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Supplementary information

Pathophysiology of COVID-19-associated acute kidney injury

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Supplementary Table 1 | Summary of histological findings in patients with COVID-19 AKI.

n	Post-mortem	Age (years)	Mechanical ventilation	Tubular injury	Acute glomerular Injury	Vascular injury	Viral inclusions	Technique for virus detection	Comments	Reference
9	Yes	73 (IQR 52–79)	4/9	Yes (in 9/9)	No	Yes (44%; rare thrombi in interlobular arteries in 4 patients)	Viral genomic RNA in 3/5 patients. Subgenomic viral RNA transcripts in 1 patient	Viral RNA	No evidence of underlying CKD in any patient	Hanley et al. (2020)[1]
21	Yes	68 (range 41–78)	16/21	Yes	No	Yes; 3 (14%) patients showed intravascular neutrophilic aggregates with platelets; 1 (5%) patient showed signs of endothelial activation (mild endothelial swelling and arteriolar sequestration of leukocytes); glomerular microthrombi in 1 patient	SARS-CoV-2-positive cells in 1 patient (9%)	IHC	Renal histopathological changes were found in 12 (57%) patients	Schurink et al. (2020)[2]
12	Yes	49–92	11/12	Yes (from mild to diffuse)	No	No	No	IHC and ISH	1 patient had findings compatible with mild acute interstitial nephritis; 1 patient exhibited renal oxalosis of uncertain cause; one-third of patients had medullary urate crystal deposits	Golmai et al. (2020)[3]
17	No	54 (range 34–77)	No	Yes (*n*=14)	Yes, CG (*n*=7)	Yes; endothelial injury/TMA (*n*=6)	NA	EM	15 patients had AKI; 11 patients had proteinuria; 2 of 3 transplant recipients developed active antibody-mediated rejection	Akilesh et al. (2020)[4]
26	Yes	69 (range, 39–87)	Yes	Yes	No	Yes; erythrocyte aggregates obstructing the lumen of capillaries without platelet or fibrinoid material. No evidence of vasculitis or interstitial inflammation	Yes (*n*=7)	EM	9/26 had elevated serum creatinine	Su et al. (2020)[5]
17	No	54 (range, 22–72)	9/17	Yes	Yes, (n=5 CG; n=4 immune-mediated glomerular diseases)	Yes; glomerular endothelial tubuloreticular inclusions in 6/10 cases	No	IHC and ISH	15/17 had AKI	Kudose et al. (2020)[6]
42	Yes	71.5 (range, 38–97	21/42	Yes (mild)	No, (n=1 collapsing FSGS)	Yes, Focal kidney fibrin thrombi in 14% cases	No	ISH of viral RNA	94% had AKI	Santoriello et al. (2020)[7]

17	Yes	72 (62–77)	11/17	Yes	No	No	Yes (*n*=10)	Viral RNA	Hemosiderin and/or pigmented casts seen in 12 of 17 patients	Remmelink et al. (2020)[8]
10	Yes	57–82 years	yes	Yes	No, (occasional wrinkling of the GBM)	Yes; glomerular endothelial swollen (n=1), Intimal hyperplasia,	Yes (viral-like particles on EM)	EM	1 patient with venous thrombosis	Xia et al. (2020)[9]
6	Yes	5–82	NA	Yes	No	Yes; erythrocyte aggregates in peritubular and/or glomerular capillaries in 5/6 patients	Yes (viral-like particles on EM)	EM	Focal infiltration of the interstitium by mononuclear cells in 2/6 patients	Werion et al. (2020)[10]
10	No	45–77	4/10	Yes	Yes; GC (*n*=1), pauci-immune crescentic GN	Yes; TMA (n=2)	No	IHC	8 patients had severe AKI requiring KRT	Sharma et al. (2020)[11]
6	No	37–65	2/6	Yes (diffuse in 5/6)	Yes; CG	Yes, focal peritubular capillaries RBC aggregates in n=1; swollen endothelial cells in n=3	No	Viral RNA	3 patients had baseline stage 3 CKD; 1 had drug-induced acute interstitial nephritis; 1 had pleomorphic interstitial infiltrate of immune cells	Wu et al. (2020)[12]
47	No	52–69	28/47	Yes (in ICU cohort)	Yes (in non-ICU cohort)	TMA (n=1) Arteritis (n=1)	No	IHC		Ferlicot et al. (2021)[13]
3	No	63–72	3/3	Yes	Yes in the patient of African ethnicity	Low degree of glomerular endothelial cell swelling	No	Viral RNA	Strong ACE2 staining was observed in the apical brush border in proximal convoluted tubules	Dargelos et al. (2020)[14]

Only cohorts with more than two patients are reported. AKI, acute kidney injury; CG, collapsing glomerulopathy; CKD, chronic kidney disease; EM; electron microscopy; FSGS, focal segmental glomerulosclerosis; GBM, glomerular basement membrane; GN, glomerulonephritis; IHC, immunohistochemistry; ICU, intensive care unit; ISH, in situ hybridization; KRT, kidney replacement therapy; NA, not available; TMA, thrombotic microangiopathy.

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