SUPPLEMENTARY TABLES

COVID-19 vaccine

Case reports and case series describe clinical phenotypes but cannot be used to infer causality. Disproportionality analyses (ROR, IC) indicate reporting signals rather than incidence or risk.

Supplementary Table S1. Kidney injury reported following COVID-19 mRNA vaccination and associated epidemiological data

Associated Kidney Injury	Number of cases and Clinical Course	Incidence
Unspecified Acute Kidney Injury (AKI)	No relevant case reports found	In a retrospective cohort study that analysed data regarding 153,183 adverse events following COVID-19 vaccination in South Korea, 17 cases of acute kidney injury were reported in patients who took BNT 162b2 vaccines[1]. In an observational, self-controlled case series study in Hongkong for type 2 diabetes patients with COVID-19 vaccinations, the incidence for AKI post BNT162b2 mRNA vaccine was 1.17/100000 doses (0.21,3.41), 2.21/100000 persons (0.46,6.46), and the incidence rate was 20.94/100000 person-years (6.75,64.92)[2]. In a retrospective study done in Korea for adolescents from 12-17 years old from March 2021 to February 2022. The incidence of AKI after Pfizer-BioNTech vaccinations was 4 cases/100000 people[3]. In a similar paper done where the population was from 5-

17 years old from March 2021 to July 2022 in South Korea, an incidence of AKI after Pfizer-BioNTech vaccinations 4cases/100000 people was also reported[4]. In a similar paper done for patients 18 and above from Feb 14 to Dec 31 2022 in South Korea, 0.1/100000 persons incidence of AKI was reported[5].

In a retrospective and prospective study in Israel, 11 individuals reported an AKI event after second booster of the COVID-19 Vaccine, and 5 individuals reported an AKI event after first booster of the COVID-19 Vaccine. The risk difference reported after the second booster is 1.68/100000 people (-3.37 to 6.74) and risk difference of second boosters versus first boosters is 3.93/100000 (−0.56 to 8.42) although both results were found to be not statistically significant. [6]

A VAERS analysis found that Pfizer-BNT has a strong AKI correlation with 627 cases giving a reporting odds ratio (ROR) of 2.15 (1.97,2.36), proportional reporting ratio (PRR) of 2.15(χ^2 =290.75), and an Information component (IC) of 0.9 (IC025=0.82), Empirical Bayes Geometric Mean (EBGM) of 1.87(EBGM05=1.73), and Moderna has a AKI correlation with 433 cases giving a ROR of 1.25 (1.13-1.39), PRR of 1.25 (χ^2 =17.97) and IC of 0.27 (IC025=0.24) and a EBGM of 1.21 (EBGM05=1.11)[7].

In a pharmacovigilance study that analysed a total of

		120,715,116 reports from VigiBase collected between 1967 and 2022, there was a disproportionate signal for acute kidney injury with COVID-19 mRNA vaccine with ROR of 2.38(2.30-2.46) and IC of 1.14(IC025=1.09)[8]. In a retrospective observational pharmacovigilance study based on the collection of reports of suspected AEFIs reported between 1 January 2021 and 31 December 2021 at the Naples 3 local health authority, 3 cases of renal and urinary disorders was reported for the Cominarty vaccine[9]. In a disproportionality study performed to analyse data acquired from the Vaccine Adverse Event-Reporting System (VAERS) between 1 January 2010 and 30 April 2021, it reported a reporting odds ratio of AKI to BNT162b2 mRNA vaccine is 5.41 (4.54-6.43) and reporting odds ratio of AKI to mRNA-1273 vaccine is 2.48 (2.05,3.00)[10]. In a Vigibase analysis of the WHO pharmacovigilance database, COVID-19 mRNA vaccines were solely associated with higher reporting of AKI (IC025 1.09) and TIN (IC025 0.48) compared to other types of vaccines[11].
Podocytopathies / Nephrotic Spectrum		
Minimal Change	Number of cases: 32 [12] [13] [14] [15] [16] [17]	In a retrospective cohort study that included subjects

Disease (MCD)	[18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] Symptoms - General oedema [28] [13] [24] [20] [26] [16] [12] [22] [23] [19] [32] [17] [15] [14] [27] - Frothy urine [22] [23] [19] [32] [17] [15] - Anasarca [23] [19] [32] [17] [15] [14] - Dyspnoea, palpitations, abdominal pain, diarrhoea, drop in urine output, fatigue [23] [19] [32] [17] [15] - Skin rash [15] - Headache, leg swelling, ascites [14] Signs - Rales at lung bases, decreased air entry at lung bases, pitting oedema [19] - Ascites [24] [20] [16] [23] [19] [32] [17] [18] [21] - Hypertension - Elevated serum creatinine [13] [24] [20] [26] [16] [12] [22] [23] [19] [32] [17] [15] [25] [18] [21] [30] [31] - Proteinuria [13] [12] [22] [27] [25] [30] [31] - Hypoalbuminemia [24] [20] [16] [12]	with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 28.6% (28/98) of patients presented with MCD with 75% of MCD due to mRNA vaccines, with most patients (35.7%) presenting within 5-7 days after vaccine[33]. In a disproportionality analysis in VigiBase, a IC/IC025 of 0.88/0.37 was reported for minimal change disease after Pfizer/BioNTech mRNA vaccine with 36 cases out of 770304 ICSRs reported[34]. In a retrospective cohort study using a cohort representing the entire adult Swiss population, they found the risk ratio between minimal change disease to COVID-19 vaccine = 1.72 (95%CI 0.46-6.38)[35].

[23] [19] [32] [17] [18] [21] [30] [31]
- Haematuria [15] [14] [31]
- Elevated BUN [14]
- Hyperlipidaemia/dyslipidaemia [26] [22] [23] [19] [32] [17] [18] [21]
- Elevated albumin-creatinine ratio [23] [19] [32] [17] [15] [18] [21]
- Positive ANA [15] [31]
- Anti-scl70 [15]
- Elevated fibrinogen with normal renal function [13]
- Elevated C3 and C4
- Hypercholesterinaemia [16] [15] [21]
- Elevated beta-2 microglobulin in urine [14]

Timeline

- Onset of symptoms range from 1 – 160 days [28] [13] [20] [16] [12] [22] [23] [19] [32] [17] [18] [21] [25] [31]
- Recovery within 10 days – 20 months with steroid treatment (e.g. prednisone, prednisolone) [12, 24] [25] [29], and diuresis [13] [22] [23] [19] [32] [15] [18, 21]; partial recovery reported as well [20]
- Concurrent acute interstitial nephritis reported; treatment with steroid

therapy with haemodialysis, partial remission within 5 weeks [28]
- Treatment with heparin [13]
- Recovery with conservative treatment (such as valsartan and loop diuretic) [17]
- Recovery within 12 weeks of methylprednisolone before starting prednisone [16] [17] [14] and renal replacement therapy
- Recovery with methylprednisolone with cyclosporine maintenance therapy [15]
- Full and partial recovery within 2 - 4 weeks with steroids, diuretics, angiotensin receptor blocker and ACE-inhibitors; proteinuria may remain [31]

Remarks

- Frequent relapsing nephrotic syndrome diagnosed in MCS patients as well, maintained with rituximab and mycophenolate mofetil or cyclosporine [26]
- Reported in post-renal transplant patient [12]
- Possible relapse of MCD after recovery (one month) [23]

Relapse of Minimal Change Disease	Number of cases: 13 [27] [29] [36] [37] [38] [32] [39] [40] [41] Symptoms - Oedema in bilateral lower extremities and sacrum[37], bilateral leg numbness, lower back pain, frothy urine, diarrhoea, vomiting [32] [36] [38] [40] Signs - Hypertension [32] [40] - Pitting oedema [32] [36] [38] [40] - Elevated serum creatinine, elevated albumin-creatinine ratio, and hypalbuminaemia [32] [36, 38], hyperlipidaemia [40] - Proteinuria [32] [27] [36] [38] [40] [41] [39] - Chest X-ray showing bilateral pleural effusion [40] Timeline - Onset of symptoms within 4 – 2 weeks [27] [40] [39] - Recovery after 3-4 weeks with steroid	No relevant statistics found

	therapy (methylprednisolone and/or prednisolone/prednisone) [29, 37] [40, 41], and diuresis [36, 38], and ciclosporin [32] [39] Remarks - Possible relapse after recovery (24 weeks) [36]	
Focal Segmental Glomerulosclerosis	Number of cases: 7 [15] [30] [42] [43] [44] [45] Symptoms – Generalised oedema [15] [42] [44] [43] – Increase in body weight [15] – Abdominal pain [44] Signs – Hypotension, pleural effusion [15] – Anuria, hypertension [42] – Hypoalbuminemia [30] [42] [44] [43] – Proteinuria [30] [45] [42] [44] [43] – Elevated creatinine [15] [45] [44] [42] [44] – Albuminuria, hypoproteinaemia, hypercholesterinaemia [15] – Renal function can be normal [15]	No relevant statistics found

	– Microhaematuria [43] Timeline – Onset of symptoms from 5 days – 3 months after [15] [45] [42] [44] [43] – Recovery within 4 weeks with high-dose prednisolone [44] – Recovery with methylprednisolone, with thromboprophylaxis and combined diuretic treatment [15] – Consider adding cyclosporine [15] – Consider rituximab for relapsing nephrotic syndrome and SGLT2 for proteinuria [15] – Recovery within 10 weeks with prednisolone, cyclosporine, lisinopril and methylprednisolone pulse [43] – Partial recovery in 2 weeks with angiotensin II receptor blocker [45] Remarks – Tip lesion variant case reported [44]	
Relapse of Focal Segmental	Number of cases: 2 [39] [46]	No relevant statistics found

Glomerulosclerosis	Symptoms – Oedema [46] Signs – Proteinuria [39] [46] – Hypoalbuminemia, elevated serum creatinine [46] – Reduced eGFR [39] Timeline – Onset of symptoms within 1 month – 56 days [39] [46] – Recovery within 4 weeks with methylprednisolone, plasmapheresis, and rituximab [46] – Recovery with oral prednisolone and cyclosporine Remarks - Reported in post-renal transplant patient [46]	
Minimal Change Disease -like	Number of cases: 1 [47]	No relevant statistics found

Podocytopathy

Symptoms

- Oedema [47]

Signs

- Oedema [47]
- Elevated serum creatinine, proteinuria [47]

Timeline

- No timeline reported

Idiopathic Nephrotic Syndrome

Number of cases: 3 [39] [48]

Symptoms

- Oedema [48]
- Vomiting [39]

Signs

- Hypoalbuminemia, proteinuria [48]

Timeline

- Onset of symptoms within 12 – 35 days

	[48] [39] – Recovery within 2 weeks with corticosteroid therapy [48] – Recovery with prednisolone and chlorambucil [39]	
Relapse of Idiopathic Nephrotic Syndrome	Number of cases: 5 [39] [48] Symptoms – Oedema [48] Signs – Hypoalbuminemia, proteinuria [48] – Proteinuria, hypoalbuminemia, haematuria [39] Timeline – Onset of symptoms within 12 – 19 days [48] – Treatment with oral prednisolone [39] – Recovery within 2 weeks with corticosteroid therapy [48]	No relevant statistics found
Unspecified Nephrotic Syndrome	No relevant case reports found	In a prospective observational study studying the safety of COVID-19 mRNA vaccines in 40 patients

		with childhood-onset nephrotic syndrome using immunosuppressive agents, 3 (7.5%) patients suffered from a relapse of nephrotic syndrome (2 and 3 days after first dose and 8 days after 2nd dose) and 2 patients suffered from transient proteinuria after COVID-19 vaccination[49]. In a disproportionality analysis in VigiBase, a IC/IC025 of 0.60/0.31 was reported for nephrotic syndrome after Pfizer/BioNTech mRNA vaccine with 103 cases out of 770304 ICSRs[34]. In a single centre retrospective cohort study looking at 95 patients with relapsing nephrotic syndrome, 17 (18%) patients had ≥1 relapse post vaccination, while 25 patients (26%) had a relapsed pre-vaccination. There was no significant difference in the risk of relapse after versus before vaccination (odds ratio 0.43), and no significant difference in relapse rates after versus before vaccination (mean difference 0.08 per 100 patient-days). 5 patients had new onset NS presenting within 60 days of taking the vaccine[50].
Immune-Complex-Mediated Glomerulonephritis		
IgA Nephropathy	Number of cases: 101 [25] [31] [45] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62] [63] [64] [65] [66] [67] [68] [69] [70] [71] [72] Symptoms	In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID Vaccine, 26.5% (26/98) of patients presented with IgA Nephropathy with 73.1% of IgA Nephropathy due to mRNA vaccines, with most

- Haematuria [31] [52] [59] [60] [67] [70] [61] [62] [55] [56] [63] [71] [64] [68] [58] [54] [51]
- Myalgia [70] [61] [62] [55] [56] [63] [71] [68] [53]
- Headache, decreased urine output, mild febrile, stiff neck, fatigue [70] [61] [62] [55] [56] [63]
- Fever [68]
- Nausea [66]
- Vomiting [54] [66]
- Malaise [71] [64] [66]
- Haemoptysis [57]
- Flank discomfort, generalized oedema
- Foamy urine [54] [51]
- No symptoms reported [65]

Signs

- Pharyngitis [55]
- Fever [71]
- Hypertension, [61, 70] [62] [56] [57, 64]
- Conjunctival pallor [57]
- Bilateral leg oedema [64] [57]
- Haematuria [52] [59] [67] [60] [55] [63] [73] [71] [64] [68] [58] [31] [53] [66] [57] [65]
- Haematuria may present with dysmorphic red blood cells [63]

patients (38.5%) presenting within 1-2 days after vaccine[33].

In a retrospective cohort study using a cohort representing the entire adult Swiss population, they found the risk ratio between IgA nephropathy to COVID-19 vaccine = 1.14 (95%CI 0.67-1.97)[35].

In a disproportionality analysis in VigiBase, a IC/IC025 of 1.51/0.71 was reported for IgA nephropathy after Moderna mRNA vaccine with 19 out of 286467 ICSRs[34].

A prospective cohort study that analysed 82 patients who presented with gross haematuria after COVID-19 vaccination found that 42 patients have a new diagnosis of IgA nephropathy (n=41)[75].

In an analysis of 20 cases from the French pharmacovigilance database where IgA Nephropathy happened after COVID-19 mRNA vaccines, the mean time to onset was 3.18 days (1-31days), where 60% of the cases came from COMIRNATY vaccine, and 40% came from SPIKEVAX. Additionally, the study found. that macroscopic haematuria was the most revealing symptom, and 35% of patients in the study had AKI[76].

In an analysis of the JADER database, a reporting odds ratio of IgA nephropathy to COVID-19 mRNA vaccines was 6.49, 95% CI: 4.38–9.61, with the

- Proteinuria [25] [31] [52] [59] [67] [60] [55] [63] [71] [64] [68] [58] [54] [53] [66] [57] [74] [45]
- Elevated serum creatinine [25] [31] [59] [67] [55] [64] [68] [54] [66] [57] [65] [74] [45] [51]
- Oliguria [55]
- Elevated serum BUN [64] [66] [57]
- Pyuria, elevated aspartate aminotransferase, elevated alanine aminotransferase, low C3/C4 [66]
- Positive ANCA [56]
- Negative ANCA [31]
- Positive ANA [31]
- Anaemia [64] [57]
- Thrombocytopenia [64]
- Elevated IgG and IgA [64]
- Elevated AST, LDH, GGT [64]
- Hypoalbuminemia [31] [64] [54] [66]
- Alveolar haemorrhage: ground-glass opacities on X-ray and CT [57]
- Bilateral enlarged kidneys on CT [57]

Timeline

- Onset of symptoms range from 6 hours – 90 days [25] [31] [59] [52] [60] [67] [70] [61] [62] [55] [63] [71] [64] [68] [58] [54] [53] [66] [57] [45]

information component being: 2.27, 95% CI: 1.70–2.83), showing a significant increase in reported number from baseline after COVID-19 vaccine. Time to onset of IgA nephropathy from vaccine are 2 patients on the same day, 5 patients 1 day later, 4 patients 2 days later and 3 patients 3-28 days later and 2 patients more than 28 days later[77].

In IgA nephropathy histopathology, acute lesions were found to be associated with renal events, and E lesions were associated with worsening haematuria[78].

- Recovery with oral prednisolone [67]
- Recovery with oral prednisolone and pulse methylprednisolone [59] [54]
- Recovery with oral prednisolone and pulse methylprednisolone, oral cyclophosphamide[70], with enalapril and gastroprotection [56]
- Recovery with lisinopril [60] and dapagliflozin [52]
- Recovery with haemodialysis for poor renal function, with steroid therapy[57]; however microscopic haematuria and slight proteinuria remained [55] [66]
- Recovery with tonsillectomy and living-donor kidney transplant [57]
- Spontaneous recovery within 3 weeks – 1 month with no treatment [62] [71] [53] [45]
- Initial treatment with pulse methylprednisolone, oral prednisolone and mizoribine but progressed to steroid induced acute liver failure requiring hemodiafiltration and plasma exchange; recovery of renal function after but haematuria remained [64]
- Unsuccessful recovery with oral prednisone [65]

	- Recovery within 1 month with angiotensin II receptor blocker [45] - Partial and full recovery within 2 – 7 weeks with steroids, ACE-inhibitor or angiotensin II receptor blocker and diuretics [31] - Recovery within 5 days with lisinopril [54] - Partial recovery within 4 weeks with mycophenolate mofetil [51] Remarks - May have previous history of IgA vasculitis [74] - Reported in post-renal transplant patient [65] - May progress to rapidly progressive glomerulonephritis [64] – Presentation with AIN and diabetic nephropathy reported [31]	
IgA Nephropathy Relapse	Number of cases: 26 [47] [51] [79] [80] [81] [73] [82] [83] [84] [85] [86] [87] [88] [89] [90] [91] Symptoms – Haematuria [73] [51] [82] [88] [83] [91] [90] [86] [85] [87] [79] [89] [84] – Decreased urine output, stiff neck,	A prospective cohort study that analysed 82 patients who presented with gross haematuria after COVID-19 vaccination found 22 had a prior diagnosis of IgA nephropathy or IgA vasculitis[75].

general malaise [91] [90] [86] [85] [87]
- Abdominal pain, arthralgia, urticaria [82]
- Fever [73] [83] [91] [90] [86] [85] [87] [89] [84]
- Headache [83]
- Myalgia [89] [84]
- Fatigue [91] [90] [86] [85] [87] [84]
- Lower back pain [91] [90] [86] [85] [87] [89]
- No symptoms [79] [80] [81]

Signs

- Hypertension [80]
- Elevated serum creatinine [73] [51] [82] [88] [83] [91] [90] [86] [85] [80] [81]
- Haematuria [73] [82] [83] [90] [87] [79] [89] [81]
- Proteinuria [73] [82] [83] [86] [89] [84] [81] [47]
- Thrombocytopenia, elevated inflammatory markers, leukocyturia, pyuria [86]
- Leucocytosis, pancytopenia [82]
- Reduced eGFR [87]

Timeline

- Onset of symptoms range from 3 hours – 1 month [51] [82] [83] [91] [90] [86] [85] [87] [89] [84] [80] [88]
- Recovery within 3 days – 2 months with prednisolone or no intervention [51] [90] [86] [85] [87]
- Recovery with tonsillectomy with steroids [87]
- Recovery within one year with pulse steroid therapy and intravenous cyclophosphamide, with partial improvement[80]
- Recovery within five months methylprednisolone pulse, prednisolone and azathioprine [81]
- Spontaneous recovery within 23 – 36 hours without treatment reported [88] [79]
- Recovery within 5 days with lisinopril [89]
- Treatment with RAAS inhibitor [84]
- Treatment with cyclophosphamide and prednisolone for 6 months then RAAS inhibitor [84]
- Recovery with high-dose pulse methylprednisolone and oral prednisolone, then with azathioprine

	within 3 months [73] – Spontaneous recovery within 3 weeks – 1 month with no treatment [73]	
IgA Vasculitis	Number of cases: 19 [74] [92] [93] [94] [95] [96] [96, 97] [98] Symptoms – Arthritis, generalised arthralgia, leg oedema, swelling of knee, abdominal pain [94] [96] [95] [93] – Rash on extremities [94] [96] [95] [93] [92] [98] – Fever, leg oedema [94] [96] [95] [93] [92] – Diarrhoea [94] [96] [95] [92] – Haematuria [94] [96] [95] [92] [98] Signs – Palpable purpura on extremities [94] [96] [95] [93] [98] – Leucocytosis with predominant neutrophil, hypoalbuminemia, normal/positive antinuclear antibody, normal/elevated IgA [94] [96] [95] – Proteinuria [74] [94] [96] [95] [93] [92] [98]	A prospective cohort study that analysed 82 patients who presented with gross haematuria after COVID-19 vaccination found that 42 patients have a new diagnosis of IgA vasculitis (n=1)[75].

- Haematuria [74] [94] [96] [95] [93] [92] [98]
- Elevated C-reactive protein [94] [96] [95] [92]
- Elevated immune complex [93]
- Elevated PR3-ANCA, anti-cardiolipin IgG [92]
- Elevated serum creatinine [74] [94] [96] [95]

Timeline

- Onset of symptoms 5h – 30 days [94] [95] [93] [92]
- Treatment with tacrolimus, cyclophosphamide and rituximab but deteriorated to ESKD requiring haemodialysis [74]
- Recovery within 1 week with oral dapsone[93]
- Recovery within 1 week - months with oral prednisolone [94] [92]
- Recovery with high-dose pulse methylprednisolone therapy before prednisolone [96] [96, 97]
- Recovery with monthly intravenous cyclophosphamide for severe cases [95]
- Recovery with steroid pulse therapy

	and tonsillectomy but microscopic haematuria and proteinuria persisted [98] – May present with pericarditis [92]	
IgA Vasculitis Relapse	Number of cases: 3 [99] [100] [101] Symptoms – Purpuric rash on extremities [100] [101] [99] – Diffuse abdominal pain [101] [99] – Diarrhoea [101] – Anuria, gross haematuria [99] – Haematuria [99] [100] – Proteinuria [100] – Fever [100] Signs – Palpable purpuric rashes, pretibial pitting oedema [100] [101] – Elevated serum creatinine, haematuria [100] [101] [99] – Proteinuria [100] [101] – Hypoalbuminemia, pyuria [101] – Elevated albumin-creatinine ratio, elevated CRP [99]	A prospective cohort study that analysed 82 patients who presented with gross haematuria after COVID-19 vaccination found 22 had a prior diagnosis of IgA nephropathy or IgA vasculitis[75].

	Timeline – Onset of symptoms within 1 month [100] – Spontaneous recovery without treatment reported [101] – May relapse with concurrent nephritis [101] – Recovery with oral prednisolone with gastroprotection and calcium/vitamin D [99] – Recovery with methylprednisolone and oral prednisolone [100]	
Lupus Nephritis	Number of cases: 6 [15] [31] [45] [102] [103] [104] Symptoms – Eyelid and bilateral leg oedema, anasarca, weight gain [103] – Bloody diarrhoea [102] – Urticaria, fever [104] Signs – Mild lower leg oedema [104] – Proteinuria [31] [45] [15] [103] [104]	In a prospective observational cohort study of 69 adolescents with systemic lupus erythematosus (SLE) in Bangkok taking the mRNA COVID-19 vaccine, 24 (34.8%) experienced SLE flares, with 14 (20.3%) out of the 69 patients experiencing a new or worsened renal flare, including 13 (27.7%) of 47 patients who have had previous lupus nephritis. 5 (7.2%) renal flares occurred within the first month, 1 (1.4%), 4 (5.8%) and 4 (5.8%) patients at the 3-, 6- and 12-month follow-ups, respectively. 4 (8.7%) out of 46 of the patients had their renal flares occurred after they were administered the third vaccine dose. The manifestations of renal flares include increased proteinuria (71.4%), abnormal urine sediment (42.9%)

- Hypoalbuminemia [15] [31] [103] [104]
- Thrombocytopenia [103] [104]
- Hypoproteinaemia, decreased C3 and C4 levels [15] [103]
- Albuminuria [15]
- Elevated serum creatinine [45] [102]
- Elevated urea, hypocomplementemia, hyperkalaemia, [102]
- Anaemia, haematuria, pyuria, leukopenia, hyperlipidaemia [104]
- Positive anti-DNA [104]
- Positive anti-dsDNA [103] [104]
- Positive ANA [31] [103] [102]
- Positive ANCA [31]
- Haematuria [31]
- Positive anti-SS-A, elevated immune complexes [103]
- Elevated anti-La [102]

Timeline

- Onset of symptoms within 2 days – 90 days [15] [31] [45] [103] [104]
- Recovery without intervention but started on cyclosporin to improve renal function [15]
- Recovery within 2 weeks with immunosuppressant [31]

and decreased renal function (28.6%). Multivariable analysis revealed that non-use of hydroxychloroquine (adjusted odds ratio [aOR] 18.83, 95% CI: 1.97, 179.60, *P* value = 0.011) and a maximum SELENA-SLEDAI score ≥8 within 12 months prior to vaccination (aOR 5.33, 95% CI: 1.38, 20.55, *P* value = 0.015) were independent factors of disease flares post-vaccination[105].

	– Recovery within 1 month with peritoneal dialysis, myfrotic 4#bid [45] – Recovery with methylprednisolone pulse, prednisolone, hydroxychloroquine, mycophenolate mofetil, belimumab [103] – Fatality reported despite treatment with methylprednisolone, IVIG, plasmapheresis, steroids, hydroxychloroquine, mycophenolic acid [102] – Recovery within 112 days with oral prednisolone, low salt diet [104] Remarks – Case in ADPKD patient reported [104]	
Relapse of Lupus Nephritis	Number of cases: 2 [47] [106] Symptoms – Fatigue, weakness [106] Signs – Proteinuria [47] [106] – Hyperlipoproteinemia,	No relevant statistics found

	hypoalbuminemia, elevated ANA, elevated C3 [106] – Elevated serum creatinine [47] Timeline – Onset of symptoms 1 week after [106] – Spontaneous recovery not successful [106] – Recovery with immunosuppressive therapy consisting of mycophenolate mofetil and prednisolone [106] Remarks – Presentation with granulomatous acute tubulointerstitial nephritis reported [47]	
Membranous Nephropathy	Number of cases: 12 [29] [31] [45] [107] [108] [109] [110] [111] [112] [113] [114] [115] Symptoms – Oedema [110] [111] [112] [108] [107] [113] [114] – Lethargy [108] – Shortness of breath, oliguria, flank	In a retrospective cohort study using a cohort representing the entire adult Swiss population, they found the risk ratio between membranous nephropathy to COVID-19 vaccine = 1.17 (95%CI 0.43-3.23)[35]. In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 10.2% (10/98) of patients

pain, weight gain [107]

Signs

- Pitting oedema [110] [108] [107]
- Hypertensive urgency, anasarca [111]
- Crackles, abdominal distension, pleural effusion, pericardial effusion, ascites [107]
- Proteinuria [31] [45] [110] [111] [112] [108] [107] [113] [114] [115]
- Hypoalbuminemia [31] [110] [111] [112] [108] [107]
- Haematuria [31] [110] [108] [115]
- Elevated total cholesterol [108]
- Elevated C-reactive protein [115]
- Elevated serum creatinine [107]
- Non-anion gap metabolic acidosis [107]
- ANA 1:80, elevated anti-Ro/SSA [107]
- Positive ANA, positive ANCA [31]

Timeline

- Onset of symptoms range from 1 day – 4 weeks [31] [45] [110] [111] [108] [107] [113]
- Partial recovery within 2 weeks with no treatment [31]

presented with membranous nephropathy with 80% of MN due to mRNA vaccines, with most patients (30%) presenting within 5-7 days after vaccine[33].

- Unsuccessful treatment with 2 immunosuppressants [31]
- Recovery within 3 months with peritoneal dialysis and cyclophosphamide [45]
- Initial symptomatic treatment can be considered [110] but may not be effective [108]
- Partial recovery after 2 months with rituximab treatment [110] [108]
- Recovery with tacrolimus [111]
- Recovery with supportive treatment, cyclical corticosteroids and cyclophosphamide [112]
- Treatment with RAAS blockage [29]
- Progression to rapidly progressive glomerulonephritis; recovery within 1 year with haemodialysis, plasma exchange, methylprednisolone pulse, calcineurin inhibitor, mycophenolate mofetil [107]
- Partial recovery within 6 months with furosemide, prednisolone and oral cyclophosphamide [113]
- Recovery within 19 months with conservative treatment consisting of telmisartan, nebivolol, dapagliflozin, metformin, glipizide, evolocumab,

	atorvastatin [114] Remarks – Anti-phospholipase A2 receptor (PLA2R) positive [110] [111] [112] [113] – Risk factors include Sjogren's syndrome [107] – Reported in post-renal transplant patient [115] – Incidental findings of MN with no signs or symptoms have been reported [109]	
Relapse of Membranous Nephropathy	Number of cases: 2 [39] [116] [117] Symptoms – Asymptomatic [39] [117] – Bilateral leg oedema, dyspnoea [116] Signs – Haematuria [39] – Proteinuria [39] [117] – Bilateral pleural effusions [116] – Proteinuria, elevated creatinine, PLA2R reactivation [116]	No relevant statistics found

	Timeline – Onset of proteinuria within 2-8 weeks [117] [116] – Recovery within 1 month with conservative management [117] – Treatment with lisinopril, furosemide and rituximab [116] – Treatment with oral prednisolone [39]	
Immune Complex-Mediated Glomerulonephritis	Number of cases: 4 [47] [118] [119] Symptoms – Shortness of breath, fatigue [47] – Leg swelling [119] Signs – Hypertension, pitting leg oedema [119] – Proteinuria, elevated serum creatinine [47] [119] – Microscopic haematuria [119] [118] Timeline – Onset of symptoms within 3 days - one week [119]	No relevant statistics found

	– Recovery with methylprednisolone and prednisone [119] – Unsuccessful treatment with methylprednisolone pulses and IV cyclophosphamide; remains dialysis dependent [118] Remarks – Presentation with severe acute tubulointerstitial nephritis reported [47] – Types of immune-complex mediated glomerulonephritis reported include crescentic fibrillary glomerulonephritis [118]	
Membranoproliferative Glomerulonephritis	Number of cases: 1 [25] Symptoms – No symptoms reported Signs – Elevated serum creatinine, proteinuria [25]	No relevant statistics found

	Timeline – Onset of disease within 17 days [25] – Partial recovery with cyclophosphamide and steroids [25]
C3 Glomerulonephropathy	Number of cases: 1 [120] Symptoms – Foamy urine [120] Signs – Elevated serum creatinine, elevated urea, hyponatremia, hypokalaemia, proteinuria, normal C3 and C4, negative ANA, ANCA, anti-GBM [120]
	Timeline – Partial recovery with prednisolone, mycophenolate mofetil; proteinuria remained [120]
	Remarks – Risk factors include missense mutation

	in SLC12A3 (c.248G>A, p.Arg83Gln), associated with Gitelman syndrome and additional variants detected in SLC5A2 and NUP205 [120]	
Cryoglobulinaemic Vasculitis Relapse	Number of cases: 1 [121] Symptoms – Palpable purpura and ulcers, worsening bilateral lower extremity pitting oedema, fatigue, fever, myalgia [121] Signs – Elevated serum creatinine, elevate serum urea, hypoalbuminemia, proteinuria, anaemia, elevated ANA, elevated anti-SS-A, elevated anti-SS-B, elevated rheumatoid factor, reduced C3 and C, elevated C-reactive protein [121] Timeline – Onset of symptoms between 2 days and 3 weeks [121] – Recovery within 4 months with immunosuppressive treatment	No relevant statistics found

	regimen consisting of a combination of intravenous Cyclophosphamide, Rituximab and corticosteroid [121]	
Crescentic / Rapidly Progressive Glomerulonephritis		
Unspecified Crescentic Glomerulonephritis	Number of cases: 5 [31] Symptoms – No symptoms reported Signs – Elevated serum creatinine, haematuria, proteinuria, hypoalbuminemia, positive ANA, positive ANCA [31] Timeline – Onset of symptoms within 2 days - 2 weeks [31] – No recovery with dialysis, immunosuppressants [31] – No recovery with immunosuppressants and angiotensin II receptor blocker [31] – No recovery with 2	No relevant statistics found

	immunosuppressants [31]	
Relapse of Unspecified Crescentic Glomerulonephritis	Number of cases: 1 [31] Symptoms – No symptoms reported Signs – Proteinuria, haematuria, positive ANCA [31] Timeline – Onset of symptoms within 3 weeks [31] – Recovery within 4 months with 4 immunosuppressants [31]	No relevant statistics found
Crescentic Glomerulonephritis: Pauci-immune	Number of cases: 17 [45] [47] [122] [123] [124] [125] [126] [127] [128] [129] [130] [131] [132] [133] [134] [135] Symptoms – Vomiting, diarrhoea [127] [129] (79) [128, 133] [125] – Haematuria [47] [129] [126] [128] [133] [125] – Dyspnoea, weight loss, oedema [129]	In a retrospective cohort study using a cohort representing the entire adult Swiss population, they found the risk ratio between Pauci-immune necrotising glomerulonephritis to COVID-19 vaccine = 0.54 (95%CI 0.26-1.15)[35]. In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 17.3% (17/98) of patients presented with pauci-immune crescentic glomerulonephritis with 94.1% due to mRNA

[126] [128] [133] [125]
- Skin rash, foamy urine [133] [125]
- Asymmetrical hand clumsiness associated with difficulty in walking [125]
- Abdominal pain, febrile sensation [134]
- Weakness [126] [128] [133] [125] [123]
- Upper thigh pain [123]
- Fever [128] [133] [125] [122]
- Headache (79) [128, 133] [122]
- Nausea [127] [129] (79) [128, 133] [125] [130]
- Cough [132]
- Anorexia [128] [133] [125] [134] [130] [124]
- Fatigue [129] (79) [128, 133] [125] [132] [124]

Signs

- Distal muscle weakness with hypotonia and sluggish reflexes, non-blanchable violaceous skin rash over both shins [125]
- Leg oedema [124]
- Proteinuria [45] [47] [127] [129] [126] [128] [133] [134] [130] [132] [124] [135]
- Elevated serum creatinine [45] [47]

vaccines, with most patients (35.3%) presenting 2 weeks after vaccine[33].

[127] [129] [126] [128] [133] [134] [130] [124] [135]

- Haematuria [127] [129] [126] [128] [133] [134] [130] [124] [135]
- Leukocyturia [127] [129] [126] [128] [133] [135]
- Elevated BUN [127] [129] [126] [128] [133] [124]
- Elevated uric acid [124]
- Hyponatremia, hyperkalaemia, metabolic acidosis [126] [128] [133] [135]
- Elevated C-reactive protein [128] [133] [124] [135]
- Hypoalbuminemia [133]
- Mild pitting oedema [129] [132] [131]
- Eosinophilia [125] [123]
- Elevated rheumatic factor [134]
- Massive rhabdomyolysis with myoglobinaemia, reduced eGFR [135]
- Mildly elevated IgA [124]
- Elevated MPO-ANCA or P-ANCA may be present for ANCA related [45] [47] [127] [129] [128] [125] [123] [122] [130] [132] [124] [135]
- May be associated with cardiac tamponade [132]

Timeline

- Onset of symptoms range from 12 hours – 63 days [45] [127] [126] [128] [133] [125] [134] [123] [122] [130] [135] [130]
- Recovery with pulse methylprednisolone, oral prednisone within one month [127] with cyclophosphamide [123]
- Recovery with combination therapy with glucocorticoid and rituximab as induction therapy[130], and plasma exchange[129], renal function may not recover [130]
- Recovery with oral prednisolone, oral cyclophosphamide, plasma exchange[70], recovery within 2 months [134]
- Recovery with cyclophosphamide and haemodialysis [126]
- Recovery with methylprednisolone, prednisolone then rituximab [122] and haemodialysis [128]
- Recovery with glucocorticoid, intravenous cyclophosphamide [125, 133], mizoribine [135]
- Pregabalin for neuropathic pain [125]
- Microscopic haematuria may still

persist after renal function recovery [133]
- Recovery with methylprednisolone, prednisolone and haemodialysis [124]
- Partial recovery within 2 months with plasmapheresis, methylprednisolone pulse, peritoneal dialysis and temporary haemodialysis [45]
- Partial recovery within 2 months with plasmapheresis and peritoneal dialysis [45]

Remarks

- ANCA-associated vasculitis reported with possible aetiologies such as microscopic polyangiitis[129], eosinophilic granulomatosis with polyangiitis [125]
- Non ANCA-associated vasculitis reported [133]
- Risk factors such as HLA-DRB1*09:01 allele may contribute to the presentation [135]
- Risk factors such as longstanding psoriasis vulgaris on bimekizumab may contribute to the presentation [124]

Crescentic Glomerulonephritis: anti-GBM	Number of cases: 6 [70] [136] [137] [138] [139] [140] Symptoms – Haematuria[70], pedal oedema, generalized arthralgia, tinnitus, and lower-limb paraesthesia [139] – Haemoptysis, cough, fever, shortness of breath [137] – Fever, anuria, anasarca [138] – Fever, decreased urine output, arthralgia [136] Signs – Generalised oedema [138] – Macroscopic haematuria, nephrotic-range proteinuria, hypertension [70] – Haematuria with dysmorphic red blood cells, proteinuria[139], leucocytosis, elevated serum creatinine, hypoalbuminemia, elevated C-reactive protein, [138] – Elevated urea [139] – Elevated IL-26, IL-1β, IL-6, TNF-α, G-CSF, IL-8, and CXCL1 [138] – HLA typing showed DRB104:03 and DRB114:05 alleles [138] – Elevated serum creatinine[136],	In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 5.1% (5/98) of patients presented with anti-GBM with 40% of MCD due to mRNA vaccines, with most patients (60%) presenting 2 weeks after vaccine[33].

elevated C-reactive protein, microscopic haematuria, [140]
- Positive anti-GBM and MPO-ANCA [140]
- Left hydronephrosis on CT urethrogram and cystoscopy [139]

Timeline

- Onset of symptoms range from 1 day – 6 weeks [70] [137] [138] [139] [136] [140]
- Recovery with pulse steroid therapy, oral cyclophosphamide, plasma exchange [70] [137] [139] and rituximab [140]
- Recovery with pulse steroid therapy, oral cyclophosphamide, leuprolide acetate plasma exchange [139]
- Recovery with pulse steroid therapy, rituximab, haemodialysis within 9 months [138]
- Recovery with haemodialysis, plasmapheresis, cyclophosphamide, prednisone; remains dialysis-dependent [136]
- Relapse eight months after initial treatment, requiring repeat pulse steroids, rituximab, and seven sessions

	of selective plasma exchange [140]	
IgG4-related Nephritis	Number of cases: 1 [141] Symptoms – Fever, malaise, thirst, polydipsia [141] Signs – Acute kidney dysfunction, elevated IgG4, MPO-ANCA positivity [141] – Renal mass on CT [141] Timeline – Onset of symptoms 1 day after [141] – Recovery with steroids and desmopressin for central enuresis [141]	No relevant statistics found
Relapse of IgG4-related Nephritis	Number of cases: 1 [142] Symptoms – Intense asthenia with arthralgia and myalgia [142] Signs	No relevant statistics found

	– Elevated serum creatinine, aseptic leukocyturia, elevated anti-SSA-52 [142] Timeline – Onset of symptoms 2 weeks after [142] – Recovery within 2 months with steroid therapy and rituximab [142]	
Crescentic Glomerulonephritis: ANCA, anti-GBM, ANA negative	Number of cases: 1 [143] Symptoms – Dyspnoea [143] Signs – Hypertension, weight gain [143] – Microhaematuria, proteinuria, elevated BUN, elevated creatinine, elevated BNP [143] – ANCA, anti-GBM, ANA negative [143] Timeline – Onset of symptoms within 6 weeks [143]	No relevant statistics found

	– Recovery with methylprednisolone pulse therapy and temporary haemodialysis [143]	
MPO-ANCA positive Crescentic Glomerulonephritis with IgA Nephropathy/Vasculitis	Number of cases: 1 [144] Symptoms – Abdominal pain, brown-coloured urine, intermittent purpura on legs, appetite loss, weight loss [144] Signs – Elevated serum creatinine, proteinuria, haematuria, hypoalbuminemia, elevated CRP [144] – MPO-ANCA positive [144] Timeline – Onset of symptoms within 1 month [144] – Recovery within 13 months with pulse methylprednisolone, oral prednisolone, rituximab, avacopan [144]	No relevant statistics found
ANCA-associated	Number of cases: 1 [145]	No relevant statistics found

Vasculitis Presenting as Isolated Renal Arteritis	Symptoms – Malaise, poor appetite, weight loss, and urinary symptoms [145] Signs – Elevated serum creatinine, anaemia, leucocytosis, elevated C-reactive protein, microhaematuria, proteinuria, urine culture positive [145] Timeline – Onset of symptoms 3 months after [145] – Recovery with diuretics, antibiotics, steroids and rituximab [145]	
Other Glomerular Entities		
Unspecified Collapsing Glomerulopathy	Number of cases: 2 [31] [146] Symptoms – Lower limb oedema [146]	In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 5.1% (5/98) of patients presented with collapsing glomerulonephritis with 80% of them due to mRNA vaccines, with most patients (60%) presenting within 5-7 days after

	Signs – Proteinuria, elevated serum creatinine, hypoalbuminemia [31, 146] – Haematuria [31] Timeline – Onset of symptoms within less than 1 week - 10 days [31] [146] – Partial recovery with tacrolimus, MMF, prednisone, prednisolone [146] – Partial recovery within 12 weeks with dialysis and immunosuppressant [31]	vaccine[33].
Collapsing Glomerulopathy + Membranous Nephropathy	Number of cases: 1 [31] Signs – Elevated serum creatinine, proteinuria, hypoalbuminemia [31] – Positive ANA [31] Timeline – Onset of symptoms within less than 1 week [31] – Unsuccessful treatment with dialysis and 3 immunosuppressants; remains on dialysis [31]	No relevant statistics found

Thin Basement Membrane Nephropathy	Number of cases: 1 [39] Symptoms – Haematuria [39] Signs – Haematuria, proteinuria [39] Timeline – Onset of symptoms within 3 days [39] – Recovery with oral prednisolone [39]	No relevant statistics found
Granulomatous Nephritis	Number of cases: 1 [25] Symptoms – No symptoms reported Signs – Proteinuria [25] Timeline – Onset of symptoms within 49 days [25]	No relevant statistics found

	– Recovery with renin-angiotensin system inhibitor [25]	
Unspecified Glomerulonephritis	Number of cases: 1 [147] Symptoms – Facial and leg swelling, decreased urine output [147] Signs – Albumin in urine, proteinuria, elevated serum creatinine [147] Timeline – Onset of symptoms within 2 days [147] – Recovery with prednisolone and supportive therapy [147]	In a retrospective cohort study looking at 111 adults with diagnosed glomerulonephritis, 22.5% developed a renal event (increased proteinuria, haematuria or 1.5x increase in serum creatinine) post 2 doses of COVID-19 vaccination, with only 0.9% requiring temporary haemodialysis and 1.8% requiring additional immunosuppressive treatment. The incidence of renal events was found to be lower in people who are 65 years old (HR: 0.34 (0.13-0.89, *P* value =0.04), and eGFR <55 ml/min/1,73m2 (HR=0.25 (0.09-0.69, *P* value=0.006)). Additionally, the incidence of renal events was significantly higher in patients with fever (HR=3.97(1.53-10.3, *P* value =0.005)). There was no difference in the onset of renal events between BNT162b2 and mRNA-1273 vaccines[78]. In a pharmacovigilance study that analysed a total of 120,715,116 reports from VigiBase collected between 1967 and 2022, there was a disproportionate signal for glomerulonephritis with COVID-19 mRNA vaccine with ROR of 13.41 (12.62-14.26) and IC of 2.98 (IC025=2.90)[8].
Tubulointerstitial & Vascular Renal Disorders		

Acute Interstitial Nephritis	Number of cases: 8 [148] [149] [150] [151] [152] [153]	No relevant statistics found

Symptoms

- Abdominal pain[148], nausea [149]
- Anorexia, asthenia [151]
- Malaise, anuria, fatigue, cough [150]
- Fever, anorexia [152]

Signs

- Elevated serum creatinine [148] [149] [151] [150] [152] [153]
- Elevated C-reactive protein [149] [153]
- Elevated urea, anaemia, eosinophilia [151]
- Leukocyturia [151] [150]
- Metabolic acidosis, hyperkalaemia, glycosuria [150]
- Haematuria [151] [150] [152] [153]
- Albuminuria [151] [150]
- Proteinuria [148] [149] [150] [152]
- Hypergammaglobulinemia [152]

Timeline

- Onset of symptoms within 4 days - 6

weeks [148] [149] [151] [150]
- Proteinuria developed subsequently 10 days after initial onset of symptoms [149]
- Consider symptomatic treatment including cimetidine, pantoprazole, tiropramide [149]
- Recovery within 2 -7 months with prednisolone [148] [149, 153], but may require dialysis initially [150]
- Treatment with steroid pulse therapy (methylprednisolone) but required haemodialysis for hyperkalaemia, elevated serum creatinine and metabolic acidosis [152]
- Unsuccessful treatment with methylprednisolone and oral prednisolone, hence requiring haemodialysis [151]

Remarks

- IgA-dominant glomerulonephritis reported [152]
  Risk factors include prior history of Immune Checkpoint Inhibitor (ICPi) treatment [153]

Acute Tubulointerstitial Nephritis	Number of cases: 5 [25] [154] [155] [156] Symptoms – Weight loss [156] [154] – Fever [154] [155] – Nausea, vomiting [156] [155] – Headache [154] [155] – Epigastric pain and poor oral intake [156] – Headache, weakness, leg pain [155] – Fatigue, chills, weight loss, night sweats [154] Signs – Elevated serum creatinine [25] [156] [154] [155] – Elevated Cystatin C, elevated C-reactive protein, elevated ESR, hypertension, epigastric tenderness, costovertebral tenderness [156] – Proteinuria [25] [156] [154] [155] – Dehydrated, positive epigastric tenderness; Metabolic acidosis, haematuria, ketonuria, glycosuria, elevated pro-BNP [156] – Anaemia, leucocytosis, elevated LDH, microscopic haematuria, positive direct	In a pharmacovigilance study that analysed a total of 120,715,116 reports from VigiBase collected between 1967 and 2022, there was a disproportionate signal for tubulointerstitial nephritis with COVID-19 mRNA vaccine with ROR of 2.43(2.11-2.81) and IC of 1.22(IC025=0.99)[8].

	Coombs test [155] – Elevated urinary β2-microglobulin [154] Timeline – Onset of symptoms 1 – 54 days after [25] [156] [155] – Recovery within 1 week – 12 days with oral steroids or supportive care [25] [156] [154] [155] – May have relapse of urinary β2-microglobulin at 7 months when prednisolone was tapered, recovery with mycophenolate mofetil to allow prednisolone discontinuation [154] – Haemodialysis and transfusion for worsening kidney function and anaemia [155]	
Granulomatous Interstitial Nephritis	Number of cases: 1 [157] Symptoms – No symptoms reported Signs	No relevant statistics found

	– Elevated serum creatinine, pyuria, leucocytosis, eosinophilia [157] Timeline – Renal function deteriorated despite fluids and supportive care; subsequently partial renal recovery within 3 months with methylprednisolone, then prednisone [157]	
Tubulointerstitial Nephritis with Dense Deposit Disease	Number of cases: 1 [158] Symptoms – Fever, urticaria, dyspnoea, haematuria [158] Signs – Pleural effusion, right hilar lymphadenopathies [158] – Raised C-reactive protein, elevated serum creatinine, haematuria, decrease in C3, elevated titre of antiScl-70 antibody, anti-cardiolipin antibody, and anti-CLβ2 GP1 antibodies [158]	No relevant statistics found

Timeline [158]

- Onset of symptoms within one day; fever, urticaria, one day after
- Dyspnoea 11 days after with pleural effusion, right hilar lymphadenopathies
- Lymphadenopathy treated with loxoprofen sodium hydrate
- TIN treated with prednisolone, recovery within 13 weeks

Acute Tubulointerstitial Nephritis with Immune Complex Glomerulonephritis	Number of cases: 1 [47] No relevant case reports found
Atypical Haemolytic Uremic Syndrome (aHUS)	Number of cases: 5 [159] [160] [161] [162] [163] No relevant statistics found Symptoms – Nausea, abdominal pain [161] [162] [159] [163] – Dark urine, reduced urine output, petechiae, hypertension [161] [162] [159] – Sclera hematoma [162]

- Headache, malaise, loose stools [159]
- Fever, dyspnoea, anuria [160]
- Abdominal pain, nausea, vomiting, periumbilical hematoma, lower limb bruises [163]

Signs

- Jaundice, hypertension, elevated serum creatinine, features of thrombotic microangiopathy (thrombocytopenia, elevated lactate dehydrogenase, low/undetectable haptoglobin) [161, 162] [159] [160]
- Hyperbilirubinemia, anaemia, schistocytes in peripheral blood film [162] [159]
- Persistent oliguria [160]
- Laboratory results of AKI Stage III [160]
- Leucocytosis, elevated pancreatic enzymes, thrombocytopenia, elevated CRP, anaemia, elevated creatinine, elevated LDH [163]

Timeline

- Onset of symptoms within 1 – 40 days

	[161] [162] [160] – Recovery with anti-hypertensives, methylprednisolone, dialysis, plasma exchange, eculizumab considering ravalizumab [161] [162] [159] and hydroxocobalamin [160] – aHUS can be secondary to necrotising pancreatitis; Recovery within 19 days with empirical antibiotics, IV fluids, plasma exchange, blood transfusion, folic acid supplementation and transgastric drainage with plastic stent [163] Remarks – Genetic risk factors identified in patients include heterozygous C3 variant [161] [162] [159] [160]	
Relapse of Atypical Haemolytic Uremic Syndrome (aHUS)	Number of cases: 2[161] Symptoms – Fatigue, diarrhoea [161] Signs	No relevant statistics found

	– No signs reported Timeline – Onset of symptoms within 2 – 40 days [161] – Treatment with eculizumab for 12 weeks [161] Remarks – Genetic risk factors identified in patients include heterozygous C3 variant and homozygous haplotype MCPggaacc [161]	
Immune Thrombotic Thrombocytopenic Purpura leading to AKI	Number of cases: 2 [164] [165] Symptoms – Haematuria, repeated vomiting [164] [165] – Headache, fever, rash on legs, foul smelling urine, progressive fatigue, exertional dyspnoea, nausea [165] Signs	In a VAERS analysis of vaccine related thrombotic thrombocytopenia, there were 934 reports of COVID-19 mRNA vaccines related thrombotic thrombocytopenic syndrome reported, with a ROR of 0.81 (0.79–0.83) and IC: -0.28 (IC025: -0.31)[166].

	– Petechiae on bilateral legs or diffusely [164] [165] – Abdominal tenderness [164] – Thrombocytopenia, elevated creatinine, haemolytic anaemia (Coomb-negative, microangiopathic) [164] – Highly suppressed ADAMTS-13 with highly elevated ADAMTS-13 antibodies and decreased ADAMTS-13 antigen [164] [165] – Hyperbilirubinemia [164]	
	Timeline – Onset of symptoms within 2 - 3 days after [165] – Recovery within 2 weeks – 5 months with plasma exchange and steroid pulse therapy, caplacizumab and immunosuppressive therapy with rituximab [164] [165]	
Systemic / Multiorgan Inflammatory Syndromes With Renal Involvement		
Systemic Capillary Leak Syndrome	Number of cases: 2 cases [167] [168] Symptoms	No relevant statistics found

	– Syncope[167], fever, malaise, decreased urine output, leg oedema, nausea, dizziness, dyspnoea [167] [168]	
	Signs – Elevated haematocrit, elevated creatinine[168], hypoalbuminemia, elevated AST, elevated lactate, elevated creatine kinase, severely reduced IgG [167] – Leucocytosis, elevated BUN [168]	
	Timeline – Onset of symptoms within 1 -2 days [167] [167, 168] – Can develop status epilepticus, cardiac arrest, anasarca, disseminated intravascular coagulation, pulmonary oedema, and pleural effusions [167] Recovery within 10 days with IV fluids[168], anticonvulsants, 4 vasopressors, antibiotics, and stress-dose corticosteroids [167]	
Prerenal AKI	Number of case: 1 [169]	No relevant statistics found

	Symptoms – Loss of appetite, difficulty in walking, disorder of consciousness [169] Signs – Dry mouth, bradycardia, hyperkalaemia, elevated serum creatinine, elevated serum urea, metabolic acidosis, anaemia, thrombocytopenia, proteinuria [169] Timeline – Onset of symptoms within 5 days – Recovery within three weeks with normal saline, calcium gluconate, regular insulin, haemodialysis [169] Remarks – Patient has background of chronic kidney disease [169]	
Multisystem Inflammatory	Number of Cases: 2 [170] [171]	No relevant statistics found

Syndrome leading to AKI	Symptoms	Signs
	– Left upper arm/chest pain bilious vomiting, loose stools and chest tightness, erythematous rash on chest wall [170] – Headache, nausea, myalgia, fever, chills, sweats, diarrhoea, erythematous rash on back [171]	– Tenderness in the left axilla, chest wall and loin. Left-arm abduction was limited due to pain, with weakness [170] – Encephalopathy, erythematous blanching rash, splenomegaly [171] – Hypotensive, elevated C-reactive protein, neutrophilic leucocytosis, marked troponin elevation without ischemic ECG changes, creatinine kinase elevation, proteinuria, haematuria [170] – Elevated CRP, ferritin, troponin, bilirubin, AST ALT, pancytopenia and acute kidney injury findings [171]

	Timeline – Onset of symptoms within 2 days [170] – Recovery with methylprednisolone for 3 days, therapeutic enoxaparin then apixaban for 6 months [170] – Recovery with prednisone course [171] – Renal biopsy showed acute tubular necrosis [171]	
Multi-Organ Inflammation	Number of cases: 1 [172] Symptoms – Fever, dyspnoea [172] Signs – No signs reported Timeline – Onset of symptoms within 1 day [172] Associated with myopericarditis that resulted in sudden cardiac death 2 days after vaccine; autopsy showed widespread T-cell-predominant inflammation in myopericardium, lungs, liver, kidneys, stomach,	No relevant statistics found

	duodenum, diaphragm, brain [172]	
TAFRO syndrome: thrombocytopenia (T), anasarca (A), fever (F), reticulin myelofibrosis, renal dysfunction (R), and organomegaly (O)	Number of cases: 2 [173] [174] Symptoms – Persistent fever, loss of appetite, general malaise, abdominal fullness, weight gain [173] – Severe oedema [174] Signs – Generalised lymphadenopathy [174] – Thrombocytopenia, elevated C-reactive protein, elevated ESR, elevated ferritin, elevated soluble IL-2 receptor, hypoalbuminemia, hypogammaglobulinemia, platelet-associated IgG positive, elevated IL-6, elevated VEGF [173] – Reticulin myelofibrosis on bone marrow biopsy [173] – CT scan: pleural effusion, hepatosplenomegaly, lymphadenopathy, ascites, periportal oedema, [173] – Anaemia, thrombocytopenia, elevated serum creatinine, hyponatremia,	No relevant statistics found

	hypoalbuminemia, elevated CRP and elevated IL-6 [174] Timeline – Onset of symptoms on the day itself [173] – Fatality despite treatment with methylprednisolone pulse therapy, prednisolone, tocilizumab, rituximab, IV immunoglobulin, abdominal paracentesis [173] – Recovery with haemodialysis, pulse steroid therapy, cyclosporine, prednisolone and eltrombopag [174]	
Necrotising Inflammatory Myositis leading to AKI [175]	Number of cases: 1[175] Symptoms – Mild fever, soreness, intermittent low-grade fever, fatigue, severe left upper arm pain, swelling extending to hand, erythema [175] Signs – Fever, left arm swelling with woody induration of deltoid and triceps,	No relevant statistics found

	erythema, pain-limited shoulder and elbow range of motion [175] – Elevated ESR, elevated CRP, macrocytic anaemia, elevated creatinine, elevated troponin [175] Timeline – Onset of symptoms within 6 days [175] – Recovery with oral prednisolone [175]	
Hemophagocytic Lymphohistiocytosis	Number of cases: 1 [176] Symptoms – Fever, fatigue [176] Signs – Agranulocytosis, anaemia, thrombocytopenia, elevated CRP, elevated ferritin, elevated LDH, elevated soluble IL-2, elevated IL-6, proteinuria, elevated BUN, reduced eGFR [176] Timeline	No relevant statistics found

	– Onset of symptoms within 12 days [176] – Recovery with IV methylprednisolone, G-CSF, oral prednisolone [176]	
Erythema Multiforme leading to AKI	Number of cases: 1 [177] Symptoms – Rashes on trunk [177] Signs – Generalised annular erythema over trunk and limbs [177] – Mild eosinophilia, signs of renal failure (not specified) [177] Timeline – Onset of symptoms within 2 days [177]	No relevant statistics found
Aseptic Meningitis leading to AKI	Number of cases: 1 [178] Symptoms – Fever, headache [178]	No relevant statistics found

	Signs – Hypoxia [178] – Elevated CRP, elevated serum creatinine, hypoalbuminemia [178] – CSF fluid with pleocytosis, low glucose, elevated protein, negative bacterial cultures [178] Timeline – Onset of symptoms within 6 months [178] – Recovery with high-dose steroids [178]	
Rhabdomyolysis leading to AKI	Number of cases: 6 [179] [180] [181] [182] [183] [184] Symptoms – Muscle pain in both lower extremities [180] [182] – Anuria [180] – Back pain, pain, shortness of breath, orthopnoea, dry cough, excessive sweating [183] – Generalised myalgia, progressive weakness [179] brown urine [184]	In an observational, self-controlled case series study in Hongkong for type 2 diabetes patients with COVID-19 vaccinations, the incidence for rhabdomyolysis post BNT162b2 mRNA vaccine was 0.75/100000doses (0.09,2.71), 1.42/100000persons (0.17,5.13), and the incidence rate was 13.48/100000person-years (3.37,53.88)[2].

- Fever, headache [179]
- Leg oedema, weakness of lower limb [181]

Signs

- Livedo eticularis [182]
- Muscle weakness [179]
- Tachycardia, tachypnoea, hypoxemia, localised myositis, bilateral fine crepitations in lung, tea-coloured urine [183]
- Elevated creatinine kinase, elevated serum creatinine [180] [183] [179] [184] [181]
- Elevated myoglobin, elevated BUN [180]
- Low platelet count, prolonged aPTT, elevated D-dimer, prolonged diluted Russell viper venom time, increased signal intensity in thigh muscles consistent with acute myositis [182]
- Hyperkalaemia, hypocalcaemia[181], elevated troponin, pro-BNP, reduced eGFR, elevated CRP, leucocytosis, [183]
- Elevated CK-MB [179]
- Severe metabolic acidosis [184]

Timeline

- Onset of symptoms within 2 days – 2 weeks after [180] [182] [179] [184] [181]
- Recovery within 3 weeks with infusion of bicarbonate Ringer's solution therapy and post dilution online hemodiafiltration switched to haemodialysis [180]
- Recovery within 2 weeks with aggressive IV hydration with saline [179]
- Fatality reported due to complication of widespread thrombotic microangiopathy with organ infarctions, extensive muscle and intestinal necrosis, glomerular C3 deposition, and myoglobin casts in the renal tubule; despite treatment with argatroban, heparin, high-dose steroids, IVIG, and eculizumab [182]
- Recovery within 16 days with aggressive IV hydration with bicarbonate and furosemide, empiric antibiotics, IV methylprednisolone and IV immunoglobulin transitioned to oral prednisolone [183]
- Recovery with methylprednisolone

	and cyclophosphamide [184] – Recovery within 4 weeks with high-volume saline, urine alkalinisation and methylprednisolone [181]	
Transplant-Related Renal Outcomes		
Renal Transplant Rejection or Pathological Changes	Number of cases: 26 [185] Symptoms – No symptoms reported Signs – No signs reported Timeline – Average time till confirmed rejection or pathological changes is 33.7 days [185] Remarks – Allograft biopsies showed findings consistent with acute active antibody mediated rejection and thrombotic microangiopathy [185]	In a prospective controlled multicentre (RECOVAC) study of 159 participants on dialysis. 1 patient faced kidney transplant rejection (patient received transplant after baseline visit) [186]. In a prospective single centre study, 40.1% of kidney transplant recipients showed a rise in creatinine, proteinuria or new microscopic haematuria[187].

	– Allograft biopsies can show findings consistent with collapsing focal segmental glomerular sclerosis [185]	

Supplementary Table S2. Kidney injury reported following vector COVID-19 vaccine and associated epidemiological data

Associated Kidney Injury	Number of cases and Clinical Course	Incidence
Unspecified Acute Kidney Injury	Number of cases: 1 [188] Symptoms – Reduced urine output [188] Signs – Elevated serum creatinine [188] Timeline – Onset of symptoms within 3 weeks [188] – Recovery with oral prednisolone and haemodialysis [188]	In a retrospective cohort study that analysed data regarding 153,183 adverse events following COVID-19 vaccination in South Korea, 62 cases of acute kidney injury were reported in patients who took AZD1222 vaccines and 6 cases in patients who took JNJ-78436735[1]. A VAERS analysis found that Jannsen vaccine was associated with 89 cases of AKI giving a reporting odds ratio (ROR) of 1.04 (0.84,1.28), proportional reporting ratio (PRR) of 1.04(χ^2=0.12), and an Information component (IC) of 0.5 (IC025=0.04), Empirical Bayes Geometric Mean (EBGM) of 1.04 (EBGM05=0.87)[7].

Podocytopathies / Nephrotic Spectrum

Minimal Change Disease (MCD)	Number of cases: 8 [24] [31] [45] [189] [190] [191] [192] Symptoms – Reduced urine output [24] [191] [192] [190] – Frothy urine [191] [192] [190] – Oedema [191] [192] [190] [189] Signs – Pitting oedema [192] [189] – Oliguria [192] – Elevated serum creatinine [24] [31] [190] [45] [191] [192] – Proteinuria [31] [30] [45] [191] [192] [190] [189] – Hypoalbuminemia [30] [45] [191] [192] [190] [189] – Hypercholesterolemia and low IgG [191] – Hypoalbuminemia, elevated BUN, hyperkalaemia, hypermagnesemia, hyperphosphatemia, haematuria [192] – Dyslipidaemia, mild elevated AST and Alt, positive IgG anti-spike antibody	In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 28.6% (28/98) of patients presented with MCD with 14.3% of MCD due to Vector vaccines, with most patients (35.7%) presenting within 5-7 days after the vaccine[33].

	[189] – Positive ANA [31] – Haematuria [31] Timeline – Onset of symptoms range from 1 day – 20 days [31] [45] [191] [190] [189] – Recovery within 2 weeks with angiotensin II receptor blocker, peritoneal dialysis and CsA [45] – Consider diuretics for oedema[191], escalating to haemodialysis if hypervolemia is refractory [192] – Recovery within 3 – 7 days with high-dose methylprednisolone/prednisone [24] [191] [190] [189] – Recovery within 38 days with high-dose methylprednisolone and prednisolone with haemodialysis [192] – Recovery within 3 weeks with steroids and diuretics [31]	
Relapse of Minimal Change Disease	Number of cases: 2 [193] Symptoms – Headache, frothy urine, ankle oedema	No relevant statistics found

	[193] Signs – Proteinuria, B-cell depletion [193] Timeline – Onset of symptoms range from 1– 2 days [193] – Recovery after 10 days – 2 weeks with high-dose prednisolone [193]	
Focal Segmental Glomerulosclerosis	Number of cases: 2 [44] [194] Symptoms – Facial oedema [44] – Leg oedema [194] Signs – Anasarca, hypertension [194] reduced diuresis, haematuria [44] – Elevated creatinine, proteinuria, hypoalbuminemia [44] [194]	No relevant statistics found

	Timeline – Onset of symptoms within1 - 3 weeks [44] [194] – Recovery within 1 year with methylprednisolone pulse therapy, furosemide, spironolactone, rivaroxaban, omeprazole, calcium carbonate, cholecalciferol and long-term cyclosporine [44] – Treatment with high-dose prednisone and dialysis; unknown recovery [194] Remarks – Diagnosis of tip-variant of FSGS found [194]	
Relapse of Focal Segmental Glomerulosclerosis	Number of cases: 1 [195] Symptoms – Generalised oedema, fatigue, poor appetite [195] Signs – Elevated BUN, elevated creatinine, hypoalbuminemia, proteinuria [195]	No relevant statistics found

	Timeline – Onset of symptoms within 1 month [195] – Recovery within 2 months with prednisolone and emergency haemodialysis [195]	
Endothelial Injury and Podocytopathy	Number of cases: 1 [196] Symptoms – Pitting oedema, gross haematuria [196] Signs – Elevated serum creatinine, proteinuria [196] Timeline – Onset of symptoms within one week [196] – No recovery with high-dose methylprednisolone pulse therapy, plasma exchange and intravenous immunoglobulin [196]	No relevant statistics found

	Remarks – Reported in post-renal transplant patient [196]	
Immune-Complex–Mediated Glomerulonephritis		
Immune-Complex–Mediated Glomerulonephritis	Number of cases: 2 [197] [198] Symptoms – Flank pain [198] – Fatigue, dyspnoea, leg swelling, and poor intake [197]	No relevant statistics found
	Signs – Proteinuria, pancytopenia, elevated urea, elevated creatinine, hyponatremia, hypoalbuminemia, elevated ALT, AST, GGT [198] – Note that case above had concomitant Brucellosis infection [198] – Elevated serum creatinine, elevated BUN, dysmorphic RBC in urine, proteinuria, ANA positive, C3 reduced [197]	

	Timeline – Onset of symptoms within 2 days – few weeks [198] [197] – No treatment [198] – Treatment with steroids, mycophenolate and haemodialysis but remains dialysis-dependent [197] Remarks – IgG, C3, C1q and C3 dominant glomerulonephritis reported [197]	
Immune Complex-Mediated Membranoproliferative Glomerulonephritis	Number of cases: 2 [47] [199] Symptoms – Lower limb swelling, foamy urine [199] Signs – Severe hypertension [199] – Elevated creatinine, proteinuria [47] [199] – Reduced eGFR, erythrocyturia, hypoalbuminemia [199]	No relevant statistics found

	Timeline – Onset of symptoms within 31 days [199] – Recovery within 15 months with methylprednisolone and cyclophosphamide [199]	
IgA Nephropathy	Number of cases: 2 [45] [200] Symptoms – Oedema of lower legs [200] Signs – Proteinuria, elevated serum creatinine [45] [200] – Microscopic haematuria [200] Timeline – Onset of symptoms within 2 weeks – 20 days [45] [200] – Recovery with angiotensin-converting enzyme inhibitor for antihypertensive treatment [200]	No relevant statistics found

	– Unsuccessful treatment with PC SGLT2 inhibitor and angiotensin II receptor blocker [45]	
	Remarks – This patient had received a renal allograft due to background of aristolochic acid nephropathy [200]	
IgA Vasculitis	Number of cases: 2 [201] [202] Symptoms – Palpable purpura on extremities, colicky epigastric pain, nausea, vomiting, watery diarrhoea, haematuria, generalised arthralgia [202] [201] Signs – Palpable non-blanchable purpura involving lower and upper extremities with no mucosal membrane involvement, diffuse abdominal tenderness [202] [201] – Elevated ESR, high CRP, leucocytosis, anaemia, hypoalbuminemia,	No relevant statistics found

	hyperfibrinogenaemia, markedly raised fibrinogen degradation products, positive ANA, proteinuria and haematuria [202] – Elevated creatinine, haematuria, elevated IgA [201]	
	Timeline – Onset of symptoms range from 48 hours - 1 week [202] – Complete recovery within 3 months with IV methylprednisolone and oral prednisolone [202] – No improvement despite colchicine and ACE inhibitor [201]	
Lupus Nephritis	Number of cases: 2 [203] [204] Symptoms – Asthenic, loss of appetite, foamy urine [204] – Eyelid oedema, foamy urine, anasarca, hair loss [203]	No relevant statistics found
	Signs	

	– Elevated serum creatinine, haematuria, anaemia, thrombocytopenia, reduced C3 and C4, elevated anti-smith antibody [204] – Hypoalbuminemia, hypercholesterolemia, lymphopenia [203] – Proteinuria, lymphopenia, elevated ANA, elevated anti-dsDNA [204] [203] Timeline – Onset of symptoms within 1 day – 1 week [204] [203] – Recovery within 10 days with methylprednisolone, IV cyclophosphamide, oral prednisolone and hydroxychloroquine [204] – Recovery within 3 weeks with mycophenolate mofetil, glucocorticoids, hydroxychloroquine and diuretics [203]	
Membranous Nephropathy	Number of cases: 1 [31] Signs – Elevated serum creatinine, hypoalbuminemia, proteinuria [31]	No relevant statistics found

	Timeline – Partial recovery within 3 weeks with diuretics [31]	
Renal Amyloidosis	Number of cases: 1[205] Symptoms – Leg swelling, foamy urine, weight gain [205] Signs – Elevated serum creatinine, hypoalbuminemia, anaemia, hyperlipidaemia, microscopic haematuria [205] Timeline – Onset of symptoms within 13 days [205] – Recovery within 3 months with daratumumab + cyclophosphamide, bortezomib, dexamethasone [205]	No relevant statistics found

Crescentic / Rapidly Progressive Glomerulonephritis

Crescentic Glomerulonephritis: Pauci-immune	Number of cases: 6 [45] [206] [207] [208] [209] Symptoms – Fever [207] [209] [208] – Polyarthralgia [207] [206] – Polyarthritis [209] – Limb weakness [207] [208] – Fatigue, pallor, foamy urine [206] Signs – Fever [207] [209] [208] – Limb weakness, hypertension [207] [206] – Elevated creatinine [45] [209] [208] [206] – Haematuria [207] [209] [208] [206] – Proteinuria [45] [207] [209] [208] [206] – Elevated urea, anaemia [208] [206] – Hypercholesterolemia, normal albumin [206] – Elevated ESR [209] – Pyuria, elevated C-reactive protein, reduced C3 [207] [208] – Elevated procalcitonin, hyponatremia, hypocalcaemia, neutrophilic	In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 17.3% (17/98) of patients presented with pauci-immune crescentic glomerulonephritis with 5.9% due to Vector vaccines, with most patients (35.3%) presenting 2 weeks after vaccine[33].

leucocytosis, [208]
- p-ANCA positive [45] [207] [208]
- c-ANCA positive [207] [208]
- MPO-ANCA positive [206]
- PR3-ANCA positive [209]

Timeline

- Onset of symptoms within 5 days – 120 days [45] [209] [208] [206]

Remarks

- ANCA associated reported [207] [209] [208] [206]
- Recovery within 10 days with antibiotics, NSAIDs, methylprednisolone, cyclophosphamide and blood transfusion [207]
- Recovery within 20 weeks with prednisolone and rituximab [209]
- Recovery with antibiotics, NSAIDs, methylprednisolone, cyclophosphamide and blood transfusion [208]
- Recovery within 10 days with methylprednisolone pulse then

	prednisone, cyclophosphamide then azathioprine [206] – Unsuccessful treatment with peritoneal dialysis and cyclophosphamide; still on haemodialysis [45] – Unsuccessful treatment with plasmapheresis, methylprednisolone pulse and peritoneal dialysis [45]	
Concurrent Lupus Nephritis + ANCA-Associated Glomerulonephritis [210]	Number of cases: 1 [210] Symptoms – Fever, headache, adynamia, progressive dyspnoea, polyarthralgia, macroscopic haematuria, foamy urine [210] – Oedema, dyspnoea [210] Signs – Oedema, pulmonary congestion [210] – Anaemia, proteinuria, leukocyturia and haematuria, neutrophilia, mixed acidosis, elevated AST and ALT, elevated bilirubin, elevated C-reactive protein, elevated serum creatinine, elevated serum urea [210] – Positive ANA [210]	No relevant statistics found.

	Timeline – Onset of symptoms from day of vaccine itself, worsened after 22 days [210] – Treatment with haemodialysis, methylprednisolone, prednisone and one dose of cyclophosphamide, recovery status unknown [210]	
Other Glomerular Entities		
Collapsing Glomerulopathy	No relevant case reports found	In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 5.1% (5/98) of patients presented with Collapsing Glomerulonephritis with 20% of them due to Vector vaccines, with most patients (60%) presenting within 5-7 days after vaccine[33].
Unspecified Glomerulonephritis	No relevant case reports found	In a pharmacovigilance study that analysed a total of 120,715,116 reports from VigiBase collected between 1967 and 2022, there was a disproportionate signal for glomerulonephritis with Ad5-vectored COVID-19 vaccines with ROR of 3.12(2.73-3.56) and IC of 1.58(IC025=1.36)[8].

Tubulointerstitial and Vascular Renal Disorders

Acute Interstitial Nephritis	Number of cases: 2 [211] [212] Symptoms – General unwell[211], flank pain [212] Signs – Hypotension, elevated C-reactive protein, elevated serum creatinine[212], proteinuria, haematuria, hyperkalaemia, metabolic acidosis [211] Timeline – Onset of symptoms within 3 - 8 days [211] [212] – Renal function improvement within months after treatment with prednisolone [211] [212] – Severe acute kidney injury may require dialysis [212]	No relevant statistics found.
Acute Tubulointerstitial Nephritis	Number of cases: 1 [213] Symptoms	No relevant statistics found

	– Weight loss, fatigue, nausea, metallic taste [213] Signs – Elevated serum creatinine, hypertension, proteinuria, haematuria, elevated C3, elevated C-reactive protein, hypoalbuminemia [213] Timeline – Onset of symptoms within one month [213] – Recovery with oral prednisolone [213]	
Atypical Haemolytic Uremic Syndrome (aHUS)	Number of cases: 4 [161] [214] [215] Symptoms – Headache, vomiting, dyspnoea on exertion, hypertension, petechiae, fever, dark urine, ongoing epistaxis, nausea [161] – Malaise, nausea, vomiting, abdominal distension, asthenia progression to leg oedema, exertional dyspnoea, abdominal pain [214] – Chills, fever, body aches, cola-coloured	No relevant statistics found

urine, lethargy, pallor, jaundice [215]

Signs

- Fever [215]
- Hypertension, progression to oliguria [214]
- Signs of microangiopathic haemolytic anaemia: anaemia, elevated schistocytes, elevated LDH
- Thrombocytopenia, elevated serum creatine, elevated urea [214] [215]
- Haemoglobinuria, positive schistocytes [214]
- Neurological involvement: diplopia and occipital headache [215]

Timeline

- Onset of symptoms within 2h – 15 days [161] [214] [215]
- Initial management symptomatically but progression to severe hypertension 60 days post-vaccine managed with captopril, then progression to acute hypertensive pulmonary 86 days post-vaccine managed with dialysis and antihypertensives; recovery after 2

	weeks [214] – Rapid and complete recovery after eculizumab therapy [161] – Recovery within one week with prednisolone [215] Remarks – Present in patients with genetic risk factors (e.g. heterozygous C3 variant) [161] – Present in patient without genetic risk factors [214]	
Relapse of Atypical Haemolytic Uremic Syndrome (aHUS)	Number of cases: 1 [216] Symptoms – Nausea, vomiting, epigastric pain, haematuria [216] Signs – Signs of microangiopathic haemolytic anaemia: anaemia, low Hct [216] – Thrombocytopenia [216] – Elevated serum creatinine, elevated urea [216]	No relevant statistics found

	Timeline – Onset of symptoms within 3 days [216] – Recovery with platelet transfusion, corticosteroids and plasmapheresis [216] Remarks – Present in patients with genetic risk factors (e.g. CD46 variants) [216]	
Thrombotic Thrombocytopenic Purpura leading to AKI	Number of cases: 1 [217] Symptoms – Altered mental state [217] Signs – Tachypnoea with scattered wheezes, GCS 12, scattered petechiae [217] – Leucocytosis, neutrophilia, elevated lactate, elevated procalcitonin, elevated CRP, elevated BUN, elevated creatinine, elevated fibrinogen, haemolysis with low haptoglobin, elevated LDH, thrombocytopenia,	No relevant statistics found

	elevated AST, haematuria, elevated troponin [217] – Suppressed ADAMTS13 [217] Timeline – Onset of symptoms within 37 days after [217] – Recovery with haemodialysis, packed RBCs, plasma exchange, high dose methylprednisolone [217]	
Thrombotic Thrombocytopenia leading to AKI	Number of cases: 1 [217] Symptoms – Left-sided convulsions with eft upper limb weakness, vomiting, severe headache [218] – Intermittent fever, malaise, lethargy, and vague abdominal pain [219] Signs – Fever, tachycardia. Left upper limb weakness, brisk reflexes, positive Babinski [218] – Tenderness over both flanks and the left renal angle	In a VAERS analysis of vaccine related thrombotic thrombocytopenia, there was 934 reports of COVID-19 Ad5-Vectored COVID-19 vaccines related thrombotic thrombocytopenic syndrome with a ROR of 1.64 (1.59–1.68) and IC: 0.69 (IC025: 0.64)[166].

- Elevated white blood cells, low haemoglobin, clumped platelets, elevated liver enzymes, prolonged PT, PTT and elevated INR, low fibrinogen, elevated creatinine, severe acidosis [218]
- Severe thrombocytopenia, elevated creatinine, elevated D-dimer, prolonged PT, PTT and elevated INR, reduced basal cortisol [219]
- Positive PF4 antibodies [219]

Timeline

- Onset of symptoms within 1 - 2 weeks [218] [219]
- Patient was commenced on therapeutic enoxaparin with antibiotics and antivirals but deteriorated and developed disseminated intravascular coagulation with acute kidney injury requiring haemodialysis, which progressed to multiorgan failure and death [218]
- Improvement within 3 weeks with argatroban transitioned to fondaparinux and rivaroxaban. intravenous immunoglobulin and

	hydrocortisone [219]	
Renal Thrombotic Microangiopathy	Number of cases: 1 [220] Symptoms – Generalised itchy scaly rash [220] Signs – Leucocytosis, normocytic anaemia, variable thrombocytosis, mild haemolysis (occasional schistocytes), elevated inflammatory markers, elevated IL2R elevated, signs of acute kidney injury [220] Timeline – Rash occurred 2 days after, followed by pericardial effusion 2 weeks later and acute kidney injury 4 months later [220] – Recovery with haemodialysis, anticoagulants, plasmaphereses and solumedrol [220]	No relevant statistics found

Systemic / Multiorgan Inflammatory Syndromes With Renal Involvement

Systemic Capillary Leak Syndrome	Number of cases: 1 [167] Symptoms – Nausea, vomiting, syncope, hypotension, and tachycardia [167] Signs – Anasarca, lower extremity compartment syndrome, widespread digital necrosis [167] – Elevated hematocrit, elevated creatinine, hypoalbuminemia, elevated AST, lactate acidosis, elevated creatine kinase, signs of disseminated intravascular coagulation [167] Timeline – Onset of symptoms within 2 days [167] – Fatality reported 7 days after onset due to cardiac arrest; despite management with IV fluids, vasopressors, antibiotics, stress-dose corticosteroids, renal replacement, IVIG and bilateral lower-extremity fasciotomies [167]	No relevant statistics found

Atypical Kawasaki Disease leading to AKI	Number of cases: 1 [221] Symptoms – Fever, headache, and diarrhoea, progressing to conjunctival injection and morbilliform skin rash over the thorax and hands, sudden onset of right leg pain, cyanosis and coldness [221] Signs – Fever, bilateral non-suppurative conjunctivitis, macular rash, palmar erythema with desquamation, strawberry tongue, cracked lips, cervical lymphadenopathy, jaundice, and acute ischemia of the right leg [221] – Elevated creatinine, elevated AST/ALT, elevated LDH, elevated GGT, elevated bilirubin, hypoalbuminemia, prolonged PT/PTT, thrombocytopenia, elevated CRP, leucocytosis [221] Timeline	No relevant statistics found

	– Onset of symptoms within 22 days [221] – Spontaneous resolution of thrombosis within 24 hours, followed by non-traumatic rhabdomyolysis secondary to reperfusion [221] – Improvement within 5 days with IV immunoglobulin and low-dose aspirin [221]	
Rhabdomyolysis leading to AKI	Number of cases: 1 [222] Symptoms – Acute malaise, dyspnoea, severe abdominal pain, myalgia, and difficulty walking [222] Signs – Hypertensive, respiratory failure, atrial fibrillation, anuria [222] – Elevated creatine kinase, elevated AST and ALT, elevated myoglobin, elevated creatinine, elevated BUN, hyperkalaemia, hypercalcemia, lymphopenia, elevated inflammatory markers [222]	No relevant statistics found

Timeline

- Onset of symptoms within 9 days [222]
- Severe rhabdomyolysis can be complicated by multi organ failure involving bone marrow, liver, lung, and kidney and cytokine storm, resulting in patient death; despite treatment with high dose methylprednisolone, anakinra and eculizumab [222]

Remarks

- Reports of heterozygous CAV3 variant (p.Thr78Met) in patients, which may predispose to muscle injury [222]

Transplant-Related Renal Outcomes

Renal Transplant Rejection	Number of cases: 1 [223] Symptoms – No symptoms reported	No relevant statistics found

	Signs – Elevated serum creatinine [223] Timeline – Recovery within 2 weeks with methylprednisolone [223]	

Supplementary Table S3. Kidney injury reported following COVID-19 inactivated vaccination and associated epidemiological data

Associated Kidney Injury	Number of cases and Clinical Course	Incidence
Unspecified Acute Kidney Injury	No relevant case reports found	In an observational, self-controlled case series study in Hongkong for type 2 diabetes patients with COVID vaccinations, the incidence for AKI post CoronaVac inactivated vaccine was 1.41/100000doses (0.46,3.28), 2.51/100000persons (0.81,5.85), and the incidence rate was 25.42/100000person-years(10.58,61.08)[2].
Immune-Complex–Mediated / Antibody-Mediated Glomerular Diseases		
IgA Vasculitis	Number of cases: 1 [224] Symptoms	No relevant statistics found.

	– Rash, colicky abdominal pain, inflammatory arthritis [224] Signs – Well-defined erythematous macules, papules, plaques on legs, arms, abdomen [224] – Microscopic haematuria, proteinuria [224] Timeline – Onset of symptoms within 1 day [224] – Recovery with steroids and omeprazole [224]	
Membranous Nephropathy	No relevant case reports found	In a retrospective cohort study looking at 253 patients with membranous nephropathy split into 2 groups (152 being vaccinated, 101 not vaccinated), 16 (11%) from the vaccinated group experienced a relapse or worsening of the disease during the follow-up period, which was similar to the 14 (16%) observed in the unvaccinated group. By cardinality matching, there was no difference in the rate of relapse or worsening between the two groups, with 10 (13%) in the vaccinated group and 11 (15%) in the unvaccinated group (hazard ratio 0.98, 95%CI 0.42–2.33)[225].

Relapse of Membranous Nephropathy	Number of cases: 1 [226] Symptoms – Lower extremity oedema [226] Signs – Elevated urea, elevated serum creatinine, proteinuria, hypoalbuminemia, positive anti-PLA2R [226] Timeline – Onset of symptoms 2 weeks after [226] – Recovery within 3 months with steroid, cyclosporine, and lisinopril [226]	No relevant statistics found
IgM Nephropathy	Number of cases: 1 [227] Symptoms – Proximal weakness of the upper and lower extremities, food regurgitation and dysphagia to solids and liquid [227]	No relevant statistics found

	Signs – Heliotrope rash and Gottron's papules [227] – Reduction in muscle power globally [227] – Elevated serum creatinine, elevated lactate dehydrogenase, positive serum anti-Mi-2 antibody, proteinuria, haematuria [227] Timeline – Onset of symptoms 1 month after [227] – Recovery within 20 days with pulse methylprednisolone and prednisolone, and intravenous immunoglobin [227]	
Relapse of Lupus Nephritis	Number of cases: 1 [228] Symptoms – No symptoms reported Signs – Cytopenia, Coombs positive haemolytic anaemia, leukopenia, proteinuria, active urinary sediments,	No relevant statistics found

	hypocomplementemia, elevated anti-dsDNA [228] Timeline – Onset of symptoms within two weeks [228] – Recovery with methylprednisolone pulse and prednisone maintenance [228]	
Podocytopathies / Nephrotic Spectrum		
Relapse of Minimal Change Disease	Number of cases: 1 [229] Symptoms – Foamy urine and oedema [229] Signs – Proteinuria, hypercholesterolemia, hyperlipidaemia, hypoalbuminemia [229] Timeline – Onset of symptoms 14 days after [229]	No relevant statistics found

	– Treatment with methylprednisolone [229]	
Crescentic / Rapidly Progressive Glomerulonephritis		
Anti-GBM disease	No relevant case reports found	In a retrospective cohort study that included subjects with de novo glomerulonephritis presenting 3 months after COVID-19 Vaccine, 5.1% (5/98) of patients presented with Anti-GBM with 60% of MCD due to inactivated vaccines, with most patients (60%) presenting 2 weeks after vaccine[33].
Crescentic Glomerulonephritis: Pauci-immune	Number of cases: 1 [230] Symptoms – Poor appetite, nausea, fatigue, foamy urine [230] Signs – Elevated creatinine, proteinuria [230] – MPO-ANCA, ANA positive [230] Timeline – Onset of symptoms within 4h [230] – Recovery within 43 days with methylprednisolone and	

	cyclophosphamide [230]	
Tubulointerstitial & Vascular Renal Disorders		
Thrombotic thrombocytopenic purpura leading to AKI	Number of cases: 2 [231] Symptoms – Dizziness, weakness, fever, myalgia [231] Signs – Petechiae, purpura [231] – Anaemia, thrombocytopenia, elevated megakaryocytes, thrombocytopenia [231] – Signs of microangiopathic haemolytic anaemia: elevated LDH, elevated indirect bilirubin, elevated alpha-HBDH, elevated schistocytes [231] – Elevated serum creatinine, elevated uric acid, proteinuria, haematuria [231] – ADAMTS13 <15% [231] – Signs of organ ischemia: neurological deterioration and coma, elevated cardiac markers (myoglobin, troponin) [231]	No relevant statistics found

	Timeline – Onset of symptoms within 3 – 5 days [231] – Recovery within 30 – 153 days with high-dose steroids, IVIG, platelet transfusion, plasma exchange, rituximab [231] – May be complicated by retroperitoneal haemorrhage requiring surgery [231]

Supplementary Table S4. Kidney injury reported following COVID-19 recombinant protein nanoparticle vaccine (GBP510) and associated epidemiological data

Associated Kidney Injury	Number of cases and Clinical Course	Incidence
Acute Kidney Injury, Rapidly Progressive Glomerulonephritis, Cutaneous Vasculitis	No relevant case reports found	In a randomised, active-controlled, observer-blinded, parallel group, phase 3 study across six countries, 3 cases of systemic adverse events were reported in the GBP510 group, with the cases being AKI, rapidly progressive glomerulonephritis and cutaneous vasculitis[232].

Supplementary Table S5. Kidney injury reported following unspecified COVID-19 vaccination and associated epidemiological data

Associated Kidney Injury	Number of cases and Clinical Course	Incidence
Unspecified Acute Kidney Injury	No relevant case reports found	In a prospective observational study in Jordan,129 AKI events were reported after COVID-19 vaccine, with 19.7 events/100000 persons reported in the study[233]. In a Taiwanese VAERS analysis, there were 12 cases of AKI reported after COVID vaccine with the time of onset falling between 1-70 days[234]. In a nationwide cohort study in South Korea, there were 5 AKIs reported post COVID vaccine (3 cases afterBNT162b2, 2 cases after ChAdOx!). The absolute risk difference for AKI per 100000 persons was reported as 0.06, with the incidence rate ratio reported as 0.67 (0.11-3.99), and hence it was not statistically significant[235]. In a retrospective observational cohort study studying the effects of COVID-19 vaccines on patients with biopsy proven glomerular disease, 23 out of 255 patients (9%) experienced a glomerular disease relapse after vaccination, with the average time to relapse from vaccination being 2.5 months[236]. A retrospective observational pharmacovigilance study found that renal failure is reported in 13 cases out of

456 COVID-19 vaccine related adverse drug reaction reports with fatal outcomes (the total reporting rate was 5.7 fatal outcomes per 100,000 persons vaccinated with at least one dose of any COVID-19). 12 cases were associated with Cominarty vaccine and 1 case associated with Spikevax vaccine[237].

In a retrospective study, after using Naranjo score to exclude probable or doubtful causality of COVID-19 vaccine to acute kidney disease, and further evaluating using expert nephrologists review, 27 cases out of 1897 COVID vaccinated adults were found to develop COVID-19 vaccine related acute kidney disease[238].

There were 1572 cases of haematuria reported in a VAERS study with 13568650 COVID-19 vaccine associated symptoms reported, with the adverse event rate of hematuria being (0.012%)[239].

In a VAERS analysis, the overall reporting rate for AKI post COVID-19 vaccine was 3.03 reports per 1 million doses and the reporting rate of renal failure post COVID-19 vaccine was 1.11 reports per million doses. Potential side effects were elevated following vectored vaccines rather than mRNA vaccines (RR of AKI post AD26.COV2.S vaccine is 12.24, 95 % CI: 10.66–13.81; while the reporting rate of renal failure post AD26.COV2.S vaccine is 3.17 95 % CI: 2.36–3.97). There were 1,312 deaths possibly associated with AKI (RR = 0.94, 95 % CI: 0.89–0.99) and 460 deaths possibly

associated with renal failure (RR = 0.33, 95 % CI: 0.30–0.36) per million vaccine doses. The odds of a ≥65yo male reporting AKI post COVID vaccine is 7.23 times (95 % CI: 6.63–7.88, *P* value = 0.000) compared to 18-64 years old. The odds of a ≥65yo male reporting renal failure post COVID vaccine is 4.74 times (95 % CI: 3.99–5.63, *P* value < 0.001) compared to 18-64 years old[240].

In a study of patients presenting with gross haematuria after COVID-19 vaccine, none of the patients in the cohort developed a 1.5-fold increase in serum creatinine from baseline, proteinuria also only temporarily increased after the vaccinations. Out of 127 patients who presented with gross haematuria, 37 patients had kidney biopsy done before where 35 patients were previously diagnosed with IgA nephropathy 1 patient with IgA vasculitis and one patient with proliferative glomerulonephritis with monoclonal IgG deposits**.** Out of the 90 patients who did not have prior kidney biopsy, 70 patients went for post gross haematuria biopsy, with 67 of them being diagnosed with IgA nephropathy 2 of them diagnosed with IgA vasculitis and 1 patient with proliferative IgA glomerulonephritis using the biopsy. (71% of these patients have had pre-vaccination abnormal urinary findings, hence COVID-19 is hypothesised to have manifested the subclinical IgA nephropathy)[241].

In a population-based retrospective observational study in Scotland that compares incidence rates of

adverse events throughout pre-pandemic and pandemic periods, it was reported that the IR of acute renal failure during the pandemic period [449.8 (CI 442.9-456.7)] was lower than the pre-pandemic period [478.4 CI(475.8-481)] [242].

In a retrospective cohort study that evaluated side effects of Covid-19 vaccination among Iranian adolescents, the study reported 8 cases of renal side effects (0.0007% of the targeted population), with 4 cases being proteinuria, 2 cases being haematuria and 2 being renal dysfunction[243].

In a retrospective cohort study that studied data from the TriNetX analytics platform, vaccinated individuals were found to have a higher incidence of acute kidney injury (HR 1.20, 95% CI 1.18–1.23) and dialysis initiation (HR 1.84, 95% CI 1.68–2.01) compared with unvaccinated individuals. At one year of follow-up, there were 7,693 deaths in the vaccinated group and 7,364 deaths in the unvaccinated group; however, mortality risk was significantly lower among vaccinated individuals (HR 0.88, 95% CI 0.85–0.91). Consistent with these findings, cumulative incidence curves demonstrated higher rates of AKI and dialysis in the vaccinated cohort, whereas the probability of death was significantly lower in vaccinated compared with unvaccinated individuals (P value < 0.001)[244].

Safety in Chronic Kidney Disease	No relevant case reports found	A global retrospective cohort study using the TriNetX database found that compared with unvaccinated patients, the vaccinated cohort demonstrated a significantly reduced risk of major adverse kidney events (MAKEs) or death (HR 0.637, 95% CI 0.581–0.689), MAKEs alone (HR 0.792, 95% CI 0.698–0.898), and all-cause mortality (HR 0.549, 95% CI 0.484–0.622)[245].
Podocytopathies / Nephrotic Spectrum		
Podocytopathies (including MCD and FSGS)	Symptoms – No symptoms reported Signs – No signs reported Timeline – Median interval from vaccination to symptom onset found in one study is 8(IQR, 2-28)[246]	No relevant statistics found
Minimal Change Disease	Number of reports: 19 [247] [248] [249] [246] [250] Symptoms	In a retrospective observational cohort study studying the effects of COVID-19 vaccines on patients with biopsy proven glomerular disease, 6 patients out of 29 patients experienced a relapse of minimal change

	- No symptoms reported Signs - No signs reported Timeline - Treatment with steroids [249]	disease after COVID-19 vaccination[236]. In a retrospective observational cohort study, the incidence of minimal change disease was significantly higher post-Spanish vaccine (n=20) (COVID-19 vaccine) than pre-Spanish vaccine (n=13) (*P* value =0.002)[251]. In a retrospective cohort study looking at 1105 adults with biopsy proven glomerulonephritis taking the COVID-19 vaccine, the absolute increase in risk of a disease flare associated with a second or third dose of a COVID-19 vaccine varied from 1%–2% in those with minimal change disease[252].
Focal Segmental Glomerulosclerosis	Number of cases: 5 [249] [248] [246] Symptoms - No symptoms reported Signs - No signs reported Timeline - Treatment with steroids [249]	In a retrospective observational cohort study studying the effects of COVID-19 vaccines on patients with biopsy proven glomerular disease, 2 patients out of 38 patients experienced a relapse of focal segmental glomerulosclerosis after COVID-19 vaccination[236]. In a retrospective cohort study looking at 1105 adults with biopsy proven glomerulonephritis taking the COVID-19 vaccine , the absolute increase in risk of a disease flare associated with a second or third dose of a COVID-19 vaccine varied from 1-2% in those with focal segmental glomerulosclerosis[252].

Relapse of Focal Segmental Glomerulosclerosis	Number of cases: 3 [247] [253] No clinical course reported	
Idiopathic Nephrotic Syndrome	No relevant case reports found	In a retrospective observational cohort study, the incidence of idiopathic nephrotic syndrome was significantly higher post-Spanish vaccine (n=18,10.7%) (COVID-19 vaccine) than pre-Spanish vaccine (n=11, 5%) (*P* value=0.036)[251].
Immune-Complex / Autoimmune Glomerulonephritis		
IgA Nephropathy	Number of cases: 28 [249] [248] [246] [247] [250] [253] Symptoms - No symptoms reported Signs - No signs reported Timeline - Treatment with pulse cyclophosphamide and steroids [253]	In a retrospective observational cohort study studying the effects of COVID-19 vaccines on patients with biopsy proven glomerular disease, 7 patients out of 41 patients experienced a relapse of IgA nephropathy COVID-19 vaccination[236]. In a retrospective cohort study looking at 1105 adults with biopsy proven glomerulonephritis taking the COVID-19 vaccine, the absolute increase in risk of a disease flare associated with a second or third dose of a COVID-19 vaccine varied from 3-5% in those with IgA nephritis[252].

Relapse of IgA Nephropathy	Number of cases: 1 [247] No clinical course reported	In a retrospective observational cohort study involving 113 patients with IgA nephropathy who took COVID-19 vaccine the results showed a significant decrease in eGFR in patients with $30 \leq eGFR < 60$ post second dose ($n = 18$, $p = 0.01$), however, there was a trend towards a decrease in eGFR after 6-month follow-up in vaccinated patients, although this difference was not significant. The study also reported that there were 10 patients who displayed worsening proteinuria post vaccination[254]. In a retrospective observational cohort study of 295 biopsy proven IgA nephropathy patients with COVID-19 vaccine, there were no significant changes in renal function or proteinuria before vs after vaccination in patients with gross haematuria, however, evaluation of the rate of change in eGFR showed that three of 16 patients with gross haematuria had an eGFR decrease of more than 10% after approximately 1 year. In addition, in four of the patients, renal biopsy was performed due and showed Crescent formation in the glomerulus in three of the patients[255].
IgA Vasculitis	Number of cases: 1 [256] Symptoms - Lower abdominal pain, diarrhoea, intermittent melena, petechial rash, unintentional weight loss [256]	No relevant statistics found

	Signs - Elevated CRP, elevated ESR [256] - Positive deamidated gliadin antibody [256] - Elevated faecal calprotectin, positive stool lactoferrin [256] - Negative infectious stool workup [256] Timeline - Onset of symptoms within 2 weeks [256] - Recovery with prednisone [256]	
Lupus Nephritis	Number of cases: 5 [248] [249] [257] Symptoms - No symptoms reported Signs - No signs reported Timeline	In a retrospective observational cohort study studying the effects of COVID-19 vaccines on patients with biopsy proven glomerular disease, 0 patients out of 69 patients experienced a relapse of lupus nephritis after COVID-19 vaccination[236]. In a retrospective cohort study looking at 1105 adults with biopsy proven glomerulonephritis taking the COVID-19 vaccine, the absolute increase in risk of a disease flare associated with a second or third dose of a COVID-19 vaccine varied from 3-5% in those with lupus nephritis[252].

	- Treatment with cyclophosphamide and steroids [249]	In a VAERS analysis in the United States, there were 16 cases of after COVID-19 vaccine reported, with a cumulative incidence rate of 0.007/100000 person years (p value=0.021) [258].
Membranous Nephropathy	Number of cases: 10 [248] [246] [247] [257] No clinical course reported	In a retrospective cohort study looking at 1105 adults with biopsy proven glomerulonephritis taking the COVID-19 vaccine, the absolute increase in risk of a disease flare associated with a second or third dose of a COVID-19 vaccine varied from 1%–2% in those with membranous nephropathy[252].
Membranoproliferative Glomerulonephritis	Number of cases: 1 [248] No clinical course reported	No relevant statistics found
Membranoproliferative Glomerulonephritis Relapse	Number of cases: 1 [247] No clinical course reported	No relevant statistics found
Endocapillary Proliferative Glomerulonephritis	Number of cases: 2 [249] No clinical course reported	No relevant statistics found
Proliferative Glomerulonephritis	Number of cases: 1[250] No clinical course reported	No relevant statistics found

Autoimmune Glomerulonephritis	No relevant case reports found	In a retrospective observational cohort study, the incidence of autoimmune glomerulopathy was significantly higher post-Spanish vaccine (n=85, 50.6%) (COVID-19 vaccine) than pre-Spanish vaccine (n=86, 39.4%) (*P* value=0.029). Regarding time-lapse between either SARS-CoV-2 vaccine or infection to AIG diagnosis, a total of 17 (20%) took place in the first 6 weeks after SARS-CoV-2 vaccine[251].
Post-infectious/Para-infectious Glomerulonephritis	Number of cases: 2 [246] No clinical course reported	No relevant statistics found
C3 Glomerulopathy	Number of cases: 2 [247] No clinical course reported	No relevant statistics found
Crescentic / Rapidly Progressive Glomerulonephritis		
Anti-GBM Disease	Number of cases: 3 [250] [253] Symptoms - No symptoms reported Signs - No signs reported	

	Timeline - Treatment with plasma exchanges with cyclophosphamide [253]	
ANCA Associated Glomerulonephritis	Number of cases: 1 [253] Symptoms - No symptoms reported Signs - No signs reported Timeline - Treatment with cyclophosphamide pulse with steroids [253]	In a retrospective cohort study looking at 1105 adults with biopsy proven glomerulonephritis taking the COVID-19 vaccine, the absolute increase in risk of a disease flare associated with a second or third dose of a COVID-19 vaccine varied from 1%–2% in those with ANCA-glomerulonephritis[252].
Unspecified Crescentic Glomerulonephritis	Number of cases: 2 [257] No clinical course reported	No relevant statistics found
Crescentic Glomerulonephritis:	Number of cases: 6 [246]	No relevant statistics found

Pauci-immune	Symptoms - No symptoms reported Signs - MPO-ANCA positive [246] - PR3-ANCA positive [246] - ANCA negative [246] Timeline - Treatment with high-dose corticosteroids and cyclophosphamide [246] - Treatment with acute kidney replacement therapy or maintenance dialysis [246]	
Relapse of Crescentic Glomerulonephritis: Pauci-immune	Number of cases: 1 [246] Symptoms - No symptoms reported Signs - PR3-ANCA positive [246]	No relevant statistics found

	Timeline - No timeline reported	
Unspecified Necrotising Glomerulonephritis	Symptoms - Weakness, generalised pain, muscle weakness, fatigue, fever, oedema [246] Signs - No signs reported	No relevant statistics found
	Timeline - No timeline reported	
Other Glomerulonephritis		
Unspecified Glomerulonephritis	Timeline - Median interval from vaccination to symptom onset found in one study is 8(IQR, 2-28) 3(IQR, 2-5) days [246]	In a retrospective cohort study looking at 1105 adults with biopsy proven glomerulonephritis taking the COVID-19 vaccine, the multivariable analysis showed that the hazard ratio of the second and third dose to glomerular disease was significant at 2.16 (1.03-4.51, *P* value =0.04), the hazard ratio for the first dose was less significant at 0.65 (0.32-1.32)[252]. In an observational cohort study, it is reported that by

		comparing glomerulonephritis disease activity between those who received a COVID-19 vaccine to matched controls who did not, vaccination did not associate with higher risk of subsequent glomerulonephritis disease worsening (HR 1.02, 95% CI 0.79 – 1.33, *P* value =0.87). Furthermore, COVID-19 vaccination was not associated with decline in eGFR following vaccination[259].
Tubulointerstitial & Vascular Renal Disorders		
Acute Tubular Injury	Number of cases: 4 [246] Symptoms - No symptoms reported Signs - No signs reported Timeline - Partial recovery and complete recovery reported [246]	No relevant statistics found
Tubulointerstitial Nephritis	Number of cases 3: [248]	No relevant statistics found

	No clinical course reported	
Interstitial Nephritis	Number of cases 3: [246] Symptoms - No symptoms reported Signs - No signs reported Timeline - Median interval from vaccination to symptom onset found in one study is 20(IQR, 2-50) [246]	No relevant statistics found
ANCA Vasculitis	Number of cases: 3 [248] [249] [257] Symptoms - No symptoms reported Signs - No signs reported	No relevant statistics found

	Timeline - Treatment with cyclophosphamide and steroids [249]	
Renal Vasculitis	No relevant case reports found	In a VAERS analysis in the United States, there were 3 cases of renal vasculitis after COVID-19 vaccine reported, with a cumulative incidence rate of 0.001/100000 person years[258].
Atypical Haemolytic Uremic Syndrome (aHUS)	No relevant case reports found	A cohort study done in Taiwan studying 21 patients with aHUS given COVID-19 vaccines found that only 1 patient had transient aHUS disease instability, but it was self-limited. After Moderna vaccine was switched to Pfizer, patient's aHUS disease activity stabilized[260].
Immune thrombotic thrombocytopenic purpura leading to AKI	No relevant case reports found	In a VAERS analysis in the United States, there were 13 cases of thrombotic thrombocytopenia purpura after COVID-19 vaccine reported, with a cumulative incidence rate of 0.006/100000 person years (p value=0.315)[258].
Systemic / Multiorgan Inflammatory Syndromes With Renal Involvement		
Multisystem Inflammatory Syndrome	Number of cases: 1 [261] Symptoms - Body aches, fatigue, diarrhoea, fever,	No relevant statistics found

shortness of breath [261]

Signs

- Hypoxic, febrile, tachycardic and hypotensive [261]
- Leucocytosis, lymphopenia, acute kidney injury, transaminitis, lactic acidosis and bilateral ground glass opacities on chest computed tomography [261]
- EBV positive but thought to be a reactivation of infection secondary to immunocompromised status [261]

Timeline

- Onset of symptoms within 6 days [261]
- Treatment with dexamethasone acetate (10 mg/m2) and etoposide as part of the hemophagocytic lymphohistiocytosis (HLH)-94 treatment protocol but patient remains on vent support one month after [261]

TAFRO syndrome	Number of cases: 1 [250] No clinical course reported	No relevant statistics found

Abbreviations; **AE**, adverse event; **AEFI**, adverse event following immunisation; **aHUS**, atypical haemolytic uraemic syndrome; **AKI**, acute kidney injury; **ALT**, alanine aminotransferase; **ANA**, antinuclear antibody; **ANCA**, antineutrophil cytoplasmic antibody; **anti-GBM**, anti–glomerular basement membrane; **aHR**, adjusted hazard ratio; **aOR**, adjusted odds ratio; **AST**, aspartate aminotransferase; **BUN**, blood urea nitrogen; **CI**, confidence interval; **CK**, creatine kinase; **CRP**, C-reactive protein; **EBGM**, empirical Bayes geometric mean; **EBGM05**, lower 5% bound of EBGM; **eGFR**, estimated glomerular filtration rate; **ESR**, erythrocyte sedimentation rate; **FSGS**, focal segmental glomerulosclerosis; **HLH**, haemophagocytic lymphohistiocytosis; **HR**, hazard ratio; **IC**, information component; **IC025**, lower 95% credibility interval of IC; **IgA**, immunoglobulin A; **IgG**, immunoglobulin G; **IgG4**, immunoglobulin G4; I**VIG**, intravenous immunoglobulin; **LDH**, lactate dehydrogenase; **MAKE**, major adverse kidney event; **MCD**, minimal change disease; **MN**, membranous nephropathy; **MPO**, myeloperoxidase; **NS**, nephrotic syndrome; **OR**, odds ratio; **PR3**, proteinase-3; **PRR**, proportional reporting ratio; **PV**, pharmacovigilance; **RAAS**, renin–angiotensin–aldosterone system; **RI**, relative incidence; **ROR**, reporting odds ratio; **RR**, risk ratio; **SCCS**, self-controlled case series; **SLE**, systemic lupus erythematosus; **TAFRO**, thrombocytopenia, anasarca, fever, reticulin myelofibrosis, renal dysfunction, organomegaly; **TIN**, tubulointerstitial nephritis; **TMA**, thrombotic microangiopathy; **TTP**, thrombotic thrombocytopenic purpura; **UPCR**, urine protein-to-creatinine ratio; **VAERS**, Vaccine Adverse Event Reporting System; VigiBase, World Health Organization global pharmacovigilance database.

Influenza vaccine

Case reports and case series describe clinical phenotypes but cannot be used to infer causality. Disproportionality analyses (ROR, IC) indicate reporting signals rather than incidence or risk.

Supplementary Table S6. Kidney injury reported following unspecified Influenza vaccine and associated epidemiological data

Associated Kidney	Clinical Course	Incidence

Injury		
Safety in patients with Chronic Kidney Disease (CKD) or/and need haemodialysis	No relevant case report found	In a retrospective analysis of patients with hypertension taking influenza vaccine, there is a significantly lower risk of CKD occurrence among vaccinated patients all season (Adjusted hazard ratio [aHR]: 0.38, 95% C.I.: 0.34–0.44) There is also decrease of risk of haemodialysis after vaccination. (aHR: 0.41, 95% C.I.: 0.33–0.51 all season) [262]. In a retrospective observational cohort study, evaluating the rate of hospitalisation with influenza vaccine in patients on dialysis, it is found that receipt of high dose was associated with a significant reduction in hospitalization. (hazard ratio, 0.93; 95% confidence interval, 0.86 to 1.00; *P* value =0.04) [263] In a population based cohort study who studied 22590 older people aged more than 65 years old who were hospitalized for kidney disease, it was found that patients who had previous influenza vaccine had lower risk of septicaemia (OR 0.77, 95% CI 0.68-0.87), need for intensive care (OR 0.85, 95% CI 0.75–0.96), and in-hospital mortality (OR 0.56, 95% CI 0.39–0.82) compared to people who did not take the influenza vaccine previously. [264]

General glomerulopathies	No relevant case report found	In a cohort study of 21 patients with glomerulopathies taking Influenza vaccine, the creatinine clearances remained relatively unchanged in all patients, and the author reported that influenza vaccination had no adverse effects on patients with glomerulonephropathies, there is no reason for withholding vaccination. [265] In a Vigibase pharmacosurveilance study, a disproportionality study found an ROR of Glomerulonephritis with influenza vaccine of 7.08 (6.32-7.93), with an IC of 2.78 (IC025: 2.59). [8]
General Acute Kidney Injury (AKI)	No relevant case report found	In a large prospective observational cohort study using target trial emulation, the incidence of AKI was 36.8 per 100000 person years in unvaccinated patients, while the incidence of AKI was 30.6 per 100000 person years in vaccinated patients, showing a hazard ratio of 0.83 (95%CI: 0.71-0.98) between influenza vaccine and AKI. [266] In a randomised controlled trial with 4707 participants taking the influenza vaccine, there was one case of a renal and urinary tract disorder, 36-72 months after trivalent influenza vaccine without the

MF59 adjuvant being reported. [267]

In a VAERS analysis of a trivalent live attenuated vaccine, there was one report of acute renal failure after vaccination. [268]

In a Vigibase pharmacosurveilance study, a disproportionality study found an ROR of AKI with Influenza vaccine of 0.84 (0.76-0.93), with an IC of -0.25 (IC025: -0.42) [8]

A nationwide nested case–control study in older adults (≥65 years) found that influenza vaccination was associated with a substantially reduced risk of hospitalization for acute kidney injury (aOR 0.67, 95% CI 0.63–0.72, *P* value<0.001). Unvaccinated individuals who developed influenza infection also had higher AKI risk (aOR 1.78, 95%CI 1.57-2.01, *P* value<0.001). On the other hand, vaccinated individuals who still got infected with influenza had no increased risk, suggesting a potential renal protective effect of influenza vaccination. [269]

In a nationwide Korean self-controlled case series analysis of more than 32,000 older adults hospitalized with first-episode AKI, the incidence of

		AKI during the 1–28-day post-vaccination window was actually lower than in control periods, with adjusted incidence rate ratios of 0.83 (95% CI 0.79–0.87) in the 2018–2019 season and 0.86 (95% CI 0.82–0.90) in 2019–2020. [270]
Tubular Interstitial Nephritis	No relevant case report found	In a Vigibase pharmacosurveilance study, a disproportionality study found an ROR of Tubular interstitial nephritis with Influenza vaccine of 0.65 (0.46-0.93), with an IC of -0.61 (IC025: -1.21). [8]

Supplementary Table S7. Kidney injury reported following inactivated seasonal Influenza vaccine and associated epidemiological data

Associated Kidney Injury	Clinical Course	Incidence
Podocytopathies		
Nephrotic Syndrome	No relevant case report found	One early influenza vaccine study in children with pre-existing renal disease reported a single relapse of nephrotic syndrome following a minor intercurrent illness in a vaccinated child. [271]

In a cohort prospective study with 63 children with nephrotic syndrome, the relapse rate was not significantly different between the pre-vaccination period and the post vaccination period between the day of vaccination to 30 days after (0.38 vs. 0.19 times/person-year). [272]

In a multicentre retrospective observational cohort study with 306 children with nephrotic syndrome, analysis showed that children receiving influenza vaccine showed a significantly lower RR for nephrotic syndrome relapse (RR: 0.22, 95% CI 0.14–0.35) compared with unvaccinated children. Furthermore, among the vaccinated children, there was a significantly lower risk for nephrotic syndrome relapse during the post-vaccination period (RR: 0.31. 95% CI 017–0.56) compared with the pre-vaccination period. [273]

In a non-randomised intervention study with 95 children with steroid sensitive nephrotic syndrome given influenza vaccine compared to a control group of unvaccinated children from the previous year, it was reported that nephrotic syndrome relapses significantly reduced in the vaccinated children (*P* value<0.001), with the odds of them getting a

nephrotic relapse after influenza vaccine being 0.29 (95%CI 0.16,0.54). [274]

In a retrospective review with 104 children with Nephrotic syndrome, there were 1.19 times/person-year incidence of nephrotic syndrome relapse. Comparing it with the various time periods post vaccination,

- Risk ratio for post vaccination days 0-30 is 1.04 (95%CI 0.82-1.89)
- Risk ratio for days 31-60 is 1.33 (95%CI 0.94-2.10)
- Risk ratio for days 61-90 is 1.19 (95% CI 0.94–2.10)
- Risk ratio for days 91-120 is 1.19 (95% CI 0.94–2.10)
- Risk ratio for days 121-180 was 1.11 (95% CI 0.98–1.76)

Hence, analysis does not show a significant increase in nephrotic syndrome relapse with influenza vaccine. Further analysis showing that steroid injection at first vaccination increases risk for NS relapses over all periods (RR 3.01, 2.18-4.17). [275]

Idiopathic Nephrotic Syndrome	No relevant case report found	In a monocentric retrospective observational study, with 57 children with steroid sensitive idiopathic nephrotic syndrome, only 14 children took the Influenza vaccine while the rest did not. 13/43 unvaccinated children experienced a relapse, while 1/14 vaccinated children experienced a relapse. Hence, relapse rates were reported to be not increased in vaccinated children compared to unvaccinated children. Relapse rates were not increased in the 6 months following vaccination (1/14) compared to the 6 months before vaccinations (5/14) too. [276]
Minimal Change Disease with acute tubular injury and acute interstitial nephritis [277]	Number of cases: 1 [277] Symptoms - Facial oedema - Pedal oedema - Cervical lymphadenopathy Signs - Proteinuria - Hyaline casts - Elevated serum urea and creatinine - ATN with interstitial inflammatory infiltrate and oedema on light microscopy Timeline	No relevant statistics found

	- Onset of symptoms 18 days post vaccinations - Rapid recovery with oral prednisolone, furosemide, enalapril, atorvastatin	
Immune-Complex Glomerulonephritis		
Immune Mediated Glomerulonephritis	No relevant case report found	In a single centre prospective case series during the 2017–2018 influenza season studying Immune mediated adverse events post influenza in cancer patients. 7 patients developed immune mediated adverse events at the 60-day mark, with 1 of the patients (13%) developing grade 3 nephritis 57 days post inactivated influenza vaccine. [278]
Mixed type cryoglobulinaemic glomerulonephritis [279]	Number of cases: 1 [279] Symptoms - Palpable purpuric rash - Lower extremity oedema - Generalized weakness Signs	No relevant statistics found

- Microscopic haematuria
- Proteinuria
- Increased serum creatinine
- Thrombocytopenia
- Positive mixed cryoglobulins (Type II)
- Hypocomplementemia (low C3 and C4)
- Positive rheumatoid factor
- Abnormal kappa/lambda light chain ratio

Timeline

- One Patient received IV Immunoglobulin and had an improvement of rash and platelet count and was discharged. Patient was readmitted with AKI, received IVIG again which improved creatinine. He was treated with rituximab infusions which improved his renal function, cryoglobulins and complement levels. Plasmapheresis was also done for the rash.

Henoch Schönlein Purpura associated Nephritis	Number of cases: 3 [280] [281] [282] Symptoms - Lower limb palpable purpura [280] [281] [282] - Bright erythematous non blanchable skin swelling [282] - Fever [280] [282] - Pink urine, headache, nausea on relapse [282] - Abdominal colic, gross haematuria, joint pains [280] Signs - Significant proteinuria [281] [282] - Microscopic haematuria [281] [282] - High BUN and creatinine [280] Timeline - Symptoms onset was 10 days to 3weeks post vaccine [281] [282] [280] - One patient was treated with symptomatic antihistamines for 1 week and long-term prednisolone was added later to control renal involvement. However, patient experienced multiple relapses of 14, 24, 30, 33 months later and was treated with methotrexate, Solu-Medrol and stress therapy. [282]	No relevant statistics found

	- One patient was treated with corticosteroid therapy, lesions cleared withing 5 days. Antihypertensives and corticosteroids were continued for persistent proteinuria and reduced creatinine clearance. Medications were tapered off by 4 months. Patient persisted with proteinuria and elevated BUN and ultimately initiated dialysis 5 months later. [280] - For one case, 7 weeks after the onset of purpura, microscopic haematuria, proteinuria oedema with worsening hypertension began that persisted for 6 months, IgA Nephritis on allograft biopsy diagnosed. Patient treated with cilazapril 1mg daily and frusemide 40mg daily. Haematuria and proteinuria persisted for 12 months more without deterioration of renal function. [281]	
Systemic Lupus Erythematosus associated Nephritis [283]	Number of cases: 1 [283] Symptoms - Pain, redness, swelling and tenderness at site of injection. - Loss of appetite - Generalised weakness - Chest pains, palpitations, shortness of breath	No relevant statistics found

	Signs - Pancytopenia - Pericardial effusion - ANA, Anti-dsDNA positive, Anti-SSA positive - Hypocomplementemia - Cloudy Urine - Proteinuria, pyuria, haematuria - Granular casts Timeline - Patient has history of SLE. - SLE flare occurred 1 month after vaccination. - Remission after 3 months of azathioprine and steroid therapy.	
Relapsing Membranous Nephropathy with AKI [284]	Number of cases: 1 [284] Symptoms - Lower extremity oedema Signs - Raised serum creatinine - Raised spot UPCR Timeline - Onset of symptoms 5 days post vaccine	No relevant statistics found

- Daily oral prednisolone (0.75mg/kg) was started with tapering dose.
- Renal function normalised after 5 weeks
- 1 week after completion of therapy, creatinine was elevated, patient was restarted on oral prednisolone was 4 months with tapering.
- 1 month after starting oral prednisolone, serum creatinine normalised and disease went to remission.

Rapidly Progressing Glomerulonephritis (Pauci-Immune)

Pauci-Immune Vasculitis Associated Glomerulonephritis	Number of Cases: 13 cases [285] [286] [287] [288] [289] [290] [291] [292] [293] Symptoms - Low grade fever [285] [286] [287] [288] [289] - Chills [285] [287] - Poor appetite [285] - Malaise [290] [291] [285] [289] - Night sweats [287] [289] - Weight loss [289] - Confusion [291] - Dyspnoea [290] [291] [288] [292] - Pleuritic chest pain [292] - Dry cough [290] [291] [288] - Haemoptysis [288]	In a randomized controlled trial involving 31 patients with ANCA vasculitis whereby patients were randomly split into 2 groups, one given influenza vaccine and one without. It was reported that - No serious adverse events that occurred over the 6-month period of the trial. - There was no significant change in disease activity in vaccinated patients compared with non-vaccinated patients as measured by ANCA titre. - There was no evidence of change in CRP, Birmingham Vasculitis Activity Score (BVAS) activity score or serum creatinine. - It was reported that there was no significant change

- Palpitations on exertion (11)
- Myalgia [285] [286]
- Arthralgia [285] [286] [287]
- Migrating oligoarhthralgia [287]
- Muscle weakness [287] [289] [292]
- Lower extremity paraesthesia ([287])
- Stiffness and paraesthesia over both hands[289]
- Loss of ability to walk [289]
- Epistaxis and nasal crusting [285]
- Sore throat [288]
- Multiple oral ulcers
- Right eye pain [287]
- Rash [287]
- Reduced urine output [291]
- General pruritis [291]

Signs [286]

- Anaemia [286, 289]
- Leucocytosis [286] [288] [289]
- Severe thrombocytopenia [286]
- Raised serum creatinine[293] [285, 286] [286] [287] [288] [289] [291] [292] [293]
- Nephritic urine sediments [290]
- Microscopic haematuria [285] [286] [287] [288] [290] [291] [293]
- Macroscopic haematuria [289]
- Proteinuria [285] [286, 290] [287] [289] [291] [292] [293]

in the level of ANCA immune-fluorescence, ANCA IgG, anti-CCP, anti-dsDNA or RF among the vaccinated healthy individuals compared with their non-vaccinated counterparts at either day 7 or 28.

- However, there were 2 singular exceptions: One patient with MPA experienced a relapse 6 months after influenza vaccine. There was another case of a healthy individual whose anti-neutrophil immuno-fluorescence became positive with a weakly positive ANCA titre against MPO of 7IU/ml. Patient had no clinical presentation and became ANCA negative at 6 months. [294]

- Severe hyponatraemia and hypokalaemia [291]
- Raised Creatinine Phosphokinase [291]
- Elevated ESR [288, 289]
- Raised CRP [286, 287] [288] [289]
- High MPO-ANCA [286] [288] [289] [290] [291]
- Positive Perinuclear ANCA [285] [293]
- Positive RF [287]
- Positive anti-GBM antibodies [293]
- Raised PR-3-ANCA [285] [287] [290] [292]
- Raised sIL-2R [288]
- Increased CANCA/PR3 titres [290]
- Hypoxaemia [288]
- Splinter haemorrhages in fingernails [285]
- Ground glass opacities on lungs on CT scan [287] [292]
- Pulmonary infiltrates or nodules found on imaging [287] [288] [290] [291]

Timeline

- Onset of symptoms ranged from 2 days-8 weeks after vaccination.
- One patient had ANCA levels recovered 5 months after Prednisolone with methylprednisolone pulse therapy and

rituximab (added 14 days into steroid treatment). [286]

- One patient was dialysis dependent even after 3months of haemodialysis, oral prednisolone, cyclophosphamide, plasmapheresis. [285]
- One patient experienced remission after Oral Prednisolone and Oral Cyclophosphamide, Oral Azathioprine switched for maintenance. [285]
- One patient given IV Cyclophosphamide together with methylprednisolone pulses followed by high dose glucocorticoids and oral CYC, patient recovered in 4 weeks as ANCA titre became negative. Maintenance of MMF continued. [290]
- One patient Given high dose methylprednisolone with oral CYC, patient had to be dialyzed and undergo plasma exchange. Renal function recovered in 8 weeks. Maintained on MMF with low dose glucocorticoids. [290]
- One patient Given high dose pulse glucocorticoids and CYC, became dialysis dependent but passed away due to severe pneumonia. [290]
- One patient had previous CANCA/PR3

positive Wegener's Granulomatosis with renal, pulmonary and ENT involvement. Pulmonary nodules of necrotizing granulomatous inflammation seen, hence started with IV pulse CYC and glucocorticoids, lab results normalized after 4 months. 6 months later patient was in full remission and switched to maintenance MMF pneumonia. [290]

- One patient treated with Solu-Medrol 1000mg for 3 days followed by prednisolone 80mg daily, rituximab 1000mg on day 1 and day 15, followed by 500mg every six months. Steroids were tapered till discontinuation and patient's current creatinine has normalized. [287]
- One patient improved after 1 dose of rituximab and pulse dose of methylprednisolone. Rituximab infusion allowed complete recovery. [291]
- One patient started on IV steroid pulse therapy followed by Oral prednisolone and cyclophosphamide. Patient improved rapidly with therapy. She is currently maintained on 2.5mg prednisolone and 25mg cyclophosphamide with no symptoms.

[288]

- One patient went through 7 rounds of plasma exchange and was inducted with oral cyclophosphamide before starting pulse cyclophosphamide (CYCLOPS). He was dialysis dependent during admission and continued intermittent dialysis on discharge. He was discharged with good renal recovery and outpatient cyclophosphamide. 9 months later, he did not need dialysis anymore. [293]
- One patient started on rituximab and methylprednisolone, creatinine normalized 3months later and PR3-ANCA became negative 6 months later. [292]
- One patient started high dosages of intravenously administered prednisolone (1000 mg) for three consecutive days followed by oral prednisolone in tapering regimen, in combination with intravenous pulse cyclophosphamide (700 mg: 10 mg/kg adjusted for age and renal function). Cyclophosphamide was continued for 3 months which resulted in remission of disease with drop of ESR and CRP levels and stabilization of serum creatinine.

[289]

Notes

Subtypes of vasculitis associated glomerulonephritis described include

- Crescentic glomerulonephritis with fibrinoid vasculitis [286]
- Focal necrotizing pauci-immune glomerulonephritis [285] [290] [292]
- Pauci-immune crescentic/necrotizing glomerulonephritis [287] [290]
- Pauci-immune glomerulonephritis with mixed active and fibrous crescents [291]
- Microscopic polyangiitis [288]
- Double seropositive vasculitis [293]

Leukocytoclastic Vasculitis associated Glomerulonephritis	Number of Cases: 6 [295-297] Symptoms - Painful purpuric rash on upper and lower limbs, buttocks [295-297] - Bullous and necrotic lesions reported in one case [297] - Oedema affecting limbs and buttocks [296] - Fever [295, 296] - Arthralgia, myalgia, malaise [296]	No relevant statistics found

- Nausea, diarrhoea, anuria [295]

Signs

- Raised uric acid [295]
- Raised serum IgA [295, 297]
- Positive ANA [297]
- Raised serum urea [296]
- Raised serum creatinine [295-297]
- Anaemia [295]
- Leucocytosis [295]
- Thrombocytopenia [295]
- Raised CRP, Raised ESR [296] [297]
- Proteinuria [295] [296] [297]
- Haematuria [296] [297]
- Albuminuria [295]
- Leukocyturia [295]

Timeline

- Onset of symptoms is 2-21 days post vaccine [295, 296]
- One patient was treated steroids and 9 days of supportive haemodialysis. Serum creatinine levels normalized 18 days later, and patient was kept on tapered steroid dose. [295]

	- One patient was treated with 4 weeks of prednisolone (1mg/kg/day) with tapering dose, rash, haematuria and CRP levels resolved in 2 weeks while proteinuria resolved in 4 weeks. Patient was kept on 2 months of low dose prednisolone (0.1mg/kg/day). Patient showed complete resolution on follow up and treatment was stopped. [296] - 2 patients were treated with clobetasol propionate ointment and recovered in 2 weeks. [297] - 2 patients recovered 10 weeks to 10 months later with oral prednisolone. [297]	
Other Crescentic Glomerulonephritis		
Polyarteritis causing Glomerulonephritis with epithelial crescents [298]	Number of cases: 1 [298] Symptoms - Myalgia - Arthralgia - Weight Loss - Malaise and Anorexia - Fever - Muscle Wasting Signs - Mild anaemia	No relevant statistics found

	- High ESR (33 mm/hr) → inflammation - Leucocytosis, eosinophilia - Increased Creatinine kinase - Elevated AST, ALT, LDH - Low albumin - Proteinuria Timeline - Onset of symptoms was 10 days after Admune Influenza vaccine. - Started on daily prednisolone, temperature, blood urea, liver enzymes, ESR normalized. - Started on azathioprine and anabolic steroids as muscles continued to waste. - Patient passed on eventually due to bronchopneumonia, Glomerulonephritis with epithelial crescents found in kidney biopsy.	
Other Glomerular Entities		
Focal Segmental Glomerulosclerosis in a patient with IgA nephropathy [299]	Number of cases: 1 [299] Symptoms - Lower extremity oedema Signs - Serum albumin level drop from baseline - Proteinuria	No relevant statistics found

	- Positive drug-induced lymphocyte stimulation test for influenza vaccine Timeline - Previous diagnosis of minimal change nephrotic syndrome and IgA nephropathy from 1 year before vaccine was taken. Patient was treated with prednisolone and had remained negative for haematuria and proteinuria. - 10 days after taking influenza vaccine symptoms presented. - 500mg/day IV methylprednisolone was administered following 30mg/day oral prednisolone. - Proteinuria was negative 13 days after treatment.	
Tubulointerstitial and Vascular Renal Disorders		
Acute Renal Failure due to acute tubule-interstitial nephropathy [300]	Number of cases: 1 [300] Symptoms – Polydipsia with compensatory polyuria – Diffuse Myalgia – Weakness – Fever of up to 38 degrees	No relevant statistics found

	Signs – Raised creatinine – Raised Urea – Leucocytosis – Minimal leukocyturia – Microscopic haematuria – Low grade proteinuria Timeline – Onset 12 days post vaccinations - Hydration and oral prednisolone for 2 weeks caused remission of symptoms and improvement of renal function.	
Atypical Haemolytic Urinary Syndrome causing AKI [301]	Number of cases: 1 [301] Symptoms - General weakness - Unsteady Gait - Non bloody diarrhoea - Reduced Urine output Signs - Tachycardia - Raised serum creatinine - Raised BUN - marked thrombocytopenia - Elevated LDH	No relevant statistics found

	- Low haptoglobin - Hypocomplementemia - Trace proteinuria Timeline - Symptoms occurred after receiving flu vaccine. - Daily TPE for 7 days but haemolysis continued, patient then developed multi-organ failure. - Haemodialysis was initiated for uraemia and fluid overload on hospital day 10. - Started on Eculizumab 900mg weekly for 4 weeks, 1200mg for 5th week then 1200mg biweekly. - By 4th dose of eculizumab, platelet count normalised, LDH improved and serum creatinine normalised.	
Thrombotic Thrombocytopenic Purpura causing Acute Renal Failure [302]	Number of cases reported: 1 [302] Symptoms - Confusion and agitation - Malaise - Fever - Headache Signs - Tachycardia - Bilateral subconjunctival haemorrhages - Severe anaemia	In a VAERS analysis of vaccine related thrombotic thrombocytopenia, there was 934 reports of Influenza vaccines related thrombotic thrombocytopenic syndrome with a ROR of 0.82 (0.77–0.88) and IC: -0.28 (IC025: -0.39). [166]

	- Severe thrombocytopenia - Extremely elevated D-dimer - Increased reticulocyte count - Increased ALT, Elevated LDH - Increased serum Urea and creatinine - Marked hyperglycaemia - Increased CRP Timeline - Onset of symptoms was 5 days after influenza vaccine. - Rapid sequence Intubation for agitation in Emergency Department, Plasma exchange overnight as a diagnosis of TTP was made. - IV prostacyclin and Rituximab was given due to continued low platelet count and complication of digital ischemia. - Plasma exchange was continued for 21 days and rituximab given weekly. Patient discharged on day 29 with stable platelet count and improvement of digital ischemia.	
Milk Alkali Syndrome associated AKI [303]	Number of cases: 1 [303] Symptoms - Dehydration, - Altered mental status Signs - Severe hypercalcinaemia	No relevant statistics found

- Increased serum urea
- Increased serum creatinine
- Increased serum bicarbonate

Timeline

- One week post H1N1 vaccine
- Patient on preexisting thiazide diuretic for hypertension, calcitriol, calcium carbonate for osteoporosis prevention.
- ICU and aggressive saline hydration
- Urgent haemodialysis
- Zoledronate
- Recovered in 1 week post treatment

Systemic / Multiorgan Inflammatory Syndromes

AKI due to Rhabdomyolysis	Number of cases: 6 [304] [305] [306] [307] [308] [309] Symptoms - Raised Serum Creatinine [304] [305] [306] [307] [308] [309] - Serum Urea elevated [304] [306] [307] [309] - Raised Serum Creatinine Kinase [304] [305] [306] [307] [308] [309] - Raised Urine Myoglobin [304] [306] [307] [309] - Haematuria [306] - Proteinuria [305] [306]	In a retrospective nationwide cohort study, it was found that statins use 1-30 days before date of rhabdomyolysis was associated with an higher odds of rhabdomyolysis with the use of influenza vaccine within 1-7 days of the date of rhabdomyolysis 1.67 (95% CI: 1.04–2.69, *P* value =0.034). [310] In a similar retrospective nationwide cohort study, it was found individuals who developed rhabdomyolysis were less likely to have received an influenza vaccine within the preceding 28 days (OR 0.65, 95% CI 0.52–0.82). [311]

- Hyponatraemia [304]
- Hyperkalaemia [306] [307]
- Hypokalaemia [304]
- Hyperphosphatemia [306] [307]
- Hypophosphatemia [304]
- Metabolic acidosis [304]
- Raised AST ALT [305]
- Elevated troponin [304]
- Anaemia [304, 306]
- Thrombocytopenia [304] [309]
- Increased PT, aPTT [309]
- Mild leucocytosis [304]
- Hypotension [304]

Signs

- Muscle weakness [304] [305] [306] [307] [308]
- Diffuse myalgia [304] [305] [306] [307, 308]
- Malaise [305] [306] [309]
- Crampy Leg Pain [304] [309]
- Haemorrhagic abdominal and flank rash [309]
- Dark Urine [305] [306]
- Poor appetite [306]

Timeline

- Onsets of symptoms are within 24 hours - 8 days post-vaccine [304] [305] [307] [309]
- Treatment for most patients include withholding statins or fibrates [308] and supportive IV NaCl and Oral Hydration. Kidney function normalised for 3 patients after this treatment. [304] [305] [309]
- One patient was treated with alkalisation of urine, forced diuresis [307] which allowed renal function to normalise within a few days, another patient required supportive haemodialysis and empirical antibiotics for immunocompromise. [309]
- One patient required Prednisolone for 10 days before CK normalised. [306]
- Serum CK decreases 3-6 days after treatment [304] [309], while one patient continued to experience Muscle weakness after a few months post-disease. [309]

Notes

- Statins use 1-30 days before date of

	rhabdomyolysis is associated (OR: 2.00, 95% CI: 1.05–3.82, *P* value = 0.036) with rhabdomyolysis with use of influenza vaccine within 1-7 days of the date of rhabdomyolysis. [306] [310] - In some cases, fibrates are common drugs within the drug history too. [307] [308]	
Hemophagocytic Lymphohistiocytosis complicated by Rhabdomyolysis causing AKI [312]	Number of cases: 1 [312] Symptoms - Fever - Nausea and vomiting - Abdominal pain - Myalgias - Weight loss Signs - Leucocytosis - Lactic acidosis - Severely elevated creatine kinase - Bicytopenia, hyperferritinemia, hypertriglyceridemia, and elevated inflammatory marker were noted after - Low NK cell cytotoxicity and elevated sCD25	No relevant statistics found

	Timeline - Onset 7 days after Influenza vaccine - Patient required mechanical ventilation and developed refractory shock. He is given pressor support and continuous veno-venous haemofiltration. - After diagnosis of HLH due to high H score, he was treated with pulse-dose corticosteroids, intravenous immunoglobulins (IVIGs), and anakinra.
Septic Shock after Seasonal Influenza vaccine leading to Multiorgan Failure [313]	Number of cases: 1 [313] Symptoms - Severe joint pain - Malaise - Sore Throat - Dysphagia Signs - Hepatomegaly, Mild Bilateral Interstitial infiltrates on Chest XR - CT scan showed diffuse enlarged lymph nodes and small abscess formations - Acute Oligo-anuria

	Timeline - Patient is HIV positive on HAART. - Onset of symptoms was 2 weeks post vaccine. One week after symptoms patient was hospitalized. Patient was treated with antibiotics, but treatment was refractory. - Patient was treated as autoimmune disorder and given plasma exchange day 21 of admission. - 1 day post plasma exchange, patient deteriorated, developing ARDS and acute renal failure. After ICU transfer and haemodialysis with IV antibiotics and antifungals, patient got better. - Prednisolone and 5 cycles of haemodialysis was done after and renal function was restored.	
Systemic Capillary Leak Syndrome [314]	Number of cases reported: 1 [314] Symptoms - Oedema - Weight Gain - Hypotension - Anuria - Diffuse Myalgia - Loss of Appetite Signs	No relevant statistics found

	- Raised Jugular Venous Pressure - Hypoalbuminemia - Increased Haemoglobin - Increased Serum Creatinine Timeline - Patient is on Peritoneal dialysis due to IgA nephropathy. - Onset of symptoms 5 weeks after vaccine. - Judicious fluid administration with alterations to dialysate glucose concentrations to optimise ultrafiltration was done. Blood pressure and diuresis improved on day 4 and body weight, blood pressure and serum albumin normalised after 10 days.	
Acute Disseminated Encephalomyelitis after Seasonal Influenza vaccine leading to AKI [315]	Number of cases: 1 [315] Symptoms - Altered Consciousness - Weakness - Fever - Retro-orbital pain - Decreased verbal response and inability to follow commands Signs	No relevant statistics found

- GCS 9
- Tachycardic
- Tachypnoeic
- Quadriparesis, Upgoing plantars, Hoffman's Sign, Perioral Fasciculations
- Increased Serum Creatinine
- Transaminitis
- CSF Pleocytosis

Timeline

- Onset of symptoms was 8 days post vaccine
- Started on empirical antibiotics but patient was refractory to treatment.
- Patient GCS worsened and was intubated and transferred to ICU, methylprednisolone had no effects and all serum studies for infections was negative.
- Plasma exchange was started on day 24 with 5 sessions, improvement seen and transfer to rehab centre on day 42.

Neurological Immune Disorders with Secondary Renal Involvement

Nephrotic Syndrome with Guillain Barre	Number of cases: 1 [316] Symptoms	In a VAERS analysis in 2004, there were 31 cases of Guillain Barre syndrome reported after Influenza vaccine. [317]

Syndrome (GBS) [316]	- General weakness - Numbness in distal limbs and face - Pedal oedema Signs - No signs reported Timeline - Onset 2 weeks post vaccination. - Treated with methylprednisolone pulse therapy and plasmapheresis for 8 weeks. - Renal markers normalised after 10 months - Able to walk 13 months after onset of GBS.	In a national case–control study from Denmark, influenza vaccination was linked to a mildly higher risk of GBS (OR:1.94 (1.12– 3.36)), particularly in the month following vaccination (OR: 2.9 (95% CI 1.2–6.8)). However, recent vaccination accounted for only 1.5% of GBS cases, corresponding to a population-attributable fraction of 0.4%, suggesting the absolute risk was extremely low. [318]
GBS causing renal salt wasting syndrome [319]	Number of cases: 1 [319] Symptoms - Vomiting - Progressive weakness - Tingling in bilateral lower limb Signs	No relevant statistics found

- Severe hyponatraemia
- Low serum uric acid
- Net volume loss of -1.0L due to 2.2L of urine
- Urine Sodium is very high
- Very high BNP
- Inappropriately normal to low renin and aldosterone levels

Timeline

- Symptoms onset few days after influenza vaccine.
- Patient rapidly deteriorated and required mechanical ventilation.
- Patient had poor response with 3% saline until Fludrocortisone 0.1mg daily was added.
- Plasmapheresis was initiated with serum sodium improvement.

Transplant-Related Renal Outcomes

Safety in patients with kidney transplants	No relevant case report found	In a retrospective, observational database study. Using a self-controlled case series method, the RI of kidney rejection during the 30-day risk period was 0.59 (95% CI: 0.13–2.63), 1.28 (95% CI: 0.52–3.15), 0.98 (95% CI: 0.34–2.80) and 0.91 (0.44–1.87) in seasons 2006/07, 2007/08, 2008/09 and pooled seasons

respectively. Corresponding RIs during the 60-day risk period were 0.50 (95% CI: 0.16–1.60), 0.82 (95% CI: 0.36–1.86), 0.42 (95% CI: 0.15–1.21) and 0.59 (95% CI: 0.32–1.08), respectively. [320]

In a prospective open label study involving 127 kidney transplant patients (91 patients in vaccinated group, 36 patients in non-vaccinated group), it was found that by comparing between the vaccinated and nonvaccinated group, there was no significant difference of eGFR before and after vaccine (Difference of eGFR from day of vaccine to 6 months after in vaccinated group (−1.0 (−5.0–2.0) mL/min/1.73 m2) vs in non-vaccinated group, (1.0 (−3.0–5.0) mL/min/1.73 m2) ; *P* value = 0.07). [321]

It was also found that there was no significant difference in serum creatinine levels, (Difference in serum creatinine levels from day of vaccination to day 60 after vaccination in vaccinated group and non-vaccinated group respectively, −1.27 (−1.71–−0.90) vs. −1.07 (−1.40–−0.89) mg/dL). [321]

As well as no significant difference in clinically significant proteinuria rates (Proteinuria rates from at day 60 post vaccination in vaccinated vs non vaccinated patients 7.4% vs. 5.8%. [321]

Kidney Graft Rejection post Influenza Vaccine [322]	Number of cases reported: 3 [322] Symptoms - Flu like symptoms - Shortness of breath - Oedema of face and lower Limbs - Joint Pain - Nausea and vomiting - Fatigue - Weight loss - Stomach and back pain Signs - Increased Serum Creatinine - Proteinuria - Leucocytosis - Raised CRP Timeline - Onset of Symptoms started immediately – 53 days - Treated with IV high dose methylprednisolone for 3 days, 7 days of plasmapheresis, IV Immunoglobulin and 750mg of rituximab. Patient creatinine continued to increase and hence treatment for intensified to mycophenolate mofetil. Haemodialysis was ultimately started.	In a prospective cohort study with 65 kidney transplant patients taking influenza vaccine, the overall cumulative incidence of biopsy proven acute graft rejection was 2 out of 37(5.4%) patients who took the adjuvanted vaccine and 2 out of 28 (7.1%) patients who took the non-adjuvanted vaccine. The incidence rate was 0.22/1000transplantdays for adjuvanted vaccinations and 0.18/1000transplant days for non-adjuvanted vaccinations. The overall cumulative incidence of graft loss was 0 who took the adjuvanted vaccine and 2 out of 28 (7.1%) patients who took the non-adjuvanted vaccine. The incidence rate was 0.18/1000transplant days for non-adjuvanted vaccinations[323].

	- Treated with methylprednisolone 500mg daily but serum creatinine still high 4 days later. Chronic dialysis ultimately started. - One patient was discharged 1 month post symptoms onset as abdominal pain got better. Proteinuria continued past discharged and plasma creatinine was noted to be high 8 months post discharge, leading to readmission. Findings showed relapsed IgA nephropathy, and peritoneal dialysis was initiated ultimately.	

Supplementary Table S8. Kidney injury reported following inactivated H1N1 Influenza vaccine and associated epidemiological data

Associated Kidney Injury	Number of cases and Clinical Course	Incidence
Incidence of Renal and Urinary Disorders in MF59® adjuvanted cell culture-derived vaccine	No relevant case reports found	Cumulative incidence of urinary and renal disorders during study is reported to be 0.1% (CI:0.0-0.3). However, 0 cases are reported to be possibly related to the vaccine and related to the vaccine [324]

Podocytopathies

Relapse of Nephrotic Syndrome [325]	Number of cases reported: 1 [325] Symptoms - Lower limb oedema - Nephrotic range proteinuria Signs - No signs reported Timeline - Medical history of steroid resistant Nephrotic syndrome secondary to FSGS. - Onset 1 week after vaccination. - Recovery after 1 month of oral prednisolone.	No relevant statistics found

Immune Complex Glomerulonephritis

Henoch Schönlein Purpura Nephritis [326]	Number of cases reported: 1 [326] Symptoms - Diffuse abdominal pain - Ankle joint pain and swelling - Haematuria, proteinuria 2 months later Signs - Significant proteinuria	No relevant statistics found

	- Microscopic haematuria Timeline - Oral prednisolone for 40 days - Oral dipyridamole for relapse 2 months later - Bed rest and Oral acetaminophen till patient recovered from the relapse 7 days later - No specific therapy needed if no renal involvement	
Membranous Glomerulonephritis causing Nephrotic Syndrome	Number of cases reported: 2 [327] [328] Symptoms - Worsening of bilateral lower limbs oedema [327] - Swelling of feet [328] - Swelling of face [327] [328] - Fever [327] - Intermittent Nausea and vomiting [327] - Pollakiuria, Nocturia [328] Signs - Elevated Serum urea [327] - Elevated Serum Creatinine [327] - Low Serum albumin [327, 328] - Low total serum protein [327] - Mildly raised AST [327]	No relevant statistics found

- Pleural effusion [328]
- Pyuria [327]
- Nephrotic range proteinuria [327] [328]
- Haematuria [327]

Timeline

- Onset of symptoms was 14 - 20 days after influenza vaccine. [327]
- One patient was started on furosemide and metolazone for oedema and amlodipine and clonidine for hypertension. She was then started on her first round of daily oral prednisolone with tapering over the next 2.5 months. The patient then had a new onset of oedema 1 week after cessation of medication. She was then reinitiated on steroids with tapering dose for 4 months. Patient went into remission after. [327]
- One patient was started on lisinopril, atorvastatin, methylprednisolone and acetylsalicylic acid for 10 days. This allowed remission of symptoms and urine markers to normalize. [328]

Systemic / Multiorgan Inflammatory Syndromes

AKI due to Rhabdomyolysis	Number of cases reported: 2 [329] [330] Symptoms - Myalgia [329] [330] - Muscle Weakness [329] [330] - Oliguria and dysuria [330] - Abdominal and scrotal oedema, pulmonary congestion [330] - Painful hepatomegaly [330] Signs - Increased serum creatinine [329] [330] - Increased serum urea [330] - Increased CK [329] [330] - Raised AST, ALT, raised LDH [329] [330] - Leucocytosis [330] - Hypermagnesemia, Hyperkalaemia [330] - Symmetrical quadriparesis and general areflexia [330] Timeline - Onset was few hours [329], and 5 days [330] after the vaccine. - Both patients were treated with IV fluids (For 10 days for one of the patients) and haemodialysis. [329] [330]	No relevant statistics found

- One patient recovered after 2 weeks of haemodialysis consisting of 7 sessions. [330]

Multiorgan Failure after Influenza vaccine [331]	Number of cases reported: 1 [331] Symptoms - Diffuse myalgia - Shortness of breath Signs - Tachypnoeic - Tachycardic - Hypotensive - Severe bilateral subconjunctival haemorrhage - Leukopenia - Mild anaemia - Raised Creatinine - Proteinuria with microscopic haematuria Timeline - Symptoms onset 1 day post vaccination. - Deteriorated 5 days post vaccination to respiratory failure and admitted to ICU. - Patient developed multiorgan failure with acute respiratory distress

	syndrome and acute renal failure with possible glomerulonephritis. - Patient recovered 7 days post vaccination via aggressive supportive management.	
Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS) syndrome causing AKI [332]	Number of cases reported: 1 [332] Symptoms - Maculopapular rash on the face, chest, abdomen, back, arms, thighs and legs - Crusted lesions around mouth Signs - Fever - Bilateral inspiratory crepitations - Eosinophilia - Leucocytosis - Raised AST, ALT, GGT and ALP - Raised Serum creatinine - Raised CRP - Pyuria Timeline - Onset of symptoms was 1 week after influenza vaccine. - Patient was given IV methylprednisolone, pheniramine maleate and IV ceftriaxone. The rash, facial oedema and fever recovered but	No relevant statistics found

	the patient developed AKI and hence was started on dialysis. - Overall, the patient fully recovered and methylprednisolone was tapered off.	
Serum Sickness with AKI [333]	Number of Cases reported: 1 [333] Symptoms - Facial swelling - Rash - Shortness of breath - Brown urine - Back pain Signs - Hypotension - Tachycardia - Accessory muscle use - Oedema of face, neck, and legs - Leucocytosis - Increased blood urea nitrogen (BUN) - Increased serum creatinine - Proteinuria Timeline - Onset of symptoms is 2 days after vaccine - Infectious workup was negative, Bone marrow biopsy revealed polyclonal plasmacytosis, C1q binding assay was	No relevant statistics found

	high and skin biopsy revealed capillaritis. - Prednisolone was started, rash and renal function improved. - At 6 weeks, symptoms resolved and renal function normalized	
Transplant-Related Renal Outcomes		
Renal Allograft Function and Transplant Rejection	No relevant case reports found	In a cohort study of 78 kidney transplant recipients taking influenza vaccine, it was reported that the serum creatinine, creatinine clearance, and 24-hour urine proteinuria levels were not significantly different between before and 1 month after vaccination (1.3 +/- 0.35 vs 1.3 +/- 0.5 mg/dL, 83 +/- 28 vs 78 +/- 31 mL/min, and 356 +/- 437 vs 293 +/- 307 mg, respectively). Serum creatinine level did not differ significantly between before and 2.5 years after vaccination (1.3 +/- 0.35 vs 1.4 +/- 0.39 mg/dL). No rejection episodes occurred during 2.5 years of follow-up. [334] The risk of rejection by organ could be assessed only for the kidney in 97 participants, including 53 exposed. The RI adjusted for time since transplantation was 0.85 (95% CI 0.38 to 1.90) within 30 days after vaccination and 0.68 (95% CI 0.33 to 1.40) within 60 days after vaccination [335]

COVID-19 and Influenza vaccine taken together

Supplementary Table S9. Kidney injury reported following COVID-19 and Influenza vaccine taken together and associated epidemiological data

Associated Kidney Injury	Number of cases and Clinical Course	Incidence
Crescentic Glomerulonephritis and Membranous Nephropathy [336]	Number of cases: 1 [336] Symptoms - Orange urine - Night sweats - Generalized weakness Signs - Increased serum creatinine - Haematuria - Proteinuria Timeline - Onset of symptoms was 1 week after both vaccines. - Renal biopsy diagnosed patient with pauci-immune crescentic	No relevant statistics found

	glomerulonephritis and membranous nephropathy. - Patient was treated with pulse dose steroids and cyclophosphamide and was later switched to rituximab. - Patient's renal function improved overtime.	
Rhabdomyolysis causing AKI [337]	Number of Cases: 1 [337] Symptoms - Severe myalgia and weakness over his lower extremities Signs - Hypotension - Raised serum creatinine - Mild leucocytosis - Elevated liver enzymes - L-lactate dehydrogenase - Hyperphosphatemia - Hypermagnesemia - Elevated C-Reactive Protein Timeline	No relevant statistics found

- Onset of symptoms are 2 days after both COVID and Influenza vaccine.
- Statins were withdrawn and IV hydration with NaCl was started. Patient was discharged when CK levels and renal function normalized Statin was eventually restarted.

Abbreviations: **AKI**, acute kidney injury; **aHUS**, atypical haemolytic uraemic syndrome; **ANCA**, antineutrophil cytoplasmic antibody; **anti-GBM**, anti–glomerular basement membrane; **aHR**, adjusted hazard ratio; **aOR**, adjusted odds ratio; **AST**, aspartate aminotransferase; **ALT**, alanine aminotransferase; **BVAS**, Birmingham Vasculitis Activity Score; **BUN**, blood urea nitrogen; **CI**, confidence interval; **CK**, creatine kinase; **CKD**, chronic kidney disease; **CRP**, C-reactive protein; **DRESS**, drug reaction with eosinophilia and systemic symptoms; **eGFR**, estimated glomerular filtration rate; **ESR**, erythrocyte sedimentation rate; **FSGS**, focal segmental glomerulosclerosis; **GBS**, Guillain–Barré syndrome; **HLH**, haemophagocytic lymphohistiocytosis; **IC**, information component; **IC025**, lower 95% credibility interval of the information component; **ICU**, intensive care unit; **IgA**, immunoglobulin A; **IgG**, immunoglobulin G; **IVIG**, intravenous immunoglobulin; **LDH**, lactate dehydrogenase; **MCD**, minimal change disease; **MF59**, squalene-based oil-in-water vaccine adjuvant; **MPO**, myeloperoxidase; **MPA**, microscopic polyangiitis; **NS**, nephrotic syndrome; **OR**, odds ratio; **PR3**, proteinase-3; **RI**, relative incidence; **ROR**, reporting odds ratio; **RR**, risk ratio; **SCCS**, self-controlled case series; **SLE**, systemic lupus erythematosus; **TIN**, tubulointerstitial nephritis; **TPE**, therapeutic plasma exchange; **TTP**, thrombotic thrombocytopenic purpura; **UPCR**, urine protein-to-creatinine ratio; **VAERS**, Vaccine Adverse Event Reporting System.

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