

SphygmoCor and Renal Disease

Gradual loss of kidney function leads to chronic kidney disease (CKD) or chronic renal insufficiency (CRI). People with CKD may progress to develop permanent kidney failure – end stage renal disease (ESRD), where the only options for treatment are dialysis and transplantation. Renal disease patients have a high risk of suffering a fatal stroke or heart attack.

The SphygmoCor® system non-invasively provides measurements showing the progression of macrovascular disease driving the patient's risk of cardiovascular disease, thus providing a tool for assisting with early identification of high-risk patients and management of disease.

Prevalence and Survival

In the United States, an estimated 7.4 million adults have physiological evidence of CKD, with more than 300,000 people receiving treatment for ESRD in 2001. Almost 100,000 new cases of ESRD are diagnosed each year, with diabetes and hypertension being reported to be the most common causes of ESRD. Once the patient has been on dialysis for three months, the probability for survival falls dramatically from 77% at one year to only 9% at 10 years¹. Compared with the general population, patients with CKD have 3–30-fold risk for succumbing to CV disease; this difference has been reported to be even more pronounced in young people. Furthermore the risk for fatal and non-fatal CV events overcomes that for renal disease progression², such that more CKD patients die from CV complications than those patients that progress to ESRD³.

Cardiovascular disease remains the leading cause of death in ESRD and CKD patients⁴, and its prevention and treatment has been recommended as a key goal in the treatment for these high risk patients. Of the 10% of the population that is afflicted with CKD, 80% will die prematurely of cardiovascular disease before they even reach ESRD.

Arterial Stiffening

The excess cardiovascular disease risk in patients with CKD and ESRD is caused, in part, by a higher prevalence of cardiovascular risk factors compared with the general population, such as high blood pressure, high blood cholesterol, diabetes and reduced physical activity⁵.

However, assessment of traditional risk factors for cardiovascular disease does not adequately explain the significantly increased mortality rates of ESRD patients. The strongest current predictors of cardiovascular mortality in haemodialysis patients relate to large artery structure and function^{6,7}. Aortic pulse wave velocity (PWV)⁶ and more significantly Augmentation Index (Alx)⁷ have been shown to be independent predictors of morbidity and mortality in ESRF patients on haemodialysis, independent of other factors known to affect the outcome. In these patients, for each increase in Alx (%) of 10, the risk of cardiovascular and all-cause mortality is increased by around 50% and that for any increase of PWV of 1 m/s there was a 39% increase in adjusted overall mortality⁷. The characteristics of this patient group included ranges for Alx of 26 ± 15 and PWV of 11.7 ± 3.0 m/s. Importantly these associations were independent of other known risk factors, including brachial BP⁷.

With elevated arterial stiffness, central systolic pressure increases, resulting in a greater cardiac workload and therefore higher myocardial demand. Increased arterial stiffness, by changing the coupling pressure profile at the heart, can contribute to the development and progression of hypertension, left ventricular hypertrophy and dysfunction and a decrease in myocardial perfusion, all of which are highly prevalent in CKD and ESRF patients. The SphygmoCor® system, through the Aortic BP Profile Analysis and Pulse Wave Velocity modules allows for the assessment of these important parameters.

Vascular calcification is reported to be a major contributor to arterial stiffness in ESRD patients and studies have demonstrated that the presence of vascular calcification in large arteries⁸ and in coronary arteries⁹ is closely correlated with increased arterial stiffness in dialysis patients. Moreover, as the aortic PWV increases, the degree of coronary artery calcification also increases proportionally⁹. This has been suggested to be of significance as arterial calcifications may be a preventable factor associated with arteriosclerosis in patients with ESRD¹⁰.

It has also been recently shown that children on dialysis have significant arterial wall structural abnormalities and as a consequence stiffer large arteries – as shown by increases in both Alx and PWV¹¹, highlighting the potential for these markers to be of importance in paediatric nephrology to assess and monitor cardiovascular risk.

While it is known that there is a high incidence of CV death in CKD patients³, arterial stiffness has not been as well documented in this group compared to ESRD. However, increased aortic stiffness (PWV) and systemic arterial stiffness (aortic Augmentation Index – Alx) have previously been shown to be associated with other conditions highly prevalent in patients with CKD, hypertension^{12,13}, diabetes^{14,15,16,17}

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atherosclerosis¹⁸ and hypercholesterolaemia¹⁹. Recent studies have shown that arterial stiffness does have an association with pre-dialysis CKD patients with mild renal impairment²⁰ and that increased arterial stiffness occurs in parallel with the decline in renal function, evident by decreasing glomerular filtration rate, in patients with CKD^{21, 22}.

There is an increasing body of publications showing the effects of cardiovascular drugs^{23, 24, 25, 26}, hemodialysis sessions^{27, 28, 29}, chronic salt and water overload³⁰, kidney transplantation^{31, 32} and exercise³³ on arterial stiffness in renal and hypertensive patients. Recently, the effect of a

dialysis session on endothelial function was also assessed in renal patients using the SphygmoCor[®] system³⁴, highlighting the scope of this system to show the effects of therapies and interventions in these patients, not only through central blood pressure, aortic and systemic arterial stiffness changes, but also through endothelial function changes.

Arterial stiffness may therefore play an important role in future prognosis and therapeutic management of patients in all stages of kidney disease. The SphygmoCor[®] system allows for the evaluation of arterial stiffness and its clinical impact on the heart.

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