

# Acute Kidney Injury in Admitted COVID-19 Patients

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COVID-19 is primarily a respiratory infection; however, there are multiple examples of multi-organ and systemic dysfunction associated with this infection.<sup>1</sup> In addition to lung damage, it appears that the virus affects the lining of blood vessels, potentially leading to clotting, embolization, and organ damage. In a recent study by Hirsch et al,<sup>2</sup> acute kidney injury (AKI) was reported to occur at a high rate in hospitalized COVID-19 patients. Our examination of EHR data confirmed these findings and also revealed an increased incidence of AKI in COVID-19 patients with hypertension, diabetes, or COPD, as well as in patients on mechanical ventilation.

In this study, we looked at the incidence of AKI in 36,396 adult patients who were admitted for COVID-19 and had either been discharged or died, as of June 24, 2020. We counted only the first admission for patients with multiple COVID-19 admissions. Additionally, patients with chronic kidney disease or end stage renal disease were excluded from analysis, as baseline serum creatinine (an important measure in our definition of AKI) is usually elevated in these patients. These criteria for our patient population slightly differed from those employed by Hirsch et al, notably in their inclusion of patients that were still hospitalized at the time of the study and patients with chronic kidney disease. In our sampled population, we found that the incidence of AKI was 31.3%, similar to the high rate of AKI (36.6%) reported by Hirsch et al.<sup>2</sup>

We also wanted to see if there was a relationship between age or sex and the incidence of AKI in COVID-19 admitted patients. As shown in Figure 1, we saw that the rate of AKI increased with age and was also higher in males.

## AKI Incidence

in admitted COVID-19 patients by Age and Sex

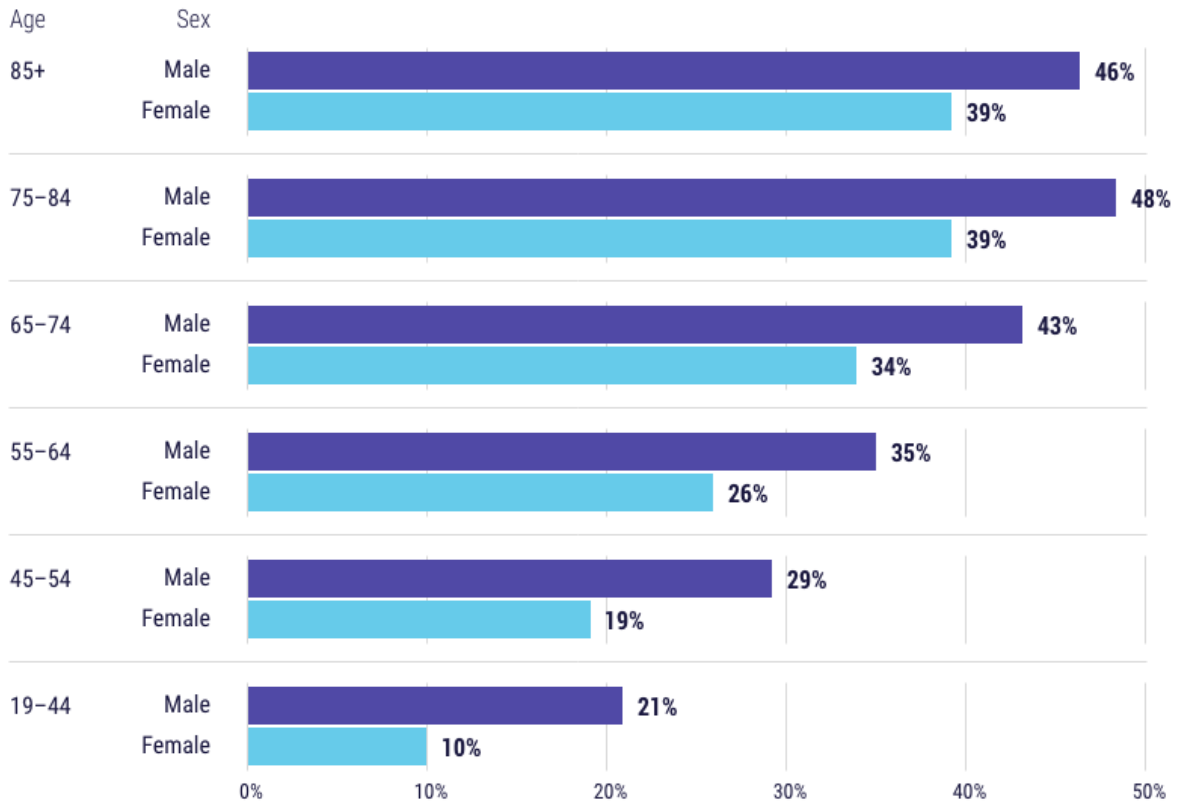


Figure 1. Percent of patients who developed AKI during a COVID-19 admission, broken down by age and sex. Note: Two patients with a documented sex of “Other” were excluded from analysis.

Next, we looked at how the incidence of AKI changed in subsets of patients with particular comorbidities or disease outcomes. As shown in Figure 2, we found the rate of AKI to be higher in patients with hypertension, diabetes, or COPD. Notably, the incidence of AKI in patients who were mechanically ventilated was 74%. While not as high as that reported by Hirsch et al<sup>2</sup> (89.7%), this nonetheless indicates a strong relationship between respiratory failure and AKI.

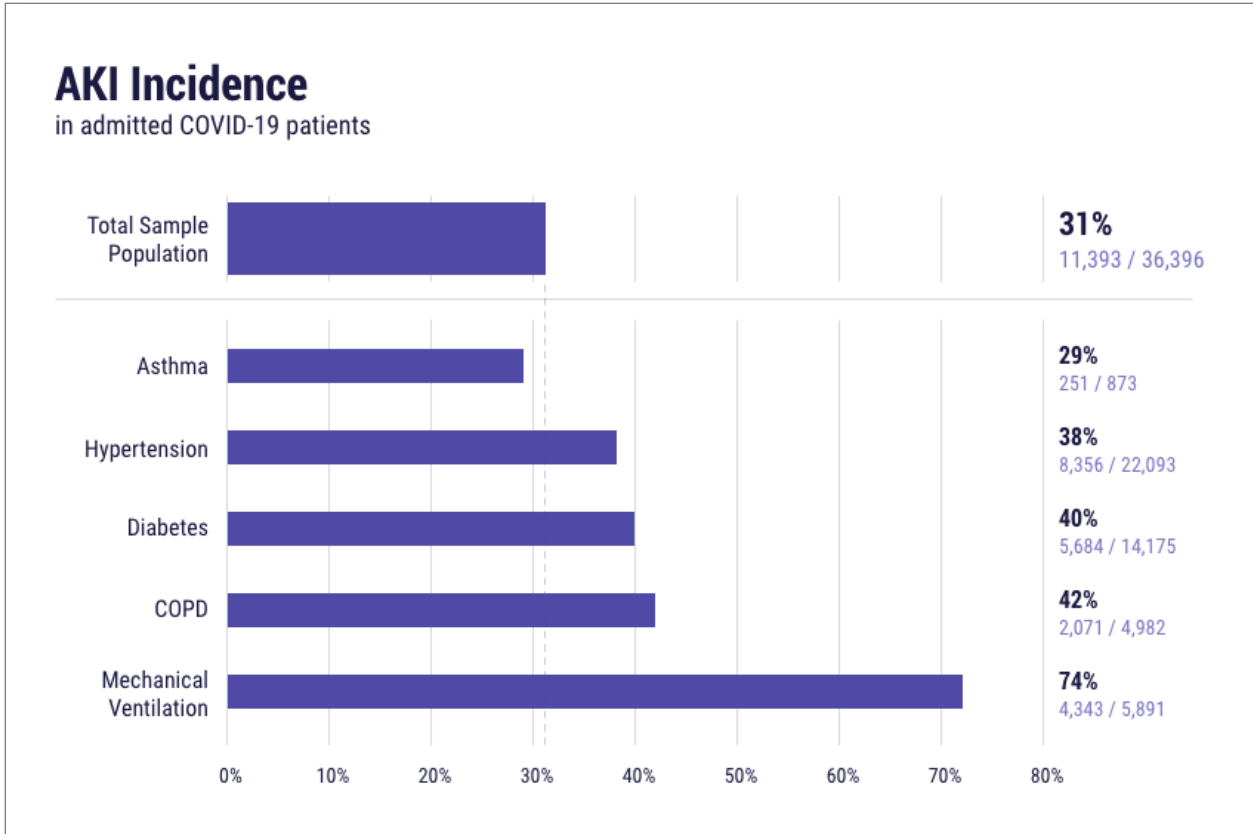


Figure 2. Percent of patients who developed AKI during a COVID-19 admission, broken down by several comorbidities and mechanical ventilation usage.

Finally, we investigated the worst COVID-19 severities for those patients who developed AKI during their admission. As shown in Figure 3, the development of AKI was associated with a higher severity of illness and poorer outcomes (e.g., death in 37% of patients), when compared to hospitalized patients who did not develop AKI.

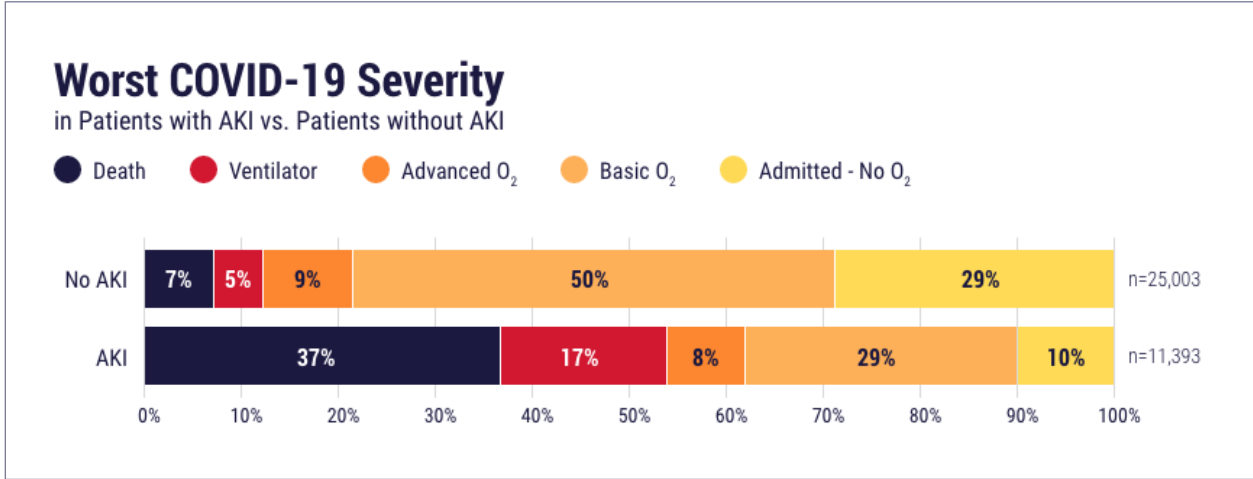


Figure 3. Percent of patients who reached a specified worst COVID-19 severity, broken down by development of AKI. Note: The total percentage shown for patients with AKI does not add to 100%, due to rounding.

Overall, the findings in this study are very similar in magnitude to the findings reported by Hirsch et al.<sup>2</sup> These results further support the high incidence of AKI in COVID-19 patients and also highlight the association between respiratory failure and the development of AKI.

*Data are pooled from 43 health systems representing 396 hospitals that span 20 states and cover 30 million active patients.*

Term	Definition
<b>Acute Kidney Injury</b>	<p>An acute kidney injury has occurred during an admission if any of the following are true:</p> <ul style="list-style-type: none"> <li>• Increase in serum creatinine by 0.3mg/dL or more within 48 hours</li> <li>• Increase in serum creatinine to 1.5 times baseline or more</li> <li>• Urine output less than 0.3 mL/kg/h for 24 hours</li> <li>• Diagnosis with ICD-10-CM code of N17* during the admission</li> </ul>
<b>COVID-19 Positive Patient</b>	Patient with a positive SARS-CoV-2 lab result or a COVID-19 diagnosis.
<b>COVID-19 Related Admission</b>	<p>A hospital admission during which the patient has a positive SARS-CoV-2 lab test or COVID-19 diagnosis, OR a hospital admission with any respiratory diagnosis which happens within 14 days of the patient's COVID-19 "start date."</p> <p><b>Respiratory Diagnosis Codes:</b> J00-J99 (ICD-10)</p>
<b>Ventilator Usage</b>	A patient is considered to be on a ventilator on a day if on any given calendar day there is documentation other than "Off" or a non-invasive mode (e.g., CPAP, BiPAP) in a Vent Mode flowsheet row or an oxygen delivery device of ventilator.
<b>COVID-19 Related Death</b>	A COVID-19 patient with a death date or discharge date with discharge disposition of deceased within 6 weeks of their COVID-19 "start date."
<b>Severity Score Index</b>	<p>An ordinal scale from most severe to least severe:</p> <ul style="list-style-type: none"> <li>• Death</li> <li>• Patient on ventilator</li> <li>• Patient on advanced oxygen support</li> <li>• Patient on basic oxygen support</li> <li>• Patient has COVID-19 related admission, no supplemental oxygen</li> <li>• Discharged</li> <li>• No Admission</li> </ul> <p>We have purposefully left our numeric values off our description of this scale. We have aligned this severity scale with the severity index scores used by numerous clinical trials, FDA, CDC, and WHO, regardless of which numeric end they have coded as "high severity."</p> <p>Severity is assessed daily. The most severe score a patient has attained on a calendar date (midnight to midnight) is recorded.</p> <p>Note, if a patient tests positive on Day 0 and is admitted on Day 4, Days 0-3 would be severity=No Admission, Day 4 would be one of the first 5 severity levels. When they are discharged, they would then be severity=Discharged.</p>
<b>Worst Severity</b>	This is defined as the worst severity a patient has attained over all the days assessed for the patient.

Term	Definition
<b>Active Patient</b>	A patient who has interacted with the health system in the past 2 years, indicated by either a face-to-face visit or an order placed on their chart.
<b>Anchor Date</b>	<p>The date by which a patient must have documentation of a given condition or medication in order for it to be considered active. This date differs by patient population:</p> <p><b>COVID-19 patients:</b> COVID-19 start date  <b>Tested (not positive) patients:</b> Date of first SARS-CoV-2 test  <b>Active (not tested) patients:</b> Date of data acquisition</p> <p>Usage in comorbidities and medications:</p> <p><b>Comorbidities:</b> The condition must exist as an active problem on the problem list with a start date before the anchor date and without a resolved date or with a resolved date prior to the anchor date. Alternatively, if there is a relevant encounter or billing diagnosis, the start date must be within 2 years of the anchor date.</p> <p><b>Prior outpatient medications:</b> Medications must be active on a patient's outpatient medication list at least 2 months prior to their anchor date, with either no documented end date or an end date on or after their anchor date.</p>
<b>Comorbidity Diagnoses</b>	<p><b>Asthma (Moderate/Severe) Diagnosis Codes:</b> J45.4, J45.40, J45.41, J45.42, J45.5, J45.50, J45.51, J45.52 (ICD-10-CM)</p> <p><b>Chronic Kidney Disease Diagnosis Codes:</b> N18-N18.5, or N18.9 (ICD-10-CM), with no subsequent diagnosis of End Stage Renal Disease or Kidney Transplant</p> <p><b>Chronic Obstructive Pulmonary Disease (COPD) Diagnosis Codes:</b> 13645005 (SNOMED) or any of its child concepts</p> <p><b>Diabetes (Type 1, 1.5, 2) Diagnosis Codes:</b> 46635009, 44054006, 420868002, 422014003, 73211009, or 74627003 (SNOMED) or any of their child concepts</p> <p><b>End Stage Renal Disease Diagnosis Codes:</b> N18.6 (ICD-10) without subsequent Kidney Transplant</p> <p><b>Kidney Transplant Diagnosis/Procedure Codes:</b> Z94.0 (ICD-10-CM), or 0TY00Z0, 0TY00Z1, 0TY00Z2, 0TY10Z0, 0TY10Z1, or 0TY10Z2 (ICD-10-PCS), or 50360 or 50365 (CPT)</p> <p><b>Hypertension Diagnosis Codes:</b> 38341003 (SNOMED) or any of its child concepts, excluding patients who also have an ICD-10-CM code starting with "O," as these are pregnancy-related conditions</p> <p>Diagnoses must adhere to the date requirements described in the Anchor Date definition.</p>

## REFERENCES

1. Dariya B, Nagaraju GP. Understanding novel COVID-19: Its impact on organ failure and risk assessment for diabetic and cancer patients. *Cytokine Growth Factor Rev.* 2020;53:43-52. Doi:10.1016/j.cytogfr.2020.050.001.
2. Hirsch JS, Ng JH, Ross DW, et al. Acute kidney injury in patients hospitalized with COVID-19. *Kidney Int.* 2020;9:209-218. doi:10.1016/j.kint.2020.05.006.

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