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Faculty of Medicine Ramathibodi Hospital

Department of Clinical Epidemiology and Biostatistics

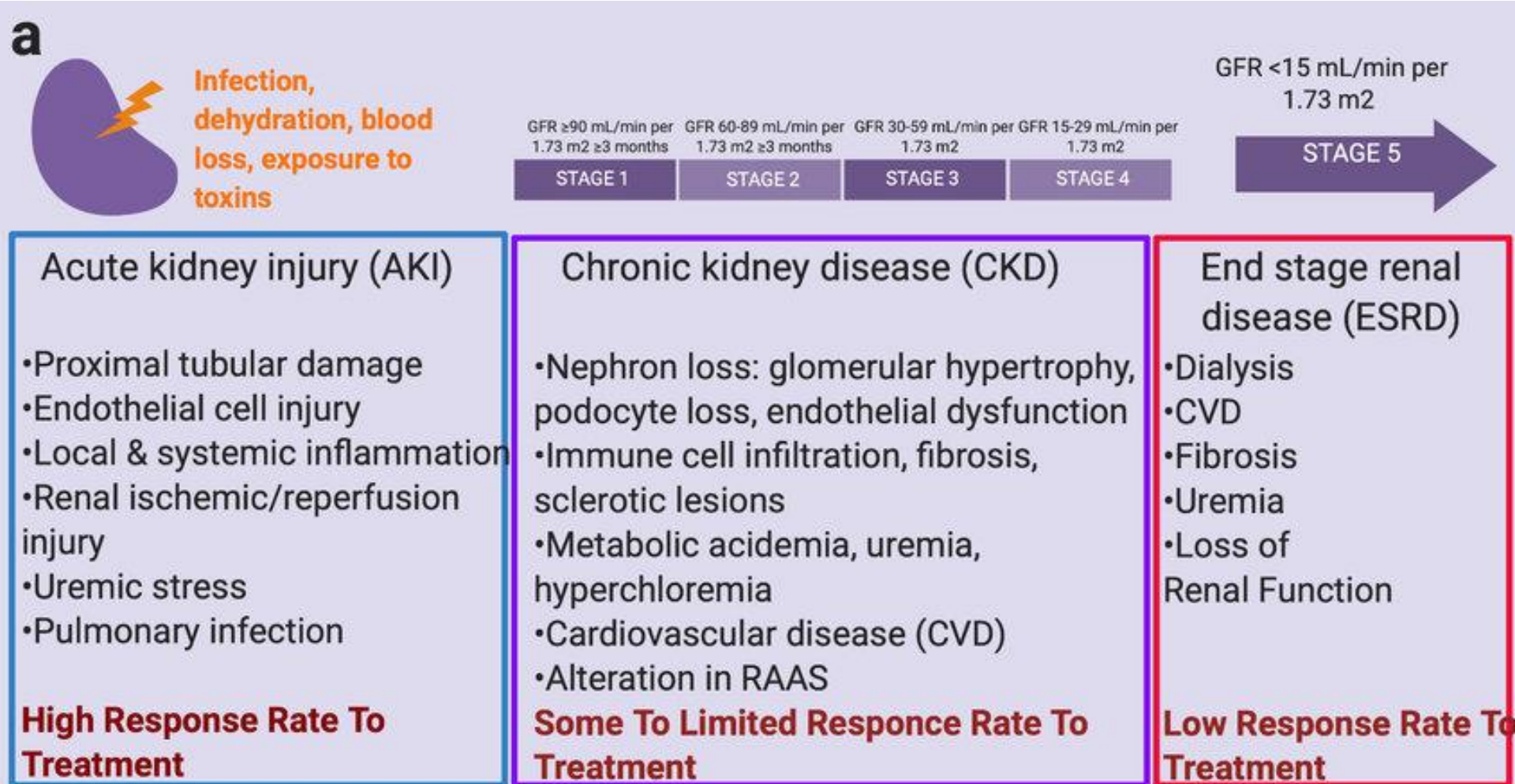
Real-world Health Data and Precision for the Diagnosis of Acute Kidney Injury, Acute-on-Chronic Kidney Disease, and Chronic Kidney Disease: Observational Study

Sharmin Akter

RADI 6336641

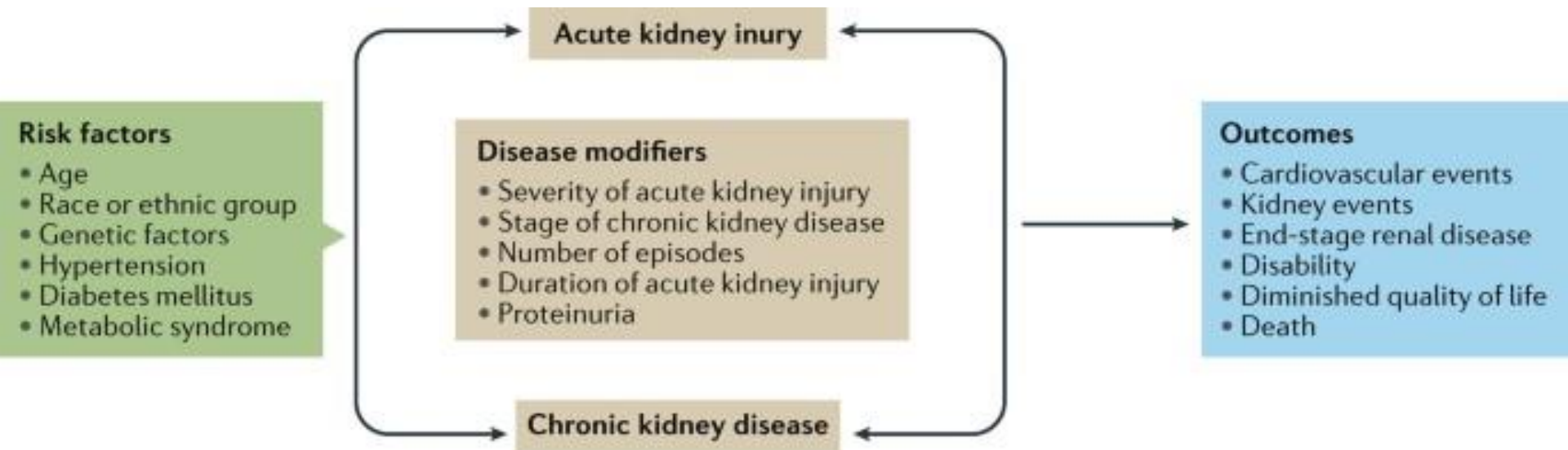


Background





Background





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- An increasing prevalence of inpatient cases with a measured eGFR of <60 ml/min can be shown for the discharge years 2014-2019
- Burden of Chronic Kidney Disease (CKD) in USA is 11.6%
- 10.21% cases in 2014 to 18.69% cases in 2019



Prevalence of cases with eGFR <60 ml/min

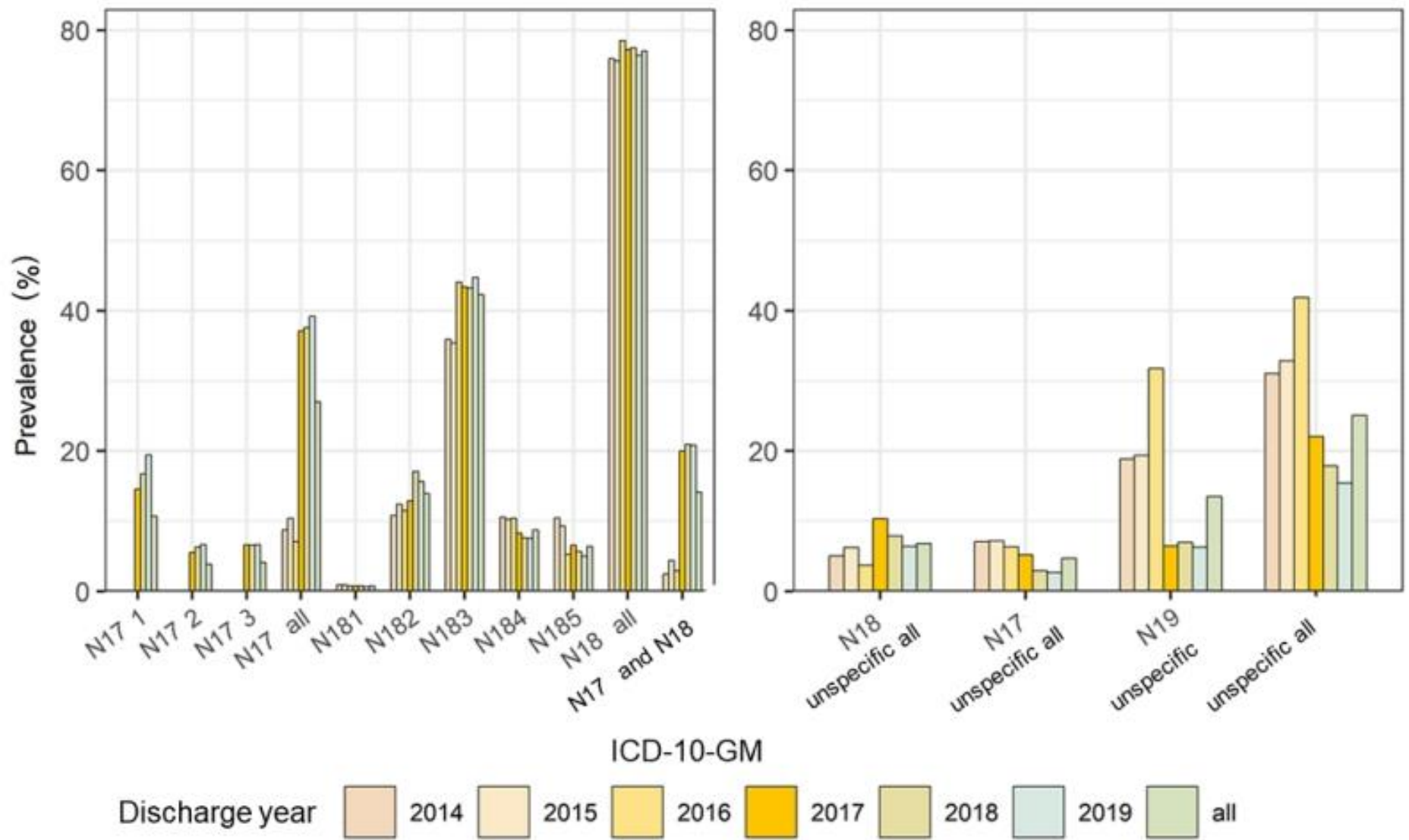
Distribution	Year of discharge					
	2014	2015	2016	2017	2018	2019
Inpatient cases, N	42,703	45,138	64,478	65,146	66,038	66,958
Inpatient cases with measured eGFR, n (% of inpatient cases total)	20,610 (48.26)	37,326 (82.69)	40,917 (63.46)	40,109 (61.57)	41,552 (62.92)	46,800 (69.89)
Inpatient cases with an eGFR of <60 ml/min, n (% of inpatient cases total)	4362 (10.21)	8786 (19.47)	11,100 (17.22)	10,695 (16.42)	10,570 (16.01)	12,519 (18.67)
Any KI-coded (ICD N17-/N18-/N19-) cases, n (%)	4491 (10.51)	4786 (10.6)	8422 (13.06)	8512 (13.06)	10,165 (15.39)	11,124 (16.61)
Any KI-coded (ICD N17-/N18-/N19-) in- patient cases with an eGFR of <60 ml/min, n (%)	2167 (49.68)	4029 (45.86)	5005 (45.09)	5031 (47.04)	5983 (56.6)	7596 (60.68)

- Increase in ICD-10 code usage, but still not high



Acute Kidney Injury (AKI) and Chronic Kidney disease (CKD)

- definitions of AKI and CKD require a **complex analysis** of a patient's recent and historical laboratory values, a **time-consuming** process impeded by **missing values** and prone to **errors** if conducted manually.
- **Misclassification** impairs the choice of **therapeutic approach**, outcomes, high-quality documentation, data validity, and reimbursement.





Kidney Disease Diagnostic Method 1

- Little health data access
- Increase or decrease of Serum Creatinine (SCr) within short time (7 days) with significant gradient
 - For example:

Diagnosis of Acute Kidney Injury (AKI) stage 3 according to the Kidney Disease: Improving Global Outcomes (KDIGO) guidelines is defined as follows: an increase in serum creatinine (SCr) from under 4 mg/dL (353.6 μ mol/L) to over 4 mg/dL within 7 days or an increase of SCr by 200% or more within 7 days.
- SCr baseline calculation has to be conducted: the **lowest value during hospitalization** or the arithmetic **mean of all outpatient measurements** before the index admission.



Kidney Disease Diagnostic Method 2

- Increasing health data availability
- Diagnosis using ICD-10
- However, the interrater reliability shows **insufficient values for certain diagnoses** when comparing **ICD codes or patients' records** of the diagnoses of AKI and chronic KD (CKD)



Impacts of Manual Validation of ICD-10

Discharge year	N19 codes generated, N	N17 codes from the N19 codes generated, n (%)	N18 codes from the N19 codes generated, n (%)	N19 codes from the N19 generated, n (%)
2014	2967	188 (6.34)	1705 (57.47)	357 (12.03)
2015	6279	475 (7.56)	3126 (49.78)	684 (10.89)
2016	7833	460 (5.87)	3924 (50.10)	1544 (19.71)
2017	7605	2027 (26.65)	3831 (50.37)	301 (3.96)
2018	7560	2420 (32.01)	4571 (60.46)	467 (6.18)
2019	9501	3204 (33.72)	5894 (62.04)	416 (4.38)

- Increase in ICD-10 code usage, but could be better



Kidney Disease Diagnostic Method 3

- Clinical decision support systems
 - can provide a **systematic** and **objective** way to enhance **complex reasoning** related to **differential diagnostics**
 - In Switzerland, since 2017, based on the official coding rules, AKI and CKD have been coded according to KDIGO classification
 - However, they did not document the exact staging in the discharge in many cases.



Objectives

- This study aims to evaluate a novel **data-driven method** to assign **highly specific diagnoses** of AKI and CKD by extracting **historical** and **real-time data** from the hospital's data warehouse.
- To improve accuracy of diagnosis of AKI and CKD



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Study Population & Setting

- Administrative and laboratory data of all inpatient and outpatient cases of Inselspital University Hospital Bern 2014-2019
- Data from 2014-2019
- 200,000 CKD patients
- 62,000 inpatient cases had ICD-10 coded diagnosis
- Data from 2014-2016 = benchmarking
- 2017-2019 data was used for testing



Acute Kidney Injury (AKI) stages

- **Stage 3:** increase of SCr from under 4 mg/dL (353.6 $\mu\text{mol/L}$) to **over 4 mg/dL** within 7 days
- **Stage 3:** increase of SCr by **200% or more** within 7 days
- **Stage 2:** increase of SCr by **100%-200%** within 7 days
- **Stage 1:** increase of SCr by **50%-100%** within 7 day
- **Stage 1:** increase of SCr by **0.3 mg/dL** (26.52 $\mu\text{mol/L}$) within 48 hours



Chronic Kidney Disease (CKD) Stages

Glomerular Filtration Rate (GFR) categories were assigned as follows:

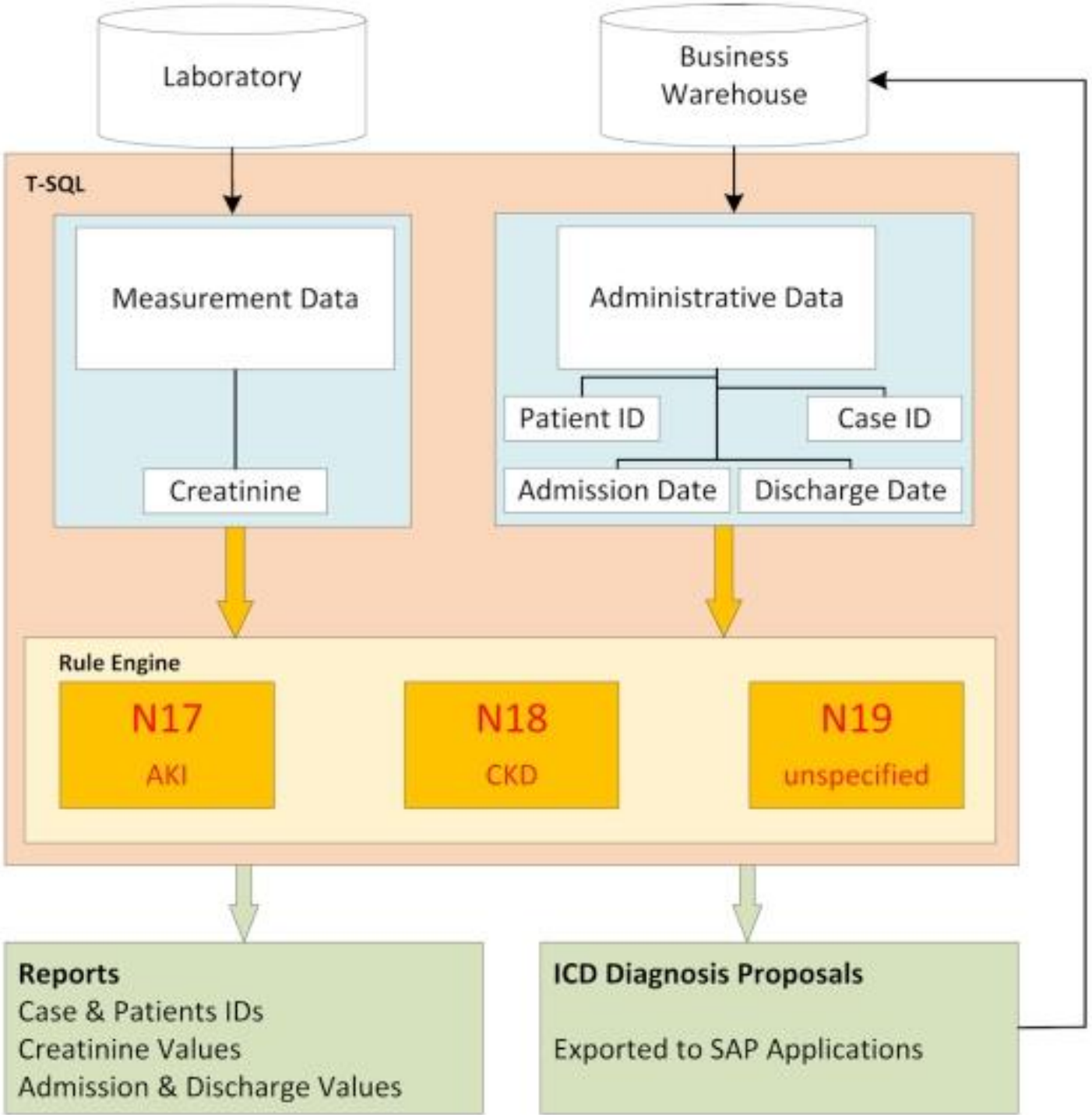
- **Stage 5:** all values **under 15 mL/min/1.73 m²** for >91 days
- **Stage 4:** all values **under 30 mL/min/1.73 m²** for >91 days
- **Stage 3:** all values **under 60 mL/min/1.73 m²** for >91 days
- **Stage 2:** all values **under 90 mL/min/1.73 m²** for >91 days



Urine Albumin to Creatinine Ratio

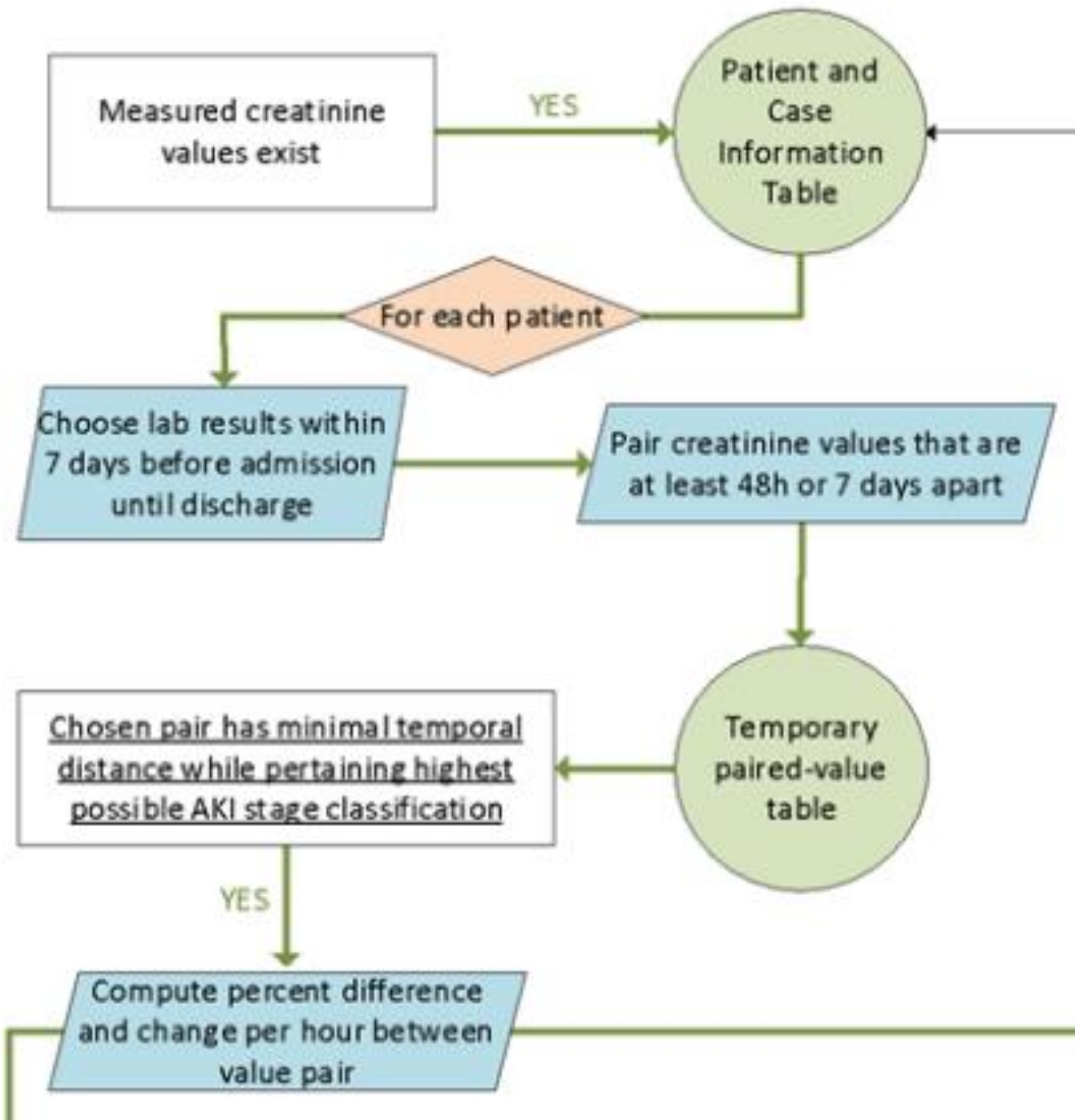
- **Severely increased:** SCr ($\mu\text{mol/L}$)/albumin (g/L) **>30 mg/g**
- **Moderately increased:** SCr ($\mu\text{mol/L}$)/albumin (g/L) **between 3 and 30 mg/g**
- **Normal to mildly increased:** SCr ($\mu\text{mol/L}$)/albumin (g/L) **<30 mg/g**

***Values from one sample or values measured within an interval of 30 days were considered.



Data Driven AKI Diagnostic Proposal Pipeline

Algorithms of Diagnosis of AKI



Compute percent difference and change per hour between value pair

Tendency

Relative Change per Hour

SCr has risen/fallen at least 50% to max. 99% during 7 days OR SCr has risen/fallen by 0.3 mg/dL (26.52 μ mol/L) during 48h

YES

PROPOSE N17.91

PROPOSE 'INCREASING TENDENCY'

APPEND DECISION CRITERIA

NO

SCr has risen/fallen at least 100% to max. 199% during 7 days

YES

PROPOSE N17.92

PROPOSE 'INCREASING TENDENCY'

APPEND DECISION CRITERIA

NO

SCr has risen/fallen at least 200% OR exceeds/understep 4 mg/dL (353.6 μ mol/L)

YES

PROPOSE N17.93

PROPOSE 'INCREASING TENDENCY'

APPEND DECISION CRITERIA

Dynamic Execution

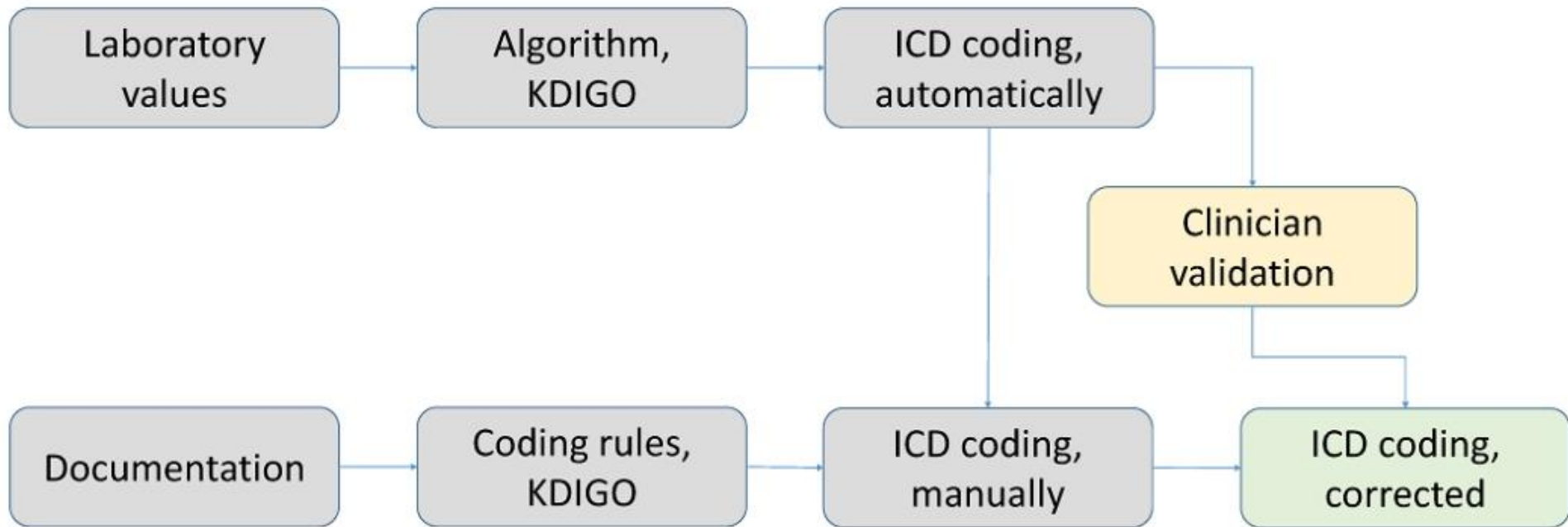


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Outcomes:





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New System Implementation

- A simulation was run at the Swiss Diagnosis Related Groups, Inpatient Tariff (SwissDRG)
- Inpatient cases from February 1, 2020, to July 31, 2020 with and without grouping automatically calculated the ICD diagnoses



Benefits of the New System

- Specific diagnoses and exact stages of AKI and CKD produced highly reliable results
- The process of communicating and verifying the diagnoses improved the validity of medical data for each patient
- Diagnoses and stages could be displayed in near to real time
- Retrospective calculations could be conducted for the previous 6 years



Limitations of the New System

- Validation of ICD diagnoses was strongly aimed at ICD codes within a selective group of people, resulting in a bias toward validating cases other group of people
- Consecutively, the exact staging of diagnoses was also limited to this group
- KDIGO classification of CKD grade 1 could not be considered for technical reasons
- Data on inpatient cases of all Insel Gruppe sites are available only for the years 2017-2019, hence could not compare to previous years



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