The importance of the arterial blood pressure pulse has been recognized since ancient times, and from then to the present, the interaction of the observer and the patient has progressed in gradual steps. It evolved from the presence of a palpable arterial pulse, being accepted as a sign of life and health condition, to the registration of the features of the arterial pulse as the first ever graphical representation of any physiological parameter in medicine, culminating in the quantification of the tension in the arterial wall as a measurement of arterial “blood pressure.”[1]

The current acceptance of high blood pressure (hypertension) as a major cardiovascular risk can claim to have part of its origins in the actuarial and data gathering endeavors of life insurance companies.[2] The ubiquitous use of the brachial cuff sphygmomanometer in the early 20th century enabled collection of numerical data on blood pressure over long periods. The accumulation of blood pressure measurements also enabled data to be collected across the whole human life span. This demonstrated that in the otherwise healthy population, that is, in the normal population with no symptoms of overt ill health, there was a wide range of blood pressure values. Systolic blood pressure varied much more than diastolic blood pressure but increased with age. Since blood pressure was thought to be related to (and drive) tissue and organ perfusion, the marked increase in blood pressure was thought to be essential for adequate blood flow, as is required for efficient organ function. Hence, the concept of “essential hypertension”[3] was used to describe this condition of elevated blood pressure as being due to the essential readjustment of the cardiovascular system to accommodate age-related changes that occur in the vasculature (such as reduced capillary density with sequelae of increased peripheral resistance, hence requiring a higher pressure for adequate tissue perfusion). However, calculations of risk of morbidity and mortality (perhaps related to the forecasting of life insurance premiums) showed that those with elevated diastolic pressure were at higher risk of clinical and multiorgan complications affecting their health.

Hence, the accepted notion of how to qualitatively understand elevated blood pressure was that it was essential that mean blood pressure would increase with age (leading to essential hypertension, with no overt symptoms or identifiable cause), that systolic pressure was mainly related to the strength of cardiac contraction (and so related to stroke volume), and that hypertension-related health complications were mainly associated with high diastolic pressure,[4] presumably as diastolic pressure was thought to be more closely associated with total peripheral vascular resistance. However, with accumulation of information from many large epidemiological studies in the latter part of the 20th century, and in particular with longitudinal and generational data from the Framingham Heart Study,[5] it is now accepted that systolic pressure is the major blood pressure component that is related to cardiovascular risk of morbidity and mortality.[6] Systolic pressure shows a much more pronounced increase with age compared to diastolic pressure, and that, in fact, diastolic pressure actually tends to decrease in the latter two decades of life, with the majority of hypertension in the elderly being categorized as “isolated systolic hypertension.” This implies that it is the pulse pressure that shows the most pronounced increase with age, in particular after the sixth decade of life.[7] This marked increase in pulse pressure is not related to changes in stroke volume, which can also show a slight reduction with age, but rather to the known increase of arterial stiffness with age; and arterial stiffness itself has been shown to be an independent factor of cardiovascular risk.[8]

While arterial blood pressure is perhaps the most widely measured physiological parameter in clinical medicine, with methods that have essentially not changed since the inception of the brachial sphygmomanometer in late 19th and early 20th century, it still presents formidable challenges in how to improve the understanding of the effects of high blood pressure on end-organ damage leading to health complications. It is some of these important challenges that are addressed in the series of comprehensive review articles and commentaries in this Special Issue of Hypertension Journal presented by investigators and
clinicians from the Faculty of Medicine, Health and Human Sciences and Macquarie University Hospital, from Macquarie University, Sydney, Australia.

The series of 10 articles spans aspects of methodology, specific effects of blood pressure and the brain, association of blood pressure and end-organ function, and the treatment and strategies in relation to overall cardiovascular risk.

The article by Butlin et al. addresses aspects of the conventional auscultation and oscillometric method of blood pressure measurement using the brachial cuff sphygmomanometer. It provides a comprehensive historical description of the advances made to date, important issues regarding sources of error and device calibration, and a view of the future with methods enabling continuous measurement of blood pressure using cuffless technology. Tan et al. extended the description of measurement of blood pressure to include the pulse waveform. With detection of the pulse waveform in a peripheral location (radial or brachial artery), the calibrated pressure waveform can be mathematically processed to provide an estimation of central aortic pressure. This is of interest, as with similar peripheral pressure values, central systolic pressure can be quite different, and so can potentially improve discrimination of pressure-dependent effects on the heart. Simultaneous detection of pulse waveforms at separate locations enables calculation of pulse wave velocity providing a non-invasive measure of arterial stiffness. The article addresses the current state of clinical utility of the estimation of central aortic pressure and arterial stiffness. The article by Mihailidou addresses the important aspect of ambulatory blood pressure and its variation in individuals as a means of identifying those with enhanced cardiovascular risk. This is significant, since the use of office blood pressure is being reassessed in relation to ambulatory blood pressure. There is an increasing trend where office blood pressure might be relegated to screening and ambulatory blood pressure to be used for reliable clinical diagnosis of hypertension.

Investigations of the effect of blood pressure on the brain are gaining significant interest with respect to vascular associations with cerebral function. The article by Neville and Savage examines the complex array of evidence of the effect of high blood pressure on cognition and Alzheimer’s disease. They also address the mixed evidence of the effect of hypertensive treatment in early life on the development of cognitive impairment in later life, and the effect of blood pressure lowering on cerebral perfusion and clearance of toxins. Additional evaluation of hypertension and the broad spectrum of dementia is addressed by the article of Fuller et al. in the context of the long-term effects of aerobic and resistance training exercise on lowering the risk of the development of dementia and cognitive decline. The article also highlights the fact that the mitigation of factors involved in the development of dementia is a multifactorial process and assesses the impact of pharmacological and non-pharmacological approaches to slow down the late age development of cognitive impairment associates with vascular dementia and Alzheimer’s disease. The effect of hypertension on cerebral dysfunction is examined in the article of Kim et al. where blood pressure is considered a major factor involved in microvascular damage. The authors discuss a range of vascular and neurogenic mechanisms that predispose to stroke and cerebral small vessel disease. In particular, they emphasize the important role of cerebral autoregulation mechanisms involved in regulating cerebral blood flow through vasomotion of large distributing and small perfusing blood vessels.

An important sequela of high blood pressure is the effect on end-organ function. The article by Li et al. addresses the relationship between blood pressure and kidney function. Specifically, it assesses the use of renal denervation for the treatment of resistant hypertension in the presence of chronic kidney disease, a condition for which the benefits of renal denervation can be varied but may also provide additional benefits beyond blood pressure reduction in terms of improving kidney function. The effect of blood pressure on the heart is addressed by the article of Barin and Avolio. The interaction between the heart and the arterial load is described as a continuum in which the decline of optimum cardiovascular function initiated by elevated blood pressure and neurohumoral changes leads to the development of the left ventricular hypertrophy and heart failure involving positive feedback mechanisms. The associations of blood pressure and vessels in the eye as an end organ are reviewed by Graham and Schultz in the context of hypertensive retinopathy. The importance of the ocular vasculature is that it enables quantitative assessment of the microcirculation and its associated organ function through the use of optical techniques for the measurement of vessel properties in relation to blood pressure and intraocular pressure, such as the development of glaucoma.

The final article by Shalaby and Lin provides a closing bookend to the series of articles in the Special Issue by examining the treatment of hypertension and overall cardiovascular risk. Undoubtedly, the association of high blood pressure and coronary artery disease is a major contribution to total risk. However, as explained by the contributions in this series, total cardiovascular risk involves a broad spectrum of compromised vascular and organ function, and while the measurement of blood pressure might be a rather simple procedure, the association of its optimum treatment and management for improved health of the individual patient still presents formidable challenges.

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