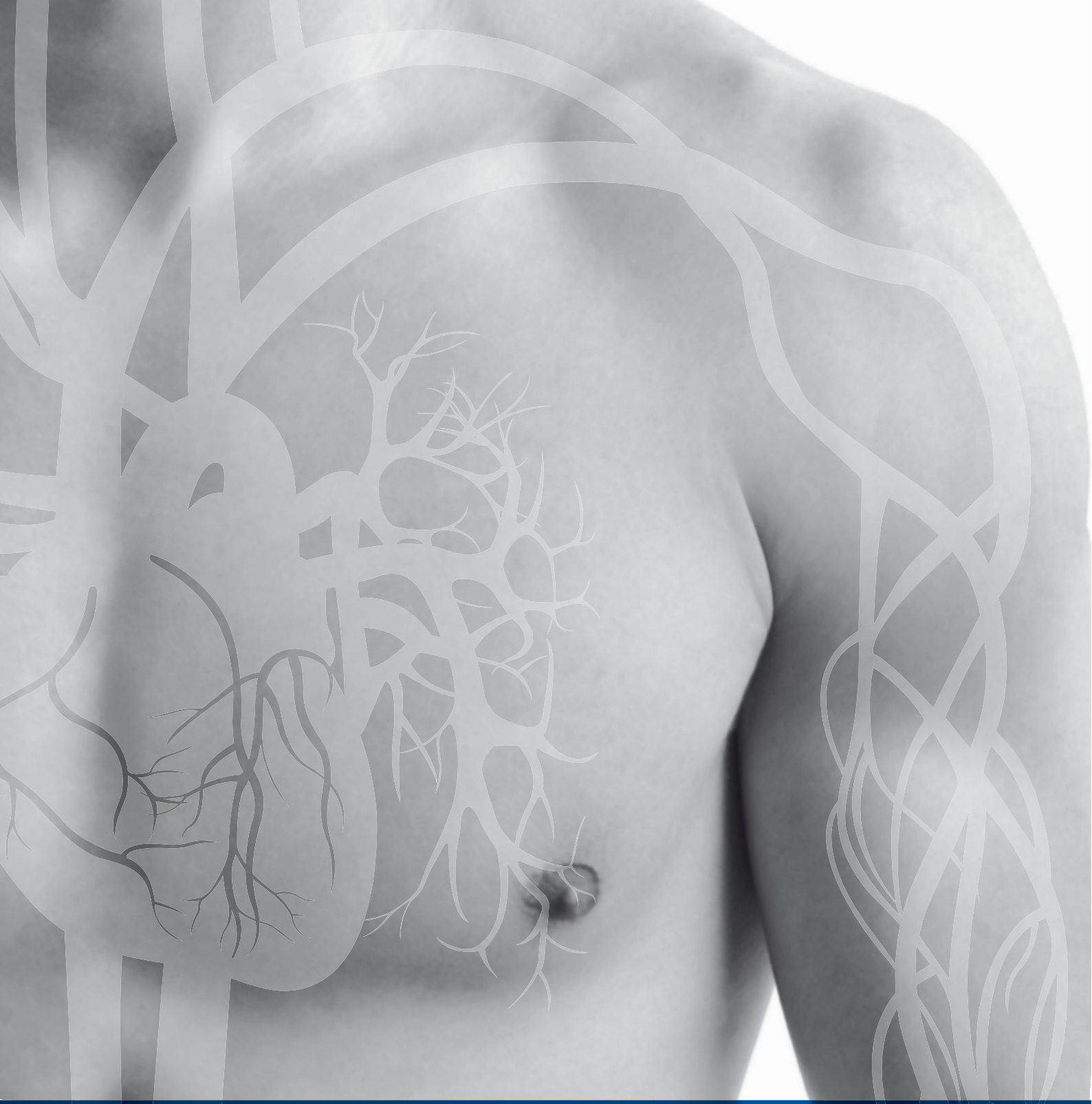


THE 6 VITAL SIGN

IMPEDANCE CARDIOGRAPHY WITH ACM TECHNOLOGY

arterial compliance modulation

THE NEW DIMENSION IN CARDIOVASCULAR DIAGNOSIS AND MONITORING

OPTIMISED FOR FLUID MANAGEMENT

medis

APPLICATIONS

MONITORING AND FLUID MANAGEMENT

Intensive Care Unit
Emergency Department
Heart Failure
Anaesthesiology
Intermediate Care
Paediatrics

- establish baseline hemodynamics
- evaluate and manage the fluid level of a patient
- trend and detect hemodynamic changes for timely intervention
- monitor drug titration to evaluate and optimise treatment
- early identification of the development of oedema by measuring TFC
- possible reduction of catheter use or when the catheter is withdrawn
- when a catheter is too risky, invasive or costly

*"… bioimpedance cardiography has been shown to be accurate and clinically interchangeable with the existing technology of Pulmonary Artery Catheterization." *1*

*"Measurements are highly reproducible on same-day determinations and show device sensitivity to normal hemodynamic changes on inter-day measurements. The availability of expected hemodynamic ranges provides a baseline for objective determination of responses to therapeutic interventions." *2*

HYPERTENSION MANAGEMENT

Hypertension Clinics
Physician' s Office

- determine cause of high blood pressure in order to target, optimise, and validate medications
- define most effective antihypertensive drug combination (Beta-blocker, ACE inhibitor, Diuretic and others)
- balance systemic vascular resistance, cardiac output and fluid level (TFC)
- measure aortic pulse wave velocity to evaluate arterial stiffness as an independent predictor of cardiovascular risk and to monitor drugs that can improve it
- diagnosis of pre-eclampsia

*"… non-invasive hemodynamic management achieved superior BP levels and control rates, when compared to management by experienced hypertension clinicians. Our results suggest that sequential non-invasive hemodynamics provide effective guidance in drug selection and titration in treatment of resistant hypertensives." *3*

*2007 Guidelines for the Management of Arterial Hypertension. *4*

CARDIOVASCULAR DIAGNOSIS

Rehabilitation
Physician' s Office

- evaluate heart performance by different function tests (orthostatic test, Valsalva manoeuvre)
- measure aortic pulse wave velocity to evaluate arterial stiffness for cardiovascular risk stratification
- combine with the measurement of Ankle-Brachial-Index (ABI) to analyse arteriosclerotic changes using the VasoScreen device

*"Because arterial stiffness is an independent predictor of cardiovascular risk, there is now great interest in its use for cardiovascular risk stratification and to monitor drugs that can alter / improve aortic stiffness." *5*

PACEMAKER ADJUSTMENT

Electrophysiology
Physician' s Office

- optimise AV-delay and VV-delay in multi-chamber pacemakers
- resynchronisation therapy (CRT)

*"In patients undergoing ventricular resynchronisation therapy, AV delay optimization based on CO determination by impedance cardiography is comparable to that measured by transmitral flow pulsed Doppler. However, ICG seems a more objective and simpler technique." *6*

PHARMACEUTICAL CLINICAL TRIALS

Phase I – III Studies

- facilitate early decision making in drug development and clinical trials

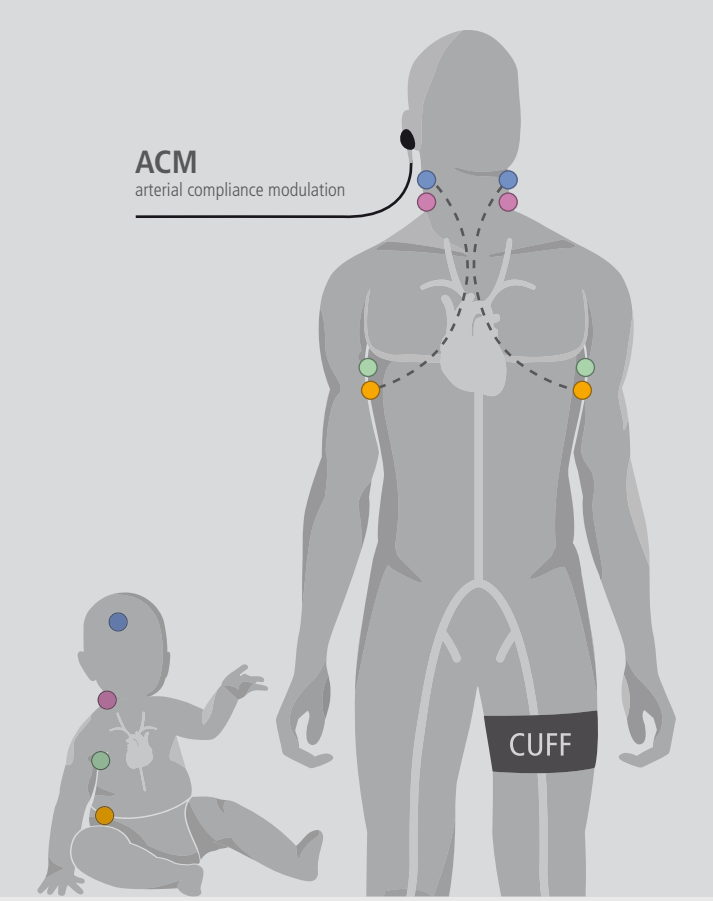
METHODS

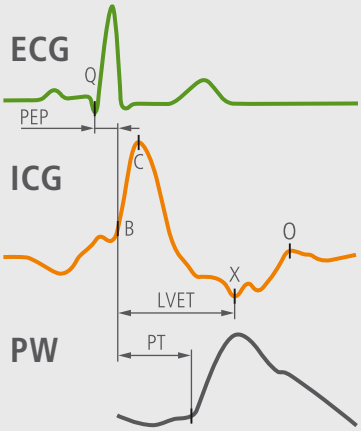
IMPEDANCE CARDIOGRAPHY (ICG)

Changes in volume and velocity of blood in the aorta cause variations in the thoracic bio-impedance which is measured and displayed as the ICG waveform. This signal is applied to innovative algorithms to provide key hemodynamic parameters non-invasively and continuously. The accuracy of the method is further improved by the **arterial compliance modulation technology (ACM)** for which a special ear clip has to be placed.

AORTIC PULSE WAVE VELOCITY (PWVao)

The opening of the aortic valve, when the blood is pumped into the aorta, is defined as the B-point in the ICG signal. On the upper leg a pressure cuff is placed to measure the arrival of the Pulse Wave (PW) and to define its Propagation Time (PT). Taking into consideration the distance between aortic valve and pressure cuff the aortic Pulse Wave Velocity (PWVao) can be calculated to evaluate arterial stiffness for cardiovascular risk stratification.





Q	Beginning of ventricular depolarisation
PEP	Pre-Ejection Period
B	Opening of aortic valve
C	Maximum systolic flow
X	Closing of aortic valve
O	Opening of mitral valve
LVET	Left Ventricular Ejection Time
PT	Propagation Time

PARAMETERS

FLOW

HR	Heart Rate	Heart beats per minute
BP	Blood Pressure	Pressure exerted by the blood on arterial walls
SV **SI**	Stroke Volume Stroke Index	Amount of blood pumped by the left ventricle with each heart beat
CO **CI**	Cardiac Output Cardiac Index	Amount of blood pumped by the heart in one minute

CONTRACTILITY

VI	Velocity Index	Reflects the peak velocity of blood flow in the aorta during systole
ACI	Acceleration Index	Reflects the maximum acceleration of blood flow in the aorta during systole
HI	Heather Index	Contractility indicator
PEP	Pre-Ejection Period	Duration of electrical systole equal to isovolumetric contraction phase
LVET	Left Ventricular Ejection Time	Duration of mechanical systole; time interval between opening (B-point) and closing (X-point) of aortic valve
STR	Systolic Time Ratio	Ratio of electrical systole to mechanical systole
FTc	Corrected Flow Time	LVET related to Heart Rate

FLUID

TFC	Thoracic Fluid Content	Indicator of chest fluid status
TFCI	TFC Index	TFC, normalised to body size

WORK

LCWI	Left Cardiac Work Index	Work the heart must perform to pump blood each minute, normalised to body size
LSWI	Left Stroke Work Index	Work the heart must perform to pump blood each heart beat, normalised to body size
CPO	Cardiac Power Output	Combination of Mean Arterial Pressure and Cardiac Output; parameter describes myocardial oxygen requirements
CPI	Cardiac Power Index	Combination of Mean Arterial Pressure and Cardiac Index; parameter describes myocardial oxygen requirements

VASCULAR

PT	Propagation Time	Propagation time of the pulse wave
PWVao	Pulse Wave Velocity	Velocity of the aortic pulse wave
SVR	Systemic Vascular Resistance	The force the ventricle must overcome to eject blood into the aorta, estimate of "afterload"
SVRI	SVR Index	SVR, normalised to body size
TAC	Total Arterial Compliance	Indicator of the degree of peripheral arterial stiffness / compliance
TACI	TAC Index	TAC, normalised to body size

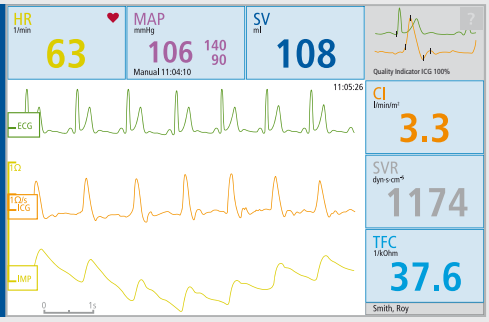
SIGNAL QUALITY

Signal Quality Indicator for validation of ICG waveforms and ACM signal show the quality of the beats used for calculations. Key events of the cardiac cycle are indicated by markers: aortic valve opens (B), peak systolic flow (C) and aortic valve closes (X).

SCREENS

MONITORING

- 6 selectable parameters out of 29
- evaluate and manage the fluid level of a patient
- 3 selectable waveforms



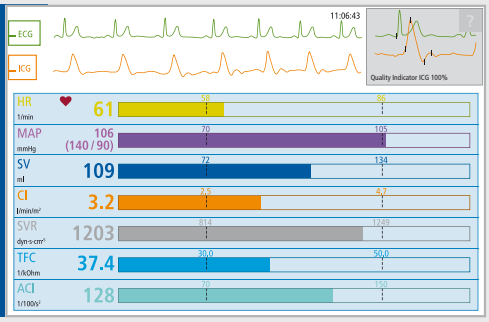
FLUID MANAGEMENT

- Passive Leg Raising (PLR) test
- standardised procedure
- automatic evaluation

SV	ml	101	132	+31%
CO	l / min	5.9	7.1	+20%
HR	1 / min	59	54	- 7%
TFC	1 / kOhm	40.4	41.3	+2%

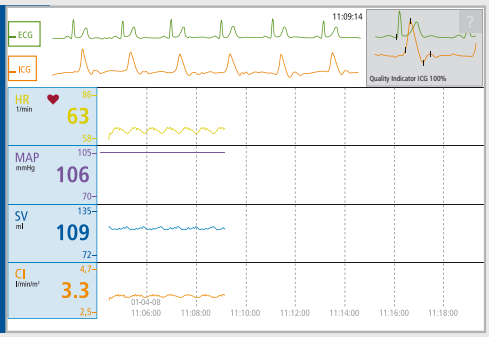
DIAGNOSTIC

- 7 selectable parameter bars with reference ranges
- ICG and ECG waveforms



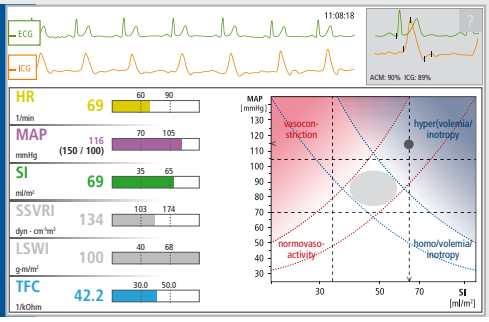
TRENDS

- 4 selectable parameters
- Selectable time scaling
- Event markers
- ICG and ECG waveforms



THERAPEUTIC

- Therapeutic graph for heamodynamic evaluation
- ICG and ECG waveforms



PRODUCTS Non-Invasive · Continuous · Easy

NICCOMO® Non-Invasive Continuous Cardiac Output Monitor

- Continuous (beat-to-beat) monitoring and recording of curves and 29 parameters
- Continuous signal quality control and adaptive artefact elimination

- Additional modules: NiBP · SpO2 · PWV (aortic Pulse Wave Velocity)

- 10" TFT colour display with touch screen
- Battery available (capacity > 60 min)

NEW STANDARDS

INNOVATIVE

Combination of hemodynamic parameters (ICG) and vascular stiffness (PWVao) to evaluate the complete cardiovascular system.

Simple · Quick · Real-Time

CardioScreen 2000®

The optimal configuration for cardiovascular diagnosis

www.cardioscreen.de

CardioScreen 1000®

Brings ICG technology to your laptop

www.cardioscreen.de

- Display of user selectable waveforms and parameters
- Different screens for optimal data presentation in different clinical settings
- Interface to patient monitors, such as Philips/HP (VueLink)

- USB ports for data export, software updates and external printer connection
- PC software for offline data analysis and data export (e.g. Excel)

- Power supply via USB port

- External computer: Panel PC with touch screen, PC or Notebook
- Combination with VasoScreen devices for vascular diagnosis possible

FLEXIBLE

Configurable measuring channels and user selectable parameters and screens. Interface to Philips / HP monitoring systems by supporting the VueLink protocol. Different device configurations depending on the needs of the customer.

EASY TO USE

Highly sensitive measuring technology and intuitive operation by touch screen. USB interface for easy data backup and software updates.

TECHNICAL DATA

		NICCOMO®	CardioScreen 2000®	CardioScreen 1000®
Measurement Principle		Impedance Cardiography (ICG) Bio-impedance	Impedance Cardiography (ICG) Bio-impedance	Impedance Cardiography (ICG) Bio-impedance
Measurement Channels	Standard Configurable	ICG / ECG + ACM ECG · NIBP · SpO2 · PWVao	ICG / ECG + ACM ECG · NIBP · SpO2 · PWVao	ICG / ECG + ACM
Impedance Cardiography (ICG)	Meas. current Basic impedance Imp. change Safety	1.5 mA eff, 85 kHz 0–60 Ohm, 0–1.5 Hz ± 1 Ohm, 0.2–160 Hz defibrillator protected	1.5 mA eff, 85 kHz 0–60 Ohm, 0–1.5 Hz ± 1 Ohm, 0.2–160 Hz defibrillator protected	1.5 mA eff, 85 kHz 0–60 Ohm, 0–1.5 Hz ± 1 Ohm, 0.2–160 Hz defibrillator protected
ECG	Input voltage Safety	± 10 mV AC, 0.2–160 Hz defibrillator protected	± 10 mV AC, 0.2–160 Hz defibrillator protected	± 10 mV AC, 0.2–160 Hz defibrillator protected
Pulse Wave (PW)	Meas. method Frequency range Cuff pressure	Air plethysmography 0.2–30 Hz 60 mmHg	Air plethysmography 0.2–30 Hz 60 mmHg	
NIBP	Measuring range Accuracy	40–260 mmHg ± 3 mmHg	40–260 mmHg ± 3 mmHg	
SpO2	Measuring range Accuracy	1–100 % SpO2 ± 2 % (at 70 %–100 % SpO2)	1–100 % SpO2 ± 2 % (at 70 %–100 % SpO2)	
Power Supply		100–240 V AC, 50 / 60 Hz max. 100 VA Battery: NiMH, cap. > 60 min	100–240 V AC, 50 / 60 Hz max. 40 VA	via USB port
Dimensions	w × h × d	290 × 320 × 140 mm	310 × 260 × 90 mm	75 × 25 × 130 mm
Weight		Approx. 5 kg (including battery)	Approx. 2 kg	Approx. 300 g
Display		10,4" TFT color with touch screen	External computer	External computer
Safety	Medical Device Directive Insulation Standards Notified Body	Class II a Class I, Type BF, 4 kV EN 60 601-1 EN 55011 Class B CE 0197	Class II a Class I, Type BF, 4 kV EN 60 601-1 EN 55011 Class B CE 0197	Class II a Class II, Type BF, 4 kV EN 60 601-1 EN 55011 Class B CE 0197
PC Requirements	Computer Operating system RAM HDD Interface		medical standard MS Windows > 1 GB > 60 GB USB 2.0	medical standard MS Windows > 1 GB > 60 GB USB 2.0

*1 | Sageman W, Riffenburgh H, Spiess BD. Equivalence of bioimpedance and thermodilution in measuring cardiac index after cardiac surgery. J Cardiothorac Vasc Anesth. 2002; 16: 8-14
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