EARLY CHRONIC KIDNEY DISEASE DETECTION

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Machine Learning and Data Science Project Management From an Agile Perspective: Methods and Challenges

Successful implementations of Machine Learning (ML) and Data Science (DS) applications have enabled innovative business models and brought new opportunities for organizations. On the other hand, research studies report that organizations employing ML and DS solutions are at a high risk of failure and they can easily fall short of their objectives. One major factor is to adopt or tailor a project management method for the specific requirements of ML and DS applications. Therefore, Agile Project Management (APM) may be proposed as a solution. However, there is significantly less study that explores ML and DS project management from an agile perspective. In this chapter, we discuss methods and challenges according to the background information and practice areas of ML, DS, and APM. This study can be viewed as an initial attempt to enhance these knowledge and practice domains in view of APM. Therefore, our future research efforts will focus on the challenges as well as the experimental implementation of APM methods in real industrial case studies ML and DS.

Contemporary developments in cutting-edge technologies, along with the advances in artificial intelligence (AI), have paved the way for various integrated and sophisticated systems. The proliferation of AI systems has enabled new business models and brought opportunities for organizations. The successful implementations of AI can have a great impact on the activities and competitiveness of an organization. On the other hand, there is also an overestimation of their benefits, opportunities, and return on investment of AI projects. How to realize AI as a long-term and stable solution is difficult, and defining the required procedures is not clear. To that aim, Bughin et al. (2017) indicate the factors for transforming an the capabilities of AI", effective and efficient AI environment, techniques and tools, solid data ecosystem, and organizational culture. Ransbotham et al. (2017) report the challenges in the adoption of AI systems as follows:

- Difficulties in the Acquisition of AI-related skills and knowledge,
- "Competing of AI projects with other projects in the company"
- Safety and security aspects of systems using AI,
- Cultural and organizational barriers in the AI adoption.

Data Science: a literature review

Data Science:

The term big data refers to the collection of large and complex data sets that are difficult to process by using traditional data management methods, tools, and techniques. Volume (size of data), variety (diversity and types of data), velocity (speed of data generation), and veracity (accuracy of data) are the main characteristics of big data. Therefore, it becomes more and more difficult to use big data resources for a maximum advantage when the amount of data grows, variety, and velocity increases. The types of data may be structured, unstructured, machine-generated, graph-based, streaming, and in the forms of audio, video, or image. DS has evolved from the traditional data management and statistics disciplines (Cielen et al. 2016). As being multidisciplinary, it borrows some of its techniques from computer science, uses complex algorithms, and includes the processes to build predictive models The main steps of a DS project are as follows:

- Problem definition,
- Data acquisition,
- Data processing (cleansing, transforming and integrating data)

Problem Definition

It is important to define a problem, set a research goal, identify the organizational benefits and how a data science project can contribute to the business processes. Understanding the context of the research is highly critical for project success. Therefore, a project charter document can help to frame the mission, scope, timeline, deliverables, success criteria, data, resources, costs, risks, project team, and approval committee.

Towards optimising chronic kidney disease detection and management in primary care: Underlying theory and protocol for technology development using an Integrated Knowledge Translation approach.

Background

Chronic kidney disease (CKD) directly or indirectly causes more than 2.4 million deaths annually. In Australia, CKD affects up to 2 million people, with 2500 commencing renal replacement therapy each year and 14 diagnosed with end-stage CKD each day. CKD is associated with increased cardiovascular disease (CVD) risk and declining kidney function is associated with reduced health-related quality of life, independent of other co-morbidities. Unlike CVD and stroke, rates of CKD are not improving. The World Health Organisation has called for targeted screening, prevention and early treatment to combat world-wide increases in the prevalence of CKD.

CKD is defined as kidney damage and/or reduced kidney function lasting 3 months or more. The five stages of CKD range from structural abnormalities that do not adversely impact on kidney function through to severe, end-stage disease requiring supportive palliation or renal replacement therapy (kidney transplant or dialysis). Generally, symptoms do not appear until kidney function has deteriorated to stage 5, so testing for earlier stages of disease is often overlooked.

Clinical guidelines support the early identification and treatment of CKD. Statin medications that reduce the risk of atherosclerotic events and renin angiotensin system blockers that lower blood pressure and reduce proteinuria can delay progression of CKD, improve clinical outcomes and reduce health care costs. Thus, there is significant potential to improve the trajectory of CKD through improved identification of patients at risk, or in the early stages, of the disease and through better implementation of clinical guidelines. General practice, where most Australians receive their medical care, is a key setting in which to test interventions and explore new models of care to optimise identification and management of CKD and chronic conditions more generally Models of care underpinned by technology can be drivers of successful chronic disease management.

Early Detection of CKD: Implications for Low-Income, Middle-Income, and High-Income Countries

Early Detection Strategies: Screening and Case Finding

Screening is a sorting process that is designed to find a few people who have higher risk of disease, among a group who currently believe themselves to be well. Positive screening tests increase the likelihood that an individual has the disease, but further testing is needed to confirm the diagnosis. However, simply identifying disease is futile unless it is linked to actions that improve clinical outcomes, ideally as part of a systematic program. Thus, early detection *per se* is simply one part of a program that must be based on sound evidence and performed with high quality; otherwise, there is risk of causing more harm than good.

In assessing the potential benefits of early detection, three specific forms of bias must be considered: length bias, lead-time bias, and—often—volunteer bias.These biases, which tend to exaggerate the apparent benefits of early detection, are typically used to describe issues in cancer screening, but are also applicable to the detection of CKD.

Alternatively, rather than searching through the whole population (population-based screening), the sorting process may focus on defined groups of people with a particular condition or set of diseases (case finding). In case finding, the target group's risk of developing an unwanted outcome is much higher than it is among the general population, and it can facilitate prompt recognition of clinical problems in patients who do not recognize a disease's early signs and symptoms. A program of case finding must also work to high standards, because it can also lead to harm.

Because early detection programs search for a relatively uncommon outcome that will occur in the future, a relatively small proportion of participants are likely to benefit from the process.Testing may identify many patients who have less severe forms of disease and who would experience a good outcome if the condition had never been detected. Perhaps the best example of inadvisable screening was a program of urine testing for catecholamines in infants, intended to detect infantile neuroblastoma.The program found many infants with high levels of catecholamines, some of whom had tumors that were treated with surgery and chemotherapy.

Chronic Kidney Disease Diagnosis and Management

CKD Definition and Staging

Chronic kidney disease is defined as the presence of an abnormality in kidney structure or function persisting for more than 3 months. This includes 1 or more of the following: (1) GFR less than 60 mL/min/1.73 m^2; (2) albuminuria (ie, urine albumin ≥30 mg per 24 hours or urine albumin-to-creatinine ratio [ACR] ≥30 mg/g); (3) abnormalities in urine sediment, histology, or imaging suggestive of kidney damage; (4) renal tubular disorders; or (5) history of kidney transplantation. If the duration of kidney disease is unclear, repeat assessments should be performed to distinguish CKD from acute kidney injury (change in kidney function occurring within 2–7 days) and acute kidney disease (kidney damage or decreased kidney function present for ≤3 months). Evaluation for the etiology of CKD should be guided by a patient's clinical history, physical examination, and urinary findings.

Once a diagnosis of CKD has been made, the next step is to determine staging, which is based on GFR, albuminuria, and cause of CKD. Staging of GFR is classified as G1 (GFR ≥90 mL/min/1.73 m^2), G2 (GFR 60–89 mL/min/1.73 m^2), G3a (45–59 mL/min/1.73 m^2), G3b (30–44 mL/min/1.73 m^2), G4 (15–29 mL/min/1.73 m^2), and G5 (<15 mL/min/1.73 m^2). Although GFR can be directly measured by clearance of agents such as iohexol or iothalamate, the development of estimating equations (eg, the Chronic Kidney Disease Epidemiology Collaboration [CKD-EPI] and Modification of Diet in Renal Disease Study [MDRD] equations) has largely replaced the need for direct measurement in clinical practice. Clinical laboratories now routinely report estimated GFR (eGFR) based on filtration markers. The most common filtration marker used is creatinine, a 113 dalton byproduct of creatine metabolism and one for which laboratory assays have been standardized since 2003. The preferred estimating equation in the United States and much of the world is the CKD-EPI 2009 creatinine equation, which is more accurate than the earlier MDRD equation, particularly for eGFR values greater than 60 mL/min/1.73 m^2.

Early chronic kidney disease: diagnosis, management and models of care

eGFR equations and age-related decline in renal function

These high lifetime risks for CKD call into question whether there is a distinction between early CKD and normal age-related decline in renal function. Reductions in renal blood flow and mass, as well as increased glomerulosclerosis, are part of the normal ageing process, with eGFR falling by about 0.75 mL/min/1.73 m^2 per year from the age of 40. This rate of progression seems non-linear, with eGFR loss in elderly patients slowing below 45 mL/min/1.73 m^2. In population studies, the majority of patients assigned as having CKD are aged over 60 years, and most of these patients do not have significant albuminuria. It is therefore difficult to differentiate between age-related loss of kidney function and renal disease. The data suggest that, for a given reduction in eGFR, elderly patients are less likely to progress to ESRD. The role of the ageing process has long been recognized for other organ systems.

Meta-analyses of over 1.5 million patients performed by the CKD Prognosis Consortium, however, have shown almost identical risks for ESRD in patients above and below 65 years of age with an eGFR of 45–59 and an ACR of <10 mg/g.These data have been interpreted as evidence against the introduction of differing thresholds for defining CKD based on age, although the interaction between renal function and proteinuria does seem to differ with age, potentially due to the competing risk for death. It has also been argued that senescent changes in eGFR are due to other disease processes rather than pre-determined renal decline.The differing interpretations of the current data on eGFR loss in the elderly underscore the need to consider eGFR trends as part of a clinical assessment. Although it is unclear whether these eGFR changes reflect intrinsic renal disease or normal ageing, CKD and senility are associated with an increased risk for morbidity and mortality in an additive fashion.

Comorbidity is common in CKD patients. In the UK, about 64% of patients aged over 65 years that are coded as having CKD have four or more additional morbidities. Whilst it is acknowledged that multi-morbidity leads to greater need for healthcare, the risk factors for multi-morbidity are ill-defined. Further work is required to determine whether renal impairment in elderly patients is associated with or causes other conditions.

Browse Chronic Kidney Disease

Chlorthalidone in Advanced Chronic Kidney Disease

Control of hypertension is central to the management of chronic kidney disease, both to preserve residual kidney function and to reduce the associated high risk of cardiovascular events. International guidelines recently updated by the Kidney Disease: Improving Global Outcomes Organization recommend that patients with chronic kidney disease and hypertension be treated to reduce standardized office systolic blood pressure to less than 120 mm Hg, unless there are obvious reasons not to do so.[1] This ambitious target is difficult to achieve with currently available antihypertensive medications, particularly in patients with more advanced chronic kidney disease (stages 4 and 5).

Hypertension, a common risk factor for both cardiovascular disease and chronic kidney disease, is often poorly controlled, especially in patients with advanced chronic kidney disease. Thiazides or thiazide-like diuretics are important agents for lowering blood pressure in patients with essential hypertension. Chlorthalidone, a thiazide-like diuretic, reduces cardiovascular morbidity, such as the incidence of stroke and heart failure, and cardiovascular mortality. However, its efficacy and safety among patients with advanced chronic kidney disease remain poorly understood. Several studies suggest that these drugs might be effective for treating hypertension in patients with chronic kidney disease. On the basis of preliminary evidence of an effect on blood pressure in patients with chronic kidney disease, we hypothesized that among patients with advanced chronic kidney disease and uncontrolled hypertension, chlorthalidone would decrease the 24-hour ambulatory systolic blood pressure. We also hypothesized that chlorthalidone would reduce the degree of albuminuria over 12 weeks and provide preliminary evidence that chlorthalidone is renoprotective and cardioprotective.

The glomerular filtration rate (GFR) is generally estimated from serum concentrations of endogenous filtration markers such as creatinine or cystatin C. During the past two decades, automated clinical laboratory reporting of GFR estimated with the use of creatinine (eGFRcr) has become widespread, coincident with increased awareness of chronic kidney disease (CKD) in the United States.

The case for early identification and intervention of chronic kidney disease: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference

Nearly 700 million persons worldwide have chronic kidney disease (CKD), and the burden falls disproportionately upon socially disadvantaged and other vulnerable groups.

In many regions, persons with lower socioeconomic status have a higher prevalence of CKD, limited access to treatment, and poorer outcomes.

Early identification of CKD by screening for kidney disease, followed by risk stratification and treatment, offers the potential to substantially reduce the morbidity and mortality from CKD and its related complications, such as cardiovascular disease.

However, at present, there is no accepted systematic strategy for CKD screening and treatment.

Despite effective methods to diagnose and treat CKD at its earliest stages, there is a lack of consensus on whether health systems and governments should implement CKD screening programs. Professional societies have been discordant on whether or not to screen for CKD.

To address this ongoing controversy, in October 2019, the Kidney Disease Improving Global Outcomes (KDIGO) held a Controversies Conference entitled "Early Identification and Intervention in CKD." Meeting participants represented a global multidisciplinary panel of clinicians and scientists. The rationale for CKD screening strategies was evaluated within the context of the World Health Organization (WHO) principles of screening for disease.

Four major topics were then addressed: (i) the selection of populations for CKD screening, (ii) the relative diagnostic and predictive characteristics of tests for kidney disease, (iii) the evidence base for treatments that reduce the risk of CKD progression and cardiovascular disease, and (iv) implementation strategies for CKD screening, risk stratification, and treatment programs and the key factors determining resource allocation and cost-effectiveness.

Early Identification and Intervention in CKD." Participants identified strategies for screening, risk stratification, and treatment for early CKD and the key health system and economic factors for implementing these processes.

Screening and early detection of chronic kidney disease at primary healthcare

Chronic kidney disease (CKD) represents a global public health concern and results in poor health outcomes. While the burden of CKD is accurately well defined in developed countries, increasing evidence indicates that the CKD burden may be even greater in developing countries. Primary care has an essential role in the early identification of CKD and the prompt integrated management between primary and secondary CKD care, with participation of the patient, should be done in high quality. Systematic screening for CKD in at-risk individuals is strongly indicated for timely intervention when needed and to perceive the impact of such policies on CKD incidence. Furthermore, failure to recognize a patient in stages 1–3 of CKD may result in high incidence of CKD complications and kidney failure, often leaving the patient unsuitable for different renal replacement therapies, such as dialysis and transplantation. Therefore, primary care early referral and consultation with a nephrologist can give a better chance for different dialysis procedures and minimize the rate of hospitalization and mortality.

The initiation, frequency, and cessation of CKD screening should be individualized based on kidney and cardiovascular risk profiles and individual preferences

The time in the life course when screening for CKD should begin should be based upon the estimated likelihood of having CKD for that individual, rather than chronologic age alone. Thus, conference participants favored initiating CKD screening based on comorbidities and individualized risk assessment rather than at a specific chronologic age.

The frequency of testing is a critical aspect of CKD screening programs and has substantial impact on costs. The conference participants agreed that the frequency of repeat testing should not be uniform for all persons, but rather should be guided by each individual's risk of developing CKD, based in part upon the results of previous testing. Risk equations that estimate 5-year CKD probabilities could be used to guide the timing of subsequent testing.

For example, individuals with a high probability of incident CKD at 5 years could be rescreened at 1- or 2-year intervals, whereas those at low risk of incident CKD could be rescreened after several years.

Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis

Discussion

CKD was more prevalent in women than in men. Two-thirds of studies -that reported gender-specific CKD prevalence- determined higher prevalence in women. Women, in general, have less muscle mass than men and muscle mass is a major determinant of serum creatinine concentration. However, the GFR estimation equations adjust for gender differences, using a correction factor for women. These findings add to the existing literature that recognise a gender-specific difference between CKD prevalence., these data cannot answer why this may occur. We can speculate that this finding may be partially explained by selection bias inherent within the studies due to a different age demographic for the two sexes. Alternatively it may be due to complex factors in the disease pathology that are not captured within the studies. Or that there is in fact more renal disease in men but the eGFR equations preferentially identify renal disease in women in the stage 3 zones.

Studies that were outliers in terms of reported results were of interest. Smoking was found to be negatively associated with CKD prevalence but this finding was negated when a single outlier was removed. The outlier was a study in which smoking was defined as >100 cigarettes ever and thus 69·1% were smokers. A Spanish study (n: 7202, Quality: 52%, CKD: 21·3%) reported 66.7% hypertension prevalence within the population compared with a global mean (from all other studies) of 31·1%. Hypertension was not defined any differently. Further, 31.5% of their sample population had diabetes and 31.1% were obese. The population was reported as unrestricted older population but although it was older than other studies (mean age 60·6yrs) these rates of co-morbidity are unexpected and were not explained. A number of studies had very high prevalence of CKD (>30%) the highest of these was a Canadian study (n: 123,499, Quality: 52%, CKD: 36·4%), a laboratory audit of patients over 65 years. The prevalence observed may be due to selection bias as the mean age of this cohort was 74 years, with 23% diabetes in the sample population, two factors associated with renal decline.

Serum creatinine measurement bias was inherent in the majority of the studies. Serum creatinine concentrations are highly variable within individuals, up to 21% within a 2-week period. NICE guidelines advise two measures of eGFR 3-months apart and within the last 12-months to minimise intra-individual variation. Not all countries have such guidelines only 5 manuscripts reported this in study design. Jaffe creatinine assay was the main method used but it is known to systematically overestimate serum creatinine to varying degrees.

CKD screening and risk stratification must consist of a dual assessment of estimated glomerular filtration rate (eGFR) and albuminuria (UACR)

Assessing both kidney function by eGFR and kidney damage by measuring albuminuria are critical both to detect and to risk stratify CKD.

Thirty-seven of the studied populations reported that they calibrated directly to the laboratory to minimize assay bias effect and twenty-seven studies used a minimally biased traceably assay (IDMS). A comparison of these studies to the remainder found no significant difference in prevalence estimates. A third of the studies (n = 36) made no mention of measures, traceability, or calibrations. It is further known that the MDRD equation systematically overestimates CKD in the general population and the prevalence rates calculated may be lower. Estimated GFR is accepted as the most useful index of kidney function in health and disease, but an uncorrected, untraceable single measure inherently introduces noise and outliers into the dataset. This latter point has been very recently clarified as an epidemiological study in Morocco found that up to 30% of patients initially classified as CKD 3a using the MDRD formula had improved renal function over 12 months and therefore would not have a CKD diagnosis.