Automatically Detecting AKI Events from Primary Care Records

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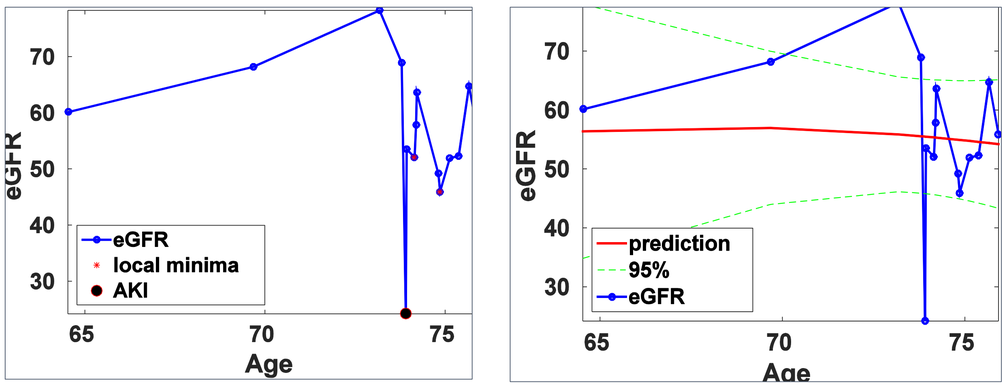
Introduction

Acute kidney injury (AKI) is defined by a rapid deterioration in kidney function based on the rate of change in a patient's estimated glomerular filtration values. In this poster we present two alternative automated approaches for detecting AKI: as the outlier points when using Gaussian process regression (GPR) and using the novel Surrey AKI detection algorithm (SAKIDA).



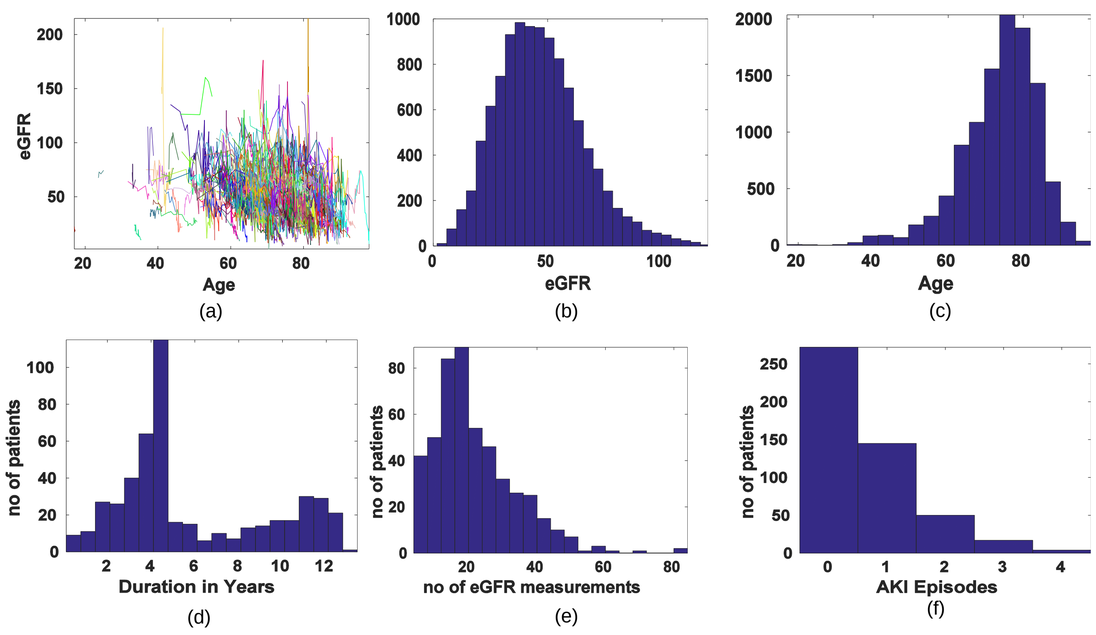
AKI detection using (a) the Surrey AKI detection algorithm and (b) Gaussian process regression. The eGFR measurements outside the confidence bounds indicate the occurrence of AKI

Advantages

- Can monitor CKD patients remotely to detect AKI in primary care (often without context).
- Reduce the human effort (and cost) in labelling the data.
- By working in eGFR rather than serum creatinine, the influence of age, gender and ethnicity are accounted for; so, making analysis on the long-term impact of AKI on CKD possible.
- By using only candidate AKI points, false alarms are significantly reduced compared to the NHS algorithm

Dataset

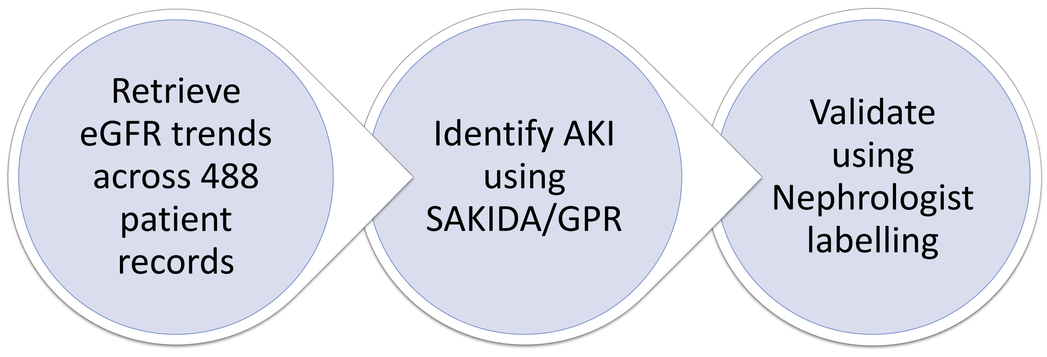
The dataset used in this work contains the eGFR series of 488 patients treated at East Kent University Hospital – 275 (56.4%) are male and 213 (43.6%) are female. It was collected as part of a study seeking to understand the characteristics of AKI and its impact on CKD. In total, there were 10,873 eGFR measurements across the 488 patients, with approximately 95% between the values of 25 and 95 mL/min/1.73m^2 and occurring in patients between the ages of 60 and 90.



Each patient's eGFR time signal was labelled with the number of AKI episodes experienced: 0, 1, 2, 3 or 4.

AKI Episodes	0	1	2	3	4	Total
Percentage	55.7377	29.7131	10.2459	3.4836	0.8197	100
Count	272	145	50	17	4	488

System Architecture



Evaluation

Each eGFR time series in the dataset was annotated by 4 nephrologists to record whether it contained 0, 1, 2, 3 or 4 AKI episodes. They were blinded to each other's responses. Where there was no agreement, patients results were discussed and a consensus reached. Taking y to be the ground truth and y* the labels predicted by algorithm. We evaluated the performance of our proposed algorithms against the experts as the accuracy with which the algorithm was able to label eGFR subdivided by the number of AKI episodes.

Validation

According to the NICE guidelines, an AKI episode occurs when the ratio of the reference value calculated from prior measurements to the current measurement is ≥ 1.5. However, this threshold is designed for serum creatinine levels, not the eGFR values derived from them. In order to determine how this threshold influences the algorithms within the eGFR space, thresholds within the set {1.1, 1.2, . . . , 2.0} were evaluated. We found that the threshold around 1.5 performs the best.

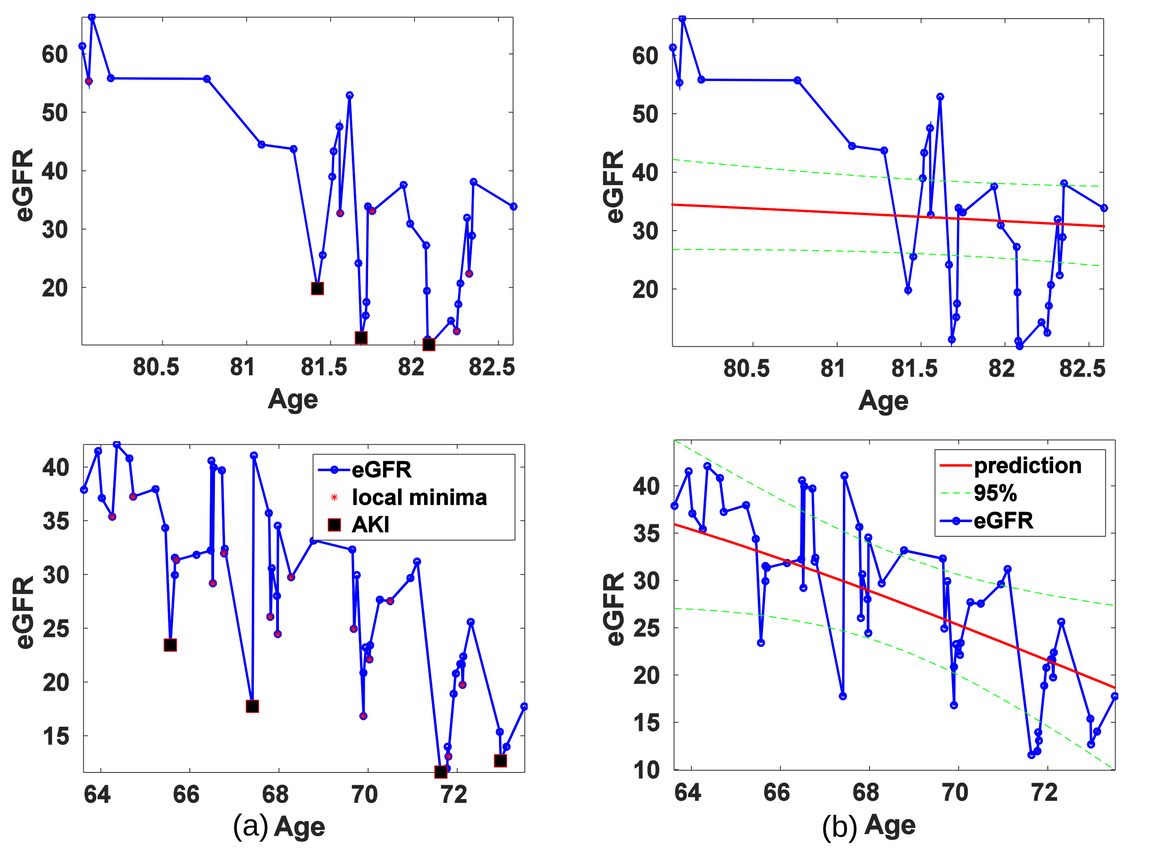
Δ ≥	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2
y = y*	19.47	42.42	61.48	69.47	**69.67**	69.06	66.19	65.78	63.52	63.11

Results

SAKIDA was able to identify patients with no AKI episodes with an accuracy of 90.44%, while GPR achieved 83.82% and NHS England 73.53%. SAKIDA also detected no more than 4 AKI episodes per signal, in agreement with the expert's classifications, while GPR and NHS England detected more in 67 and 99 patients respectively.

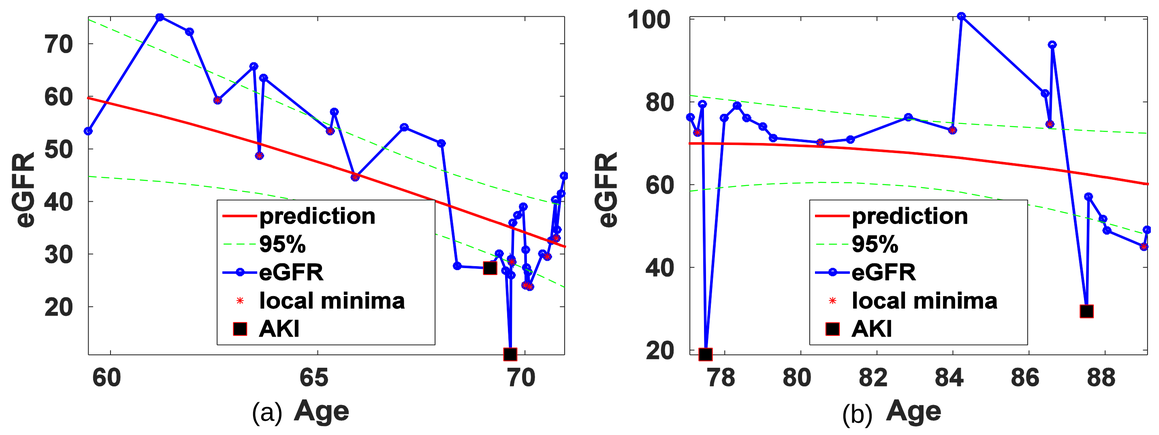
	0	1	2	3	4
NHS	73.53	22.07	16.00	17.65	0.00
GPR	83.82	28.97	20.00	5.88	0.00
SAKIDA	90.44	53.10	30.00	5.88	25.00

Performance of SAKIDA, NHS England & GPR in detecting the number of AKI episodes.



Comparison of (a) SAKIDA and (b) GPR algorithms.

Hybrid visualisation of SAKIDA and GPR algorithms.(a) unstable and (b) stable eGFR signal trends with GPR model outliers that include AKI episodes. SAKIDA localises the AKI episodes in both signals.



Conclusion

We introduced a novel algorithm "SAKIDA" to detect AKIs from the primary care data. The proposed SAKIDA performs better than GPR and NHS England algorithms in the primary care settings with 70% accuracy. GPR and NHS England are more suitable in real-time systems e.g., in secondary care settings. Hybrid system involving SAKIDA and GPR could visualise eGFR trends as well as localise AKI episodes (SAKIDA).

References

[1] Tirunagari, S., Bull, S.C., Vehtari, A., Farmer, C., de Lusignan, S. and Poh, N., 2016, December. Automatic detection of acute kidney injury episodes from primary care data. In *Computational Intelligence (SSCI), 2016 IEEE Symposium Series on* (pp. 1-6). IEEE.

[2] NHS-England, "Patient safety alert on standardising the early identification of acute kidney injury, (03 august 2016, date last accessed)," 2014. [Online]. Available: http://www.england.nhs.uk/2014/06/09/psa-aki/

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