Hemodialysis shake-up on the front lines of the Covid-19 pandemic: the Treviglio Hospital experience

L'epidemia Covid-19: diario di bordo di una emergenza

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ABSTRACT
The new coronavirus disease (Covid-19) pandemic in Italy formally started on 21st February 2020, when a 38-years old man was established as the first Italian citizen with Covid-19 in Codogno, Lombardy region. In a few days, the deadly coronavirus swept beyond expectations across the city of Bergamo and its province, claiming thousands of lives and putting the hospital in Treviglio under considerable strain. Since designated Covid-dialysis hospitals to centrally manage infected hemodialysis patients were not set up in the epidemic areas, we arranged to treat all our patients. We describe the multiple strategies we had to implement fast to prevent/control Covid-19 infection and spread resources in our Dialysis Unit during the first surge of the pandemic in one of the worst-hit areas in Italy. The recommendations provided by existing guidelines and colleagues with significant experience in dealing with Covid-19 were combined with the practical judgement of our dialysis clinicians, nurses and nurse's aides.

PAROLE CHIAVE: COVID-19, hemodialysis, end-stage kidney disease, coronavirus, pandemic.

Introduction

Since December 2019, an outbreak of new coronavirus disease (Covid-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has developed into a global pandemic [1]. Its outburst in Italy officially dates back to February 21st, 2020. In a few days, the number of detected cases increased beyond expectations [2]. The deadly coronavirus swept across the city of Bergamo and its province, claiming thousands of lives and putting the hospital in Treviglio under considerable strain; all departments had to be readapted and most beds were rapidly occupied by infected patients.

Droplet spread and close contact are the main routes of Covid-19 transmission [3]. Hemodialysis centers have an exceptionally high risk of infection exposure due to patients' recurring attendance at the facilities, physical proximity and several times a week mobility; their co-morbidities and suppressed immunity enhance the risk of infection further, endangering the staff unit in close contact [4]. Since designated Covid-dialysis hospitals to centrally manage infected hemodialysis patients were not set up in our area, we had to implement local strategies to prevent/control the infection and spread resources during the emergency from February to May 2020, in one of the worst-hit areas in Italy. We took into account the Institute of Medicine definition of 'crisis surge' that states *"Adaptive spaces, staff, and supplies are not consistent with usual standards of care, but provide sufficiency of care in the setting of a catastrophic disaster (i.e., provide the best possible care to patients given the circumstances and resources available). Crisis capacity activation constitutes a significant adjustment to standards of care."* [5]. The recommendations provided by guidelines and colleagues with significant experience in dealing with Covid-19 [6–9] were combined with our staff's practical judgement (Table I).

Area management
Avoid crossing areas
Create staff filter zones
Create a check-in area to welcome and screen patients
Create different paths for patients
Dialyze patients in separate hemodialysis rooms or group them in a proper area
Apply environmental cleaning and disinfection of the areas
Management of healthcare team members
Educate staff
Avoid cluster activities
Screen and protect staff
Cohort manpower
Use PPE judiciously
Implement contingency plans
Work with local Covid-19 Response Team to apply best practice changes
Management of hemodialysis patients
Screen patients
Educate patients
Create an environment where patients feel safe

Table I: Our guiding principles for the Covid-19 outburst

Area management

The usual entry to the dialysis center gave access to a large waiting room, where patients used to meet before entering the aisle and reach their changing rooms. Hence this zone was closed to

avoid movement across different areas and a new outside entrance was established directly from the outdoor parking. Team members wore personal protective equipment (PPE) in a tiny passage which became the filter zone to enter the hemodialysis area. Stable patients waited outside the facility in their private vehicle/ambulance or standing in line keeping proper distances. Patients with symptoms or those who had had contact with Covid-19 infected people were asked to inform the staff by phone before arrival, so we could be prepared to anticipate their entrance. Accompanying people, including ambulance personnel and relatives, were not allowed to enter the center, being potential vectors of the disease. A check-in was set up at the entrance to welcome patients one-by-one, require them to use hand sanitizer, wear supplied surgical face mask and gloves, take the temperature with a temperature gun and ask about their epidemiologic contact history and state of health, with a focus on fever, cough, dyspnoea, rhinorrhoea, conjunctivitis, diarrhoea. According to their medical status, they were accompanied one-by-one to distinct changing and waiting rooms, equipped with given numbered lockers and well-spaced armchairs to avoid gatherings; patients with mild symptoms were screened one-by-one in a dedicated room, whereas those with dyspnoea and signs of organ dysfunction were referred to the emergency ward. Hospitalized hemodialysis patients were accompanied to the facility by dedicated paths according to their infection status. Separate hemodialysis rooms, with separate access serving as both entrance and exit, were used for suspected or confirmed Covid-19 patients; early in the pandemic, our dialysis operating room was turned into a two-bed Covid-19 room, but as the epidemic spread, infected patients were clustered in a designated seven-bed room. In our dialysis facility in Romano di Lombardia a separate room was not available, thus patients were grouped during the same shift at the end-of row stations, away from the main flow and spaced from the others in all directions. Assigned healthcare teams entered the isolation room/cohort area. Staff members took off PPE in a dedicated zone before getting out of the hemodialysis area. Environmental cleaning and disinfection of the areas were carried out at the end of each shift by personnel equipped with PPE. The medical waste from suspected or confirmed Covid-19 patients was considered as infectious material and disposed of accordingly. Uremic critical patients with Covid-19 were treated separately by dedicated portable reverse osmosis systems in the Covid-19 Sub-Intensive Care Unit.

During the pandemic, almost all operating rooms were converted into Intensive Care Units and creation/revision of arteriovenous fistulas became impracticable. We quickly replaced short term in use hemodialysis central venous catheters (CVC) with tunnelled ones. A designated room was identified at the Department of Interventional Cardiology for catheters placement in non-infected patients. Covid-19 infected patients who needed CVC placement were managed in dedicated areas. During the first surge of the pandemic, we observed only two arteriovenous fistula thrombosis; they occurred in two infected patients a few hours before their died.

Management of healthcare team members

Dialysis physicians, nurses and nurse's aides received instructions in SARS-CoV-2 infection prevention and control. Nurses were trained to take nasopharynx swabs for Covid-19 polymerase chain reaction. Cluster activities (i.e., large shifts, group studies, patient discussion, coffee breaks) were cancelled; when gathering was essential, it was mandatory to wear protective equipment. Staff members were required to take body temperature at the beginning of their shift and inform the team leader. If the body temperature was ≥ 37.5°C, they were suspended from duty and examined by nasopharynx swabs and chest x-ray; they could return to work only after the evaluations proved negative. Hand hygiene was strictly implemented. Hemodialysis staff wore appropriate PPE putting on filtering face piece (FFP2) masks, goggles or shields, hats, gloves, long-

sleeved waterproof isolation clothing, shoe covers during check-in, nasopharynx swab collection and hemodialysis sessions. Manpower was divided in separate teams for the management of suspected or confirmed COVID-19 and non-infected patients. We established policies to optimize PPE use, as these precious resources had to be deployed for many weeks: only the minimum required team entered the hemodialysis restricted area and all non-scheduled colleagues were excluded; patients were grouped according to their infective status in order to plan full shifts; reusable shields and goggles were cleaned and disinfected. Contingency plans were continuously implemented as Covid-19 infections curtailed the staff available to dialyse patients; the shortage of qualified personnel was due to illness. Physicians communicated daily with the local Covid-19 Response Team to apply best practice changes.

Healthcare workers experience severe emotional stress on the front lines of a pandemic, knowing that some of them might die. The Impact of Events Scale-Revised (IES-R) [10] and the Hospital Anxiety and Depression Scale (HADS) [11–13] were administered to assess their psychological impact and immediate stress. Of the 40 renal healthcare staff members who were on duty during the Covid-19 outbreak, 14 completed the survey. The total response rate was 35.0%. The response rates stratified by employment group were as follows: doctor, 57.1% (100% of total medical staff); nurse's aide, 7.1% (50% of total nurse's aide staff); nurse, 35.8% (17% of total nurse staff). The mean IES-R score was 30.50 ± 17.02; of all responders, 6 (42.8%) received a score of 33 or higher, indicating the presence of PTSD (post-traumatic stress disorder). In the HADS 7 staff members (50.0%) scored 8 or above on the anxiety item and 5 (35.7%) scored 8 or above on the depression item (Table II). Prompt psychological help was provided as needed.

#	**Employment role** (1=nurse's aide; 2= nurse; 3=doctor)	**HADS D** (cut-off >8)	**HADS A** (cut-off >8)	**IES-R** (cut-off >=33)	**IES-R Intrusion Subscale**	**IES_R Avoidance Subscale**	**IES-R Hyperarousal Subscale**
1	1	**14***	**14***	**44***	2.33	2.00	1.71
2	2	7	7	19	0.57	1.25	0.71
3	2	7	**10***	27	1.14	1.13	1.43
4	2	5	7	18	0.71	0.88	0.86
5	2	**10***	**12***	**36***	2.00	0.88	2.14
6	2	**11***	**13***	**55***	2.43	2.63	2.43
7	3	7	5	10	0.71	0.50	0.14
8	3	**11***	**15***	**53***	3.14	1.88	2.29
9	3	3	4	20	1.57	0.63	0.57
10	3	**12***	**16***	**59***	3.57	2.04	2.57
11	3	7	6	15	0.57	0.88	0.57
12	3	1	4	10	0.57	0.75	0.00
13	3	8	**11***	**39***	2.00	1.50	1.86
14	3	5	9	22	1.43	0.50	1.14
Mean		*7.71*	*9.50*	*30.50*	*1.62*	*1.24*	*1.31*
(SD)		*(3.60)*	*(4.11)*	*(17.02)*	*(0.99)*	*(0.66)*	*(0.86)*

Table II: IES-R and HADS measurements in renal healthcare staff members

Our infection rates were 12.5% for medical staff (1 out of 8), 20% for nurses (6 out of 30) and 50% for nurse's aides (1 out of 2); most infections and subsequent absences from duty occurred in March 2020. Nobody needed hospitalization and everyone had a benign course.

Management of hemodialysis patients

We drew up a triaging plan to identify infected patients before they entered the treatment area. Subjects with signs and symptoms (fever, cough, dyspnoea, rhinorrhoea, conjunctivitis or diarrhoea) or those who had had contact with the new coronavirus infected people were asked to inform staff by phone to anticipate their arrival. Stable patients waited in the outdoor parking. They were welcomed and screened one-by-one by staff members at the new entry, as described in detail above. According to their medical status, patients were accompanied one by one to distinct changing and waiting rooms, equipped with given numbered lockers. We had two available changing rooms: one was dedicated to asymptomatic patients, the other to infected ones. The latter was also outfitted as waiting room for infected patients with suitably spaced armchairs. While time-consuming, the procedure allowed to avoid moving across areas and increased safety; Collective Patient Transport personnel was very cooperative in managing travel management despite some delay.

In absence of positive finding, the patient proceeded to normal dialysis treatment. If an abnormal body temperature (≥ 37.5°C) or any signs and symptoms or contact history were detected, the patient was screened for Covid-19 in a dedicated room and submitted to nasopharyngeal swab, thoracic X-ray, and biochemical determinations. If the first swab came back negative but thoracic X-ray and clinical criteria were highly suspected for Covid-19, patients were treated as if they were infected and re-examined for SARS-CoV-2 nucleic acid [14]; most of them turned out positive. Patients with dyspnoea and signs of organ dysfunction were referred to the emergency ward. If Covid-19 was excluded, the patient came back for routine dialysis. Patients with suspected or confirmed Covid-19 were clustered in designated hemodialysis rooms or grouped during the same shift at the end-of row stations.

During the dialysis session, nurses provided education on keeping social distances, coughing and sneezing etiquette, how to use face masks, how to dispose of contaminated items, and how and when to perform hand hygiene. Patient snack time during the session was cancelled.

Discontinuation of isolation was determined on a case-by-case basis, depending on the resolution of the symptoms, imaging improvement (thoracic x-ray and/or computed tomography) and the detection of two consecutive negative nasopharynx swabs.

The world pandemic created concern in many hemodialysis patients. Hence, IES-R [10] and HADS [11–13] were administered to assess their psychological impact and immediate stress. Of the 130 hemodialysis patients, 29 completed the survey. The total response rate was 22.3% (13 female and 16 male). The mean IES-R score was 26.93 ± 17.61; of all responders, 10 (34.4%) received a score of 33 or higher, indicating the presence of PTSD (post-traumatic stress disorder). In the HADS, 5 patients (17.2%) scored 8 or above on the anxiety item and 4 (13.7%) scored 8 or above on the depression item (Table III). Psychological help was provided as needed by phone or appropriate electronic means.

Covid-19 was diagnosed from 10th to 30th March 2020 in 23 people out of a population of 130 hemodialysis patients (infection rate 17.6%, mean age 68±14 years, dialysis vintage 52±47 months, 14 male and 9 female). Infected patients' hospitalization rate was 61%. Seven patients died (mean age 71±10 years, 6 male and 1 female); at the initial presentation of the disease, their White Blood Cells Count (6.5±2.1 vs 4.9±1.6 10^3/mcL, $p<0.05$), Neutrophils (80.9±8.8 vs 69.9±13.7 %, $p < 0.05$) and C-reactive Protein level (153.9±57.9 vs 47.5±49.4 mg/L, $p<0.05$), tested by Student's t-test for paired data, were significantly higher than in recovered Covid-19 patients. Detailed data are provided in Table IV.

#	Age (years)	Gender (1=Male; 2=Female)	HADS Depression (cut-off >8)	HADS Anxiety (cut-off >8)	IES-R (cut-off >=33)	IES-R Intrusion Subscale	IES_R Avoidance Subscale	IES-R Hyperarousal Subscale
1	75	2	3	4	15	0.75	0.57	0.67
2	67	1	0	1	25	0.75	1.88	0.67
3	56	1	1	2	23	0.88	1.25	1.00
4	76	2	**12***	8	**53***	2.38	2.13	2.83
5	79	2	**16***	**15***	**58***	3.00	2.00	3.00
6	49	1	4	4	18	1.13	0.88	0.33
7	30	2	**15***	**14***	**59***	2.50	2.38	3.33
8	57	1	2	4	20	0.75	0.88	1,17
9	67	1	6	5	**34***	1.63	1.75	1.17
10	81	1	1	2	12	0.75	0,75	0.00
11	51	1	6	4	27	1.58	1.00	1.00
12	68	2	1	2	14	1.00	0.29	0.67
13	61	2	5	1	20	0.50	1.25	0.83
14	71	2	7	8	**54***	0.63	0.50	0.17
15	74	1	2	5	20	3.00	1.88	2.33
16	49	2	3	3	**36***	1.50	0.63	0.50
17	49	2	3	4	18	3.38	2.04	2.67
18	81	1	2	3	17	0.50	0.88	0.67
19	75	1	7	8	21	0.75	0.88	1.17
20	62	2	**10***	**12***	**57***	2.75	2.50	2.00
21	54	1	7	8	**55***	1.25	0.38	1.17
22	64	2	1	1	8	1.00	1.13	1.67
23	52	2	3	7	19	0.75	0.88	0.83
24	69	1	7	**14***	**37***	2.29	2.00	1.67
25	89	1	5	5	0	1.75	0.88	2.50
26	67	1	0	3	20	0.50	0.75	0.00
27	38	2	4	**10***	**34***	2.38	2.63	2.50
28	68	1	1	0	7	2.00	1.50	1.83
29	73	1	0	0	0	1.38	0.50	1.17
Mean	*63.86*		*4.62*	*5.41*	*26.93*	*1.49*	*1.27*	*1.36*
(SD)	*(13.59)*		*(4.26)*	*(4.28)*	*(17.61)*	*(0.87)*	*(0.69)*	*(0.94)*

Table III: IES-R and HADS measurements in hemodialysis patients

#	Age (years)	Gender (1=Male; 2=Female)	Dialysis vintage (months)	Presenting symptoms/signs					Pneumonia (x-ray or CT scan)	Laboratory Findings				Treatment			Hospitalization	Outcome (1=death; 2=recovery)
				Fever	*Cough*	*Dyspnea*	*GI*	*Myalgia*		*WBC (10^3/mcL)*	*N (%)*	*D-dimer (ng/ml)*	*CRP (mg/L)*	*Antiviral*	*HCQ*	*LMWH*		
1	60	1	24	X		X	X		X	5.7	87.7		118.6	X	X		X	1
2	84	1	28	X	X				X	7.6	70.0		128.1	X			X	1
3	84	1	26	X					X	9.1	76.4		207.8				X	1
4	60	2	65	X	X				X	3.7	73.8	651	90.1	X	X		X	1
5	84	2	26	X	X				X	3.5	73.7	6122	90		X		X	2
6	60	1	2	X						3.6	50.6	578	28.4		X		X	2
7	69	1	57	X		X			X	6.4	82.3	2006	255.7	X	X		X	1
8	73	2	37	X					X	2.3	58.4		27.6		X			2
9	65	1	55	X						4.9	72.2	306	10.5		X			2
10	65	1	210	X					X	4.3	80.0	859	124.5	X	X		X	1
11	83	1	138	X		X			X	3.1	70.6	1720	14.2		X	X		2
12	61	2	8	X					X	7.3	88.5	3835	40.4	X	X		X	2
13	74	1	68	X					X	5.8	82.9	1838	77.8			X	X	2
14	82	2	73	X			X		X	5.8	38.7	1012	6.4		X			2
15	78	1	8	X					X	9.2	96.1	20000	153	X	X		X	1
16	37	2	45	X				X	X	4.6	59.6	1356	2.9		X	X		2
17	76	1	21	X					X	4.4	88.8	2016	87.7		X			2
18	47	2	58	X						5.7	69.2	1083	23.2		X	X		2
19	66	1	106	X					X	3.0	67.7	4715	84.3		X	X	X	2
20	86	1	5	X		X			X	8.4	86.2	1620	194.2			X	X	2
21	73	1	38	X						6.5	65.5	1027	21.5		X	X		2
22	38	2	73	X					X	4.6	68.1	481	36.9		X	X		2
23	67	2	26	X		X			X	5.3	78	1002	15			X	X	2

Table IV: Clinical features of hemodialysis patients with Covid-19 infection in order of disease onset

***Abbreviations*: GI: gastrointestinal symptoms; WBC: white blood cells count; N: neutrophils; CRP: C-reactive Protein; Antiviral: lopinavir/ritonavir; HCQ: hydroxychloroquine; LMWH: low molecular weight heparin.**

Home hemodialysis and peritoneal dialysis

Patients continued the treatment at home using electronic systems for clinical management. None of them (21 patients on peritoneal dialysis and 3 on home hemodialysis) developed symptomatic infection.

Conclusions

COVID-19 is a major global human threat that has turned into a pandemic. Being prepared for a surge of patients, suspected or confirmed, is crucial to minimize the risk for other patients and personnel taking care of them. We are currently facing a new, bigger wave; cases are surging mainly in other provinces and our hospital is supporting them.

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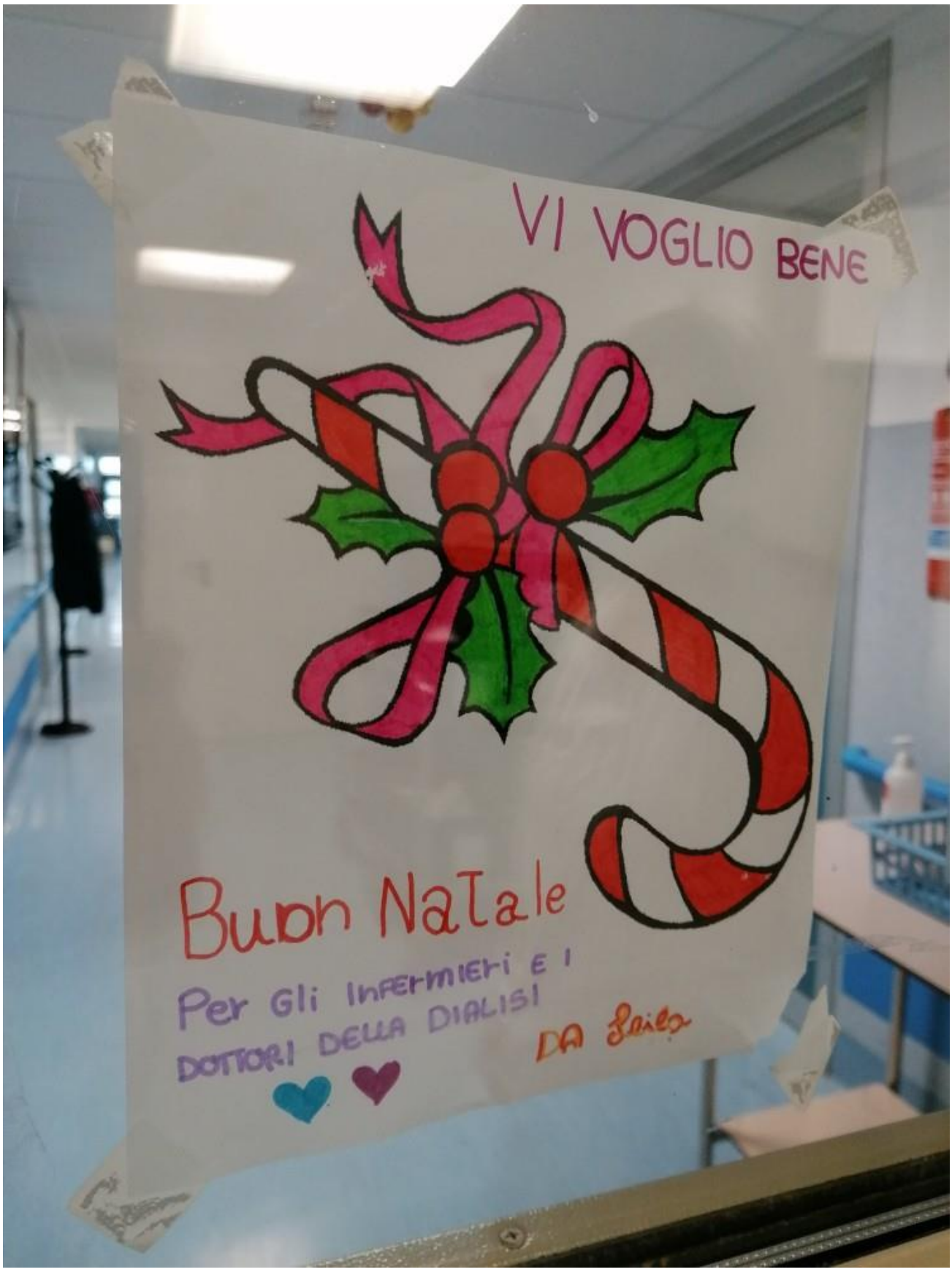

The best reward. Courtesy of Simona Zerbi

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