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Artificial Neural Networks for Diagnosis of Kidney Stones Disease

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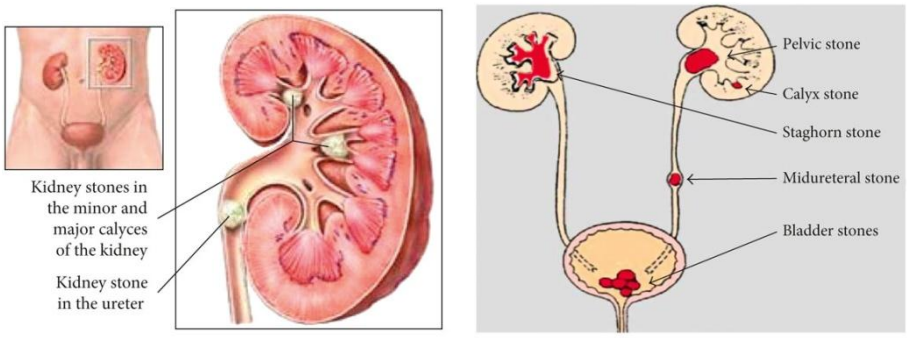
Abstract: *The foundation of medical care for children with renal stone disease is the assessment of metabolic risk factors, which aims to stop the growth of preexisting calculi and subsequent stone occurrences. In this retrospective analysis, 90 children with kidney stone disease who had been sent to our institution and had undergone clinical testing in accordance with a defined procedure had their metabolic risk factors, clinical histories, and family histories assessed. Our pediatric patients were 10.7 years old on average, with a male to female ratio of 1.14:1.0. In 84.4% of the instances, biochemical abnormalities were discovered. Of the patients, 52.2% (n = 47) had only one urine metabolic risk factor, whereas the remaining 31.1% (n = 28) had several risk factors. Adrenal hypercalciuria. The aim of this work is to compare the performance of all three neural networks on the basis of its accuracy, time taken to build model, and training data set size. We will use Learning vector quantization (LVQ), two layers feed forward perceptron trained with back propagation training algorithm and Radial basis function (RBF) networks for diagnosis of kidney stone disease. In this work we used Waikato Environment for Knowledge Analysis (WEKA) version 3.7.5 as simulation tool which is an open source tool.*

Keywords: Kids. genealogy inside the family. hypercalciuria. Low urine volume. fat-related risk factors. The urolithiasis

I. INTRODUCTION

1.1. Introduction to Kidney Stones.

The kidney(s) are where kidney stones mostly lodge. Urinary tract diseases, the most common one, have plagued humanity since 4000 B.C. and have caused millennia of suffering. Preventing the recurrence of kidney stones is still a major concern for human health.A deeper comprehension of the mechanics underlying stone development is necessary to prevent the recurrence of stones. An increased risk of end-stage renal failure, cardiovascular disease, diabetes, hypertension, and chronic kidney disorders has been linked to kidney stones. Kidney stones have been proposed as a systemic illness associated with the metabolic syndrome. If nephrolithiasis is linked to nephrocalcinosis, it accounts for 2 to 3% of end-stage renal patients.(1-23)



(a) (b)

Figure 1: Kidney stone locations in the urinary system. (a) Adopted from . (b) Adopted from .

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II. MATERIALS AND METHODS

SELECTION OF PARTICIPANTS AND ASSESSMENT :

The Kidney Stone Center at St. Michael's Hospital accepted consecutive patients between February 2002 and March 2004 who were between the ages of 18 and 50. The center serves the health needs of about six million people, including the Greater Toronto Area community, and might be categorized as a population-based treatment institution. It houses one of only three shockwave lithotriptors in Ontario. The study was authorized by the hospital's Research Ethics Board. Before their planned lithium treatment visit, age-eligible patients were called to explain the study's purpose, gauge their interest in taking part, and give the study personnel permission to speak with their families. The documented reasons for nonparticipation were examined. Interested parties were requested to gather one 24-hour urine sample, beginning in the morning.[26]

CLASSIFICATION OF URINARY VARIABLES AND DISEASE STATUS

Hyperuricosuria and hypercalciuria were defined according to standard protocols. Restrictive definitions for outcome variables were chosen in order to maximize specificity, as is advised for aggregation research. As a result, type 2 diabetes was defined as being treated with insulin after the age of 40 years old or with oral hypoglycemic medicines at any age for hypertension. Hypertension was defined as being treated with antihypertensive medications to control blood pressure. Obesity was defined as having a BMI of 30 kg/m2 or greater. Since there is no accepted criteria, weight growth was deemed overly arbitrary when it above the 75th percentile of the gender-specific 5-year weight change distribution. For men, it was 5.1 kg, while for women, it was 6.8 kg.[25-32]

BIOCHEMICAL PROCEDURES

As a preservative, thymol crystals were dissolved in isopropanol and placed in each 24-hour urine collection bottle. Using commercially accessible analyzers, the levels of creatinine, uric acid (UA), and urinary Ca2_ were measured. When a patient's creatinine value fell outside of the daily reference range of 8.8 to 22 mmol for men and 4.5 to 16 mmol for women, urine specimens were deemed to have been obtained improperly and were not included in the study.

STATISTICAL ANALYSES

Based on odds ratios (OR) from studies evaluating genetic susceptibility using intermediate phenotypes, power to detect an OR of 3 was calculated to be _80% with a sample size of 308 and a two-sided __ 0.05 assumption. We estimated that 25% of first-degree relatives would have hypertension and 25% of patients with KSD would have hypercalciuria while performing this computation. Patients were divided into binary groups for the primary analysis according to whether they had high Ca2_ or UA excretion. Four subgroups were created out of them: normal Ca2_ and UA, hypercalciuria/hyperuricosuria, hypercalciuria /normal UA, and hypercalciuria/hyperuricosuria. The final grouping served as the reference group. For continuous data, mean values (_SD) were calculated, and for categorical variables, percentages. Broadly speaking[33-38]

INDEPENDENT STUDY OF SIBLINGS

Our hypothesis regarding a genetically based impairment in Ca2_ metabolism was further evaluated by measuring the amount of Ca2_ excreted in the urine of both research participants and a separate group of siblings of patients suffering from hypercalciuria. The latter sample was drawn from a prior study that employed the same approach as this one to enroll 75 patients with KSD and hypercalciuria, ages 18 to 50 (39). The results of the urine tests have never been released. Siblings were surveyed over the phone with their consent in order to gather data on demographics, the existence of KSD and hypertension, the names of all prescribed drugs and additional health products, and the siblings' current height and weight. Those using multivitamins or Ca2_ supplements were not included. a pee bottle and guidelines for gathering a fasting urine sample. [39]

Kidney Stone Dataset:

The kidney stone illness diagnosis dataset is made up entirely of real set data. The data set utilized in this study was gathered from several medical facilities that screen individuals for kidney stones. The 1000 patient data, or 1000

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instances, with 7 attributes, were used in this work. The characteristics are really kidney stone symptoms, which is how we trained neural networks to diagnose kidney stones. Lymphoctyes, Monocytes, Eosinophis, Neutrophil, S. Creatinine, Blood Sugar, and U. Acid are the characteristics used for diagnosis. To make it easier to use the dataset in experiments to determine if kidney stone disease is present or absent, it has been separated into two classes. Class 1 has a yes value, which indicates the presence of disease, and Class 2 has a no value, which indicates no sickness.

ATTRIBUTES	WEIGHT	ACTUAL RANGE
LYMPHOCTYES	30 gms	2- 50 %
MONOCYTES	01 gms	1 - 6 %
NEUTROPHIL	02 gms	1 - 4 %
S. CREATININE	61 gms	50 -70 %
EOSINOPHIS	3 gms	4 -10 %

Table 1 Sample Report for Kidney Stone

According to Table 1's attributes, a person has kidney stones if their parameters are within the actual attribute range, or if their class is YES; if not, their class is no.

Characteristics of study patients

At baseline (fig 1⇓), there were 3 089 194 eligible patients without ESRD (orestimular glomerular filtration rate <15 mL/min/1.73 m2). Of them, 1,954,836 had serum creatinine measurements obtained during outpatient visits. them were analyzed along with new cases of stage 3b–5 chronic renal disease, as well as sustained increases in serum creatinine levels from baseline. Table 1⇓ displays the characteristics of the research participants with and without kidney stone incidents. Individuals with a history of kidney stones, hypertension, and advanced age were more prevalent in kidney stone patients than women. Over the course of the 11-year median follow-up period (range: 1 day to 12 years), 5333 registry patients (0.2%) experienced ESRD, 200 790 (7%) passed away, and 229 556 (7%) relocated outside of Alberta. Within the

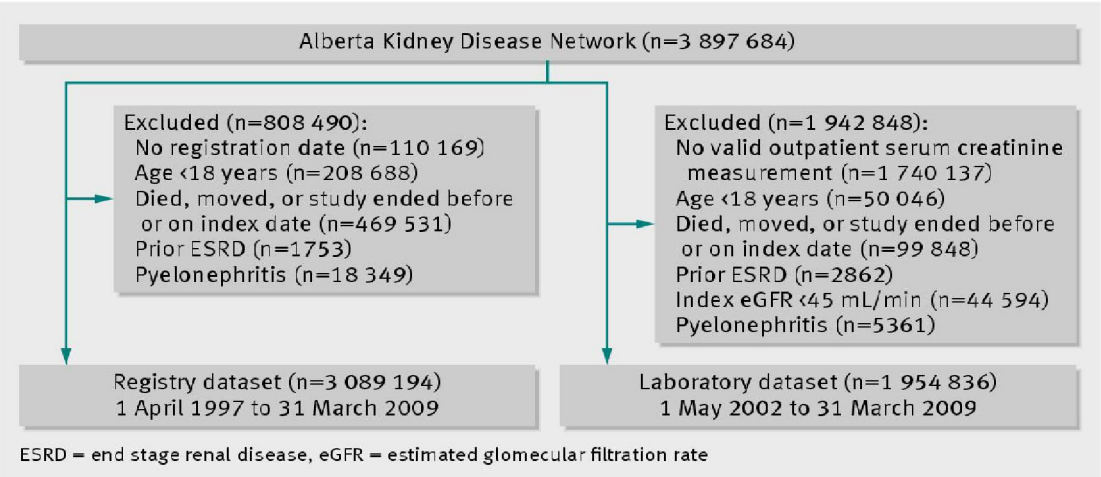

Fig 1 Patient flow through study

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Characteristic	Registry dataset* Stone(s) (n=23 706)	No stone (n=3 065 488)	Laboratory dataset† Stone(s) (n=11 609)	No stone (n=1 943 227)
Median (IQR) 45.9 (34–57.6) age (years)	46 (35.1–60.1)	35.4 (23.2–48.6)	51.6 (41.2–63.2)	
Male 869 635 (44.8)	15 686 (66.2)	1 537 388 (50.2)	7517 (64.8)	
Aboriginal 47 562 (2.4)	450 (1.9)	84 244 (2.7)	222 (1.9)	
Receiving social 58 305 (3) assistance	819 (3.5)	81 852 (2.7)	440 (3.8)	
Rural residence 249 150 (12.8)	3357 (14.3)	389 597 (12.8)	1788 (15.4)	
Comorbidities:				
Median (IQR) Charlson 0 (0–1) score‡	0 (0–1)	0 (0–0)	0 (0–1)	
Hypertension 394 661 (20.3)	3766 (15.9)	252 467 (8.2)	3573 (30.8)	
Prior nephrolithiasis§ 216 (0.6) IQR=interquartile	4056 (17.1)	4150 (.1)	5796 (49.9)	11

Table 1| Demographic and clinical characteristics of study patients with and without kidney stone episodes. Values are numbers (percentages) of patients unless stated otherwise

IQR=interquartile range. CKD chronic kidney disease

*Full set of 3 089 194 eligible patients without end stage renal disease at baseline.

†Subset of 1 954 836 patients with serum creatinine measurements available.

‡Charlson score includes AIDS/HIV, metastatic cancer, non-metastatic cancer, cerebral vascular disease, chronic obstructive pulmonary disease, dementia,
diabetes, heart failure, mild liver disease, moderate/severe liver disease, myocardial infarction, paraplegia, peptic ulcer, peripheral vascular disease, and
rheumatological disease.

§Nephrolithiasis occurring within 3 years or 8 years before follow-up period in the registry and laboratory dataset respectively.

Figure 1: Display a multilayer perceptron structure with N input neurons, which correspond to N output and hidden neurons.

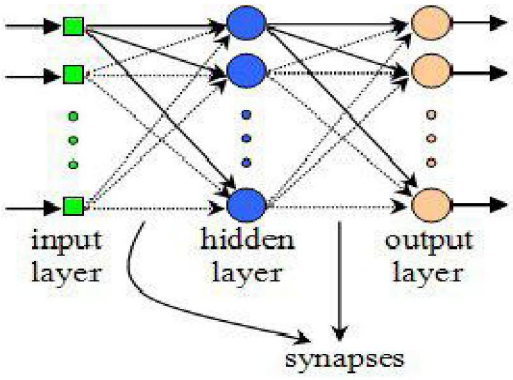

Figure 1: Multilayer Perceptron architecture

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These days, artificial neural networks are the most commonly utilized technique for disease diagnosis. Medical diagnosis and many other fields are seeing an increase in the use of artificial neural networks due to their fault tolerance, generalization, and learning from environment characteristics. The feed forward network is one of the most popular network topologies, in which network connections are only permitted between nodes in one layer and those in the one below. A feed-forward back propagation neural network is employed as a classifier to differentiate between those who are infected and those who are not.

Figure 2: This illustrates the decision-making architecture of feed forward neural networks (MLP). Three inputs are given to the network in this manner, and the summation function is used to add the inputs and weights together. The final output is expressed as Yes or No in binary form. Yes in the case of a sick patient and no in the case of an unaffected individual. In order to diagnose kidney stones and detect the disease early, three neural network algorithms—LVQ, RBF, and feed forward architecture with back propagation algorithms—have been studied in this work. To identify those who are impacted and those who are not, the classification accuracy of each of the three algorithms is evaluated.

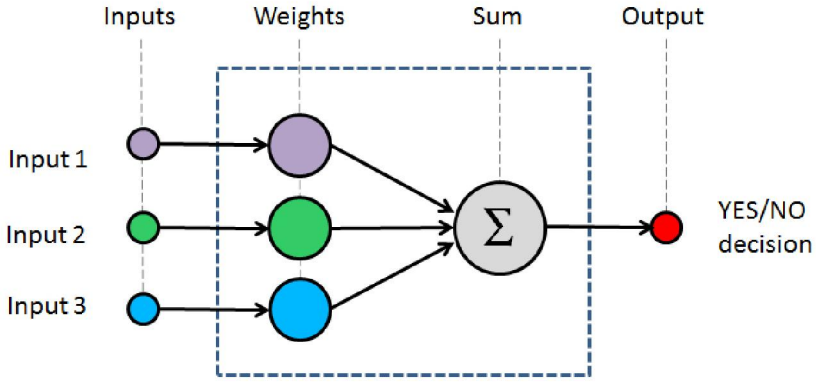

Figure 2 Feed Forward Architecture in Decision Making

III. CONCLUSION

Dietary changes can lower the chance of a stone recurrence. Almost all stone-formers should benefit from increased fluid intake and a diet containing 800–1200 mg of calcium; reduced amounts of sodium and animal protein; and higher intake of fruits, vegetables, and grains (apart from the high-oxalate ones). However, an individualized dietary prescription must be tailored according to stone type or urinary risk factors. It's also advised to consume less sugar, like in the low-calorie DASH diet. 107 According to the Recommended Dietary Allowances, Table 3 displays the sufficiency of the nutrients. From these recommendations, dietary changes (nutrient increases or decreases) can be computed, as previously suggested in Tables 1 and 2.

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