Mortality Risks in Heart Failure Patients

Among patients hospitalized for heart failure, how do age and serum creatinine levels relate to death, and does that relationship differ by diabetes status?

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Why Heart Failure, Creatinine, and Diabetes?

- We are pre-med students and wanted a clinical question we could answer using data from real clinical studies.
- Heart disease is the leading cause of death in the U.S., and heart failure is a major driver.
- Serum creatinine measures kidney function. Impaired kidneys are linked to higher cardiovascular risk.
- Diabetes affects both the heart and kidneys, so it could change how creatinine and age relate to death.

Dataset

- UCI Machine Learning Repository: 299 heart failure patients, Faisalabad Institute of Cardiology, April-December 2015 (8 mo.)
  - Contains 13 clinical variables; we focused on 4:
    - Age, in years
    - Serum creatinine, in mg/dL: higher means poorer kidney function
    - Diabetes (yes/no)
    - Death during follow-up period (yes/no). Follow-up length varies by patient (4 - 285 days).
- Dataset Limitations: The dataset comes from a single hospital. Results may not generalize and may contain regional biases.

Summary Statistics by Diabetes Status and Outcome

Table 2: Five-number of age by diabetes status and outcome.

Diabetes	Outcome	n	Minimum Age	Age Q1	Median Age	Age Q3	Maximum Age
No diabetes	Survived	118	40	50.00	60.0	67.75	90
No diabetes	Died	56	45	55.00	68.5	75.00	95
Diabetes	Survived	85	40	50.00	60.0	65.00	80
Diabetes	Died	40	42	56.75	60.0	70.00	94

Table 3: Five-number of creatinine levels (mg/dL) by diabetes status and outcome.

Diabetes	Outcome	n	Minimum Creatinine	Creatinine Q1	Median Creatinine	Creatinine Q3	Maximum Creatinine
No diabetes	Survived	118	0.5	0.90	1.10	1.2	5.0
No diabetes	Died	56	0.6	1.08	1.35	1.9	9.4
Diabetes	Survived	85	0.6	0.90	1.00	1.2	6.1
Diabetes	Died	40	0.6	1.08	1.30	1.9	6.8

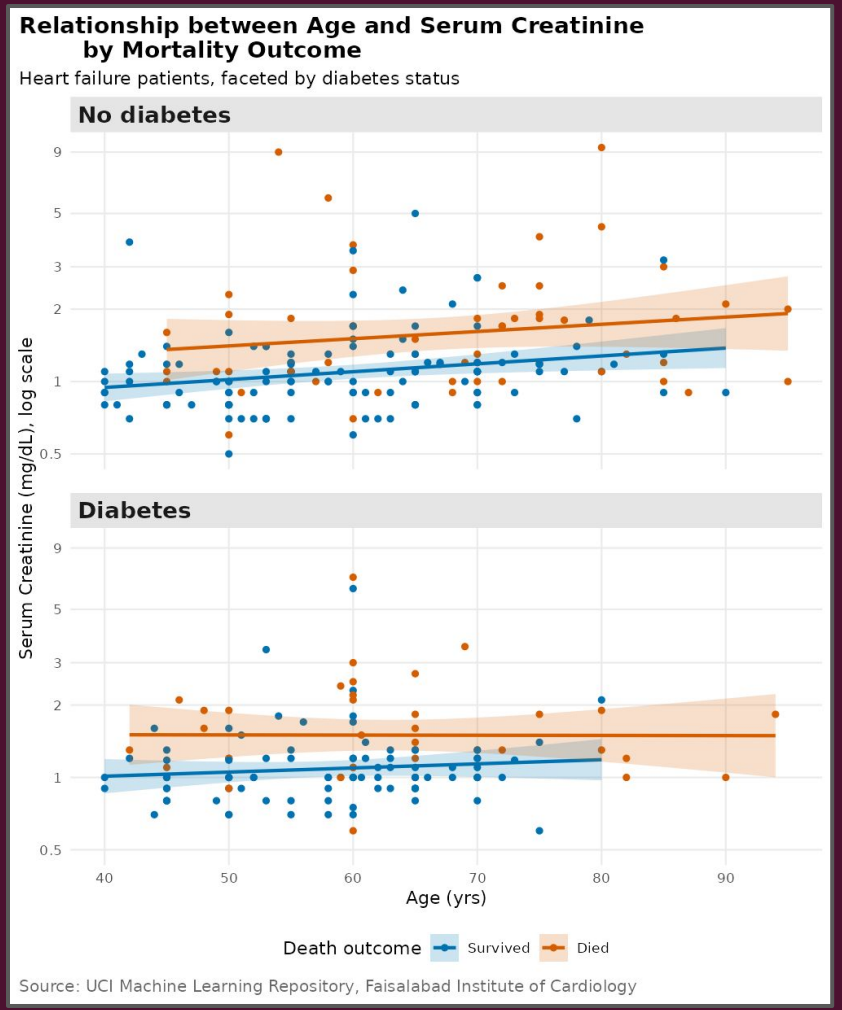
Death and Creatinine

Faceted Scatterplot

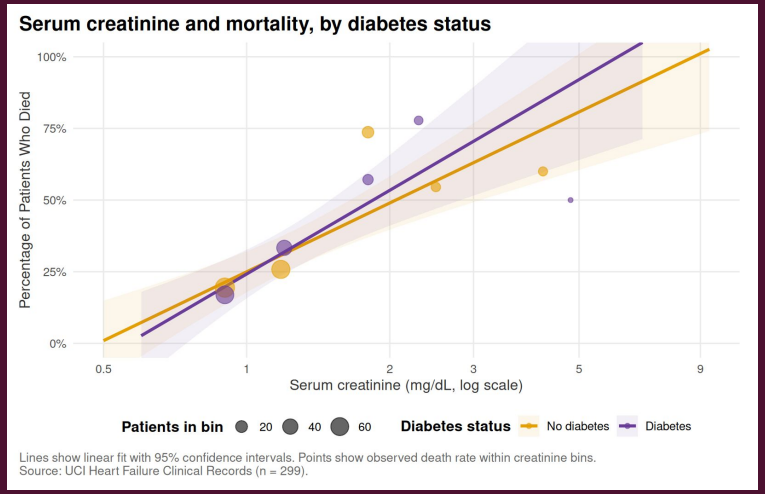
Do patients who died have higher creatinine than survivors of the same age, and does this relationship change with vs without diabetes?

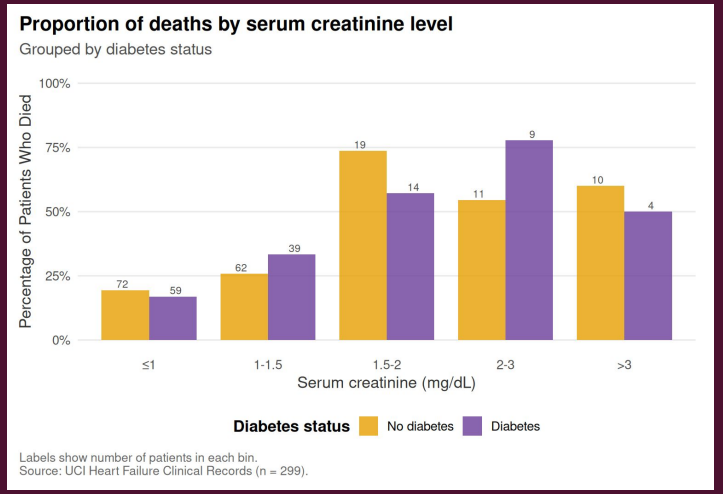
Lines are linear fits with 95% bands. Creatinine is on a logarithmic scale because of its wide range.

In both panels, the patients who died typically had higher serum creatinine levels, than survivors at same age. Among survivors, creatinine rises slightly with age in both panels.



Death Rises with Creatinine Regardless of Diabetes Status





Does the proportion of patient deaths rise as creatinine rises, and does diabetes change this relationship?

Left: Each point is the observed death rate in one creatinine bin, sized by patient count. Lines are linear fits with 95% CIs. Death rates rise with creatinine levels.

Right: In every bin at or below 1.5 mg/dL, 17-33% of patients died. In every bin above 1.5, 50-78% died. Bins above 2 mg/dL have only 4-11 patients, so those rates are imprecise.

Patients Who Died Had Higher Creatinine Levels

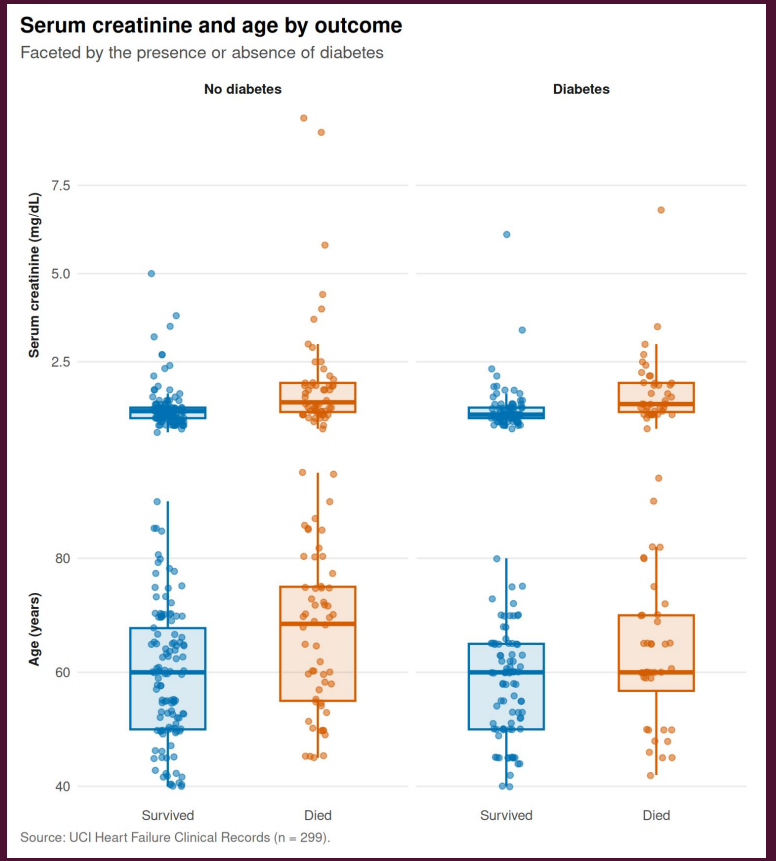
Do patients who died have higher serum creatinine and older age than survivors, and does this differ by diabetes status?

Creatinine:

- The creatinine axis is linear; a few extreme values stretch the scale.
- The median creatinine is higher among patients who died in both groups: 1.35 vs 1.10 mg/dL without diabetes, 1.30 vs 1.00 with diabetes.

Age:

- Without diabetes, the median age is 68.5 for patients who died vs 60.0 for survivors.
- With diabetes, the medians are equal at 60, but the *Died* box sits higher (Q1 56.75 vs 50, Q3 70 vs 65).



Conclusions, Limitations, and Future Directions

- Higher serum creatinine is associated with higher death rates. Patients who died had higher creatinine at the same age.
- Death rates by diabetes status are nearly identical (32.2% vs 32.0%), and the creatinine pattern looks similar in both groups.
- Limitations:
  - Single hospital, n = 299. Observational data, so no causal claims.
  - Follow-up time varies, so “died” isn’t easily comparable across patients.
  - Age and creatinine are likely correlated, and we did not adjust for both together.
  - Diabetes is only yes or no; no severity or duration data.
- Future Directions: Look at relationships with ejection fraction and serum sodium. Fit a multivariable logistic regression, or a survival model using follow-up time.