BEDSIDE DIALYSIS USING PORTABLE HEMODIALYSIS APPARATUS- OUR EXPERIENCE DURING COVID-19 PANDEMIC

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ABSTRACT

Objective: To share our experience of bedside hemodialysis using a portable hemodialysis machine and dialysis drum in COVID-19 patients requiring renal replacement therapy.

Study Design: Cross sectional study.

Place and Duration of Study: Combined Military Hospital, Lahore from Apr 2020 to Jun 2020.

Methodology: Fourteen patients undergoing indoor treatment for moderate to severe COVID-19 infection in COVID isolation wards/intensive care unit received bedside hemodialysis by means of a portable hemodialysis machine and improvised "dialysis drum" from 1st April 2020 to 30th June 2020 at Combined Military Hospital, Lahore.

Results: A total of seventy five hemodialysis sessions were conducted with a mean of 5.35 sessions per patient. Mean age of the patients was 59.92 years. Out of a total of fourteen patients, there were twelve males (85.7%) and two females (14.3%). None of our cases had any significant procedure related complication. Nine patients (64.3%) were discharged after making a clinical recovery including two patients who were successfully weaned off mechanical ventilation while five patients (35.7%) had an in hospital mortality.

Conclusion: The bedside delivery of dialysis by means of an improvised manually mobile hemodialysis apparatus is an effective technique which can be employed in the management of patients requiring renal replacement therapy in strict isolation settings.

Keywords: COVID-19, Experience, Portable hemodialysis.

INTRODUCTION

Dialysis units are faced with a unique challenge in the event of catastrophic disasters in order to provide appropriate care to the dependent patients while ensuring the protection of healthcare workers. The current COVID-19 pandemic has presented a new challenge to the crisis management capacity of dialysis units worldwide[1,2]. The current epidemic is secondary to Severe Acute Respiratory Syndrome-Corona Virus-2 (SARS-CoV-2) infection also known as "COVID-19" which is a new viral strand from the coronavirus family, initially emerged in December 2019 at Wuhan, China subsequently spreading to other regions of the world and eventually gained the status of a "Global Pandemic" by the World Health Organization on 11th March 2020. Previously, during the initial decades of the current century, there had been three major pandemic outbreaks of air borne infections leading to severe respiratory complications all caused by viruses from the same coronavirus family classified as Severe Acute Respiratory Syndrome-Corona Virus (SARS-CoV), Middle East Respiratory Syndrome-Corona Virus (MERS-CoV) and SARS-CoV-2 respectively. However, the current COVID-19 pandemic is considered to be more contagious, but has a lesser case fatality rate than the previous two viruses. The data available till date suggests COVID-19 pandemic bears the case fatality rate of about 2.3% which is significantly lower than those recorded in SARS, MERS and H7N9 which were 9.5%, 34.4% and 39% respectively. As a consequence of rapid spread, the epidemic area of COVID-19 is much larger with greater number of infected cases and consequently mortalities resulting in a significant strain on worldwide healthcare resources and

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consequently a greater global financial loss[3,4]. The increased number of mortalities associated with COVID-19 infection has been found to be secondary to the development of severe pneumonia, acute respiratory distress syndrome (ARDS) and coagulation dysfunction. The increased severity of infection and mortality among the hospitalized patients is especially noticed among the subset of patients with underlying comorbidities such as hypertension, diabetes mellitus, cardiovascular diseases, smoking, chronic lung pathologies like chronic obstructive pulmonary disease, malignant disorders, and chronic kidney disease[5]. Uremic patients secondary to advanced chronic kidney disease bear a very fragile and weak immune system making them highly susceptible to develop severe respiratory infection along with advanced complications like ARDS, respiratory failure and shock in current COVID-19 pandemic. This is further complicated by their increasing age and usual presence of other comorbidities such as diabetes mellitus, hypertension and ischemic heart disease adding to the already existing high risk of severe complicated disease and mortality. Another factor playing a significant role is their frequent visits to dialysis and healthcare facilities increasing their susceptibility to acquire the infection on one hand and on the other hand making them high risk cases of transmitting the infection to other susceptible dialysis dependent patients in their close proximity sharing the same dialysis facility as well as to available healthcare staff. Such patients once infected require specialized dialysis support augmented by special measures for isolation and infection control, putting our healthcare systems under greater strain. This fact highlights the significance of strict implementation of maximal measures required to be taken for infection control in dialysis facilities[6]. At present, in our healthcare facilities a large number of such high risk hemodialysis dependent patients with advanced chronic kidney disease either suspected of or having a laboratory confirmed COVID-19 infection are being managed indoors for moderate to severe disease. Besides patients of end stage renal disease, dialysis support is also required for the effective management of critically ill COVID-19 patients with severe acute kidney injury[7-10]. In this article we share our experience of an improvised dialysis technique enabling the delivery of hemodialysis to COVID-19 affected patients at their bedside in isolation settings maintaining full personal protective measures enabling the safety of dialysis staff as well as avoiding the risk of infection spread to other unaffected susceptible patients receiving regular sessions of maintenance hemodialysis at dialysis unit.

METHODOLOGY

We have so far conducted bedside dialysis of 14 patients undergoing indoor treatment for moderate to severe COVID-19 infection by means of an improvised portable hemodialysis apparatus over a period of 3 months from April 2020 to June 2020. A large plastic tank carrying a capacity to hold 200 litres of processed water sufficient for a complete dialysis session was mounted on a wheeled trolley along with a 0.45hp electric water pump. After undergoing appropriate sanitation and sterilization processing the tank was filled with processed water from the reverse osmosis plant of our main dialysis unit. Subsequently filled water tank along with dialysis machine were manually driven by thetrained staff in full personal protective equipment (PPE) to the COVID isolation ward or intensive care unit. Water and electrical circuits were established at patient's bedside followed by initiation of hemodialysis session. At the conclusion of dialysis session, contaminated surfaces of the tank assembly underwent chemical disinfection with 0.05% sodium hypochlorite solution before being driven back to main dialysis unit where it was refilled for subsequent hemodialysis session.

RESULTS

From 1st April 2020 to 30th June 2020 a total of 14 patients underwent bedside hemodialysis by means of an improvised apparatus. Mean age of the patients was 59.92 years. There were twelve males (85.7%) and two females (14.3%).

A total of seventy five hemodialysis sessions were conducted with a mean of 5.35 sessions per patient. Eight patients (57.1%) underwent thrice weekly hemodialysis, four patients (28.6%) had

Figure-1: Bedside hemodialysis underway in COVID-19 Intencive Care Unit.

hemodialysis sessions twice a week while two patients (14.3%) only had a single hemodialysis session.

None of our cases had any significant

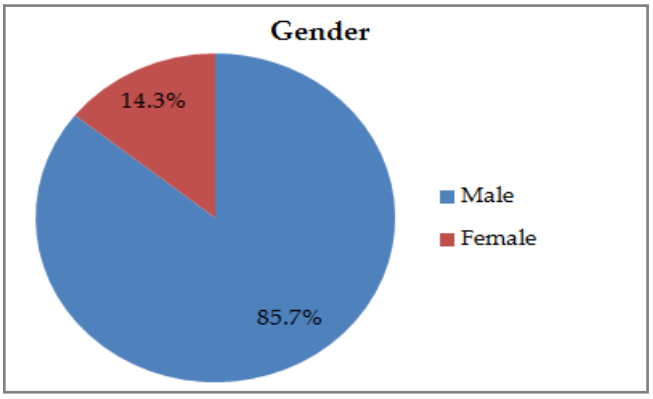

Figure-2: Gender distribution of COVID-19 patients on improvised hemodialysis.

procedure related complication. Nine patients (64.3%) were discharged after clinical recovery while five patients (35.7%) had an in hospital mortality.

DISCUSSION

Hemodialysis remains a key component of renal replacement therapy in the cases of end stage renal disease as well as severe acute kidney injury. The global burden of chronic kidney disease is growing day by day so is the burden of hemodialysis dependent population[11-13]. In the event of global pandemics involving highly infectious disease such as COVID-19, the delivery of hemodialysis remains an important entity in

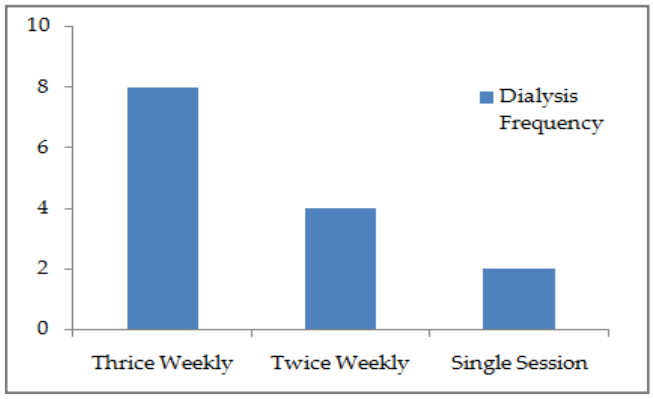

Figure-3: Distribution of the frequency of improvised hemodialysis sessions.

the management of disease affected patients with preexisting end stage renal disease as well as for critically ill patients with disease induced severe acute kidney injury while maintaining the safety of health care workers and unaffected patients

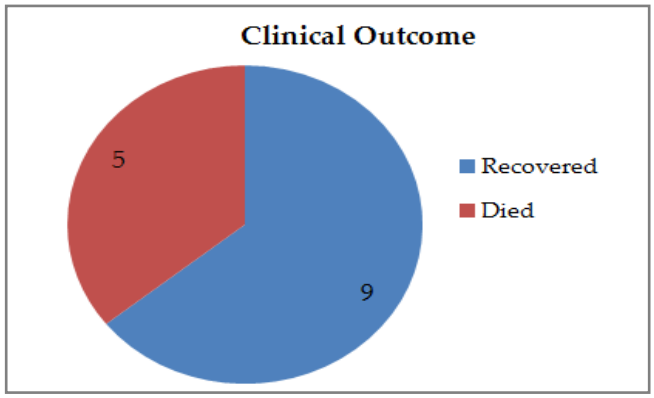

Figure-4: Frequency distribution of clinical outcome.

in dialysis units. The patients on maintenance hemodialysis have frequent movement from the community to dialysis centre and other health-care facilities making them potentially effective vectors in transmission of infectious diseases. COVID-19, an air borne infection after originating in China has rapidly spread across the world achieving the status of a global pandemic within a few months and it is now known that the viral shedding may start by 48 hours before the onset of disease symptoms and up to 25% of the

patients after getting infected with COVID-19 may never develop clinical symptoms further adding to the risk of dissemination of infection without even identification of affected persons[17]. The lengthy dialysis sessions conducted in close proximities increase the vulnerability of acquiring the infection among the dialysis patients with significantly impaired immune system necessitating the need of effective isolation measures in dialysis facilities. Although there is sufficient data available till date providing the guidance regarding appropriate measures to be taken within dialysis centres during the current COVID-19 pandemic however much less data is available sharing the experiences gained after the indoor management of COVID-19 patients with moderate to severe disease dependent on renal replacement therapy in isolation wards and critical care units. Presently the available data suggests that many of the healthcare facilities worldwide had been carrying out hemodialysis sessions of COVID-19 patients at the dialysis centres either in specified rooms or in separate shifts from those of unaffected patients, with arrangements to maintain personal protective measures especially hand and respiratory hygiene by the dialysis staff. Despite practicing appropriate measures at dialysis units there had been multiple incidents of spread of infection to unaffected patients sharing the same dialysis facility and healthcare staff[18-21]. In order to meet this challenge faced by dialysis facilities in the current pandemic, an improvised hemodialysis technique was employed at our hospital delivering the renal replacement therapy at the patient's bedside within the isolation wards and critical care unit which proved to be significantly effective in preventing the spread of infection to other unaffected dialysis dependent patients and healthcare staff.

Hemodialysis dependent COVID-19 patients managed indoors by Wang *et al* at Wuhan, China were of the ages between 47 to 67 years with dominance of male gender as 60% of their cases were males while 40% of the cases were females. The mean age of our patients was 59.92 years with predominance of male gender as 85.7% of our patients were males and 14.3% of the patients were females[18].

The data on the spread of COVID-19 infection at other dialysis facilities in Wuhan indicates that the infection eventually involved 26% of hemodialysis dependent patients and 33% of the healthcare staff despite appropriate steps taken for early detection of affected patients in dialysis units and full personal protective measures adopted by dialysis staff[19]. Brazilian data by Sesso *et al* sharing their experience in the management of the COVID-19 patients on renal replacement therapy also indicates the spread of infection to 2 of the health care workers in each of the two separate hospital facilities[20]. Similar data shared by Su *et al* has reported that 12.12% of the health care staff got infected while managing the hemodialysis dependent patients of COVID-19[21]. In our experience with the effective employment of improvised hemodialysis away from our main dialysis centre within the isolation settings there was not a single incident of spread of infection to any of the unaffected patients on maintenance hemodialysis or any of our dialysis staff.

The patients of end stage renal disease infected with COVID-19 have been found to develop severe disease with subsequent life threatening outcomes secondary to dysfunctional immune status[6]. The short term mortality has been found to be high in hemodialysis dependent patients especially those on mechanical ventilation in critical care units[14]. The data from Wuhan indicates that the mortality was observed in 52% of the hemodialysis dependent patients managed for COVID-19 infection while 28% patients were discharged after making a clinical recovery[19]. In the Brazilian data by Sesso *et al* the mortality was observed in 7.7% of the patients with 15.4% of patients recovered clinically while 76.9% of the patients still receiving indoor care because of inadequate clinical recovery[20]. In our management experience 64.3% of the patients had a complete clinical recovery with subsequent discharge from the hospital including two of the patients who were successfully weaned off from ventilatory support while 35.7% of the patients had an in

hospital mortality. Although mortality secondary to dialysis related metabolic abnormalities has also been reported during the current pandemic, however none of our patients had any significant procedure related complication[15,16]. The mortality observed in our setup was secondary to COVID-19 related respiratory complications mainly severe acute respiratory distress syndrome with subsequent respiratory failure and shock.

There remains a possibility of the addition of a portable reverse osmosis system in this hemodialysis setup resulting in availability of processed water within the isolation facility that would further help in reducing the risk of spread of infection[22]. However, with the utilization of the reverse osmosis facility of our main dialysis centre through the improvised apparatus after proper chemical disinfection, our portable hemodialysis system is comparatively much less expensive and its bedside availability makes it more feasible especially for critically ill and mechanically ventilated patients. Although, disinfection of the "dialysis drum" and its refilling for each session from reverse osmosis plant of main dialysis center may prove to be a bit cumbersome activity.

CONCLUSION

The bedside delivery of dialysis by means of an improvised manually mobile hemodialysis apparatus is effective in delivering adequate renal replacement therapy to the patients being managed in isolation settings in the event of a highly infectious and communicable pandemic such as COVID-19.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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