Artificial Intelligence In Pediatric Nephrology- Where Are We Heading?

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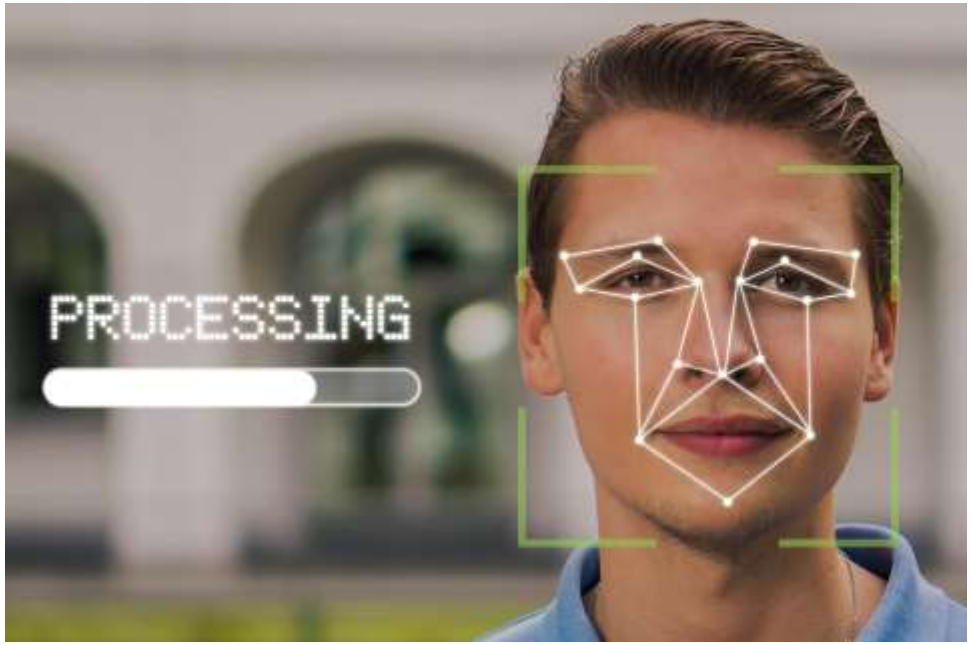
Outline

- What is AI?
- What are the potential applications of AI in nephrology?
- Advantages and limitations of AI

Disclaimers

- Not an expert in AI
- Major part is created using natural intelligence, augmented with AI
- Not an exhaustive review of literature

AI in daily life



Face recognition software

Tesla’s Autopilot

nature

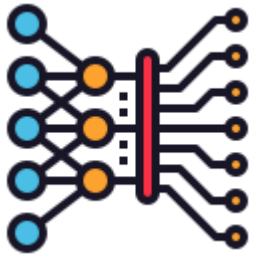
nature › news › article

News | Published: 15 March 2016

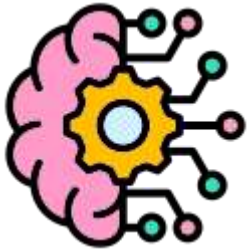
The Go Files: AI computer wraps up 4-1 victory against human champion

Tanguy Chouard

What is AI?

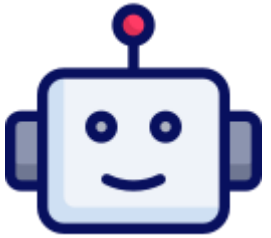


Machine learning
Alexa



Neural network
Autopilot

Natural language processing
ChatGPT

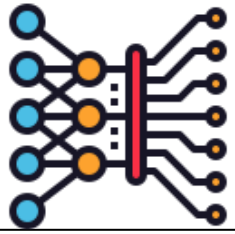


Robotics
Da Vinci

How does AI work?

Data
Labeled or unlabeled

Learning
Supervised or unsupervised



Machine learning models
- Supervised vector machine
- Random forest algorithm
- Artificial neural network
- Convoluted neural network

Niel AJKD 2019

Potential for AI in pediatric nephrology

Diagnostics
- AI algorithms
- Imaging analysis

Predictive analysis
- Disease progression
- Risk stratification

Management and monitoring
- Precision medicine
- Remote monitoring
- AI alerts
- Personalised therapy

Research and Innovation
- Clinical trials
- Drug discovery/development

Teaching learning

Jayaraman IJN 2025

Use of AI for diagnostics in nephrology

AI in diagnostics for nephrology

- A patient comes with a rare systemic genetic disease with kidney involvement. The family is worried about the risk of kidney failure.

- A new resident on call sees the ultrasound report of a patient and is unable to interpret the image

A newly trained pathologist in a remote area wants to confirm the findings of a histopathology slide from a kidney biopsy

AI for rare genetic kidney diseases

Uses

- Patient-centred diagnosis support
  - Tools like GDDP and Pubcasefinder – associate patient and disease phenotype
- Disease-centric screening
  - Useful in rare disease with small data
- Prognostic modelling
  - Risk prediction models for CKD

Chen, KI 2025

AI in diagnostic kidney imaging

- ResNEt-50 was built using data from normal and abnormal ultrasound images of kidneys in children
- Abnormalities – hydronephrosis, stone, cyst, hyperechogenicity, space-occupying lesions
- Overall accuracy – 92.9%

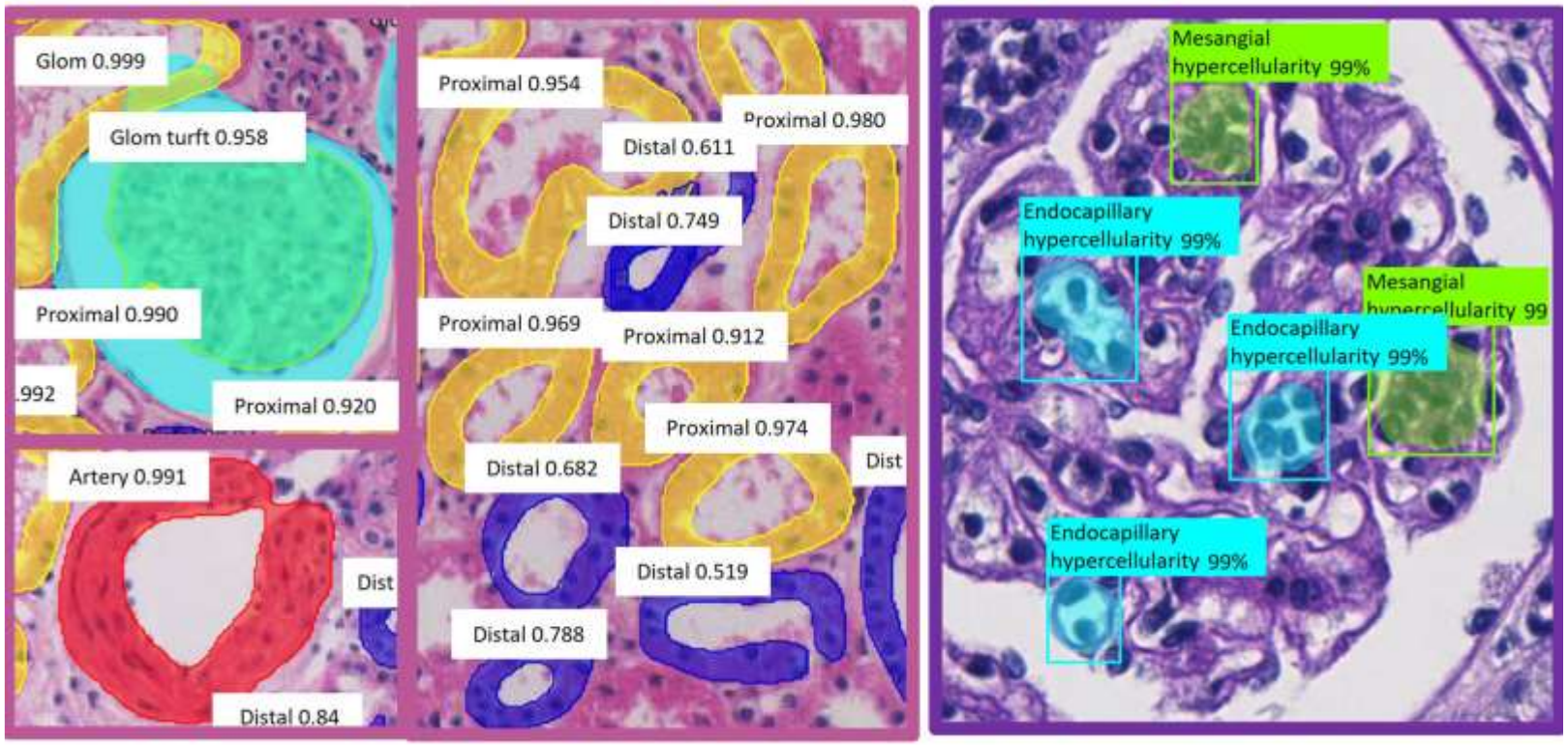
- Multi-instance deep learning method used to identify posterior urethral valves on ultrasound
- Performed better than single image models

Tsai JMIR Medical informatics 2022
Yin Urology 2020

AI for histopathology

AI based pediatric kidney disease network (APKD)

- Used annotated digitised slides to train CNN models
- High accuracy >95% for detection of histological structures, abnormal findings like crescents



Feng Bioinformatics 2024

AI for risk prediction

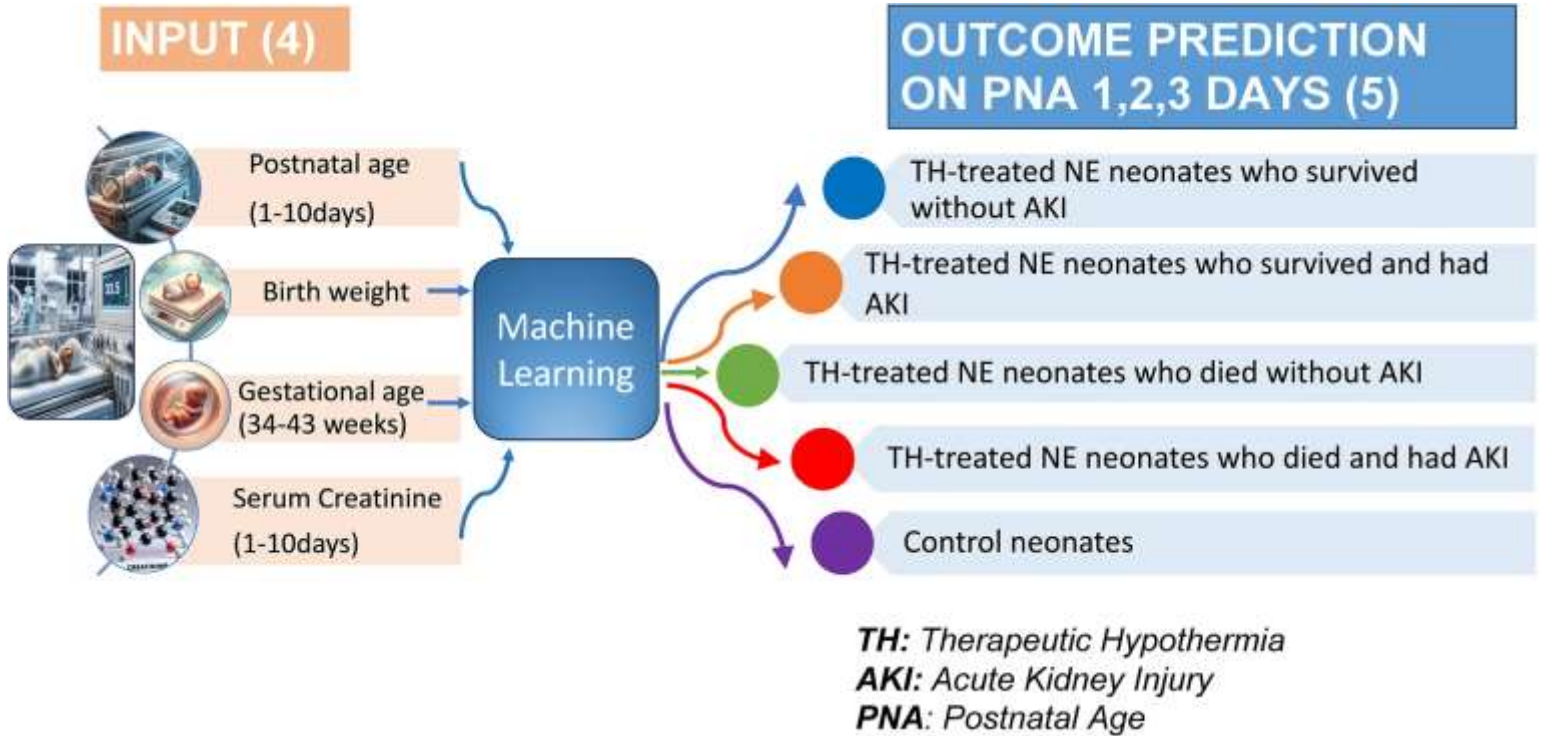
AI for risk prediction

- A neonate is admitted with HIE stage 2. Can we predict his risk of AKI?

- A child is admitted to the ICU with severe AKI requiring kidney support therapy. Can we predict his risk of AKD/CKD?

AI for risk prediction of AKI

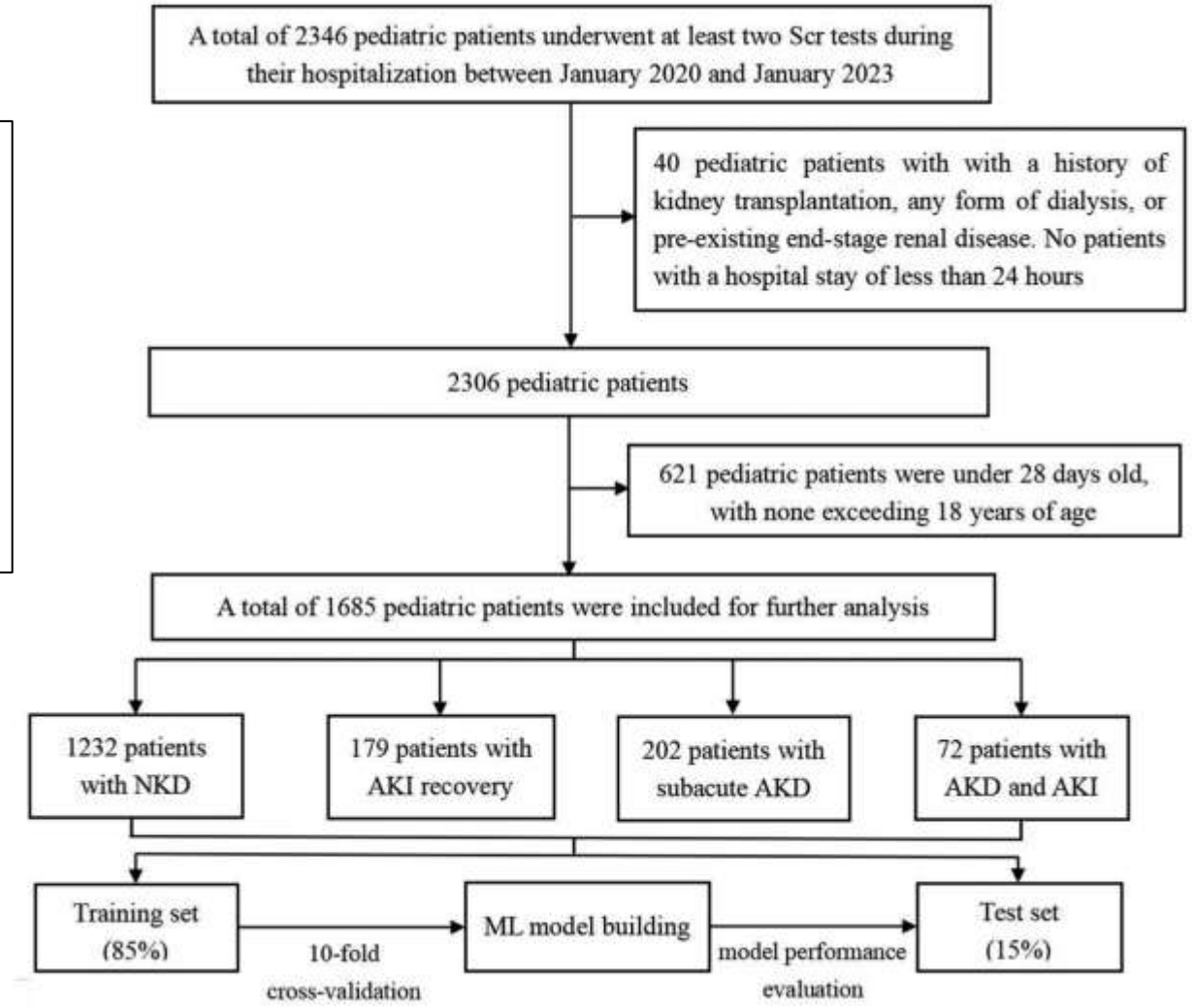
- Prediction of clinical outcomes, including AKI in neonates treated with therapeutic hypothermia.
- Achieved an AUC of 95% and accuracy of 75% for predicting AKI



Keles Sci Rep 2025

AI in AKI/D risk prediction

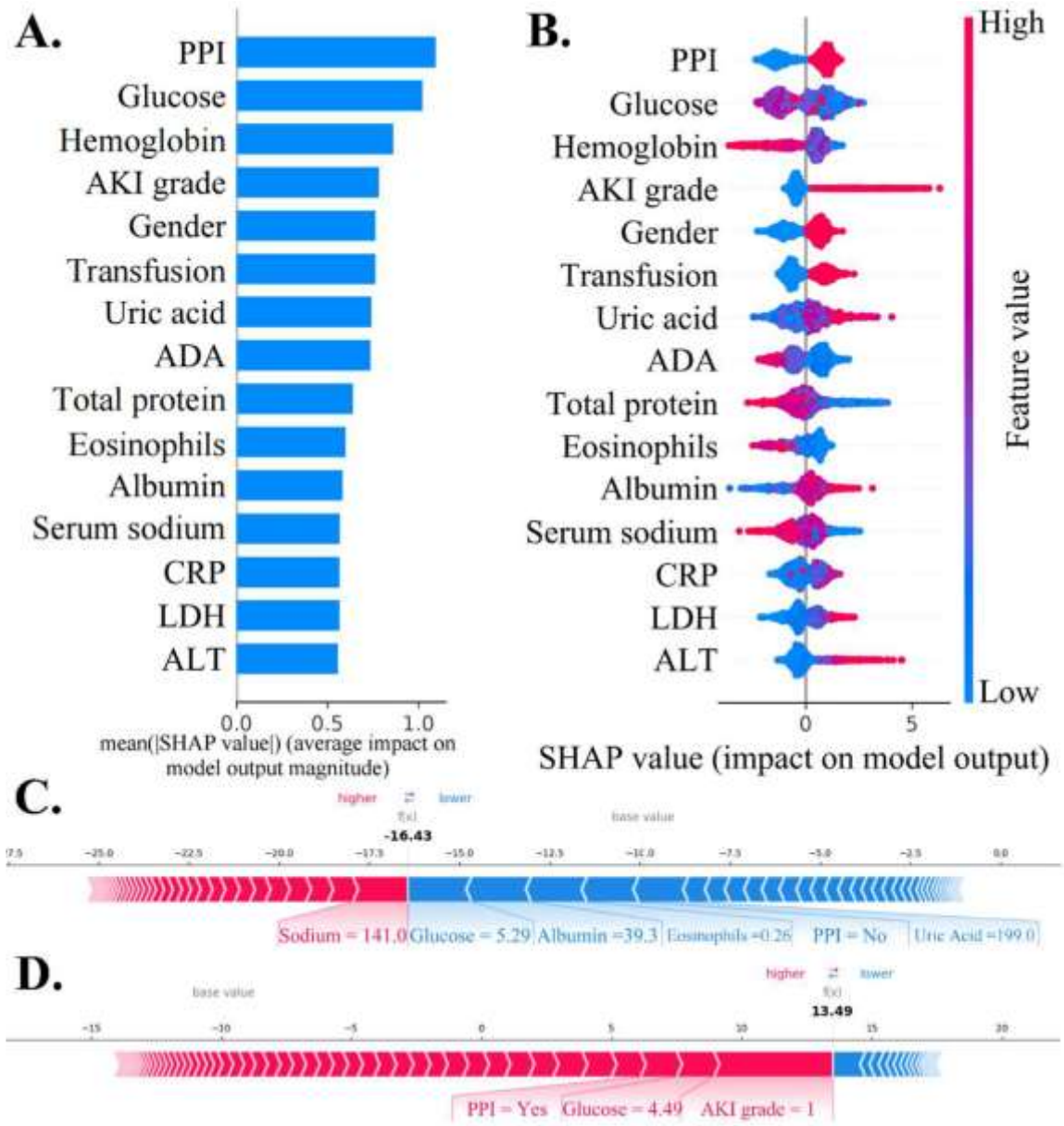
- Used data from in-patients to develop risk prediction modules for AKI, AKD and CKD
- Similar models have been developed for post cardiac surgery, patients in ICU



AI in AKI/D risk prediction

Risk prediction of AKD

- Global and individual risk prediction is available
- Patient C - <10% risk of AKD
- Patient D - >90% risk of AKD



Xu, Renal Failure 2024

AI for predicting mortality in dialysis

- ML tool developed to predict 5-year mortality in chronic hemodialysis
- Accuracy -81%
- Identified albumin, LDH – important predictors of mortality

ML model to predict mortality on children undergoing CKRT
AUC – 0.87
PELOD score 2 and respiratory failure – 2 important predictors

Gotta NDT 2021
Thadani CCEJ 2024

AI for management and monitoring

AI for management and monitoring

- A child with kidney failure is admitted with fluid overload. He has started dialysis and is improving. How can we estimate his dry weight?

- A child admitted to the hospital is receiving multiple nephrotoxic antibiotics. Can we prevent or detect AKI early?

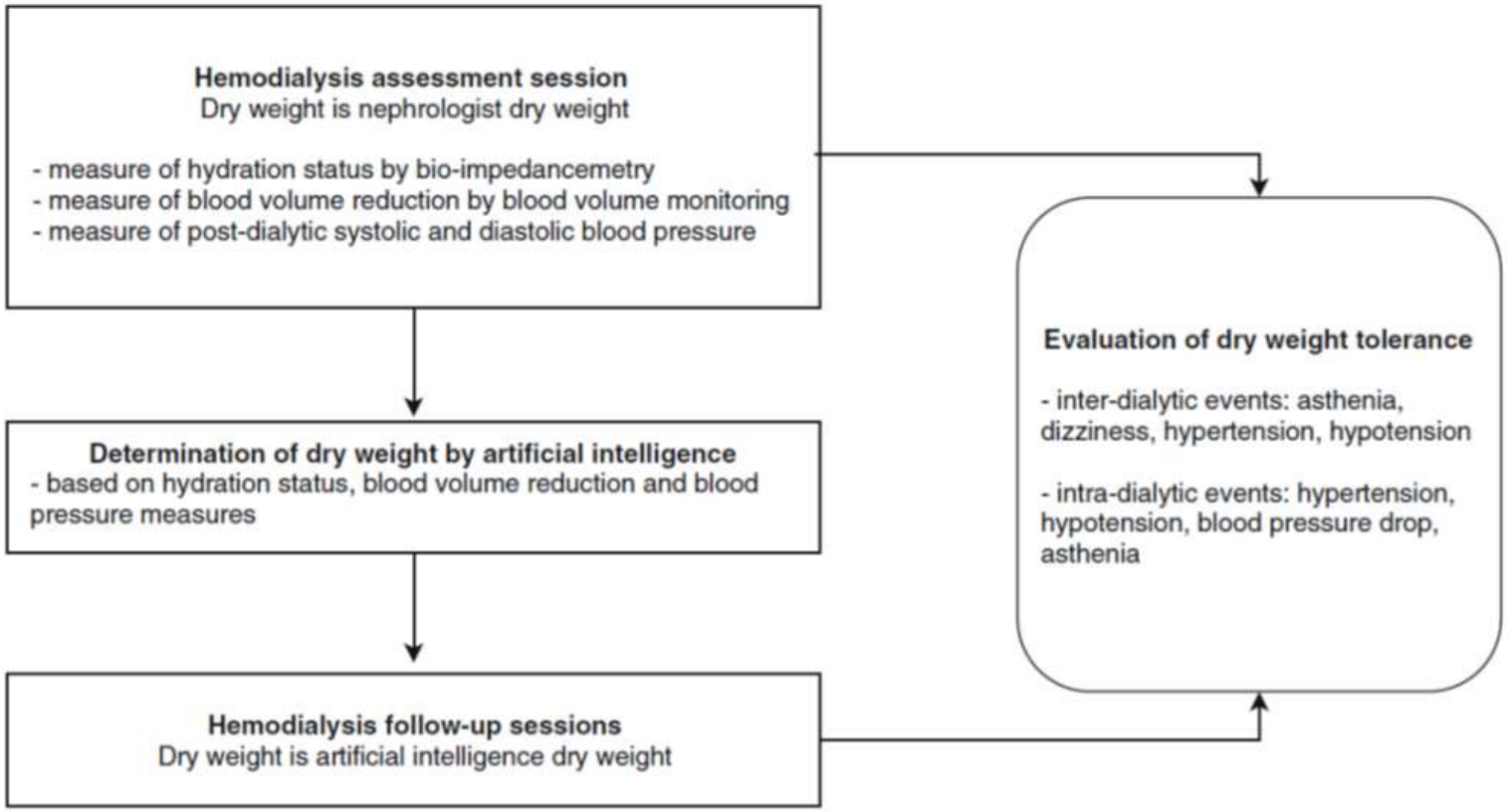
AI in chronic dialysis

- Improving the accuracy of dry weight assessment in chronic hemodialysis patients

Inputs
- Hydration status
- Blood volume monitoring
- Blood pressure

Perceptron neural network

- AI DW – different from clinical DW in 78%
- Clinical improvement after using AI DW



Neil Ped Nephro 2018

AI in prevention of AKI

NINJA and Baby NINJA

- Used electronic health alerts along with pharmacy-supported clinical decision making – antibiotic stewardship
- Significant reduction in incidence of AKI

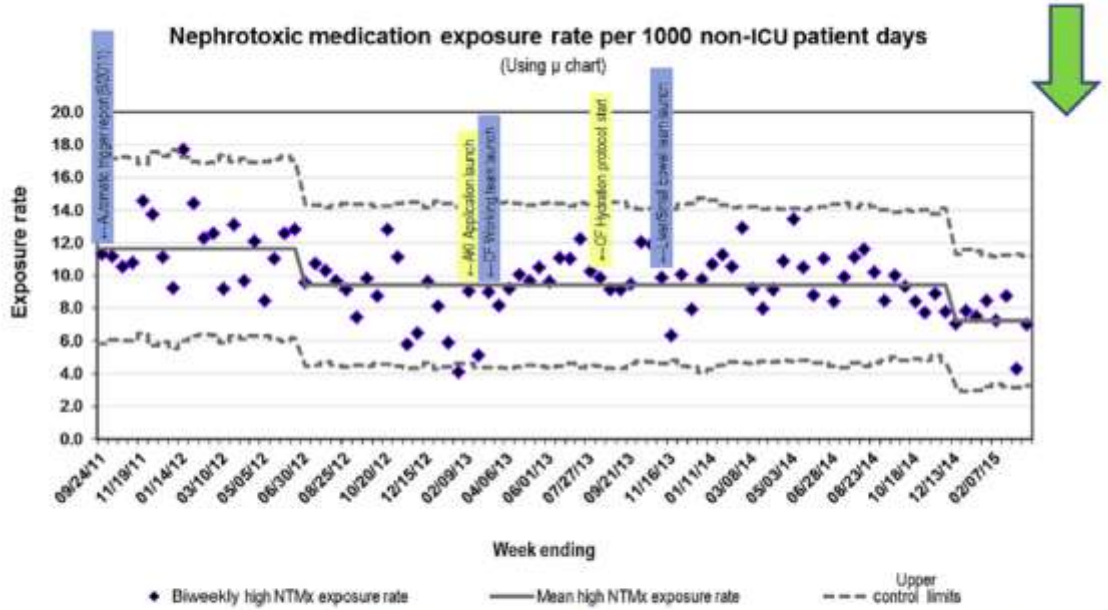
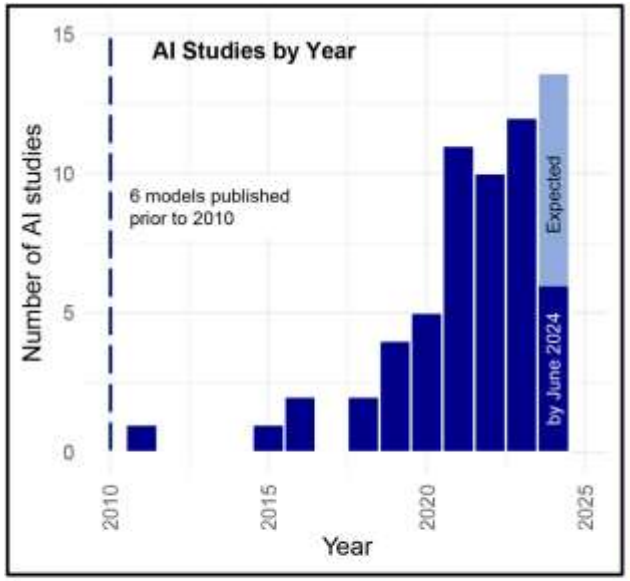
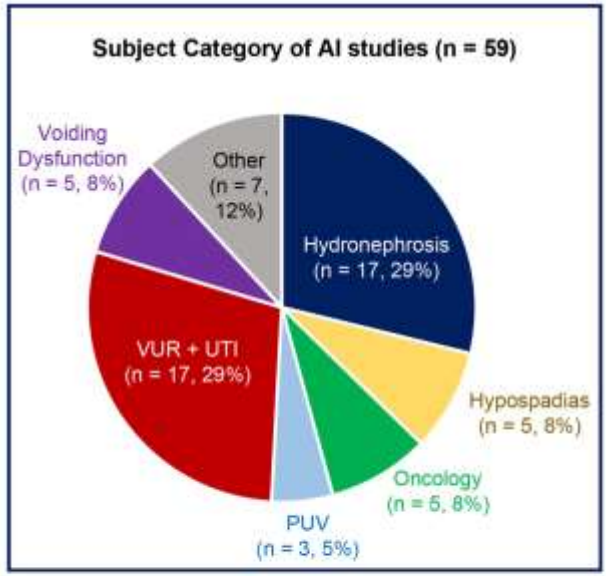


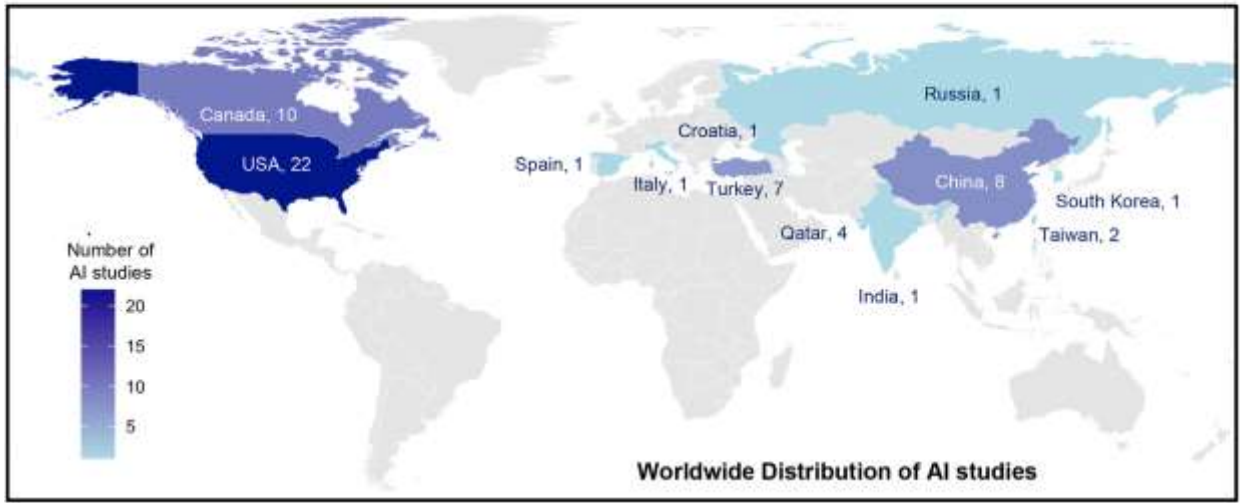
Figure 2| Biweekly average nephrotoxic medication exposure rates as measured by exposed patients per 1000 noncritically ill patient hospital days. The rate decreased from 11.63 to 7.24 admissions per 1000 patient-days over the course of the study, as revealed by 8 consecutive weekly rates below the baseline rate, representing a 99.7% likelihood that a special cause was present. Each data point represents 2 weeks beginning from a Monday to the Sunday occurring 14 days later. The green arrow represents the desired change in direction. AKI, acute kidney injury; CF, cystic fibrosis; ICU, intensive care unit; NTMx, nephrotoxic medication-associated.

Goldstein KI 2020

AI in Pediatric Urology







- Using data from CUTIE and RIVUR – which patient will benefit from an invasive VCUG after first UTI
- What renal/bladder ultrasound parameters could be used to defer a diuretic renogram in antenatal hydronephrosis

Khondker J Ped Urol 2025

AI in the surgical arena

- Robotic-assisted open and laparoscopic pediatric urological surgeries – increasing
- Good outcomes
- Increased operative time
- Steep learning curve

Salkini Annal Urol 2022

AI for teaching and training

AI in teaching and learning

- AI-based personalised training modules – cater to the level of the student
- Simulation-based learning- learn skills, problem-solving
- AI-based adaptive assessment

Advantages of AI

- Enhance clinical decision making – augmented intelligence
- Remote use - access to new technology

Limitations of AI

- Requires a large amount of data for training
- Need good predictors to approximate functions correctly
- Training of ANN/CNN – a large amount of computational resources
- Lack of interpretability
- Bias – historical, population
- Privacy and confidentiality of data
- Ethical issues- accountability
- Impact on the physician-patient relationship

Conclusions

- Wide range of applications in pediatric nephrology
- In clinical care - Diagnostics, risk prediction, management, monitoring
- Research and teaching-learning
- Enhances clinical decision making
- Needs a large quantity of good-quality data for training
- Vulnerable to bias
- The new age Frankenstein - Faithful servant, formidable master

Thank you