative idea that could potentially contribute to empower patients, promote individualized care through self-management and improve the necessary multidisciplinary collaboration into PAH clinics.

Back to Contents
The Kino-cardiograph: Non-invasive inotropic state monitoring via smartphone and wearable connected sensors

Hossein A.,1 Gorlier D.,1 Juarez Del Rio J.I.,2 Mirica D.C.,2 Van De Borne P.,2 Monfils J.,1 Migeotte P-F.1
1 Université libre de Bruxelles, Brussels, BELGIUM; 2 Hopital Erasme, Brussels, BELGIUM

Background
While we see more and more solutions for heart rate and ECG monitoring or remotely via smart applications or connected devices, there are no simple solution for monitoring cardiac inotropic state. There is a huge and unmet need in doing so for post-surgical and heart failure (HF) monitoring in order to adapt treatment. The Kino-cardiograph is such a wearable, automated and non-invasive device able to measure both the chronotropic and the inotropic state of the heart, providing feedback to the patient and the doctor when needed. The potential of Kino-Cardiograph to detect changes of the heart inotropic state in healthy subjects in a clinical environment was tested and validated.

Methods
The Kino-Cardiograph provides a 1-lead ECG, together with linear accelerations and angular motions of the surface of the body with two sensors: one is placed proximal to the heart on the thorax and the other in the lumbar region. A smart application is used to control the Kino and to collect the data via Bluetooth protocol. Data acquired is then sent in the cloud where it is automatically analysed and stored in a database. The system provides feedback in the form of an ECG, heart rate and a direct measure of inotropic state by means of computed heart kinetic energies (HK) from linear (HKlin) and rotational (HKrot) signals. A randomized, double-blind and placebo controlled study was designed to assess the ability of HK to detect an increase in myocardial contractility induced by the infusion of increasing doses of dobutamine in healthy subjects. 34 subjects were tested; 16 males and 18 females. The mean age is 25 y (+/- 2) and the mean BMI is 22 kg/m² (+/- 2). After a basal measure, subjects received 3 gradual doses of physiological serum (5,10,20 µg/kg.min) and then, after a wash-out period of at least 20 min, 3 gradual doses of dobutamine (5,10,20 µg/kg.min). The Kino was used to record signals during 90 seconds at each step.

Results
The analysis was done in full blind: for each subject, the total HK was sorted in ascending order; the 3 highest HK were then supposed to correspond to the 3 doses of dobutamine. A sensitivity of 96.91% and a specificity of 98.01% are obtained with all dobutamine levels taken into account. 100% is reached for both sensitivity and specificity while only considering high doses (10 and 20 mg/kg.min) to detect dobutamine infusion. The total mean HK (Mean±95%CI) are 5,2±1,6 mJ, 25,1±6,2mJ and 31,22±8,1mJ for the respective (0,10,20 µg/kg.min) dobutamine levels.

Conclusions
The ability to correctly classify the level of dobutamine with high specificity and sensitivity is remarkable. The advantages of combined inotropic and chronotropic measures are numerous. The Kino-Cardiograph is a wearable device providing feedback within 3 seconds thanks to automated analysis. Therefore, it is ideal for monitoring outside ICU towards home for post-hospitalization monitoring or HF treatment management. Additional clinical validations are ongoing to demonstrate its full potential.

Back to Contents
Assessment of quality of life in patients with chronic heart failure under conditions of long-term telemonitoring - prespecified substudy of the randomized, controlled Telemedical Interventional Monitoring in Heart Failure (TIM-HF) study

Kähler J., Hofmann T., Deckwart O., Kähler K., Rose M., Stengel A.
1 Universität Leipzig - Faculty of Medicine, Leipzig, GERMANY; 2 Charité Center for Internal Medicine and Dermatology, Department for Psychosomatic Medicine; Charité - Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin and Berlin Institute of Health, Berlin, GERMANY; 3 Department of Cardiology and Angiology, Center for Cardiovascular Telemedicine, Charité - Universitätsmedizin Berlin, Campus Mitte, Berlin, GERMANY; 4 Charité Center for Internal Medicine and Dermatology, Department for Psychosomatic Medicine; Charité - Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin and Berlin Institute of Health; Department of Psychosomatic Medicine and Psychotherapy, University Hospital Tübingen, tübingen, GERMANY

Background
Quality of life is greatly reduced in patients with chronic heart failure (HF). Telemonitoring might be an efficient way of improving patients’ quality of life.

Purpose
The aim of the study is to investigate the course of quality of life in patients with chronic heart failure over a period of at least one year.

Methods
The present study represents a prespecified substudy of the “Telemedical Interventional Monitoring in Heart Failure (TIM-HF) Study”, a randomized, controlled intervention trial (NCT 00543881) investigating the impact of telemedicine on mortality in ambulatory patients with heart failure. Patients with chronic heart failure staged New York Heart Association (NYHA) II/III, left ventricular ejection fraction (LVEF) ≤ 35%, a history of HF-hospitalization were randomized to either a daily remote device monitoring consisting of electrocardiogram, blood pressure and body weight or to standard care provided by the patients' local physician. The primary endpoint was total mortality. Somatic parameters and quality of life were assessed every three months during the first year and every 12 months during the second year using the 36-Item Short-Form Health Survey (SF-36).

Results
A total of 710 patients with chronic HF was enrolled in the study and followed up over a period of at least one year, mean follow-up was 21.5±7.2 months. The primary endpoint of TIM-HF trial was neutral. In the prespecified subgroup of HF-patients with a previous decompensation of HF less than 12 months prior to randomization the secondary endpoint “number of days lost due to HF-hospitalization or death of any cause” was significantly improved in patients that underwent telemonitoring.

Conclusion
Telemonitoring might improve the secondary endpoint “quality of life“ in all study patients undergoing telemonitoring compared to patients receiving standard care only, a hypothesis to be tested in the present study.
Extraction of knowledge of physiological signals based on deep neural networks

Macias E., Morell A., Serrano J., Vicario J.L.
Telecommunications and Systems Engineering Department, Universitat Autònoma de Barcelona, Barcelona, SPAIN

Background
Big Data analysis in eHealth allows extracting knowledge of large amounts of medical data to increase the efficiency of diagnoses and methods of patient monitoring. Besides, working with continuous physiological signals in applications where streaming services are used, data arrives in streams, and if they are not processed immediately or stored, they will be lost forever. Then, storing the most relevant information helps to have predictive diagnoses or to activate other mechanisms, such as alarms and notifications to the expert staff. Therefore, we present a global methodology for knowledge extraction based on neural networks techniques that allow us to find specific pathologies within physiological signals.

Methods
We start by segmenting the signal to find and storage some known pathologies, then they are processed and normalized to have the same length and a normal distribution, N(0,1). Later, a Deep Neural Network (DNN) is trained and finally the trained model is run on new data to find those features. To illustrate it, we present the detection and classification of Cardiac Cycles (CC) in ECG, using two architectures of DNN: Multi-Layer Perceptron (MLP) that take the input data as features and is used to classify; and Convolutional Neural Network (CNN) architecture which combines several convolutional layers to extract features and Fully-Connected layers to classify them. The dataset is composed of 8528 short (30-60 seconds) labeled ECGs, each contains between 20 to 40 CC. There are 4 types of ECGs: Normal rhythms, Atrial Fibrillation (AF), other rhythms and ECG that are very noisy to classify. To test the two architectures, initially 115 ECGs were segmented from each class, extracting a total of 4400, they were then adjusted to the same length, normalized and used to train the networks, dividing the dataset by 60-20-20% for training, validation and testing respectively.

Results
The performance of CNN was higher than MLP with 94.5% vs 68% classifying the CC. In a future analysis, complete ECGs will be classified by combining the information extracted, by CNN, from the individual CC with the heart rate of each patient; its performance is expected to be higher than that obtained by classifying individual cycles.

Conclusion
The most important aspect of this methodology is that it can be extended to other continuous physiological signals, besides the possibility of training a model with few data, less than 4% of the total, generalizing for many patients and avoiding training a network for each one. In addition, the detection of features in these signals allows optimizing their representation by saving only the relevant information, in the study case the type of rhythm, instead of saving the complete physiological signal and having the ability to use this information either to give a diagnosis, analyzing a long signal, or to trigger alarms in patients who are monitored.

Back to Contents