

## Telemedicine: interventional decentralised blood pressure telemonitoring (idTBPM)

### An efficient tool for application by general practitioners and specialists

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#### Summary

Telemedicine comprises different methods of bridging a spatial distance between doctor, medical and care services and patients. These include mere data transmissions as well as alarm functionalities, consultations and therapy recommendations.

A special form of telemedicine application is the interventional decentralised telemonitoring (idTM). Here the patient-practitioner relationship forms the basis for therapy control and optimisation using telemetrical medical data.

To identify areas of indication of idTM, a detailed definition of transferred parameters, alarm conditions and intervention algorithms is required as well as cost efficiency and feasibility studies.

The quality of the telemedical application is determined by the medical quality of the derived actions.

**Key words:** arterial hypertension; telemedicine; blood pressure; therapy

#### Introduction

Over the course of the last 20 years, telemedicine has been introduced, comprising various concepts to bridge a spatial gap between doctor, medical and care services, and the patient, ranging from mere data transmission to measures including alarm functionalities, consultation services or therapy recommendations.

#### Abbreviations

ABDM	ambulant blood pressure monitoring
ESC	European Society of Cardiology
ESH	European Society of Hypertension
HTTPS	hypertext transfer protocol secure
idTBPM	interventional decentralised blood pressure monitoring
idTM	interventional decentralised telemonitoring
SMS	short message service
SSL	secure sockets layer
TBPM	telemetric blood pressure monitoring
TBWM	telemetric body weight monitoring

Common to all these approaches is the absence of immediate, direct collection of clinical data and findings (e.g., like physical examination of the body), as well as therapy initiation and control. The strongest variations between methods are introduced by the actual bridged distance and the quality and quantity of transferred data.

The increasing demand for telemedical solutions can be explained by ageing societies and an increase in chronic diseases with earlier onset, centralisation of medical competence and a decline in medical service coverage in rural areas, as well as an increase in social isolation, with more one-person households and the loss of support networks inside and outside of families. Furthermore, expectations of therapy standards by both patients and medical societies, especially within the narrowly defined targets for blood pressure levels of high-risk patients (compare Nds. *Ärztblatt* 05/2014, Schulz et al.) are to be mentioned. The resulting increase in visits per patient put a strain on medical and economic resources. Thus telemedicine could help to manage an ever-increasing and longer living collective of chronically ill patients.

#### Interventional decentralised telemonitoring (idTM)

A special form of telemedical application is interventional decentralised telemonitoring (idTM). Here the individual practitioner-patient relationship forms the basis for therapy control and optimisation by use of telemetrical medical data.

Essential to the feasibility and success of the method is, besides the demand for therapy optimisation and its socioeconomic relevance, its implementation by an individually and continuously attendant general practitioner or specialist with a deep understanding of the condition to which therapy idTM is applied, and the ability to devise well-defined and where necessary personalised alarm conditions and parameters for consequent medical actions. The method is both convenient and reliable as there is no patient action required to transmit the data. This way also the eld-

erly, in general technologically less well-versed patients, are able to supply nursing staff and doctors with reliable and authentic data for therapy.

To identify possible areas of indication, a detailed definition of transferred parameters, alarm conditions and intervention algorithms is required. In the case of arterial hypertension these requirements are met. The broad application of the method, however, necessitates a cost efficiency and feasibility assessment which is currently being carried out in the study EDiMed, which focuses on the indication "arterial hypertension" (idTBPM, [www.edimed.de](http://www.edimed.de)).

## Technological background

Telemonitoring refers to a combination of medical technology (e.g., scales or blood pressure monitoring devices) and a data transmission unit, such as mobile phones or data modems, enabling the communication of medical telemetry data. Medical parameters measured by the patient at agreed intervals are either stored and regularly communicated or transmitted immediately after measurement. Communication occurs automatically via a suitable data transmission unit (e.g., via Bluetooth) which forwards the measurements to a central database. Data are embedded in a proprietary protocol enabling the unique correlation of patient, monitoring device and measurement, and assuring complete and accurate communication with the receiver. State of the art SSL encryption guarantees a tap proof HTTPS connection between the database and the user. Individually defined thresholds trigger automatic notification of the practitioner and, if applicable, the patient as well by SMS, e-mail or fax.

Communicated measurements can also be accessed using a web browser. An internet connection is all that is needed. After providing authentication information, the individual practitioner gains access to all of his or her patient's data and is granted rights to create new patient data sets and to associate measurement devices with patients.

With respect to diagnostics and therapy, the attending doctor is able to check the transferred data as well as to evaluate the measurements in the individual patient context and if necessary initiate additional steps e.g., contacting via telephone to adjust therapy.

## Arterial hypertension

Hypertension is the leading risk factor for early death with high prevalence and mortality in Europe. The prevalence in men between 45 and 54 years of age in Germany lies between 40% and 70%. Its socioeconomic relevance is increasing owing to hypertensive target organ damage, especially stroke, as well as the rise in the average age of the population. The main reason for the low quality of therapy (worldwide 34%, in Germany 10% to 25% of hypertension patients reach blood pressure values below 140/90 mm Hg) is, besides bad compliance and side effects of medication, suboptimal pharmaceutical therapy including incomplete dose titration and an insufficient number and combination of antihypertensive drugs. At the same time, especially with patients at high vascular risk like diabet-

ics and patients with renal insufficiency, antihypertensive over-medication has to be avoided as well.

To reach the target corridor of therapy outlined above, frequent (every two weeks) visits to the practice are recommended by the ESH/ESC during the medication titration phase [1]. The resulting time constraints on the patient/practitioner contact reduce quality of treatment, adherence to medication, persistence and compliance.

Blood pressure values in the morning are strongly correlated with cerebrovascular events. The American Heart Association is therefore suggesting an observation regimen comprising two measurements, in the morning and in the evening (as an image of the blood pressure during the day). Studies document that data recorded by the patient differ from automatic measurements stored in blood pressure monitoring devices. Moreover, the doctor cannot directly relate these data to clinical events such as symptomatic hypo or hyper-tension as reported by the patient, e.g., on the phone, which might lead to wrong therapy decisions.

In this light, remote observation by means of telemetrical blood pressure monitoring (TBPM or idTBPM) seems to be a good way to enable early assessment of the patients' reaction to their antihypertensive medication. In addition, idTBPM strengthens trust and confidence of the practitioner in the process of individual medication titration and serves to improve adherence to medication by the patient. Especially idTBPM of blood pressure in the morning is having an important role in the prevention of hypertensive events as only meaningful data here can document the necessity to lower the blood pressure during the night and in the early morning by additional antihypertensive medication late in the evening.

The feasibility of the approach for use in practice including alarm criteria established here for the first time, has been proven based on ABDM in a study on former inadequately treated hypertension patients. There were 60 patients treated in a specialised hypertension ambulance, based on an initial ABPM measurement alone or additional telemetric measurements over the course of three months. Patients under telemetric observation exhibited a more pronounced reduction of blood pressure which can be explained by adequate dose titration including an additional dose of the angiotensin receptor antagonist late in the evening [2]. A long term follow-up study showed a long lasting impact of the telemetrical intervention, having an effect for on average 20 months [3].

Amongst other things, the cost effect balance of the method is currently subject of the study EDiMed. Here, first analyses suggest safety of the method and the feasibility of its implementation in practice as well as the particular importance of idTBPM as professional aid for the decision making process of the attending doctor. Furthermore, less frequently described para effects of this telemedical application such as increased perceived quality of life and stronger patient interest in the condition are described in preliminary evaluations of the data.

## EDiMed

The joint research project EDiMed ("Effizienzbewertung von Dienstleistungskonfigurationen in der Telemedizin" –

<http://www.edimed.de/2014/01/08/guideline-effizienzbewertung-von-dienstleistungskonfigurationen-in-der-telemedizin/> – Efficiency rating of service configurations in telemedicine) supported by the German federal ministry of education and research (BMBF) investigates means to assess efficiency of telemedicine services. Participating in EDiMed are the Centre for Performance Research & Analytics of the University of Augsburg, the Chair of Information Management of the University of Göttingen, The Institute of Medical Informatics of the University Medical Centre Göttingen, the Department of Business Informatics of the University of Kassel as well as the Institute for Health Economics and Health Care Management of the University of Bielefeld and the Blutdruckinstitut Göttingen e.V. (“Goettingen Institute of Blood Pressure”). The project develops an efficiency rating tool and aims to devise suggestions suitable to increase efficiency by process analysis taking an interdisciplinary approach.

In order to define processes and benchmarks, case studies on different fields of telemedicine were executed. Here the respective processes and affected systems were protocolled and data for efficiency assessment collected. In cooperation with the Centre of Nephrology Göttingen GbR (NZG) 77 patients were treated in a randomised controlled trial and surveyed with respect to several patient-specific parameters [4].

Focus of the surveys was, e.g., quality of life, protection of data privacy and patient-practitioner relationship. In addition, the attending staff collected and documented data on parameters for the efficiency of a treatment approach from the perspective of the service provider. First evaluations of the data suggest particularly a high potential of telemedical methods to aid processes in practice.

## Conclusions

### Blood pressure telemonitoring for arterial hypertension (idTBPM)

idTBPM is an effective and – cost-efficiency assessment suggests – also efficient tool for the optimisation of blood pressure monitoring ([www.edimed.de](http://www.edimed.de)). The optimised blood pressure levels obtained are maintained over long periods of time.

idTM provides the attending general practitioner as well as specialist with an instrument to optimally monitor personal patients and improve their therapy were applicable. The transferred data and applied alarm conditions are here

defined with respect to the different areas of indication for which different levels of evidence for the effectiveness and efficiency of telemedical methods exist. The consolidation of an existing practitioner-patient relationship, avoidance of data overload through well-defined indication specific alarm conditions and limited necessary time period of application as well as the direct accessible consequential personal medical action of the trusted attending doctor are setting idTM apart from other telemedical applications dominated by centralisation.

Telemedicine is certainly not the answer to all the problems of our changing health system, but as a tool, telemedicine could be a significant enrichment in relation to common diseases after a precise indication.

Finally the following must apply: The quality of the telemedical application depends on the quality of the resulting medical action. This is why intensive training in the institutions applying idTM conducted by specialists in the respective area of indication is essential for the success of the method.

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