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clue medical
**7 case studies in
cardiology and
internal medicine**

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Introduction

clue medical can be employed both as an event recorder and to detect heart rate variability. It enables simple and complex heart rate variability evaluations to be undertaken via a two minute ECG. The bandwidth of the individual RR intervals is analysed in terms of absolute figures and percentages by means of the time domain evaluation. The frequency domain is employed for the measurement of the vegetative nervous system.

clue medical is always employed as an event recorder when it is not possible to document dysrhythmia by means of existing methods of examination, or if therapy monitoring is required in the case of a change in therapy.

With the aid of the simple heart rate variability, certain courses of disease can be thoroughly documented or a risk stratification carried out, respectively. In the event of complex heart rate variability, changes in the vegetative nervous system (stress and relaxation) can be thoroughly documented and, in a series of cases, **clue medical** can be employed for the monitoring of treatments and the review of results.

The case studies

1. **Tachycardia – event recording**
2. **Therapy monitoring for atrial fibrillation**
3. **Dysrhythmia – event recording**
4. **Follow-up of patients with dysrhythmia**
5. **Risk stratification of patients following myocardinfarct**
6. **Follow-up and therapy control of patients with cardiomyopathy**
7. **The impact of other illnesses on the cardiovascular system**

1. Tachycardia – event recording

Some patients often suffer from very fast heart rates up to several times per month. However, it has not been possible to document this because the cardiac dysrhythmia did not occur when the patient was in hospital or had a 24-hour ECG attached.

Case study:

The 32-year-old patient, M. E., reported the occurrence of tachycardia several times per month, usually lasting for just a few minutes.

All previous examinations, such as normal 12 lead ECG's and several 24-hour ECG's, as well as exercise ECG's, had so far not given any indication of the cause of the tachycardia. The patient nevertheless reported of a sudden start and end to the cardiac dysrhythmia, and specified that the heart began to beat "like mad".

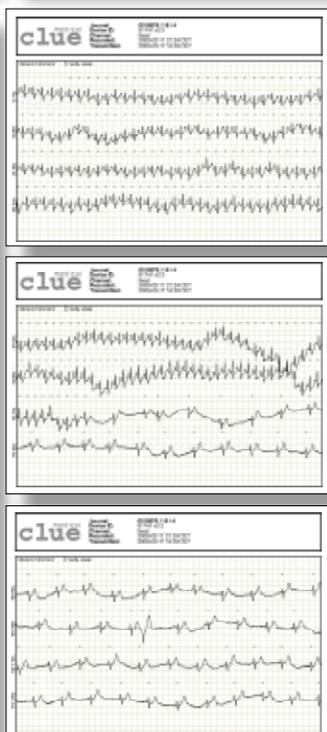
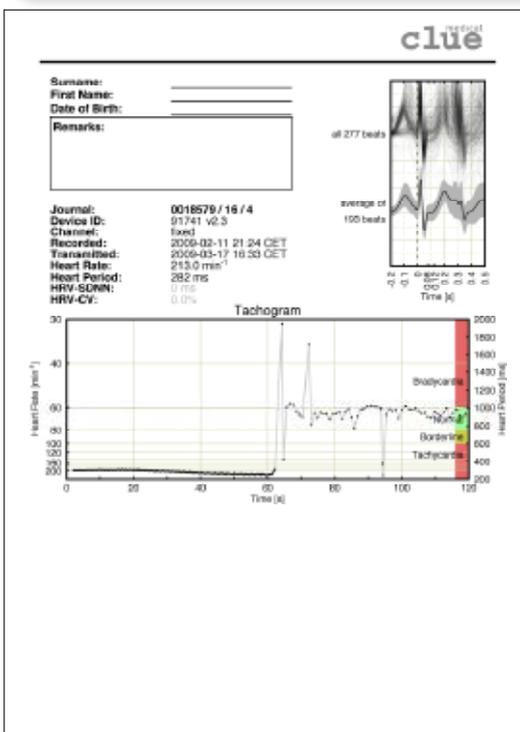
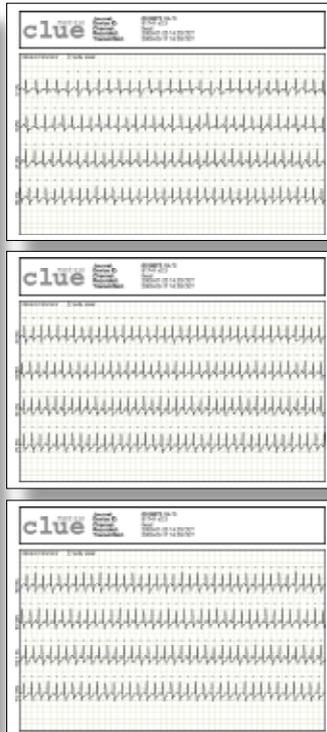
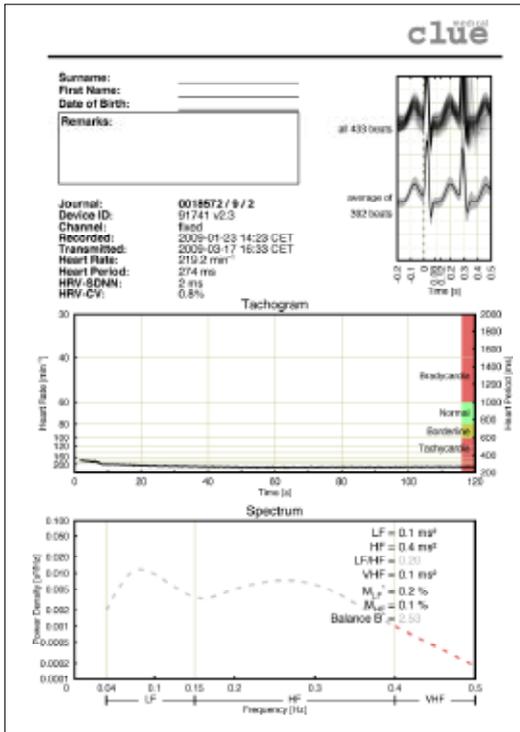
Up to now, it was not possible to record this dysrhythmia. Using **clue medical**, it has ultimately been possible to successfully document several cases. Results show that the condition in question is a so-called narrow complex tachycardia, which requires good access to an ablation therapy.

The patient was admitted to hospital and the dysrhythmia was successfully treated by high frequency ablation. The patient has not suffered any dysrhythmia since.

The employment of clue medical

clue medical should be employed for all unexplained and hitherto undocumented dysrhythmia or cases of cardiac dysrhythmia. In this way, dysrhythmia can be detected earlier and better documented, and a targeted therapy (e.g. an ablation therapy) introduced.

In addition, it is possible distinguish this from other forms of dysrhythmia - such as atrial fibrillation.



2. Therapy monitoring – atrial fibrillation

As a basic principle, it is important to have a performance review as quickly as possible in the case of a change of therapy. **clue medical** makes it possible to receive patients' ambulant recordings just a few hours after the change of therapy. It is thus possible to monitor patients outside the hospital and to detect the success or failure of a therapy in order to be able to introduce changes to the action being taken if necessary.

Case study:

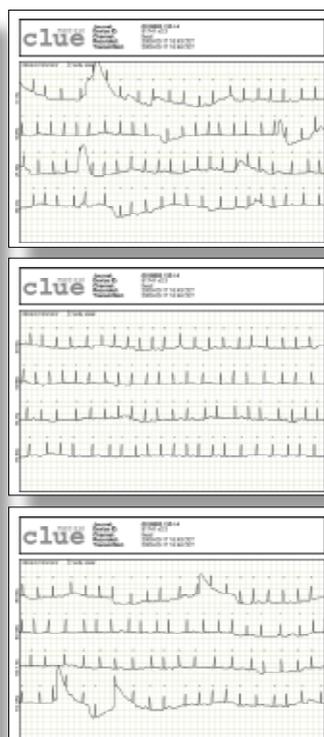
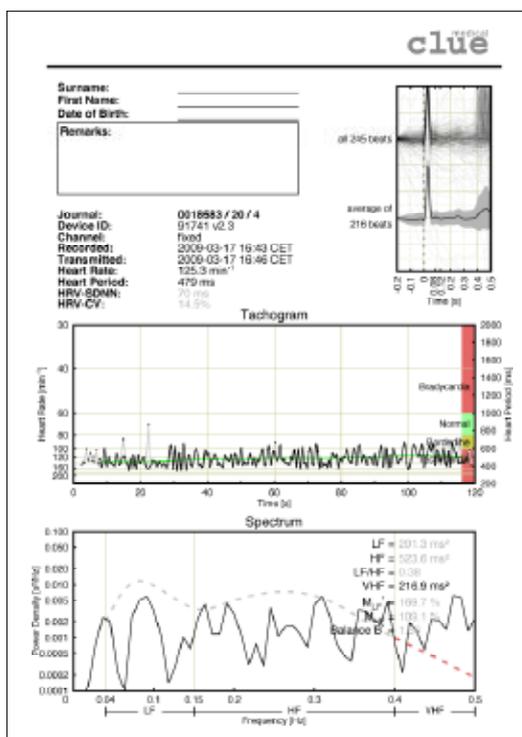
The 63-year-old patient, G. S., has already undergone cardioversion once on account of atrial fibrillation and continues to complain of paroxysmal (episodic) atrial fibrillation.

Since the patient had just mild symptoms following a longer period of undergoing a beta blocker therapy, and attacks only appeared infrequently, he visited the outpatient clinic on account of tachycardia.

A tachycardic atrial fibrillation with an average rate of more than 120/minute could be found in the rest ECG documented there. The atrial fibrillation lasted several days and had a tendency to be on the higher end of the scale. The patient wanted to start a medical trial therapy and was reluctant to undergo a further cardioversion.

A decision was taken to give the patient a **clue medical** appliance to take away. It was intended that the patient should now record ECG's several times per day and document the changes in medication. The patient was transferred from a standard beta blocker onto Sotalol 3 times 80 mg. The patient was introduced to **clue medical** in the outpatient clinic and a first recording was carried out. (See illustration 1 of the first recording.) The idea was to monitor the therapy and, as rapidly a possible, to either confirm the success or to see that the change in therapy didn't show any success in order to then start a cardioversion if need be. The next day it was already possible to show that the atrial fibrillation had largely been suspended under the Sotalol therapy and that there were only brief paroxysmal episodes (illustration 2). The patient was in a stable sinus rhythm just 2-3 days following the change of therapy, which could be thoroughly documented by means of clue medical (illustration 3). The patient meanwhile sends ECG's several times per week. These show that the patient is in a stable sinus rhythm most of the time, apart from a few brief episodes of atrial fibrillation.

Illustration 1



The employment of clue medical

clue medical should be employed in all ambulant changes of therapy. It is therewith possible to very rapidly detect all successes or failures and not simply wait for the next check-up, which may only take place weeks later.

Illustration 2

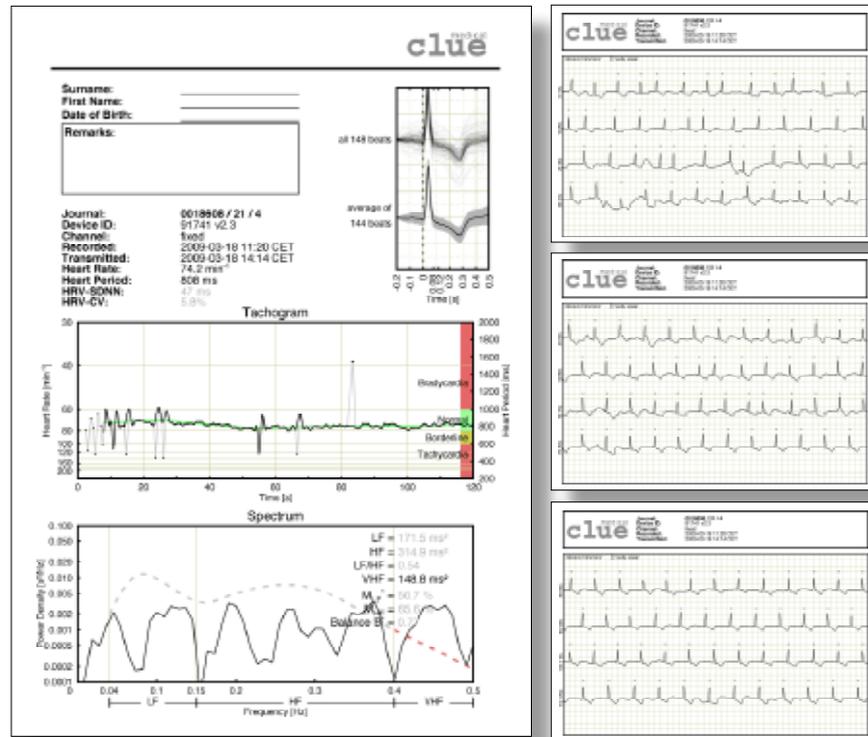
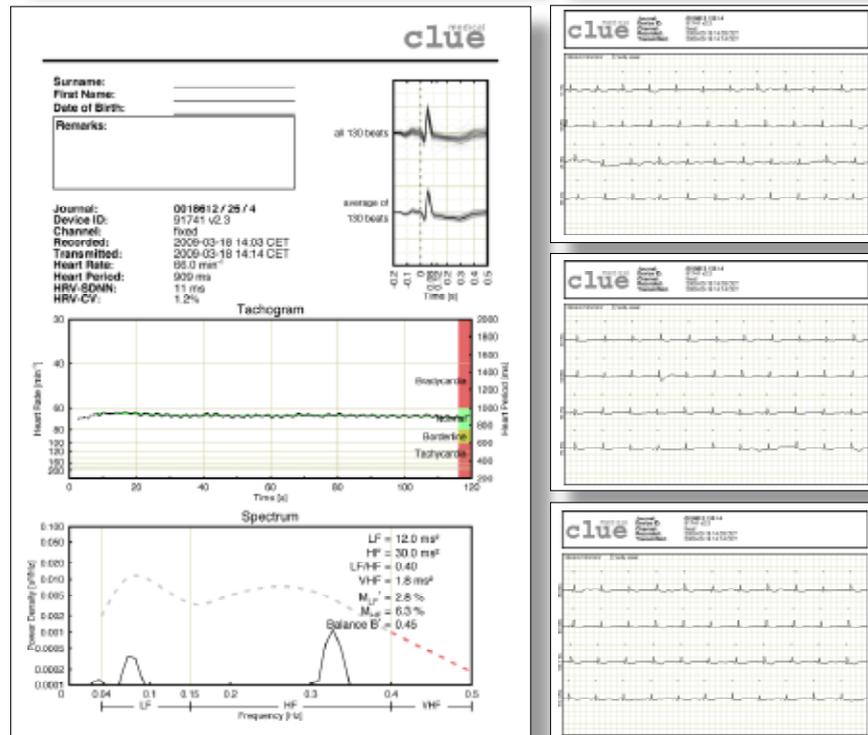


Illustration 3



3. Arrhythmias - Event Recording

Patients often suffer from cardiac arrhythmias which are not captured on either the resting ECG or the 24 hour ECG (Holter) since they occur on an irregular basis.

With **clue medical** it is possible to record the arrhythmia right when it occurs. This way, arrhythmias can be better detected and treated.

All previous examinations such as multiple 12 lead ECGs and some 24 hour ECGs as well as an stress ECG had, up to that point, always yielded normal findings.

Consequently, a psychological cause was already under discussion.

With **clue medical**, it was finally possible to document the problem for the first time.

The patient was able to record the arrhythmia and several short episodes of atrial runs were found. The other cardiological tests such as, e.g. an ECG were also normal, resulting in the arrhythmia being classified as benign and the patient was treated with a β -blocker.

Since that time, the patient has been symptom-free.

The employment of clue medical

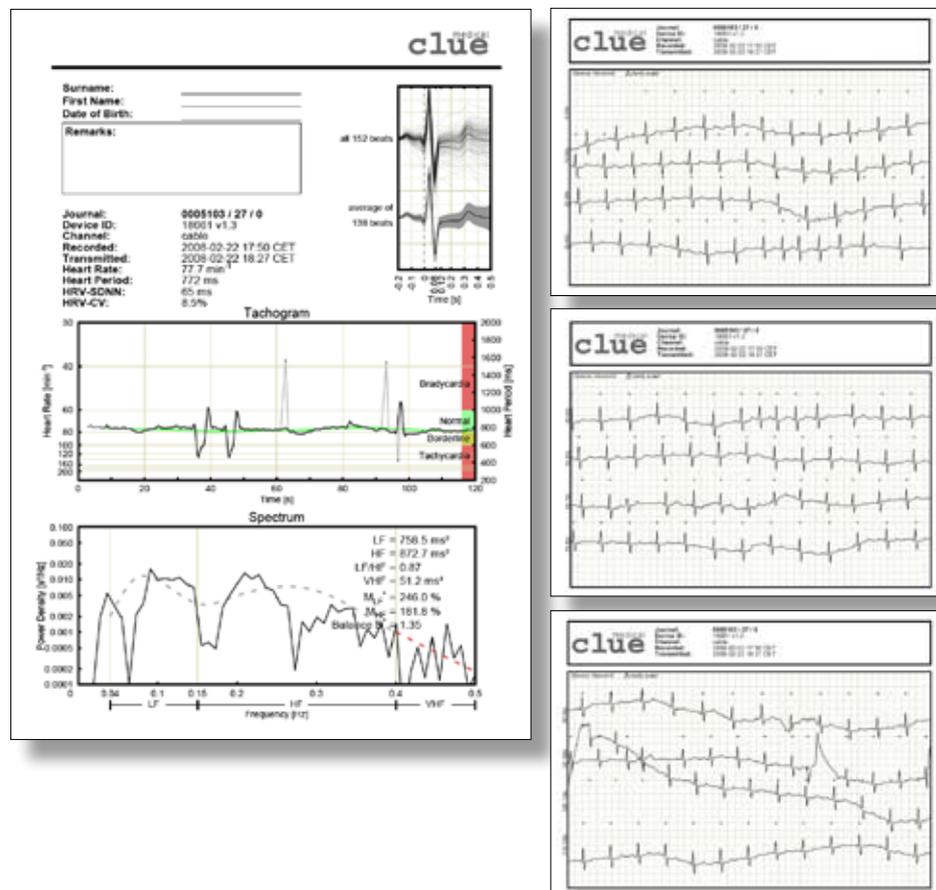
clue medical should be used for all non-clarified and not yet documentable arrhythmias. This way, arrhythmias can often be documented for the first time or ruled out if appropriate.

In the event of arrhythmias which can be treated with ablation therapy, such as, e.g. AV nodal re-entry tachycardia, atrial flutter and others, based on this test, a targeted and in most cases curative course of therapy can be started.

The 52 year old patient R.G. complains of severe extrasystoles which she experiences as being unpleasant and oppressive.

Literature

*Ambulatory cardiac rhythm monitoring
Rao A, Lomax S,
Ramsdale K,
Ramsdale D
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2007 Mar;
68 (3):132-8.*



4. Follow-up of Patients with Arrhythmias

Since arrhythmias mostly only occur at irregular intervals and not all episodes are noticed and/or felt by patients, it is often difficult to perform targeted follow-up and therapy monitoring.

With **clue medical**, patients can record and transmit ECGs themselves over a longer observation period, even several times a day. This enables the doctor to adjust the treatment much better and if necessary initiate other measures such as a catheter ablation.

Although she still presented some episodes of atrial fibrillation even after the ablation, in the course of three months, the arrhythmia stopped almost completely.

Today the patient is completely symptom-free.

The employment of clue medical

clue medical can be used with paroxysmal arrhythmias for the purpose of ongoing general monitoring and rhythm monitoring.

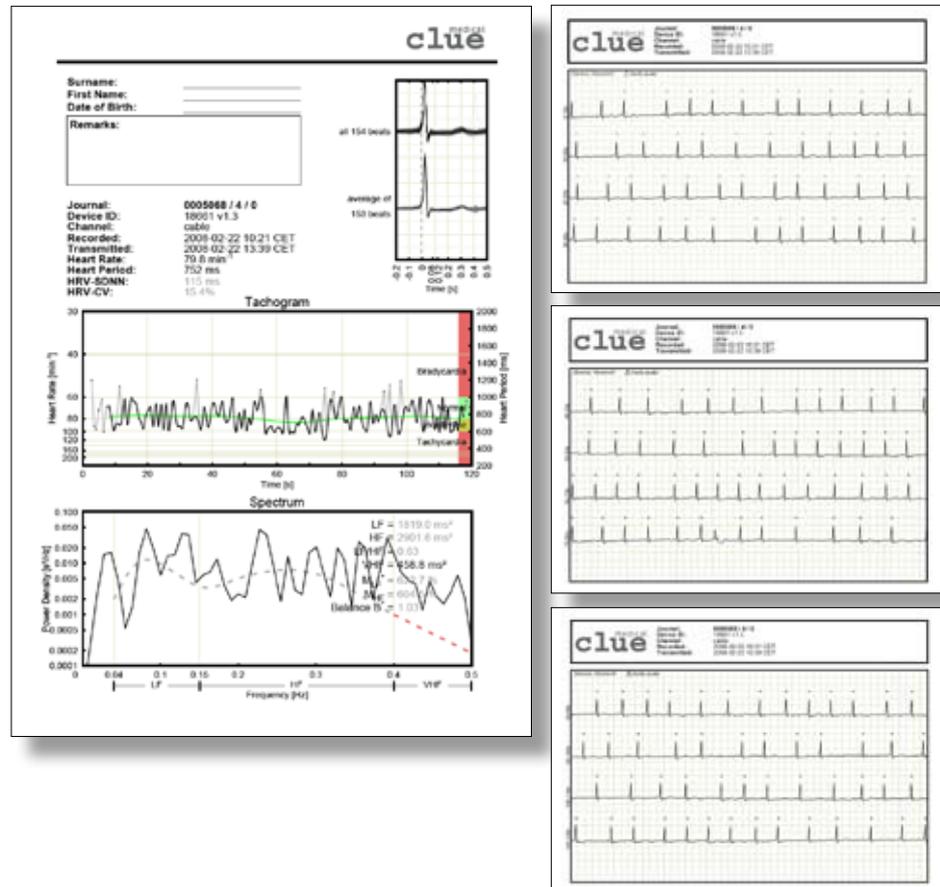
Patients can transmit recordings several times a day. This allows for a significantly better assessment of a course of drug therapy. It is possible to adapt or change the treatment at shorter intervals. Further therapeutic options such as ablation therapy can also be implemented earlier on.

The 73 year old patient had suffered from paroxysmal atrial fibrillation for years.

*She received a **clue medical** and transmitted at least one recording each day as well as additional ones when symptoms occurred.*

Literature

*Autonomic nerve activity and atrial fibrillation
Peng-Sheng Chen, MD,
Alex Y. Tan, MD
Heart Rhythm 2007;
4: Pages 61–64*



5. Risk Stratification of Patients following Myocardial Infarction

In patients with a condition following a myocardial infarction, there exists, with a reduced heart rate variability, a heightened risk of sudden cardiac death (sudden death).

With **clue medical**, it is easily possible to examine such patients after a myocardial infarction on a mobile basis and apply a risk stratification.

In the measurements taken by the patient at home with **clue medical** in the subsequent weeks, noticeably reduced heart rate variability values were recorded on several occasions as well as a slightly increased resting heart rate of slightly higher than 80/min. The reduced heart rate variability was also able to be confirmed in a 24 hour ECG recording.

The patient then underwent programmed ventricular stimulation. In this test, sustained ventricular tachycardia was able to be induced.

A defibrillator implant was recommended to the patient and subsequently performed.

The employment of clue medical

clue medical can be used in patients having suffered a heart attack for follow-up observation.

Particular attention should be given to a changed and/or reduced heart rate variability which is described in many publications as a risk marker for sudden cardiac death (sudden death).

The 58 year old patient T.I. suffered a heart attack in January 2008. Following coronary intervention, the patient was symptom-free. He presented a moderately reduced left ventricle function.

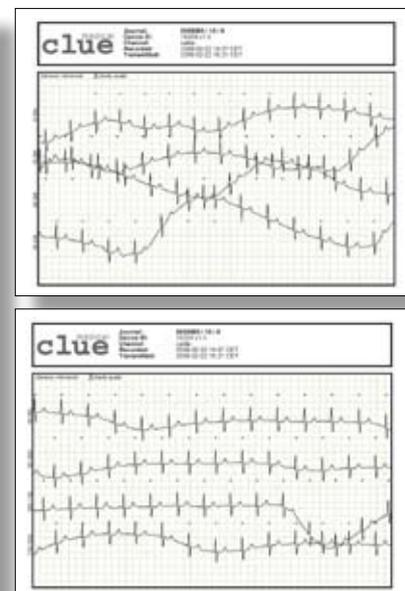
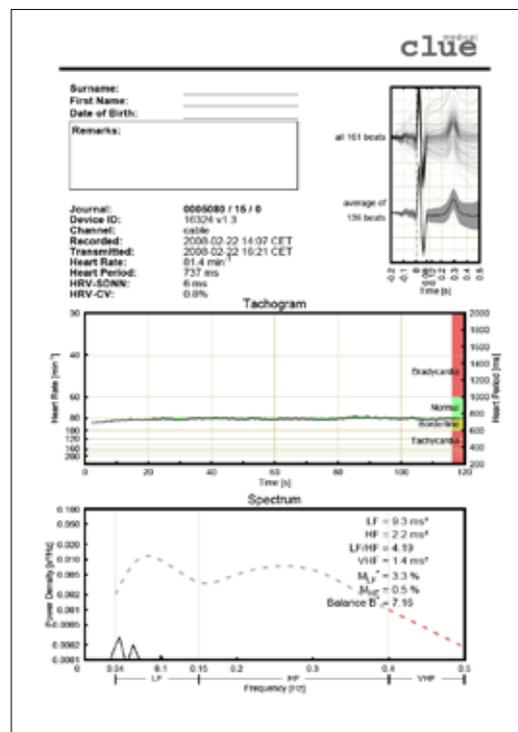
Literature

Noninvasive Risk Stratification for Sudden Death: Signal-Averaged Electrocardiography, Nonsustained Ventricular Tachycardia, Heart Rate Variability, Baroreflex Sensitivity, and QRS Duration, Kenneth M. Stein Progress in Cardiovascular Diseases Volume 51, Issue 2, September-October 2008, Pages 106-117

Heart rate variability in myocardial infarction and heart failure

Nipon Chattipakorn, Tanat Incharoen, Natnicha Kanlop, Siriporn Chattipakorn, International Journal of Cardiology 120 (2007) 289-296

Heart Rate Variability KENNETH C. BILCHICK, M.D. and RONALD D. BERGER, M.D., PH.D. J Cardiovasc Electrophysiol, Vol. 17, pp. 691-694, June 2006



The 53 patient F.P. was diagnosed with dilated cardiomyopathy. The patient's clinical condition worsened with an increase in shortness of breath which lead to an outpatient check-up on 1. 3. 2008.

6. Follow-up and Therapy Monitoring of Patient with Cardiomyopathy

With **clue medical**, using the parameters of heart rate variability, effective and easy outpatient follow-up and therapy monitoring can be carried out.

The drug therapy was changed and the patient's cardiac insufficiency therapy with ACE inhibitors and β blockers was stepped up. At the check-up, a recording was made with **clue medical** according to which a decreased heart rate variability and a high resting heart rate of 93/min were shown.

After just 8 days, an improvement in heart rate variability and a decrease in resting heart rate were observed in the recordings subsequently taken and transmitted by the patient at home.

In a telephone follow-up, the patient confirmed that her condition had improved.

The employment of clue medical

clue medical is ideally suited for use in patients with cardiomyopathy and cardiac insufficiency for mobile outpatient therapy monitoring.

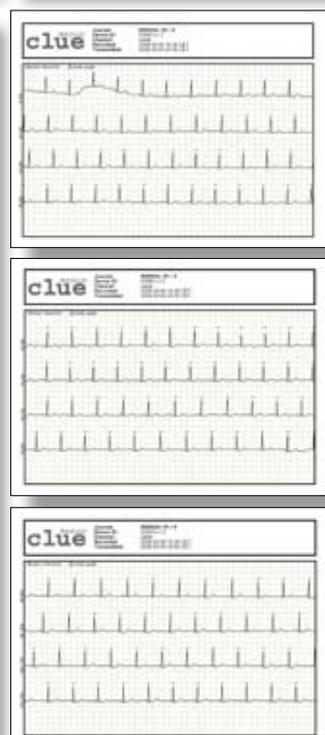
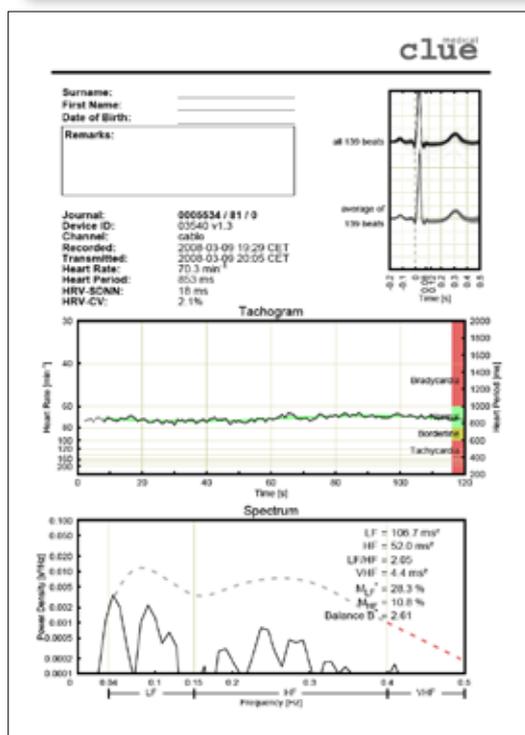
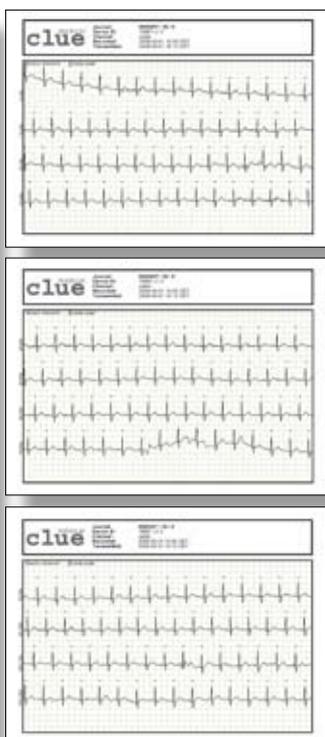
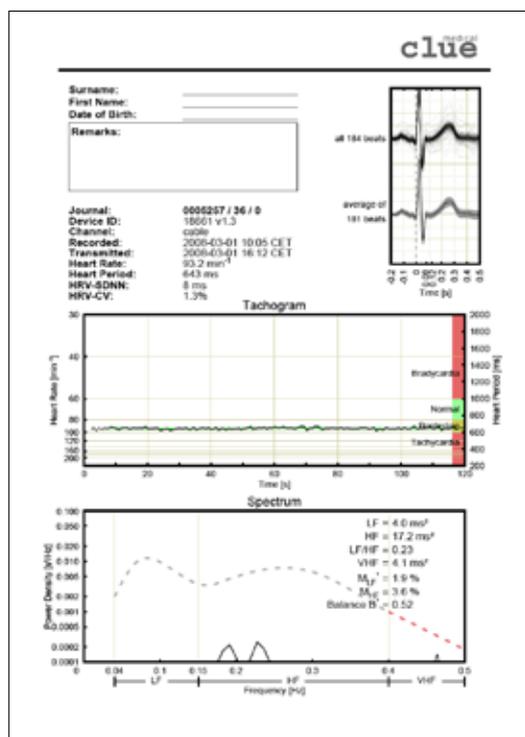
It allows for both early detection of a worsening and verification of subjective improvement in condition.

Literature

Assessment of Autonomic Function in Cardiovascular Disease Physiological Basis and Prognostic Implications
 Marc K. Lahiri MDA, Prince J. Kannankeril MDA and Jeffrey J. Goldberger MD,
FACC Journal of the American College of Cardiology
 Volume 51, Issue 18,
 6 May 2008,
 Pages 1725-1733

Heart rate variability in myocardial infarction and heart failure
 Nipon Chattipakorn, Tanat Incharoen, Natnicha Kanlop, Siriporn Chattipakorn,
International Journal of Cardiology 120 (2007) 289–296

Heart Rate Variability: A Review
 U. Rajendra Acharya, K. Paul Joseph, N. Kannathal, Choo Min Lim, Jasjit S. Suri
Med Bio Eng Comput (2006) 44:1031–1051



7. Effects of other Diseases on the Cardiovascular System

Diabetes, kidney and thyroid disease as well as a number of other diseases are also manifested in cardiac parameter changes, in particular heart rate variability changes.

With **clue medical**, all of the aforementioned groups can be easily tested and monitored in the course of disease.

In the HbA1C test ultimately performed, a value of over 10 (normal: up to 6) was found and the diagnosis was confirmed. The patient was started on insulin therapy.

The 65 year old patient M.B., was suspected of having diabetes mellitus.

A test with clue medical showed a considerably reduced heart rate variability.

This strengthened the suspicion that the patient was suffering from long-standing untreated diabetes.

Since then, the patient has been well controlled and properly treated.

The employment of clue medical

Even with non-cardiac diseases such as diabetes, kidney and thyroid disease, measurement of heart rate variability using **clue medical** can provide interesting additional information with prognostic significance.

Literature

Heart rate variability (HRV) in kidney failure: measurement and consequences of reduced HRV
Reena Ranpuria¹, Martica Hall², Chris T. Chan³ and Mark Unruh¹ Nephrol Dial Transplant (2008) 23: 444-449

Cardiovascular autonomic neuropathy: diagnosis and management.
Vinik AI, Erbas T. Curr Diab Rep. 2006 Dec;6(6): 424-30.

Diabetic Autonomic Neuropathy
Aaron I. Vinik, MD, PHD, Raelene E. Maser, PHD, Braxton D. Mitchell, PHD and Roy Freeman, MD
Diabetes Care 26: 1553-1579, 2003

