Initial impact of COVID-19 on Dialysis provision; review of international guidelines and adaptation of a hub unit's service

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Abstract: The COVID-19 pandemic has put a strain on many aspects of health care including the provision of dialysis. Two categories of patients have had the greatest impact on dialysis capacity. Those with COVID-19 related acute kidney injury and those chronic dialysis patients who required isolation or cohort dialysis because of the pandemic. Limited information on incidence hampers capacity planning and the rapid change in demand provides further challenges. In the four weeks after our first patient, the incidence of confirmed infection in our dialysis population has been 5.1%. By the third week, haemodialysis had to be provided in critical care as the in-house capacity for haemofiltration had been overwhelmed. The interventions that enabled these needs to be met are detailed in this paper alongside a review of international recommendations and how they have been adapted to meet local pressures.

Key Words: COVID-19, AKI, chronic dialysis, service provision

Introduction:

In the current COVID-19 pandemic, in addition to the increased number of patients, hospitals have struggled to meet the demand for provision of ventilatory support, both invasive and non-invasive. Level 2 and level 3 beds and staff, the supply of equipment and consumables remain under constant pressure. At the beginning of the pandemic the focus of hospital management was mainly to increase the capacity for ventilatory support, but soon it was evident that dialysis capacity was a

crisis of its own. In Britain, acute kidney injury [AKI] sufficient to require dialysis has been noted in 22.3% of ventilated patients.[1] In addition, chronic dialysis patients who are infected with COVID-19 require isolation or cohorting.[2] Both factors stretch dialysis programs that are at capacity. Applying the lessons from previous disaster situations and colleagues across the world who have faced similar or worse pressures, alongside local innovations provide the means to care for these groups of patients.

Background:

The Critical Care Unit [CCU] at Aintree University Hospital has provision for 23 patients. The in-patient non-invasive ventilatory unit caters for ten patients. The chronic dialysis program averages 220 patients that include in-centre, satellite and home haemodialysis, and peritoneal dialysis.

COVID-19 related changes: To cope with the expected demand over the pandemic, dialysis capacity in the acute hub unit was increased from 6 stations to 12 stations. Critical Care capacity was increased to 39 beds on the Aintree site and seven in the adjacent Walton Centre for Neurosurgery and Neurosciences. Provisions were made for a further step wise increase in Critical Care capacity to 56 and then 65 beds if required. Non-invasive ventilatory beds were increased to 30 with plans for CPAP on regular wards if demands outstripped the unit's capacity. All areas in the hospital were designated as either red with COVID-19 positive patients, yellow with patients suspected of having COVID infection, green with patients who had recovered or had negative swab but had possible exposure to COVID-19 positive patients in cohort wards and white with patients who did not have the infection. Dialysis area in the hub unit was segregated into red, yellow green and white areas. All of our chronic dialysis population were advised to practice shielding at home that involves self-isolation and avoidance of face to face contact, and their GP's informed. Similar advice was conveyed to all our transplant recipients and others on immunosuppression. Hand hygiene, social

distancing and spacing of dialysis stations were reinforced. Patients were issued surgical masks to be worn before getting into their transport, through dialysis and until they got out of their transport. All in-centre and satellite out-patient haemodialysis patients were advised of possible changes to their dialysis shifts and location but reassured that dialysis would continue. Patients who could safely move to twice weekly dialysis were identified but not implemented and previously existing Do Not Resuscitate orders verified. Patients who could avail of their own transport were advised to do so. Patients were also advised to ring their respective unit ahead of their slot to inform if they had any fever or new onset cough. Any patients with such symptoms were advised to not attend their usual unit but instead to go to the designated area in the hub unit. The waiting areas were set up to enable staff to screen for temperature and symptoms. Patients who were suspected to have COVID at the waiting area screening were to be transferred to designated yellow area in the hub unit for swab and dialysis.

Initial plans in collaboration with colleagues at the Royal Liverpool University hospital involved the designation of one satellite unit to provide dialysis for all cohorted COVID-19 positive out-patients. A unit was identified in the centre of the geographical area covered by the two hospitals. Infection control measures were reinforced and combined rotas for staff and consultants drawn up. However, problems with transporting infected patients proved insurmountable and the two hospitals reverted to separate plans. Decommissioned dialysis machines were recommissioned by the renal engineers and deployed to expand capacity in the cohort area of the acute hub unit. At Aintree, the nephrology day case unit that was previously plumbed for dialysis was designated as the area for COVID swabbing and cohort dialysis for patients suspected of being infected. Those patients whose swab tests came back as positive were then to be moved to a separate area that previously housed home therapies training, for cohort dialysis. Those patients whose swab tests came back as negative were to be de-escalated back to their dialysis unit unless they remained symptomatic. In such patients the plan was to continue cohort dialysis until the second swab came back as negative. The aim was to continue out-patients dialysis as long as the patient was well enough to not require admission.

Patients without the infection who could be moved to the satellite units were transferred to create capacity in the acute hub unit. De-escalation of infected patients was initially set for 10 days after their positive swab test if they were asymptomatic by then, as per guidance from the hospital's virologists and infection prevention and control team. Except in those patients with prior do not resuscitate orders, following consultation amongst the multi-professional team, a decision was taken to set ceilings of care only after discussing this with patients and their families.

Transport for infected out-patients to their dialysis treatment using the ambulance service proved challenging with increased waiting times for patients. Arrangements were made with private Patient Transport Service providers used for inpatient discharges to establish safe and timely transport of suspected and infected dialysis patients to their treatments 6 days a week. The drivers had prior training in infection control measures and the renal unit issued personal protection equipment [PPE] to them.

For in-patients, in order to minimise transfers, portable home dialysis machines [NxStage®] would be taken by dialysis staff to the patients. When capacity for this provision was exceeded, the plan was to then cohort non ventilated in-patients to the red area in the acute hub unit, although that would involve moving patients to the dialysis unit and back to their ward. Ventilated patients were to be prioritised to get dialysis at their bedside. Dialysis patients who developed COVID-19 infection and were admitted to other hospitals without an on-site renal team would be prioritised for transfer to Aintree. As the CCU had sufficient haemofiltration machines, disposables and staff, it was expected that support from the renal team would only be required if demand exceeded their capacity and for those patients who were being ventilated in other areas. To provide for this demand, another portable home dialysis machine and consumables was negotiated with the supplier. De-escalation plans mirrored those for out-patients.

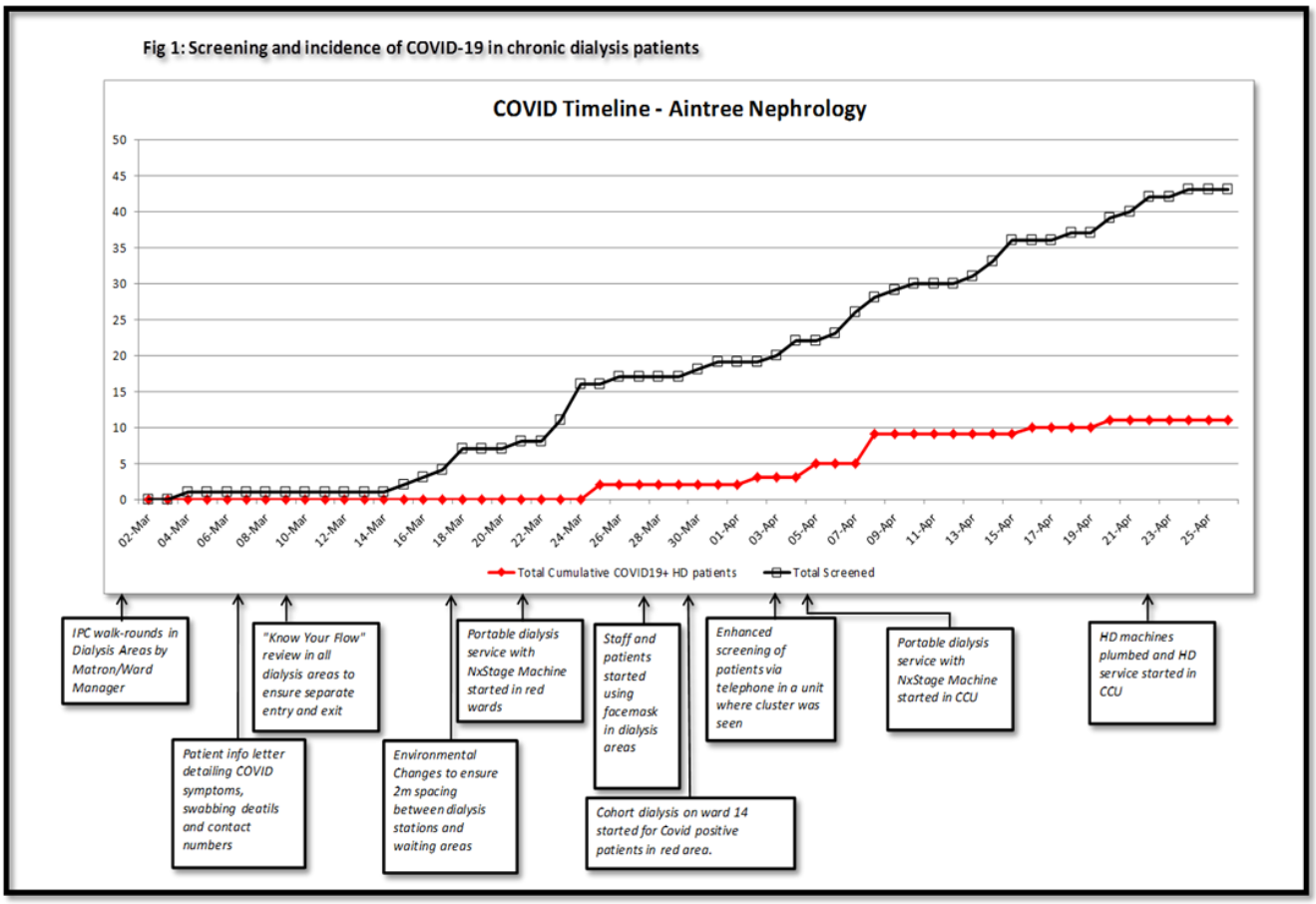
The decision was made to continue to grow the home dialysis program, both peritoneal and haemodialysis to free up in-centre and satellite haemodialysis capacity. Also, to manage home

patients at home as far as possible even if they developed the infection. As all elective surgery was cancelled, creation of arteriovenous fistulae for patients within six months of requiring haemodialysis was postponed. The decision was made that if any of them needed dialysis, they would commence on tunnelled dialysis catheters. Surgical placement of peritoneal dialysis catheters was also cancelled. The risk of aerosols with laparoscopes put a stop to emergency placements but special valves to eliminate the risk were ordered. Medical insertions of these catheters were to continue.

Evolution of service delivery:

The plans worked well at the beginning. However, 25% of the staff trained on the portable machines had to self-isolate. Critical Care initially managed the renal replacement requirements of their patients. The first chronic dialysis patient to get infected was confirmed on 25th March. Dialysis was provided at the bedside. By the fourth week of April, 42 chronic dialysis patients had been screened and cohorted for dialysis until their tests came back as negative. [Fig 1.] Eleven of these patients, 5.1% of our dialysis population were confirmed to be infected. Four of the 11 were from the same unit at the same time, along with 1 staff member. After the two confirmed cases from a single unit on the same shift enhanced telephonic screening was used to identify and swab suspected patients. Designated nursing staff would ring every patient on that shift prior to their dialysis and screen them for any symptoms. If patients reported any symptoms other than fever and new cough, further telephone screening was undertaken by a consultant. This enhanced screening identified two further positive patients who were redirected to cohort area from their homes. To reduce the number of contacts during treatments, a named nurse or dialysis assistant was designated for the full treatment of each patient which included connecting, disconnecting and attending to machine alarms or any problems encountered during treatment. Furthermore, a second patient flow review was undertaken in the satellite units which highlighted issues with patients' dialysis card storage and

cleaning of the weighing scale in between patients. This learning was cascaded to all dialysis areas and patients were sent written communication. The above measures helped us to contain the cluster.



None of the infected patients dialysed at home. One patient had pneumonia with pyothorax and dialysis dependant AKI, but was COVID-19 negative and was stepped down from CCU. Subsequent to their step down, a worsening clinical picture triggered repeat tests that confirmed COVID-19 infection. Therefore, the incidence in our in centre haemodialysis [ICHD] population worked out to 5.8%. Two were in-patients and three required admission, two of whom were then transferred from another hospital. Three of the five in-patients died and one recovered enough to be discharged. Mortality rate was 1.3% of our total dialysis population or 1.7% of our ICHD patients. Six other patients never required admission. As the numbers of patients changed, the red and yellow areas in the acute hub unit were interchanged after decontamination to provide for the two separate

cohorts. However, prolonged positivity of swab tests in some patients beyond two weeks after diagnosis and the revised national guidance for the general population that was released on the 9th of April[3] prompted a change in our policy to continue cohort dialysis for beyond two weeks in those who had recovered whilst seeking national and regional consensus unless cohort capacity was overwhelmed. A separate "green" shift was arranged on the acute hub unit to provide dialysis for such patients. We were able to deliver prolonged cohort dialysis for recovering patients by adjusting the cohort shifts of different categories in the two designated areas with the recommended cleaning protocols.

The biggest impact was from the sudden drop in supply of haemofiltration consumables to the Critical Care team. On the 16th of April, they were informed that they would receive only 10% of their previously confirmed orders. That increased demand for bedside portable dialysis delivery by the renal team with a major impact on staffing and consumables. Dialysate shortages were overcome by moving from bagged dialysates to online dialysate preparation. This step however involved a longer duration. To improve dialysis efficiency and thereby shorten the time required for each dialysis session and increase the number of patients who could be dialysed every day, plumbing works were undertaken in the CCU. Once water quality and pressures were verified, dialysis machines with attached individual reverse osmosis machines were moved to the CCU and replaced the portable home dialysis machines. Training was commenced so that eventually CCU staff would be able to take over dialysis there with supervision from the nephrologists. Plans were also made to commence acute peritoneal dialysis if the haemodialysis capacity in CCU was overwhelmed.

In the four weeks since our first COVID-19 positive dialysis patient, four patients with end stage renal failure were commenced on peritoneal dialysis after medical placement of their catheters. One of them was an established satellite haemodialysis patient, thereby vacating a much needed slot. Two patients with AKI unrelated to COVID-19 and five end stage renal failure patients were commenced

on haemodiafiltration. Of the five, two were on tunnelled lines. One chronic dialysis patient from another renal centre was admitted with COVID-19 infection and required renal support. 62 infected patients required admission to Critical Care, of whom 15 patients required renal replacement. Ten sessions of dialysis were provided to four patients in CCU over the last eight days of this 4 week period when CCU required help with renal replacement. CCU had coped with their demand using haemofiltration prior to that. One 90 year old on assisted peritoneal dialysis at home developed symptoms but had decided with his family that he would not be for admission and that his ceiling of care would be antibiotics at home. He was treated for pneumonia, dialysis was continued and he gradually recovered.

One staff member developed COVID-19 infection but some individuals required self-isolation or sick leave for other reasons.

Discussion:

This summary of the rapidly changing demand for dialysis provision during the COVID-19 epidemic also demonstrates some of the solutions that were implemented. As it is relatively early in the course of the pandemic and numbers of patients reported are limited, best practice will continue to evolve as the experience of more units is collated.

In our centre, on a background of staff who were either self-isolating or ill, the first major pressure arose around the establishment of measures to prevent the spread of infection from chronic dialysis patients who became infected [Table 1] while continuing to provide for dialysis patients who were not infected and patients who needed to commence dialysis irrespective of the pandemic. The second strain on the system arose from patients with COVID-19 related AKI. This was in addition to patients with AKI3 due to other causes. Sustained efforts were required to overcome difficulties with

patient transport, rapid testing of dialysis patients, acquiring additional dialysis machines, consumables and appropriate PPE.

The ambulance service that traditionally transported our patients to and from dialysis was unable to expand their service to allow for the transport of infected or potentially infected patients in isolation. Recruitment of private providers who had the required training in infection control measures, coupled with our supply to the drivers of PPE allowed such patients to be treated in a timely manner without being admitted. At a time when testing capacity was far short of the demand, the slow turn- around of results prolonged the period when symptomatic patients required isolation. Setting up a dedicated testing facility, coupled with cohort dialysis and a fast track for test results on dialysis patients helped to cope with demands for isolating potential COVID-19 patients. The expansion of dialysis capacity to allow for two separate cohort areas was hampered by the lack of equipment. Negotiations to purchase dialysis machines met with limited success because of the surge in similar bids across the world. The recommissioning of previously retired machines alongside plumbing works to accept them provided the solution. New, sometimes costlier, contracts were negotiated to enhance supply of consumables, helped by the easing of financial controls in response to the rapid worsening of the epidemic. Also, the reduction in usage of begged dialysate by plumbing new areas to accept dialysis machines with attached reverse osmosis machines eased that pressure. PPE remained a problem as the national supply chain struggled with the demand. In the light of the revised Public Health England guidance,[4] it proved difficult to convince management of the risks involved in interventions that were not on the national list and therefore the level of PPE required. Local procurement coupled with finding the best albeit imperfect combinations of PPE to reduce risk allowed the service to continue.

Capacity planning is hamstrung without a clear idea of demand. There are varying reports on the incidence of COVID-19 with the Italian data suggesting that 0.61% of the whole population would get infected but only 0.45% will be detected.[5] Amongst the confirmed cases, 36.1% required

admission, 4.3% to Critical Care. Of those admitted to hospital, Chinese researchers reported incidence of AKI between 0.5% and 15%, there being a much higher incidence in Wuhan.[6,7] The requirement for renal replacement showed a similar variation between 5% in Wuhan versus 0.8% across the whole country.[6,7] UK figures from the Intensive Care Network recorded that 22.3% of those admitted to Critical Care required renal replacement,[1] whereas in New York, 3.2% of the 5700 hospitalised patients required renal replacement.[8] If the incidence rates are similar to those of Italy, 4500 patients per million population [pmp] will be diagnosed, of which, 1620 pmp will be ill enough to require hospital admission. Incorporating the Chinese data, up to 243 pmp will develop AKI of which, US experience suggests that 52 pmp will require renal replacement. This is on a background demand for dialysis in AKI patients that has grown from 286 pmp population in Scotland in 2002[9] to 512 pmp in France in 2014.[10] That translates into a 10 -18% increase in demand for acute renal replacement and has resulted in a worldwide shortage especially of disposables required to provide haemofiltration in Critical Care.[11] Our CCU faced similar problems that we initially overcame by providing bedside haemodialysis using portable home dialysis machines and consumables. When that proved insufficient, intermittent haemodialysis was provided after plumbing stations in the CCU to accept conventional haemodialysis machines. If demand outstripped this provision, the next step in our escalation plan was to undertake acute peritoneal dialysis. All of these options are in line with national guidance.[12,13]

Data on the requirement for isolation dialysis is scant. The incidence of COVID-19 infection in haemodialysis patients was reported as 2.5% in one unit in Wuhan.[14] In contrast to the predicted rate of confirmed infection in 0.45% of the general population in Italy,[5] data from Brescia recorded that 4.5% of ICHD patients required admission due to COVID-19.[15] This is similar to the 4.9% noted in the UK[16] but lower than our incidence rate of 5.8%. In addition, demand for cohort or isolation dialysis to also cater for those suspected of being infected worked out to 24.3% of our ICHD population. While a relatively temporary measure in those who were subsequently proved negative for the virus, the surge did impact heavily on limited capacity. Based on data submitted from UK

renal units, the UK Renal Registry devised a model to predict the number of infected patients amongst the dialysis population. Using this model, we were able to reassure ourselves that the infection prevention and control measures we had put in place alongside the national lock down did help to bring down the incidence. The interventions for dialysis services recommended in UK, Europe and the USA are summarised in Table 1.[2,17,18,19,20,21,22]

Table 1: Recommended COVID-19 infection control measures in dialysis units

	UK	EU	USA	India	Local
Dialysis patients					
Education	Yes	Yes	Yes	Yes	Yes
Self-isolation [Shielding]	Yes	Yes	NS	NS	Yes
Special transport, not public	Yes	Yes	Yes	NS	Yes
Screening	Yes	Yes	Yes	Yes	Yes
Distance between stations	NS	2m	6ft	2m	2m
Face covering/mask	NS	NS	Yes		Yes
Isolation/ Cohort dialysis	If suspected	If suspected	If suspected	If suspected	If suspected
Confirmed cases					
Isolation/ Cohort dialysis	Yes	Yes	Yes	Yes	Yes
Facemask	Yes	Yes	Yes	Yes	Yes
Isolation if asymptomatic, in days	7	7 & 2 negative swabs [a]	7+/-2 negative swabs [b]	NS	14+
Staff					
Senior coordinating team	Yes	Yes	Yes	Yes	Yes
Provision for illness	Yes	Yes	Yes	Yes	Yes
Training	NS	Yes	Yes	Yes	Yes
PPE at screening swab	FFP3, visor/goggles gown, gloves	FFP2, cap, goggles gown, gloves	Facemask gown, gloves	NS	Facemask visor gown, gloves
PPE on treating +ve patients	Facemask apron, gloves	FFP2/ FFP3 cap, goggles gown, gloves	N95 visor/goggles gown, gloves	N95, cap visor/goggles gown, gloves shoe covers	Facemask visor gown, gloves [c]

NS – not specified

a. EU recommendations include advice to follow national or regional guidelines

b. USA recommendation is to follow testing based or symptom based pathway

c. FFP3 used with any ventilated patient or if risk of aerosol.

We did not implement some of the other UK guidance such as documentation of ceiling of care without discussing the matter with patients. The exception was in those who had pre-existing do not resuscitate orders. Another notable variation was our prolongation of isolation or cohort dialysis in those who had recovered from COVID-19. Importantly, despite a higher incidence, mortality rate in our ICHD patients was 1.7% while the national 7 day mortality was 11%.[16]

To summarise, in the current pandemic, the keys steps to enable renal replacement for all those who require it are reduction in infection rates, prevention of AKI altogether or at least the progression of AKI, the resources to provide renal support and defined ceilings of care based on transparent and equitable criteria. Aintree has a strong history in AKI management.[23] In this paper, we have focussed on the provision of renal replacement.

In the chronic dialysis population, the issues that required attention in the current circumstances included measures to prevent infection in this vulnerable population, identification of those who would normally be for escalation of treatment and the management of those who did get infected without allowing transmission to other patients or staff. Early and repeated communication with reassurance to patients that dialysis would be provided in the safest manner possible proved to be a crucial element. Verbal assurances backed up by posters, phone calls and letters enabled patients and their families to have a clear picture of the evolving situation and the measures being undertaken, many of which had an impact on their normal routine. That strategy helped patients overcome their anxieties and cope with the changes. However, clinical psychology support was

required for the few who had difficulties with being informed that they were at extremely high risk and the associated prolonged period of shielding. Enhanced telephone screening by nurses and doctors along with meticulous attention to patient flow and IPC measures were proven to limit clustering in our units. Dialysis units are to expect a 5% incidence of infection and that up to a quarter of their patient population may require cohort or isolation dialysis because of confirmed or suspected infection.

We have managed pressures for acute dialysis and cohort dialysis to date but the crisis is far from over. Rapid adjustment of delivery plans to the resources available and the evolving knowledge about COVD-19 appears to be the crucial element in providing for our patients.

References:

1. ICNARC report on COVID-19 in critical care 24 April 2020 https://www.icnarc.org/Our-Audit/Audits/Cmp/Reports ICNARC COVID-19 Report 2020-04-24 [accessed 28/04/2020]

2. NICE Guideline: COVID-19 rapid guideline: dialysis service delivery. 2020. https://www.nice.org.uk/guidance/ng160 [accessed 13/04/2020]

3. Public Health England. Guidance for stepdown of infection control precautions and discharging COVID-19 patients. 2020. https://www.gov.uk/government/publications/covid-19-guidance-for-stepdown-of-infection-control-precautions-within-hospitals-and-discharging-covid-19-patients-from-hospital-to-home-settings/guidance-for-stepdown-of-infection-control-precautions-and-discharging-covid-19-patients [accessed 15/04/2020]

4. Public Health England. COVID-19: infection prevention and control guidance. V2.27, 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/881489/COVID-19_Infection_prevention_and_control_guidance_complete.pdf

5. Giordano, G., Blanchini, F., Bruno, R. et al. Modelling the COVID-19 epidemic and implementation of population-wide interventions in Italy. *Nat Med* 2020; https://doi.org/10.1038/s41591-020-0883-7

6. Guan W, Ni Z, Hu W et al. Clinical characteristics of coronavirus disease 2019 in China. *N. Engl. J. Med* 2020;382:1708-1720. https://doi.org/10.1056/NEJMoa2002032

7. Zhou F, Yu T, Du R et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020;395:1054-62. https://doi.org/10.1016/S0140-6736(20)30566-3

8. Richardson S, Hirsch JS, Narasimhan M et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. *JAMA*. Published online April 22, 2020. doi:10.1001/jama.2020.6775

9. Prescott GJ, Metcalfe W, Baharani J, et al. A prospective national study of acute renal failure treated with RRT: incidence, aetiology and outcomes, *Nephrol Dial Transplant*, 22(9), 2007;2513–2519, https://doi.org/10.1093/ndt/gfm264

10. Garnier F, Couchoud C, Landais P, Moranne O (2019) Increased incidence of acute kidney injury requiring dialysis in metropolitan France. *PLoS ONE* 14(2): e0211541. https://doi.org/10.1371/journal.pone.0211541 [accessed 28/04/2020]

11. Mahasse E. Covid-19: increasing demand for dialysis sparks fears of supply shortage *BMJ* 2020;369 doi: https://doi.org/10.1136/bmj.m1588 [accessed 28/04/2020]

12. NHS England. Clinical guide for renal replacement therapy options in critical care during the coronavirus pandemic. Version 1. 14 April 2020. www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/04/C0298-speciality-guide-clinical-guide-for-renal-replacement-therapy-options-in-critical-care-v1.1.pdf. [accessed 22/04/2020]

13. The Renal Association. April 2020. Statement on COVID-19 related acute kidney injury and intensive care capacity. https://renal.org/statement-covid-19-related-acute-kidney-injury-intensive-care-capacity/ [Accessed 30/04/2020]

14. Ma Y, Diao B, Lv X et al. 2019 novel coronavirus disease in hemodialysis (HD) patients: Report from one HD center in Wuhan, China: medRxiv preprint. https://doi.org/10.1101/2020.02.24.20027201 [accessed 13/04/2020]

15. Alberici F, Delbarba E, Naenti C, Econimo L et al. Management of Patients on Dialysis and With Kidney Transplantation During the SARS-CoV-2 (COVID-19) Pandemic in Brescia, Italy. Kidney Int Rep. 2020 Apr 4. doi: 10.1016/j.ekir.2020.04.001 [Epub ahead of print]

16. Renal Association. Initial analysis of the impact of COVID-19 infection on patients with advanced chronic kidney disease in the UK. Renal Association 2020. https://renal.org/covid-19/data/ [accessed 01/05/2020]

17. Basile C, Combe C, Pizzarelli F et al. Recommendations for the prevention, mitigation and containment of the emerging SARS-CoV-2 (COVID-19) pandemic in haemodialysis centres. *Nephrol Dial Transplant* 2020;1–4. doi: 10.1093/ndt/gfaa069

18. European Centre for Disease Prevention and Control. Discharge criteria for confirmed COVID-19 cases – When is it safe to discharge COVID-19 cases from the hospital or end home isolation? 2020. https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-Discharge-criteria.pdf [accessed 15/04/2020]

19. Centers for Disease Control and Prevention. Screening and Triage at Intake. Screening Dialysis Patients for COVID-19. CDC 2020. https://www.cdc.gov/coronavirus/2019-ncov/hcp/dialysis/screening.html [accessed on 14/04/2020]

20. Centers for Disease Control and Prevention. Discontinuation of Transmission-Based Precautions and Disposition of Patients with COVID-19 in Healthcare Settings (Interim Guidance) https://www.cdc.gov/coronavirus/2019-ncov/hcp/disposition-hospitalized-patients.html [accessed 29/04/2020]

21. Prasad N, Agarwal SK, Sahay M et al. Indian Society of Nephrology COVID-19 Working Group Guidelines. http://www.isn-india.com/file/Guidelines-and-position-statements-for-COVID-19.pdf [accessed 20/04/2020]

22. Kliger AS, Cozzolino M, Jha V, Harbert G, Ikizler TA, Managing the COVID-19 Pandemic: International Comparisons in Dialysis Patients. *Kidney Int* 2020; doi: https://doi.org/10.1016/j.kint.2020.04.007.

23. T Chandrasekar, A Sharma, L Tennent, et al. A whole system approach to improving mortality associated with acute kidney injury, QJM: An International Journal of Medicine, 110(10), 2017:657–666. https://doi.org/10.1093/qjmed/hcx101