Paradigm shift in blood pressure evaluation – insight into arterial stiffness

Arterial stiffness is an independent and distinct "biomarker" of vascular health that is prognostic for cardiovascular risk. The fundamental physical characteristics of pulse waves in the cardiovascular system resemble those of acoustic waves. The form and velocity of the pulse wave depend on the stiffness of the arteries. Starting from the heart, the arterial tree tapers off into the periphery (tunnel effect), which leads to an increase in blood pressure amplitude from the lower central pressure to a higher peripheral pressure, an effect called "blood pressure amplification". At young ages, when arteries are more flexible, blood pressure amplification is more pronounced. As people age, central blood pressure increases and pressure amplification decreases. This process is caused by increased arterial stiffness with aging.

Analysis of the pulse wave provides various parameters. In addition to aortic pulse wave velocity, it provides such parameters as augmentation index, a measure of the contribution of the reflected wave to the amplitude of the central pulse wave. These parameters provide predictive values associated with risk of heart attack and stroke. They therefore add additional cardiovascular to risk stratification, beyond the traditional parameters such as brachial blood pressure, age or cholesterol levels. Every contraction of the left ventricle generates a pulse wave. Stiffening of the arterial wall leads to early wave reflection during systole, which in turn leads to an increase of central aortic-systolic pressure. This increased central aortic systolic pressure causes unfavorable increase in cardiac afterload. Because the wave reflection is early, during systole, rather than later, during diastole as is when the arteries are less stiff, there is reduced coronary flow and myocardial microcirculation. Recent research suggests that other organs such as the kidneys, eyes and brain can also suffer due to the increased central blood pressure associated with increased arterial stiffening.

How can blood pressure PWA measurements reduce healthcare costs?

Initial therapy can be individualized via risk classification and knowledge of haemodynamics. In uncomplicated hypertension without increased arterial stiffness, inexpensive medications can also be utilized without specific effect on the wall, although naturally this would basically be advantageous. Consider replacing this by simply "This can lead to advantageous use of less expensive medications".

The offer of blood pressure measurement in the medical practice leads to higher diagnostic accuracy and more specific therapy. The monitoring of therapy via PWA may enhance the physician/patient relationship, treatment adherence, and patient follow-up.

How is Blood Pressure PWA measurement reimbursed?

As of February 2013, CMS has provided reimbursement code 0311T which is an experimental code for the measurement of central blood pressure and associate parameters. We believe it carries a reimbursement rate of about $27–329 depending on the location of the clinic. It has been shown that people in Germany are most willing to pay out of pocket. A more targeted and effective treatment is achieved through the measurement of "vascular age".

Literature and sources:

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3. Differential Impact of Blood Pressure-Lowering Drugs on Central Aortic Pressure and Clinical Outcomes: Principal Results of the Candesartan Arterial Function Evaluation (CAFE) Study; Bryan Williams et al; Circulation. 2006;113;1231-1235
5. Electromagnetic estimation of aortic pulse wave velocity in comparison with intra-aortic catheter measurements; Bernhard Hametner, Siegfried Wassertheurer, Johannes Kipfthaler, Bernhard Wanner; Hypertension. 2006;47:771-777
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9. Hypertension 2006;47:771-777
10. ECG: Value of Noninvasive Hemodynamics to Achieve Blood Pressure Control in Hypertensive Subjects; Rafael D. Smith et al.; Hypertension 2006;47:771-777
12. Series: Hypertension Management in Medical Practice
13. "Increased central blood pressure is an expression of increasing arterial stiffness and better represents the cardiovascular morbidity and mortality than the blood pressure value on the upper arm"

Cardiovascular technology and indication service

Today’s topic:
Blood pressure & pulse wave measurement combined in one procedure
Re-classification of patients risks

"Blood pressure measurement with the cuff is more efficient than other methods in routine practice. Specific therapy makes the measurement promising in terms of healthcare economics."
Clinical background – scientific evidence. What is the clinical and prognostic significance of arterial stiffness?

A current evaluation of the Framingham Heart Study (Karis et al.) illustrates a relationship between blood pressure and arterial stiffness over a period of 7 years among 1,759 participants. Increased arterial stiffness was significantly associated with the subsequent incidence of hypertension.

In the CAFE Study, antihypertensive treatment based on two different medications were analysed on the basis of central blood pressure compared to peripheral blood pressure with regard to mortality and morbidity. Blood pressure among 2,199 participants was measured on the arm and centrally, calculated by means of a generalised transfer function from the peripheral pulse waveform. Patients were randomised to either amlodipine or atenolol as baseline treatment. After a 1/2 year follow-up, antihypertensive treatment resulted in similar peripheral (brachial) blood pressure to atenolol but resulted in a significantly lower central blood pressure compared to peripheral blood pressure with regard to mortality and morbidity. This suggests that the effect of different drug therapies on central blood pressure was more predictive of outcome and vascular changes than their effect on brachial blood pressure.

Simple measurement method – the most important aspects in short form

Arterial stiffness is quantified via the aortic pulse wave velocity (PWV) (measured in meters/second). The stiffer the aorta, the higher the PWV. The prognostic significance of aortic PWV is very well documented.

Central aortic pressures (central systolic pressure, central pulse pressure) are more accurate measurements of the actual haemodynamic burden on the heart and arteries. Increasing arterial stiffness inevitably leads to an increase of central pressure values. PWV and central systolic pressure are measured non-invasively either tonometrically or with oscilometric systems. The measurement of blood pressure and pulse wave analysis (PWA) by a single device is now possible – Blood pressure Pulse Wave Velocity (PWV) measurement. The measurement accuracy compared to the standard invasive catheter technology has been validated and published. Additional information about peripheral resistance and cardiac stroke volume can also be obtained in order to provide additional information for therapeutic decisions.

The added value in medical practice – risk classification in accordance with ESC/ESH recommendations

The early diagnosis of subclinical (clinically still silent) end-organ damage is of crucial importance in determining cardiovascular risk. Measuring pulse wave velocity is a simple method for assessing damage to the vascular system and it is included in the European recommendations for classification and treatment of hypertension. If subclinical end-organ damage is demonstrated, patients in this high-risk group (class 3/4) should start therapy immediately.

Blood pressure Pulse Wave measurement supports a therapeutic decision making according to vascular and validated against the standard invasive catheter technology. Blood pressure Pulse Wave Velocity (PWV) measurement, is now possible and can be be tested during check-ups (for example during check-ups) in order to recognize early vascular aging.

Why is blood pressure pulse wave analysis so valuable?

The risk of cardiovascular events, particularly in people with medium risk, can be calculated with the PWV measurement. A better therapeutic decision can be made on this basis and patient management can be optimised.

- Screening – detection of subclinical and organ damage
- Initiation of a specific therapy
- Objective data for better patient motivation in an understandable metric – Vascular Age

Important criteria when selecting a measurement system:
The efficiency of Blood Pressure Pulse Wave measurement

Non-invasive PWV and central aortic pressure are mostly measured using either tonometric or oscillometric systems. Measurement of both central blood pressure and pulse wave analysis (PWA) together, called blood pressure Pulse Wave Velocity (PWV) measurement, is now possible and can be tested and validated against the standard invasive catheter technology. Blood pressure Pulse Wave Velocity measurement provides parameters of arterial stiffness together with peripheral resistance and stroke volume, thus offering simple and concise information that can aid in decisions about appropriate therapies.