WHITEPAPER

# Algorithm for non-invasive screening of chronic kidney disease (CKD)

Clinical decision support tools from Arkangel AI

Arkangel Ai

## About Arkangel AI:

Arkangel AI is a software company based in Montreal, Canada that specializes in early disease detection using artificial intelligence. The company's mission is to enable people to live free of preventable diseases through early disease detection. Arkangel AI's products are optimized for diseases from the global south and medical equipment available in the region, translating into fewer entry barriers to urban and rural settings. Arkangel AI has operations in Canada, Colombia, Uruguay, and Mexico. For further information on this research or strategic partnerships:

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## Introduction

Chronic kidney disease (CKD) presents as a clinical syndrome when there is an irreversible change in kidney function or structure [1]. CKD damages one or several kidney compartments because different pathological damages can occur (vasculature, tubulointerstitium, or glomerulus) [2]. The increased relative hypoxia within the kidney and the outer medulla is caused by microvascular loss and advanced fibrosis. Pericytes are responsible for this change since they are responsible for vascular integrity. In other words, a loss of pericyte-endothelial contact, in addition to migration, takes the form of profibrotic myofibroblasts that deposit interstitial collagen [2].

Likewise, there is a gradual increase in cells responsible for expressing markers of aging and cell cycle arrest. Consequently, scarring collagen replacement of tubular cells and increased chronically infiltrating macrophages result in loss of renal function [2]. Kidneys with CKD present a greater activation of the renin-angiotensin system and a decrease in the number of glomeruli, which leads to hyperfiltration and increased tubular oxygen consumption, a situation that worsens with the imbalance between oxygen requirement and supply. [3]. Reduction in renal blood flow from decreased blood volume, obstruction, or blood redistribution, known as ischemia, results in stabilization of hypoxia-inducible factor 1-α (HIF1α) [2].

An adult person has CKD when, for three months or more, the glomerular filtration rate (GFR) is less than 60 ml/min/1.73 m2, or the GFR is greater than 60 ml/min/1.73 m2 with injury to the renal structure [4]. Other indicators of CKD are albuminuria (more than 30 mg of albumin in 24-hour urine), hematuria, persistent hydroelectric disorders, or histological changes in renal biopsy [4]. CKD is a prevalent problem in the adult population. In the United States, it is estimated that there is a prevalence of 13.1% in this population [5]. In the same way, it is associated with an increased risk of cardiovascular disease that can cause death. Global data in 2013 reported that 4% (2.2 million) of deaths worldwide are associated with CKD [6], where approximately more than half of that number of deaths are related to cardiovascular causes [6].

## 1. Chronic Kidney Disease in LATAM.

Latin America is a set of countries that share Latin languages and present extreme variations in socioeconomic status. The prevalence and incidence rates of the disease in this region have been increasing due to various factors such as the aging of the population, the increase in type 2 diabetes, and the epidemiological transition of the area [7]. Likewise, LATAM has the highest CKD mortality rate in the world. 90% of patients are not diagnosed since this silent disease is generally detected in late stages. The current underdiagnosis amounts to 90%, causing morbidity and morbidity rates in patients and costs for the health system. When the disease is diagnosed, patients are already advanced, or already fatal [8].

Similarly, due to late health system strategies, CKD imposes an enormous cost on low- and middle-income countries [9]. Today 45% of patients die before starting dialysis, which is why strategies for early diagnosis or screening for CKD are being developed in some countries. "Knock out chronic kidney disease" is one of them, created to raise awareness of the importance of diagnosing and treating CKD early. "Inside CKD" is a strategy that models the increase in disease burden at five years, showing the clinical and economic benefit of early interventions and timely treatment. "Search" is another strategy created to calculate GFR when a creatinine test is requested automatically. This campaign was born because, on many occasions, the doctor determines the renal alteration only with creatinine without calculating the GFR, which can cause an underdiagnosis.

Current information on the prevalence of risk factors that cause CKD progress is not completely clear and does not even exist in some countries. Some data constraints that make it difficult to understand are marked by the LATAM's change in mortality and disease patterns [9]. Therefore, this lack of knowledge makes it impossible to develop public health policies or programs that allow reducing the shocking statistics towards CKD. The importance of continuously carrying out national health surveys to combat these problems is thus highlighted. However, most LATAM countries carry them out sporadically and focus on other issues such as infections and infant and maternal mortality. Despite this, some studies have shown that smoking, increased obesity, and increased metabolic syndrome may be risk factors for the progression of CKD [10].

## 2. AI for early detection of CKD.

Artificial intelligence (AI) is a set of computer algorithms created to mimic and augment human thought patterns or actions. AI has begun to be used in different fields of industry; in the health area, it has uses in areas such as drug development, health control, medical data management, disease diagnosis, and personalized treatment [11]. At the same time, these technologies allow doctors to be efficient, assertive, and easy to carry out their work. In nephrology, multiple experiments have been carried out to predict the prognosis of various kidney diseases, including anemia control, cardiovascular events, technical failure of patients on peritoneal dialysis, and prediction of acute kidney injury [12].

Although technology seeks to enhance medicine, it also works hand in hand with doctors since they are one of the greatest beneficiaries of these implementations. The uses of AI in the hospital environment include the analysis of medical images, disease diagnosis, risk prediction, and prognosis, which allow the doctor to clarify his decisions without the need to be replaced [13]. What provides all these opportunities from technology is the use of data. Medical data is vast, multidimensional and requires high computational power to understand [13]. In the same way, there are prediction and stratification risk scores to identify people with a higher risk of CKD, used by some medical institutions, such as the one proposed by O'Seaghdha and collaborators [14]. These risk scores present a major problem as they are only developed with studies of non-representative cohorts of the population to work, in this case sites in LATAM. AI models offer a solution to this because they are trained on retrospective data from the same institution where it will be implemented and learn the differences between one patient from another.

Based on these advances and the problems detected worldwide and in LATAM, various countries have developed algorithms for non-invasive screening for chronic kidney disease (CKD). In other words, there is a continuous search to build an artificial intelligence (ML/AI) model that allows the non-invasive detection of CKD. The above generates benefits such as the increase in the base of diagnosed patients and the number of patients who can benefit from sodium-glucose cotransporter 2 (ISGLT2) inhibitor drugs. These drugs are fundamental for treating patients in different stages of chronic kidney disease (CKD) (14). For implementing these algorithms, databases of patients collected in several hospitals diagnosed with CKD are used.

To develop one of such algorithms a healthcare institution will have to run 3 phases to develop it: (i) run quality control and data analysis on your current dataset, (ii) algorithm development and selection, and (iii) algorithm deployment and maintenance. The first phase refers to the execution of the statistical analysis, transformation, and pre-processing of the data. The second phase is the selection of modeling techniques, training multiple algorithms in parallel, and selecting the top performing algorithms according to the validation metrics. The last phase refers to the algorithm's deployment, monitoring, maintenance, retraining, and unlimited updates.

## 3. Final thoughts and conclusions.

In the last decade, interest and studies based on AI have increased considerably in different industries, where health is no exception. AI algorithms are created from the use of medical data that is accessed through various hospital services. These data points can be radiological images, laboratory results, statistical results, etc. In fields such as nephrology, structuring medical data will enable the use of AI as a tool for medical staff to make timely diagnostic and treatment decisions. By this, we mean providing tools that quickly detect risks, improve diagnostic accuracy, and provide better disease management.

For this reason, it is also essential to work hand in hand with doctors, especially those dedicated to primary health care and the population in general. To increase access to early disease diagnosis to. Personnel from different professions (nephrologists, bioinformaticians, and engineers) seek to develop accurate AI models using innovative algorithms to reduce the statistics of undiagnosed patients with CKD. These efforts aim to help improve kidney health shortly, increase screening in the population at risk, and carry out follow-up controls. Consequently, reducing the progression of chronic kidney disease without patients reaching dialysis, transplants, or death.

## SOURCES

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