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CKJ REVIEW

Strategies to prevent SARS-CoV-2 transmission in hemodialysis centres across Europe—lessons for the future

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ABSTRACT

Background. Early reports on the pandemic nature of coronavirus disease 2019 (COVID-19) directed the nephrology community to develop infection prevention and control (IPC) guidance. We aimed to make an inventory of strategies that dialysis centres followed to prevent infection with COVID-19 in the first pandemic wave.

Methods. We analyzed IPC measures taken by hemodialysis centres treating patients presenting with COVID-19 between 1 March 2020 and 31 July 2020 and that completed the European Renal Association COVID-19 Database centre

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questionnaire. Additionally, we made an inventory of guidelines published in European countries to prevent spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in dialysis centres.

Results. Data from 73 dialysis units located in and bordering Europe were analyzed. All participating centres implemented IPC measures to mitigate the impact of SARS-CoV-2 during the first pandemic wave. Measures mentioned most often included triage with questions before entering the dialysis ward, measuring body temperature, hand disinfection, masking for all patients and staff, and personal protective equipment for staff members. These measures were also recommended in most of the 14 guidelines that were identified in the inventory of national guidelines and were also scored as being among the most important measures by the authors of this paper. Heterogeneity existed between centres and national guidelines regarding the minimal distance between dialysis chairs and recommendations regarding isolation and cohorting.

Conclusions. Although variation existed, measures to prevent transmission of SARS-CoV-2 were relatively similar across centres and national guidelines. Further research is needed to assess causal relationships between measures taken and spread of SARS-CoV-2.

Keywords: centre practices, guidelines, hemodialysis, SARS-CoV-2, virus transmission

INTRODUCTION

During the initial phase of the pandemic, coronavirus disease 2019 (COVID-19) had devastating effects on patients treated with kidney function replacement therapy (KFRT) [1, 2]. In-centre hemodialysis patients visit the dialysis unit several times a week and thus cannot shield adequately rendering these patients prone to infection. Moreover, when infected, mortality is extremely high [1]. This makes in-centre hemodialysis patients a vulnerable population that deserves extra attention.

Already early in the pandemic, the nephrology community was aware of the importance of preventive measures to stop the spread of the virus and protect patients with KFRT. In May 2020, the European Dialysis (EUDIAL) Working Group of the European Renal Association (ERA) published guidelines providing recommendations for the prevention, mitigation and containment of COVID-19 in hemodialysis centres [3]. However, this guidance requires translation to the local situation, e.g. depending on the regional prevalence of COVID-19, characteristics of the patient population, cultural and social factors, and the logistics and availability of resources in individual dialysis centres. Indeed, Meijers and colleagues found considerable variation in preventive measures implemented during the first months of the pandemic between three centres in Belgium and Italy. Interestingly, these differences could not fully be explained by differences in the regional prevalence of COVID-19 [4].

Individual experiences with COVID-19 containment in hemodialysis centres may help colleagues from other centres to develop and/or adjust strategies for their own centre. In this study, we therefore sought to evaluate the different strategies that dialysis centres across Europe followed to prevent infection with COVID-19 in patients and staff members in the first pandemic wave. For this purpose, we analyzed data on preventive measures of hemodialysis centres collected with a centre questionnaire as part of the ERA COVID-19 Database (ERACODA). In addition, we made an inventory of national guidelines across European countries for the prevention of spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in dialysis centres and summarized the recommendations in these guidelines.

MATERIALS AND METHODS

Part I: ERACODA centre questionnaire

ERACODA was established in March 2020 and involves the cooperation of approximately 225 physicians from over 140 centres in 33 countries, mostly in Europe and bordering the Mediterranean Sea [5]. Data were collected on adult patients (≥18 years old) with KFRT, either on chronic dialysis or with a functioning kidney allograft, who had been diagnosed with COVID-19. The diagnosis was based on a positive result on a real-time polymerase chain reaction (PCR) assay of nasal or pharyngeal swab specimens, a rapid antigen test, and/or COVID-19 compatible findings on a computed tomography (CT) scan of the lungs. Data were collected from outpatients as well as hospitalized patients. Physicians responsible for the care of these patients registered the detailed demographic data including information pertaining to disease severity, treatment and outcomes. In addition to individual patient data, they also reported centre-level data on practical measures that were taken in the dialysis unit to prevent the spread of SARS-CoV-2.

For the current study we included data from all centres located in the geographical area covered by the ERA (Europe plus countries bordering Europe or the Mediterranean Sea) with a haemodialysis unit that treated patients who presented with COVID-19 in the first pandemic wave (1 March 2020 to 31 July 2020) and that completed the ERACODA centre questionnaire. We removed incomplete surveys and excluded data from national/regional registries because they could not provide information on individual dialysis centres. Furthermore, duplicate questionnaires completed by nephrologists from the same centre ($N = 6$) were removed; the questionnaire that was submitted first was used for analysis.

The ERACODA database is hosted at the University Medical Center roningen (UMCG), The Netherlands, and uses REDCap software (Research Electronic Data Capture, Vanderbilt University Medical Center, Nashville, TN, USA) for data collection [6]. The study was approved by the Institutional Review Board of the UMCG, who deemed the collection and analysis of data exempt from ethics review in the context of the Dutch Medical Research Involving Human Subjects Act ('Wet medisch-wetenschappelijk onderzoek met mensen'; WMO).

Characteristics of the participating centres and patients are summarized using descriptive statistics. Continuous data are presented as mean with standard deviation and non-normally distributed data as median with interquartile range (IQR). Categorical data are presented as percentages.

All analyses were performed using Stata version 14.2 (College Station, TX, USA). A two-sided P-value $<.05$ was set to indicate statistical significance.

Part II: inventory of national guidelines

Complementary to the ERACODA centre questionnaire we made an inventory of national guidelines that aimed to prevent the spread of SARS-CoV-2 in dialysis centres. For this purpose, we retrieved contact information of representatives from all countries belonging to the region of the ERA via (i) the list of directors of national societies of nephrology on the ERA website [7], (ii) representatives from all national renal registries contributing data to the ERA Registry [8] and (iii) active ERACODA collaborators. These persons were contacted by e-mail with the question of whether a national guideline for prevention of the spread of COVID-19 in dialysis centres was available and a request to send the actual guideline. All non-English language guidelines that we received were translated to English using Google Translate. The information retrieved from the translated guidelines was checked and corrected if needed by the national representatives. In the table presenting the national guidelines we also include the recommendations from EUDIAL on the prevention, mitigation and containment of COVID-19 in haemodialysis patients. Although this is not an official European guideline, it had a great impact on the work processes of many dialysis units and formed the basis for many national guidelines [3].

Finally, all nephrologists among the full authors of this article ($N = 13$; B.M., R.T.G., A.C., R.D., L.B.H., M.H.H., G.M., I.N., E.P., G.P., S.T., L.Z., C.F.M.F.) rated which of the recommendations included in the different guidelines they considered important by giving them a score from 1 (not important at all) to 5 (very important). Based on their answers we calculated a mean author score for each recommendation listed.

RESULTS

Part I: ERACODA centre questionnaire

Nephrologists from 110 out of 141 centres active in ERACODA completed the questionnaire, resulting in a response rate of 78%. Of these 110 responses, 2 were excluded because they represented national registries, 2 because the centre was located outside the area covered by the ERA and 33 other responses were excluded because the respondent's treatment centre did not have a haemodialysis unit. Seventy-three centres treating a total of 874 haemodialysis patients that presented with COVID-19 in the first pandemic wave were included for the analyses. The number of COVID-19 patients per centre ranged between 1 and 190. The characteristics of these patients are shown in Supplementary data, Table S1.

As shown in Table 1, most of the 73 included centres were either a university hospital ($N = 37$) or a general hospital ($N = 36$). Although we only included data on haemodialysis patients in the current study, these centres also treated peritoneal dialyses patients and kidney transplant recipients. Most respondent units were located in the Netherlands ($N = 20$) and in Italy ($N = 11$) (Table 1).

Table 1: Characteristics of the dialysis centres in ERACODA that were treating haemodialysis patients with COVID-19 during the first pandemic wave.

	$N = 73$	
Type of center, N (% yes)[a]		
University hospital	37 (51)	
General hospital	36 (49)	
Stand-alone dialysis centre	9 (12)	
Transplantation centre	6 (8)	
Median (IQR) number of patients per centre by type of treatment		
In-centre haemodialysis	110 (70, 185)	
Home haemodialysis	1 (0, 5)	
Peritoneal dialysis	25 (12, 39)	
Follow-up after KTx	215 (50, 500)	
Country	Centres, N (%)	Patients, N (%)
Belgium	6 (8.2)	49 (5.6)
Czech Republic	1 (1.4)	1 (0.1)
Egypt	1 (1.4)	3 (0.3)
France	2 (2.7)	38 (4.3)
Germany	3 (4.1)	16 (1.8)
Greece	1 (1.4)	5 (0.6)
Italy	11 (15)	83 (9.5)
Lithuania	1 (1.4)	3 (0.3)
Morocco	1 (1.4)	2 (0.2)
Netherlands	20 (27)	95 (11)
Norway	1 (1.4)	11 (1.3)
Poland	1 (1.4)	19 (2.2)
Portugal	4 (5.4)	50 (5.7)
Romania	1 (1.4)	190 (22)
Russia	4 (5.5)	68 (7.8)
Serbia	1 (1.4)	5 (0.6)
Slovakia	1 (1.4)	2 (0.2)
Slovenia	1 (1.4)	5 (0.6)
Spain	4 (5.5)	94 (11)
Switzerland	1 (1.4)	5 (0.6)
Turkey	4 (5.5)	76 (8.7)
UK	3 (4.1)	59 (6.8)

[a]Percentages do not add up, because more than one answer may apply.
KTx, kidney transplant.

Centre-related risk factors for transmission of COVID-19

In 62 centres (85%) PCR tests were used as screening method for dialysis patients who developed symptoms suggestive of COVID-19 or with direct COVID-19 exposure in the first pandemic wave, whereas 22 centres (30%) indicated to (also) use chest X-rays and/or pulmonary CT scans ($N = 25$; 34%). Four of these centres used only radiologic techniques for the diagnosis, whereas six centres (8.2%) did not use any of these methods and indicated to make the diagnosis based on clinical and/or laboratory data.

The vast majority of centres ($N = 69$; 95%) had started dedicated COVID-19 wards, thus facilitating provision of haemodialysis to COVID-19-positive patients in isolation. Most units did not experience shortage of isolation beds ($N = 65$; 89%) and a minority (6 centres; 8.2%; from five different countries) at times experienced shortage of capacity for isolated dialysis treatment. This information was missing for two centres.

Most centres treated fewer than 5 (38%) or 5–9 (40%) patients in the same room during a shift, mostly with a distance of 1–1.5 m (24%) or 1.5–2 m (51%) between dialysis chairs or beds. The nurse-to-patient ratio was very similar across centres: in almost 80% of the centres, 1 nurse treated 3–4 patients (Fig. 1).

Measures for patients and staff

There was a strong similarity between centres in ERACODA regarding the screening of patients, although still practice variation was observed. As presented in Fig. 1, 95% of the centres triaged patients with questions before they entered the dialysis ward. In 89% of centres, patients were instructed to disinfect their hands before entering. In 85% of centres, the patients' temperature was measured before start of the dialysis session and in

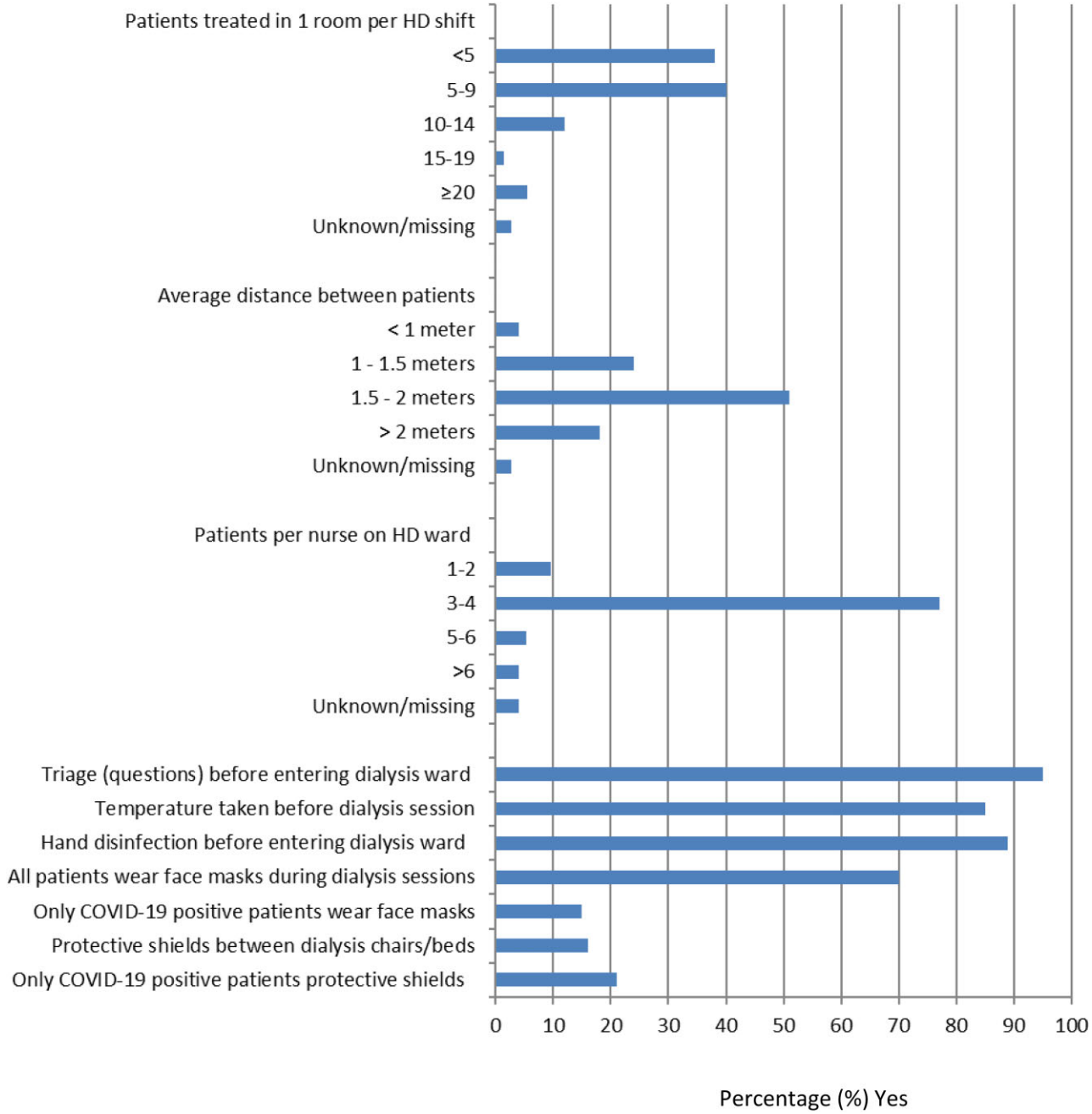

Figure 1: Centre-related risk factors for viral transmission and strategies used to prevent transmission (% yes) in dialysis centres treating haemodialysis patients with COVID-19 during the first pandemic wave ($N = 73$).

70% of the units face masks were compulsory for patients during the treatment sessions. Protective shields or curtains between the dialysis chairs/beds were not often used (in only 16% of centres and 21% for patients with confirmed COVID-19).

In a large proportion of the centres, the staff used some form of personal protective equipment (PPE) prior to the onset of the COVID-19 pandemic, including gloves (85%), surgical masks (67%), FFP2 or FFP3 masks (9.6%), goggles or face shields (38%), and aprons (32%) (Table 2). The use of FFP2 or FFP3 masks, goggles/face shields and aprons increased after the start of the pandemic. Almost one-third (29%) of the centres indicated there were (temporary) shortages of protective equipment for dialysis staff.

We linked the estimated percentages of patients and staff members that tested positive for COVID-19 in each centre during the first wave to the reported measures that were taken in that specific centre (Supplementary data, Figs S1 and S2). Supplementary data, Fig. S1 may suggest that the use of protective shields for all patients (and not only for COVID-19-positive patients) resulted in a lower percentage of staff members that got infected, but the difference was small and was not seen for the percentage of dialysis patients that got infected.

Table 2: Preventive strategies for the dialysis staff, N (%).

	N = 73
Usual protective equipment to prevent infections that staff used before the COVID-19 pandemic[a]	
Surgical masks	49 (67)
FFP2 (or FFP3) masks	7 (9.6)
Gloves	62 (85)
Goggles or face shield	28 (38)
Aprons (or other types of disposable protective clothing)	23 (32)
Did the staff use additional protective equipment (see below) to prevent infection?[a]	
At all times	31 (42)
During close contact with a patient	22 (30)
In case of respiratory symptoms of a patient	26 (36)
In case of respiratory symptoms of the respective staff member	15 (21)
Only in case of confirmed COVID-19	16 (22)
In case the staff did use additional protective equipment, which of the following was used?[a]	
Surgical masks	44 (60)
FFP2 (or FFP3) masks	46 (63)
Gloves	58 (79)
Goggles or face shield	50 (68)
Aprons (or other types of disposable protective clothing)	44 (60)
Was there any (temporary) shortage of protective equipment (as advised by your local guidelines) for your dialysis staff?	
Yes	21 (29)
No	50 (68)
Unknown/missing	2 (2.7)
Estimated percentage of dialysis staff tested positive for COVID-19 during the first wave	
0%–5%	43 (59)
5%–10%	13 (18)
10%–15%	7 (9.6)
15%–20%	2 (2.7)
>20%	5 (6.9)
Unknown/missing	3 (4.1)

[a]More than one answer may apply.

Part II: inventory of national guidelines

National representatives of 43 countries were surveyed via e-mail on national guidelines on COVID-19. Sixteen countries were found to have national guidelines for the prevention of COVID-19 transmission in dialysis centres. Remarkably, it was especially countries from Southern and Eastern Europe that had such guidelines. Of note, 2 out of 16 guidelines did not mention specific measures that could be applied in the centre and were thus excluded from our summary. As a result, guidelines from 14 countries, including Italy [9], Romania, Spain, Croatia [10], Cyprus, Germany [11], Slovakia [12], Portugal [13], Greece [14], Ukraine, Turkey, Poland, Israel and the UK [15], could be analysed. Representatives from another 14 countries answered that a national guideline was not available, whereas 13 did not respond (Fig. 2).

One of the first guidelines for the prevention, mitigation and containment of COVID-19 in haemodialysis centres was published by EUDIAL. The most important recommendations from this European guideline are summarized in Tables 3–6, together with the recommendations presented in all the separate, national guidelines. In the last column of these tables, the score (between 1 and 5) we assigned to each item is presented (which is calculated as the average score by the 13 clinical authors). These scores are presented in different shades of grey; the higher the average score (i.e. the more important the recommendation is considered to be) the darker the grey colour.

Screening and triage

Recommendations regarding screening and triage in the different national guidelines are summarized in Table 3. These recommendations show a relatively high level of concordance across the national guidelines as well as with the average author score. The highest priority was given to adherence to the generic population-wide rules for distancing, disinfection, masking and vaccination. Additional guidance, specific for dialysis centres, rated as very important (i.e. a score between 4 and 5) were the appropriate education of personnel in updated clinical knowledge of the COVID-19 epidemic, prevention tools and guidelines, and the training of nurses in taking nasopharynx swabs for PCR tests. Also, self-monitoring of symptoms, both for patients and staff, and immediate testing in case of symptoms were considered very important. Finally, symptom-driven triage as well as temperature measurement before entering the dialysis unit were deemed very important. Routinely testing staff or asymptomatic patients by PCR or by self-test was felt to be less helpful.

Hygiene

Table 4 summarizes the recommendations for hygiene measures. These recommendations were also consistent throughout most of the national guidelines and the average author score. In particular, measures concerning masking and hand hygiene were given high priority and should play a central role in preventive strategies according to the authors of this paper. That staff should wear fluid-resistant surgical masks, and change these masks bi-hourly, was not given a high priority.

Isolation and cohorting

Table 5 shows there was more heterogeneity in national recommendations regarding isolation and cohorting. For example, one guideline advised to admit all patients with confirmed COVID-19 to the hospital, while—in contrast—another guideline stated that these patients should be dialysed at home (if possible). There was broad consensus that negative, suspected and confirmed cases should not be mixed and that the staff should use PPE when taking care of suspected or confirmed cases. Furthermore, in the majority of guidelines it was recommended that in case isolation in separate rooms is impossible, suspected and confirmed cases should be dialysed in a separate shift, preferably at the end of the working day. These measures were also scored as the most important measures regarding isolation and cohorting. Although separate entrances and exits for dialysis units, and fixed routes to these entrances and exits may help shielding patients to prevent transmission, this was not given high priority, not by national guidelines, or by the average author score.

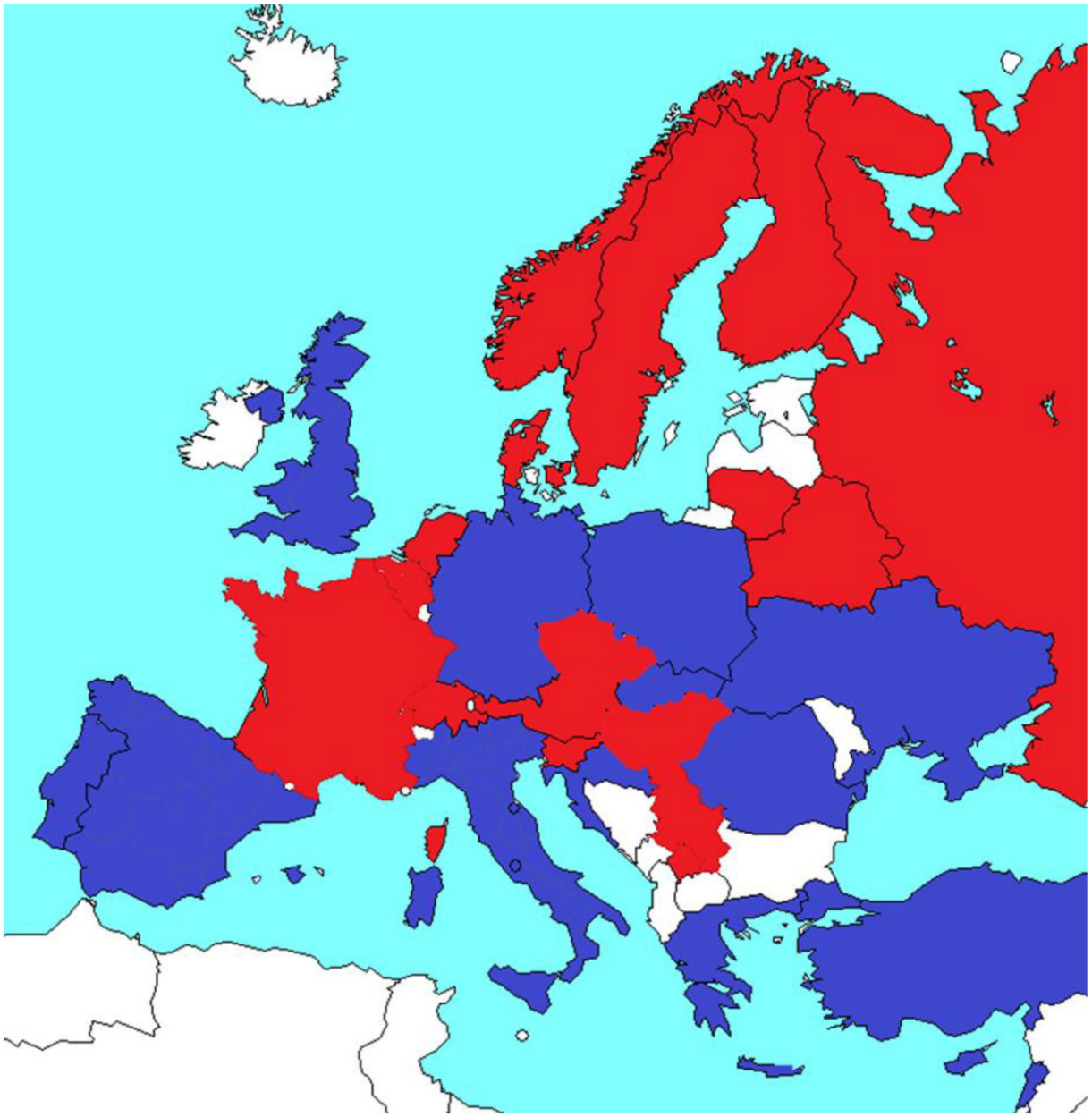

Figure 2: Map of Europe indicating which countries reported to have a guideline for the prevention of COVID-19 transmission in dialysis centres (dark blue). Countries in which a national guideline was not available are depicted in red.

Social distancing and transport

Recommendations regarding social distancing varied considerably between countries (Table 6), with recommended minimal distances varying between 1 and 2 m. The authors of this paper rated a distance of 1.5 m in waiting rooms and between dialysis chairs as appropriate. A high priority was given to measures concerning transport, in particular the advice for both patients and drivers to wear masks during transport, and that suspected and confirmed cases should not travel together with patients from other groups. It was not felt necessary that haemodialysis patients with COVID-19 be transported by specific medical vehicles (such as ambulances), but that regular transportation, preferably by own transport, would suffice. If own transport is not available, a taxi can be used when both the patient and the driver wear a face mask during the ride.

DISCUSSION

The ERACODA centre questionnaire shows that all participating centres treating patients with COVID-19 during the first wave of the pandemic have implemented infection prevention and control (IPC) measures to mitigate the impact of SARS-CoV-2. For patients, the most commonly mentioned preventive measure was triage using a set of questions before entering the dialysis ward, followed by taking the body temperature, disinfection of the hands and masking for all

Table 3: Summary of guidelines—measures regarding screening and triage.

Guideline (month/year publication or last update)	EUDIAL (03/20)	Italy (02/20)	Romania (03/20)	Spain (03/20)	Croatia (04/20)	Cyprus (04/20)	Germany (04/20)	Slovakia (04/20)	Portugal (05/20)	Greece (06/20)	Ukraine (08/20)	Turkey (03/21)	Poland (10/21)	Israel (01/22)	UK (01/22)	Author score[a]
General																
Follow general/national rules for distance, disinfection, masking, vaccination		X					X		X	X		X	X			5.0
Screening and triage																
Staff																
Designates an employee responsible for dealing with SARS-CoV-2							X									2.8
Prepares a Contingency Plan for the COVID-19 pandemic			X						X							4.2
Receives training in updated clinical knowledge of the COVID-19 epidemic, prevention tools and guidelines	X		X	X	X				X			X		X		4.7
Nurses are trained to take nasopharynx swabs for PCR tests, with appropriate dressing (FFP2, goggles, hair cap, disposable blouse, gloves)	X				X											4.6
Self-monitors their symptoms and inform the team leader if they/family members develop symptom(s). Sick staff members should stay at home (independent of the result of a PCR/self-test)	X		X		X	X	X		X	X		X				4.3
Self-test (lateral flow test) twice weekly															X	2.2
PCR test at least every 14 days										X			X		1.5	
Periodic testing (timing not specified)										X						2.2
Measures temperature before work							X									2.8
Patients																
Report in advance if they have symptoms or were in contact with someone with COVID-19	X		X	X	X	X	X		X	X	X	X				4.5
Triage (questions) by telephone before arrival			X					X				X				3.2
Triage (questions) at arrival, before entering the waiting room/treatment area	X		X		X	X	X	X		X	X	X	X	X	X	4.4
Measure temperature before dialysis session	X		X		X	X	X	X		X	X		X	X	X	4.2
Measure temperature after dialysis session	X		X		X	X		X		X						1.8
Bring patients with symptoms as soon as possible to an appropriate treatment area to minimize time in waiting areas	X		X					X			X					4.4
Test immediately when patient has symptoms (in separate room)	X			X[b]	X	X			X[b]							4.8
Test each new patient within 2 × 24 h prior to entry into the unit										X						2.5
Weekly PCR test of asymptomatic patients (surveillance testing)															X	2.1
Keep a central record of dialysis sessions, used waiting rooms and/or transport for each patient (to identify close contacts)											X			X	X	2.8
Keep a record of staff members who had contact with the patient				X					X							3.3

[a]Score between 1 and 5 is calculated as average from scores based on expert opinion from the ERACODA working group and authors on this article.
[b]Location not specified.

Table 4: Summary of guidelines—measures regarding hygiene.

Guideline (month/year publication or last update)	EUDIAL (03/20)	Italy (02/20)	Romania (03/20)	Spain (03/20)	Croatia (04/20)	Cyprus (04/20)	Germany (04/20)	Slovakia (04/20)	Portugal (05/20)	Greece (06/20)	Ukraine (08/20)	Turkey (03/21)	Poland (10/21)	Israel (01/22)	UK (01/22)	Author score[a]
Hygiene																
Staff																
Washes or disinfects hands regularly	X	X			X	X	X			X			X			4.5
Wears mask throughout the working day (type not specified)						X	X	X	X	X	X	X	X			4.8
Wears fluid-resistant surgical mask (IIR) throughout the working day															X	3.2
Replaces surgical masks every 2 h					X						X					2.3
Wears long-sleeved apron, and eye and face protection where there is a risk of splashing of blood or bodily fluids															X	4.2
Optimizes fresh air ventilation where possible	X				X					X		X		X		4.4
Avoids sudden changes in room temperature										X						1.8
Cleans/disinfects machines following protocol	X	X	X	X	X	X	X	X		X	X	X		X		4.7
Collects medical waste following protocol	X				X			X			X	X		X	X	4.5
Patients																
Instructions/information on hygiene rules (e.g. posters, leaflets, orally)	X		X	X	X	X	X	X	X	X	X	X			X	4.8
Hand disfection fluid is available at entrance/in waiting rooms	X	X		X	X			X		X		X				4.6
Wash or disinfect hands before dialysis session	X	X	X	X	X	X	X	X		X	X	X	X			4.4
Wash or disinfect hands after dialysis session	X		X		X			X							X	3.6
Wear mask in waiting room		X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.0
Wear mask during dialysis session		X	X	X	X	X	X	X	X	X	X	X	X	X	X	4.5
No food during dialysis sessions					X	X		X		X	X	X		X		3.1
Masks may be removed to allow eating/drinking but should be replaced immediately afterwards															X	2.4

[a]Score between 1 and 5 is calculated as average from scores based on expert opinion from the ERACODA working group and authors on this article.

Table 5: Summary of guidelines—measures regarding isolation and cohorts.

Guideline (month/year publication or last update)	EUDIAL (03/20)	Italy (02/20)	Romania (03/20)	Spain (03/20)	Croatia (04/20)	Cyprus (04/20)	Germany (04/20)	Slovakia (04/20)	Portugal (05/20)	Greece (06/20)	Ukraine (08/20)	Turkey (03/21)	Poland (10/21)	Israel (01/22)	UK (01/22)	Author score[a]
Isolation/cohorts																
Use separate entrance and exit for dialysis unit					X											2.8
Fixed course/route (with marking) to entrance of dialysis unit						X										2.6
Patients with suspected/confirmed COVID-19 use separate entrance/exit and waiting area															X	3.8
Never mix suspected and confirmed cases	X		X		X			X	X		X			X		4.6
Use separate dialysis rooms for non-infected, suspected and infected patients			X		X				X		X					4.6
Cohort staff in separate teams for management of high- and low-risk patients					X			X								2.7
Patients with suspicion of COVID-19																
Isolate (not cohorted) until PCR result is known		X	X		X	X	X	X	X		X			X	X	4.7
Dialysis in last shift if isolation is impossible			X		X	X		X	X					X	X	4.5
Staff must use PPE, including long-sleeved waterproof isolation clothing, hair caps, goggles/faceshield, gloves and medical masks (FFP2/3 if available)		X			X	X	X	X	X	X	X			X		4.8
Staff should not be involved in the treatment of other patients						X	X	X								2.8
Consider medical waste from suspected patients as infectious and dispose of it accordingly	X		X	X	X			X								3.9
Patient(s) with confirmed COVID-19																
Should be hospitalized			X													1.7
Should not receive dialysis in an outpatient dialysis facility	X				X											1.5
Admit to an airborne infection isolation room (if available) for dialysis	X				X											3.8
Dialyse and isolate in quarantine for 14 days								X								3.5
Isolate or cohort for at least 10 days														X	X	4.1
Isolate from negative and potentially positive patients		X						X	X			X		X		4.8
Dialysis at home if possible				X												3.0
Dialysis in separate room (with other confirmed cases) if home dialysis is impossible		X		X		X	X					X		X		4.6
Dialysis in last shift if isolation is impossible	X			X	X	X		X	X			X		X	X	4.4
Staff must use PPE, including long-sleeved waterproof isolation clothing, hair caps, goggles/faceshield, gloves and medical masks (FFP2/3 if available)	X	X	X	X	X	X	X	X	X	X	X	X		X		5.0
Only the assigned healthcare team should enter the isolation room/cohort area, all non-scheduled team-mates should be excluded at all times	X			X			X	X				X				3.8
This staff should not be involved in the treatment of other patients						X	X	X								2.5
Consider medical waste from confirmed cases as infectious and dispose of it accordingly	X		X	X	X			X								3.9

[a]Score between 1 and 5 is calculated as average from scores based on expert opinion from the ERACODA working group and authors on this article.

Table 6: Summary of guidelines—measures regarding social distancing and transport.

Guideline (month/year publication or last update)	EUDIAL (03/20)	Italy (02/20)	Romania (03/20)	Spain (03/20)	Croatia (04/20)	Cyprus (04/20)	Germany (04/20)	Slovakia (04/20)	Portugal (05/20)	Greece (06/20)	Ukraine (08/20)	Turkey (03/21)	Poland (10/21)	Israel (01/22)	UK (01/22)	Author score[a]
Social distancing																
Apply social distancing in centre, distance not specified													X			3.8
>1 m distance between patients (not suspected/confirmed cases)						X						X				2.8
1.5 m distance in waiting rooms and/or dialysis chairs								X		X						4.1
2 m distance in waiting rooms	X				X										X	3.8
2 m distance between dialysis chairs	X				X		X		X						X	3.7
Patients avoid waiting rooms (and wait in car) if possible						X				X	X	X				3.5
Reduce frequency dialysis sessions (from 3 to 2) if possible			X			X										2.0
Advise patients to self-isolate: no public transport, no events, avoid (grand) children	X				X											3.6
Patients can have dialysis as usual if they have a family member/caregiver in self-isolation without symptoms	X															3.3
Consider a patient with a family member/caregiver with confirmed COVID-19 as suspected case	X															4.2
Patients from one shift must leave the unit before patients from the next shift enter							X	X						X		4.0
No visitors during dialysis sessions						X	X	X						X		4.0
Visitors only allowed if absolutely necessary, maximum of 1 visitor per patient										X						3.5
Staff keeps 1.5 m distance whenever possible							X			X						3.8
Transport																
Use own transport only, if possible (no taxi/public transport)	X			X			X	X	X	X		X				3.8
Not more than 1 patient per ambulance/van									X							3.1
Patients and ambulance crew disinfect their hands before transport			X													4.2
Patient wears mask during transport			X					X	X			X				4.9
Driver wears mask during transport			X	X					X			X				5.0
Disinfect ambulance after each round of patients (chairs, handles, doors, etc.)			X	X					X			X				4.1
Patients with suspected COVID-19 travel alone				X				X							X	4.1
Patients with suspected COVID-19 are transported by medical vehicles (may share transport with other suspected patients), personnel should use PPE			X								X					2.6
Patients with confirmed COVID-19 may share transport with each other but not with other patient groups									X						X	4.3
Patients with confirmed COVID-19 are transported with a properly equipped 112-ambulance, personnel should use PPE			X													2.8
Patients with confirmed COVID-19 should not be transported at all (should be hospitalized). If necessary, they must be transported separately								X								1.4

[a]Score between 1 and 5 is calculated as average from scores based on expert opinion from the ERACODA working group and authors on this article.

patients. For clinical staff, masking was a universal measure in most centres, combined with the use of other PPE such as gloves, goggles/face shields and protective aprons/coats. These measures were also recommended in most of the published national guidelines and were scored as being among the most important measures by the authors of this paper.

The results from the centre questionnaire showed some variation between centres in the measures that were taken to prevent the spread of SARS-CoV-2. For example, most centres applied recommendations for keeping a distance between patients and staff members, but this distance varied between <1 m and >2 m. Similar discrepancies were observed when we compared national guidelines. Notably, any differences that we observed in the centre questionnaire could not be explained by differences in recommendations in the national guidelines for those countries, but were probably due to differences in the local situation, such as the regional COVID-19 prevalence and factors related to the patient population, logistics and availability of resources in the dialysis centre.

When we collected national guidelines for our inventory, we noticed that many countries across Europe did not have specific guidelines to prevent the transmission of COVID-19. This is remarkable because COVID-19 was an immense threat to dialysis patients, who have an extremely high mortality. We advise that there should be such national guidelines and preferably also an international guideline from a widely acknowledged body such as the ERA or Kidney Disease: Improving Global Outcomes (KDIGO) via an official process of multidisciplinary consultation and consensus including not only nephrologist and dialysis nurses, but also patients, virologists, epidemiologists and social workers.

Remarkably, a large part of the recommendations in the national guidelines was similar. This is notable, because during the first pandemic wave, national guidelines for dialysis centre practices were scarce. It may be that many dialysis centres followed the strategies recommended in the European guideline published by EUDIAL in May 2020 [3] and/or the recommendations issued by the Centers for Disease Control (which have considerable overlap) [16]. However, the authors of the EUDIAL review only had very limited sources. At the time that EUDIAL wrote their review (March 2020), only one case series from a single haemodialysis unit in Wuhan had been published [17]. These authors reported on 37 COVID-19-positive haemodialysis patients (out of a total of 230 patients; 16.1%) and on 4 COVID-19-positive staff members (out of a total of 33; 12.1%). In a scoping review that was published in November 2020, Akbarialiabad *et al.* summarized a total of 22 articles, but most included publications were perspectives, editorials and case series [18]. So, during the first wave literature was scarce and evidence on which to base clinical practice was very limited.

Notwithstanding the overlap of the recommendations in the national guidelines, there was also considerable practice variation. Such heterogeneity was also reported by investigators from the International Society of Nephrology (ISN) and the Dialysis Outcomes and Practice Patterns Study (DOPPS) who recently published the results of a web survey with the aim to assess the impact of COVID-19 among 412 haemodialysis centres in 78 countries [19]. They found that there has been wide global variation in SARS-CoV-2 infection rates among haemodialysis patients and staff, PPE availability, and testing, and the ways in which services have been redesigned in response to the pandemic. For instance, they found that surgical masks were not available at all in 1% of centres, and that there was a severe shortage in 5% and a moderate shortage in 22% of the centres. This latter percentage is similar to the percentage of 29% of centres in ERACODA that reported that there had been, at some point, a (temporary) shortage of protective equipment for the dialysis staff. We found that the reported use of some forms of protective clothing/equipment, including FFP2/3 masks, goggles, face shields and aprons was rather low (between 60% and 79%, Table 2). However, we do not know why these percentages were that low and we can only speculate that the (un)availability of these materials played a role. Also, the transportation of patients to and from the dialysis centre was reported to be challenging in many or most centres across all regions in the ISN/DOPPS study. The large amount of, often conflicting, recommendations regarding patient transport that we found in our inventory of national guidelines suggests that transportation was also challenging in the ERACODA region.

Of note, several recommendations considered very important (author score between 4 and 5) by the 13 authors of this paper were not advised in most of the published national guidelines. For example, the recommendation to prepare a contingency plan for the COVID-19 pandemic was considered important by the authors (score 4.2), but was only mentioned in two guidelines. The same holds true for the advice to train nurses in taking nasopharynx swabs for PCR tests, with appropriate dressing (FFP2, goggles, hair cap, disposable blouse, gloves). This advice was given in only one guideline plus the EUDIAL review, whereas it received a mean author score of 4.7.

In our study we could not demonstrate strong associations between measures that were taken in a centre and the proportion of patients that got infected with SARS-CoV-2. This may be the result of a negative self-fulfilling prophecy. It is probable that measures were applied more strictly in centres when the prevalence of COVID-19 was high or increased rapidly over time. This reaction of stricter measures in response to a higher prevalence strongly influences the analysis of the association between the effectiveness of preventive measures and the proportion of patients and staff members infected with SARS-CoV-2.

A small part of the centres (5.5%) used only radiological findings (chest X-rays and/or pulmonary CT scans) for making the COVID-19 diagnosis and another 8.2% indicated that they did not use any laboratory or radiology investigations at all. Unfortunately, we do not have information on how the COVID-19 diagnosis was made in these latter centres. However, since the number of concerning centres was so small, this probably only had a very small influence on the overall findings. It would be interesting to determine whether cohorting strategies were different in the centres that did not use laboratory tests for the COVID-19 diagnosis. However, we cannot draw any conclusions on the cohorting strategies in these centres on the individual patient level, but only on centre level, and we could not detect any remarkable differences in the preventive strategies of these centers and the other centers.

Another potential limitation of the ERACODA centre questionnaire is that it was distributed halfway through the first pandemic wave. It is not clear whether the answers would have been different at a later stage of the pandemic. Moreover, the results would likely be different in the time period that vaccinations (and guidelines for vaccination) became available for patients and staff, new variants of the virus arose and much more information and recommendations on prevention, diagnosis and treatments were published. However, even if data were collected in a later phase of the pandemic, the timing could still have been problematic because the virus and the literature describing it continues to evolve.

A similar limitation can be observed in the inventory of national guidelines, because there is a wide variation in the time period in which the national guidelines were published. Some were updated in the meantime, but most were not (as far as we are informed). Furthermore, we may have missed national guidelines because our contact persons may not have been aware of the existence of such a guideline. However, we tried to reduce the risk of this potential problem by contacting multiple persons per country. We unfortunately did not collect data on which guidelines (if any) were adopted in countries that did not have a national guideline.

We could also not analyse whether infection rates among staff and/or patients were different between countries with and without national guidelines, because we could not calculate infection rates based on the ERACODA data. Our study includes only data of patients who were infected with SARS-CoV-2 and for whom their nephrologist entered data on a voluntary basis. This means that our database probably does not include all patients on KFRT with COVID-19. Moreover, we do not know how many KFRT patients did not get COVID-19.

On the other hand, this study has several strengths. First of all, it includes information on a large number of European centres, for which also granular individual patient data was available. Furthermore, this is the first study summarizing information from multiple national clinical guidelines, which gives useful insight in the measures taken in different countries.

In conclusion, measures mentioned most often in both the centre questionnaire and the national guidelines were triage with questions before entering the dialysis ward, measuring body temperature, disinfection of the hands and masking for all patients and staff and PPE for the staff members. Although there was predominantly overlap in measures taken to prevent the spread of SARS-CoV-2 across centres and national guidelines, there was also considerable heterogeneity. It is remarkable that, despite COVID-19 having such devastating impact on haemodialysis patients, many countries across Europe did not have guidelines for IPC. Further research is needed to assess causal relationships between measures taken and the spread of SARS-CoV-2.

SUPPLEMENTARY DATA

Supplementary data are available at *ckj* online.

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DATA AVAILABILITY STATEMENT

Collaborators that entered data in ERACODA remain the owner of these data. The database can therefore not be disclosed to any third party without the prior written consent of all data providers, but the database will be made available to the editorial offices of medical journals when requested.

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CONFLICT OF INTEREST STATEMENT

I.N. is member of the *CKJ* Editorial Board. The other authors state that there is no conflict of interest. The results presented in this paper have not been published previously in whole or part, except in abstract format.

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