ABSTRACT

Introduction: The coronavirus disease 2019 (COVID-19) caused by novel coronavirus (SARS-CoV-2) infection has created a pandemic leading to a global struggle to cope with the sheer numbers of infected persons, many of whom require intensive care support. To date, there is no specific antivirus treatment for COVID-19. The use of convalescent plasma transfusions could be of great value in the current pandemic.

Methods: A Google Scholar and PubMed search was conducted between November 2019 and July 2020.

Results: We found 150 articles. After using the exclusion criteria and deleting duplicate articles, we reviewed 37 studies. We included 18 studies (5 case reports, 4 case-series, 2 systematic review, 7 article reviews) with 90 participants. Recovered SARS-CoV-2 patients who may be suitable donors undergo apheresis in order to obtain convalescent plasma containing high-titer antibodies, granted they meet blood donation criteria.

Conclusion: The benefits and effectiveness of convalescent plasma far outweigh the possible side effects, since there is no specific pharmacological therapy or vaccine available. Convalescent plasma therapy use in the management of patients at different severity levels of COVID-19 disease has become a management pillar in global management and an accessible option in developing countries.

Key words: COVID-19; SARS-CoV-2; Plasma; COVID-19 serotherapy (source: MeSH NLM).
INTRODUCTION

On March 11, 2020, the World Health Organization (WHO) declared coronavirus disease 2019 (COVID-19) caused by novel coronavirus (SARS-CoV-2) infection a pandemic. Since early December 2019 and up to July 2020, over 15 million COVID-19 infections with over 640,000 deaths are reported in 188 countries (1). Coronaviruses are enveloped viruses, with a positive-stranded RNA and a nucleocapsid. Among its structural elements, spike glycoproteins composed of two subunits (S1 and S2) are of great importance (2,3). Receptor-binding protein (RBD) is a peptide domain fundamental in the pathogenesis of infection; it represents a binding site for the human Angiotensin-Converting Enzyme 2 (ACE2) receptor (4). COVID-19 presentation ranges from asymptomatic form to conditions characterized by respiratory failure requiring mechanical ventilation and ICU support, reaching multiorgan and systemic manifestations like sepsis and septic shock (4,5). Virologic testing (i.e., using a molecular diagnostic or antigen test to detect SARS-CoV-2) should be done in all patients with symptoms consistent with COVID-19 and people with known high-risk exposures to SARS-CoV-2. The WHO recommends collecting specimens from the upper respiratory tract and lower respiratory tracts, such as expectorated sputum, endotracheal aspirate, or bronchoalveolar lavage (6). In the laboratory, amplification of the genetic material extracted from the saliva or mucus sample is processed through a reverse polymerase chain reaction (RT-PCR) to confirm the diagnosis (7). Despite the numerous studies reported on treatments, antiviral therapy for COVID-19 has not been approved, and vaccine development is still under clinical trials. Current treatment focuses on symptomatic management of hypoxemic patients ranging from conventional oxygen therapy to intubation and invasive mechanical ventilation (8). Among the multiple treatments proposed, convalescent plasma therapy represents a therapeutic option currently under study (5,9). The usage of plasma treatment has been described in several immunoglobulin therapies in the past for pathogens like H1N1 and Ebola virus disease, severe acute respiratory syndrome, and thrombocytopenia syndrome (10). Despite its use, COVID-19 history and the lessons learned from previous infections with SARS coronavirus and MERS-CoV, still raise concerns favoring careful surveillance by clinicians during human trials (11). In this review, we aim to recognize when convalescent plasma usage is appropriate, its effect on improving clinical symptoms, and the safety of convalescent plasma for COVID-19 by measuring the severity of its adverse effects based on the current literature.

METHODS

We performed a search in Google Scholar search and PubMed between November 2019 to July 2020, using the following terms: COVID, COVID19, SARS-CoV-2, convalescent plasma treatment, and plasma treatment therapy. The studies could be conducted worldwide and include participants of any gender, age, or ethnicity, with mild, moderate, or severe COVID-19.

Selection criteria

We included all studies (case reports, case series, meta-analysis) evaluating convalescent plasma treatment in patients testing positive for COVID-19.

We excluded studies including articles that no involve plasma as a treatment description, articles currently being performed, a language other than English or Spanish, letters to the editors, editorials, and abstracts.

RESULTS

We found 150 articles. After using the exclusion criteria and deleting duplicate articles, we reviewed 37 studies. We included 18 studies (5 case reports, 4 case-series, 2 systematic review, 7 article reviews) with 90 participants.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Study</th>
<th>Number of patients treated with convalescent plasma</th>
<th>Amount of CP plasma administrated</th>
<th>Efficacy</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhang et al., Aging, 2020</td>
<td>Case series</td>
<td>1</td>
<td>200 mL single dose</td>
<td>D-dimer remained increased Clinical recovery and transfer to general ward</td>
<td>No adverse effects observed</td>
</tr>
<tr>
<td>Zeng et al., J Infect Dis, 2020</td>
<td>Retrospective case-control</td>
<td>6</td>
<td>200–600 ml</td>
<td>All patients presented viral clearance achieved after convalescent plasma administration and one patient remained on the hospital</td>
<td>5 of 6 patients in the treatment group and 14 of 15 patients in the control group died</td>
</tr>
<tr>
<td>Zhang et al., Chest, 2020</td>
<td>Case series</td>
<td>4</td>
<td>200–2,400 ml</td>
<td>Pulmonological improvement on CT Clinical recovery and discharge from hospital</td>
<td>No adverse effects observed</td>
</tr>
<tr>
<td>Duan et al., Proc Natl Acad Sci USA, 2020</td>
<td>Clinical trial</td>
<td>19</td>
<td>200 mL single dose</td>
<td>Clinical recovery Pulmonological improvement on CT Reduced viral load Laboratory improvement</td>
<td>Two showed an evanescent facial red spot</td>
</tr>
<tr>
<td>Olivares-Gazca et al., Rev Invest Clin, 2020</td>
<td>Case series</td>
<td>10</td>
<td>200 mL single dose</td>
<td>Clinical recovery Laboratory improvement Pulmonological improvement on X-ray (6 out of 10) and CT (7 out of 10)</td>
<td>No adverse effects observed</td>
</tr>
<tr>
<td>Shen et al., JAMA, 2020</td>
<td>Case series</td>
<td>5</td>
<td>400 ml</td>
<td>Clinical recovery Reduced viral load Pulmonological improvement</td>
<td>No adverse effects observed</td>
</tr>
<tr>
<td>Im et al., J. Korean Med. Sci, 2020</td>
<td>Case report</td>
<td>1</td>
<td>250 mL for 2 consecutive days</td>
<td>Clinical recovery for 3 days after convalescent plasma Respiratory distress 4 days after achieving clinical improvement</td>
<td>No adverse effects observed</td>
</tr>
<tr>
<td>Xu et al., Virol J, 2020</td>
<td>Case report</td>
<td>1</td>
<td>Unknown</td>
<td>Clinical recovery</td>
<td>No adverse effects observed</td>
</tr>
<tr>
<td>Ahn et al., J Korean Med Sci, 2020</td>
<td>Case report</td>
<td>2</td>
<td>Unknown</td>
<td>Clinical recovery Reduced viral load Pulmonological improvement</td>
<td>No adverse effects observed</td>
</tr>
</tbody>
</table>
DISCUSSION

Since early December 2019 and up to July 2020, over 15 million COVID-19 infections with over 640,000 deaths are reported in 188 countries\(^1\). Former coronavirus epidemics, like severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), have caused numerous deaths. However, the scale and impact of the COVID-19 pandemic remain an unparalleled crisis for public health and the world economy challenging health facilities and healthcare workers worldwide\(^{2,3,12}\).

Coronaviruses are enveloped viruses, with a positive-stranded RNA and a nucleocapsid. Among its structural elements, spike glycoproteins composed of two subunits (S1 and S2) are of great importance\(^{2,3}\). Characteristic findings in SARS-CoV-2 infection are severe fever, cough, fatigue, dyspnea, and chest radiographs, revealing invasive multilobed lesions that might lead to intensive care unit admission (ICU). In contrast, nasal congestion, runny, and diarrhea are noted in some patients\(^2\). Despite the numerous studies reported on treatments, antiviral therapy for COVID-19 has not been approved, and vaccine development is still under clinical trials. Current treatment focuses on symptomatic management of hypoxemic patients ranging from conventional oxygen therapy to intubation and invasive mechanical ventilation\(^8,13\). One study that evaluated the treatment with dexamethasone in patients hospitalized with COVID-19, show the use of dexamethasone resulted in lower 28-day mortality among those who were receiving either invasive mechanical ventilation or oxygen alone at randomization but not among those receiving no respiratory support, that mean patient that are not critical ill the improvement was not important\(^14\).

Lack of proven antiviral treatment has led hospitals and clinicians to treat COVID-19 infection with convalescent plasma, a strategy of passive immunization used in the prevention and management of infectious diseases since the early 20th century. Recently recovered SARS-CoV-2 patients who may be suitable donors undergo apheresis in order to obtain convalescent plasma containing high-titer antibodies, granted they meet blood donation criteria\(^{12,16}\). Continuous centrifugation of donor blood allows a selective plasma collection. From this method, single apheresis can yield 400-800ml of plasma, which needs to be stored in 250mL units and frozen within 24h\(^7\). During apheresis, in addition to neutralizing antibodies (NAbs), proteins such as clotting factors, anti-inflammatory cytokines, defensins, pentraxins, and other undefined proteins are also obtained. Rojas et al.\(^2\) hypothesized that transfusion of convalescent plasma to infected patients might provide immunomodulation via decreasing a severe inflammatory response; thus, improving patient outcomes.

Considered convalescent plasma donors are asymptomatic individuals age 18-65, with a negative test for COVID-19 after 14 days of recovery and at the moment of the donation\(^2\). Donors' physical examination to establish good health and confirm the absence of respiratory symptoms and fever is essential\(^{16}\).

Based on the current findings, convalescent plasma treatment should be given to patients with COVID-19 at the right phase or severity of illness and at the right time point. During the first week after infection viremia usually peaks in most acute viral diseases, a primary immune response is found by day 10-14 following virus clearance. By the third week, inflammatory or hyperimmune attacks rather than direct virally caused tissue damage causes clinical deterioration. In theory, convalescent plasma should probably be administered early in the course of the disease (i.e., before day 14, or during the viremic and seronegative stage)\(^{11,18}\). Timing on convalescent plasma administration appears to be the key. Mild cases can resolve without treatment, yet convalescent plasma administration in critically ill patients with multiorgan failure does not reduce the mortality rate\(^{11,18}\).

On a systematic review\(^{15}\) authors suggested that the effectiveness of convalescent plasma in reducing hospital length of stay depends on early administration of the therapy, and use as prophylaxis is more likely to be beneficial than treating severe disease. We do not know the optimal timing and dosage of convalescent plasma therapy\(^{19,19}\). So prompt recognition of COVID-19 patients that are likely to become critically ill is vital to the administration of convalescent plasma. Convalescent plasma treatment can significantly decrease the relative risk of patients' mortality, as shown by previous evidence\(^{12}\); this may be because the antibodies from convalescent plasma could suppress viremia. Hence, the convalescent plasma intervention's effectiveness could depend on the level of SARS-CoV-2 neutralizing antibodies in donor plasma\(^{11,18}\). On chest CT scans, different degrees of absorption of pulmonary lesions were observed after...
transfusion[19]. Improvement of routine laboratory values and pulmonary function were among the laboratory findings: a significant increase in neutralizing antibody (NaBs) titers and lymphocyte count, and a decrease in C-Reactive protein, alanine aminotransferase, and aspartate aminotransferase after convalescent plasma transfusion[20,21]. Data from ten critically ill patients infected with COVID-19 from 3 different hospitals in Wuhan suggested high-titer convalescent plasma transfusion can effectively neutralize SARS-CoV-2, without severe adverse events. These patients showed improvement in clinical outcomes or were cured and discharged from the hospital[15,20].

Convalescent plasma is a generally safe and well-tolerated therapy (Table 1); although, side effects can occur. Currently, there is little information about severe adverse effects due to convalescent plasma, but symptoms reported are similar to those found in other types of plasma blood component transfusion, including fever or chills, allergic reactions, and transfusion-related acute lung injury (TRALI). Plasma transfusions are also known to cause transfusion-associated circulatory overload (TACO)[3,12,21]. Convalescent plasma decreased viral load, and there were no reported side effects[21,22]. A case report[23] noted that respiratory distress developed in two patients four days after convalescent plasma therapy showed clinical improvement.

CONCLUSION
Convalescent plasma provides the potential to render an immediate promising treatment option while evaluating existing drugs and developing new specific vaccines and therapies. It is important to note that in theory, convalescent plasma should probably be administered early in the course of the disease (i.e., before day 14, or during the viremic and seronegative stage). Still, appropriate timing on convalescent plasma administration and the severity of its adverse effects needs to be further studied. Furthermore, the benefits and effectiveness of convalescent plasma far outweigh the possible side effects, since there is no specific pharmacological therapy or vaccine available. Convalescent plasma therapy use in the management of patients at different severity levels of COVID-19 disease has become a management pillar in global management and an accessible option in developing countries.

Author’s contribution: The authors participated in: RChC, CLM and JJU in the genesis of the idea and design of the project, RChC in the collection of information and RChC, CLM, SMC, LCL in the interpretation of data, analysis of results and revision of the manuscript of the present work. research.
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