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Original Article

Efficacy of ganciclovir in the treatment of cytomegalovirus (CMV) infection in infants and its effect on inflammatory reaction and immune function

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Abstract: Objective: To investigate the efficacy of ganciclovir in the treatment of cytomegalovirus (CMV) infection in infants and its effect on inflammatory reaction and immune function. Methods: In this retrospective analysis, from January 2019 to December 2022, a total of 100 infants with CMV infection were collected from the Department of Pediatrics of Anhui Maternal and Child Health Hospital and divided into two groups (50 in each group) based on differences in intervention methods. The control group (CG) was given routine treatment and antiviral therapy, and the observation group (OG) was additionally given intravenous drip of 5-6 mg/kg ganciclovir on the basis of routine treatment given to the CG. After 21 d of treatment, the clinical efficacy, inflammatory factor levels, immunoglobulin levels, T-lymphocyte levels and incidence of adverse reactions of both groups were observed and compared. Results: After treatment, the overall response rate in the OG (92.00%) was significantly higher than that in the CG (76.00%) (P = 0.029). The OG after treatment displayed significantly lower levels of tumor necrosis factor α (TNF-α) and interleukin 6 (IL-6) (P = 0.006, P = 0.000), but significantly higher level of interleukin 10 (IL-10) than CG (P = 0.000). Compared with CG, levels of immunoglobulin G (IgG), immunoglobulin A (IgA), immunoglobulin M (IgM), $CD3^+$, $CD4^+$ and $CD4^+/CD8^+$ in the OG increased significantly (P = 0.048, P = 0.000, P = 0.000, P = 0.000, P = 0.000, P = 0.000), whereas level of $CD8^+$ decreased significantly (P = 0.000) after treatment. No significant difference in the incidence of adverse reactions between the two groups was observed (P > 0.05). Conclusion: Intervention of ganciclovir can effectively treat CMV infection in infants, reduce the inflammatory reactions and enhance the immune function of the body, without increasing the incidence of adverse reactions.

Keywords: Ganciclovir, cytomegalovirus, inflammatory factors, immunoglobulin, T-lymphocyte, adverse reactions

Introduction

Cytomegalovirus (CMV) is a kind of large and encapsulated virus, which belongs to the b-herpesvirus subfamily, and the virus particle is composed of a double stranded, 235 kb DNA genome [1]. The main target of CMV is epithelial cells, thus the virus is transmitted from host to host through mucosal epithelium [2]. CMV infects a wide range of human tissues and is subsequently secreted in body fluids such as urine, breast milk, saliva, and genital secretions. Both frequency and severity of CMV diseases are negatively correlated with immune capacity of host. Severe CMV diseases rarely occur in individuals with strong immune systems [3]. Therefore, most adult individuals infected with CMV do not exhibit specific clinical symptoms. However, infants are susceptible to CMV due to their underdeveloped immune system, and could be infected by congenital infections or acquired infections through breast milk, urine, and droplets [4, 5]. CMV infection in infants clinically manifests as overt symptoms, which is harmful to multiple organs, tissues, and systems throughout the whole body, resulting in diseases such as rash, persistent jaundice, hearing impairment, liver and lung injury, respiratory system, and nervous system diseases, of which can be serious or even life-threatening [6]. Consequently, it is suggested that more attention should be paid to infants suffering from CMV infection and effective treatment should be implemented.

Anti-virus and symptomatic treatments have been mainly used in the treatment of CMV infection currently. The purpose of symptomatic treatment including protecting the liver, reducing jaundice, and lowering liver enzymes is to alleviate the damage of CMV to tissues and organs, and ganciclovir is mainly used in etiological treatment [7]. At present, Ganciclovir is the preferred drug for treating CMV infection [8]. Ganciclovir, as a nucleoside analogue of guanosine, is the first antiviral drug found to be active against CMV [9]. Currently, it has been widely used in the treatment of infants with congenital and other acquired CMV infection. In cells, ganciclovir is first converted to ganciclovir triphosphate, which restrains the activity of CMV DNA polymerase by competitively inhibiting the incorporation of deoxyguanosine triphosphate into extended viral DNA and slows down the elongation of viral DNA to suppress viral replication, transcription, and activity of CMV [10, 11].

A large number of studies have only focused on the summary and analysis of clinical symptoms, diagnosis, and treatment of infants with CMV infection in the past; whereas, less research has been reported on the relationship between the onset of infants with CMV infection and changes in the inflammatory response and immune function of body. This study aimed to explore the efficacy of ganciclovir in the treatment of CMV infection in infants and its effect on inflammatory reaction and immune function, laying a theoretical foundation for effective immunotherapy combined with symptomatic treatment of CMV infection in the future.

Materials and methods

Clinical data

In this retrospective research, a total of 100 infants with CMV infection admitted to the Department of Pediatrics of Anhui Maternal and Child Health Hospital from January 2019 to December 2022 were collected and divided into two groups based on differences in intervention methods. Fifty infants treated with routine treatment were included in the control group (CG) and 50 infants additionally treated with ganciclovir were included in the observation group (OG) (**Figure 1**). All patients admitted to our hospital with CMV infection have undergone the examination of inflammatory cytokines levels including TNF-α, IL-6 and IL-10 in routine clinical practice, which was reflected in their medical records. This study was approved by the Ethics Committee of Anhui Maternity and Child Health Hospital (Permit Number: YYLL2021-2020YJ2(1)-01-01).

Inclusion and exclusion criteria

Inclusion criteria: (1) Patients with CMV infection confirmed by virological diagnosis and clinical diagnosis [5], (2) Patients ≤ 6 months old, (3) Patients with complete and standard medical records, including current and past medical history, as well as laboratory examination results, (4) Patients or their guardians who were informed of the content and purpose of this study and agreed to participate in this study.

Exclusion criteria: (1) Patients with allergic reaction to ganciclovir, (2) Patients who had recently received treatment of immune preparations, (3) Patients combined with liver or kidney disease, congenital disease and multiple pathogenic bacteria or virus infection, (4) Patients with incomplete data needed for this research.

Data collection

This retrospective research was conducted at Anhui Maternal and Child Health Hospital. All the data for this study were collected from the Electronic Medical Records System of Anhui Maternal and Child Health Hospital. All 100 printed paper medical records were manually reviewed, and the results were compared with the electronic medical records, and the accuracy of all data was fulfilled. Further examination was conducted on the medical records to ensure that the diagnosis met the criteria and was correct.

Methods

The CG was given routine treatment after admission, including anti-inflammatory, liver protection, maintenance of the balance of water electrolyte and acid-base, and antiviral therapy, such as vidarabine monophosphate (Guangdong Longfu Pharmaceutical Co., Ltd., H10970334, 5-10 mg/kg, once a day). The OG was additionally given intravenous drip of ganciclovir (Hubei Keyi Pharmaceutical Co., Ltd., H10980189, 50 mg/dose) on the basis of rou-

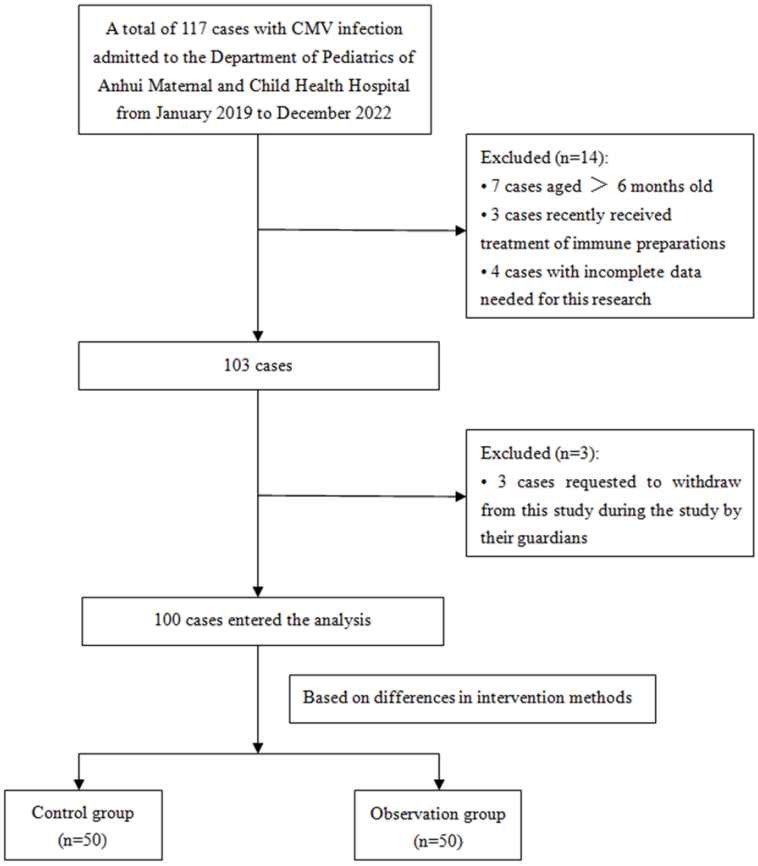

Figure 1. Flow chart for case inclusion in retrospective analysis.

tine treatment. Treatment was divided into induction period and maintenance period. Induction period treatment: ganciclovir, 5-6 mg/kg each time, dissolved in normal saline, intravenous drip, twice a day, for 14 consecutive days. Maintenance treatment: 5-6 mg/kg each time, once a day, for 7 consecutive days. The total course of treatment in both groups were 21 days [12].

Outcome measurement

(1) Evaluation of overall response rate. The overall response rate between the OG and CG after treatment was compared. At 21 d after treatment, the clinical efficacy was evaluated as apparent, improved, and ineffective, respectively. Apparent: clinical symptoms disappeared and laboratory indicators returned to normal after the complete treatment. Improved: clinical symptoms disappeared or improved significantly, but laboratory indicators partially return to normal. Ineffective: no improvement in clinical symptoms and laboratory indicators [13].

Overall response rate = (apparent + improved)/total number of cases × 100%.

(2) Determination of inflammatory factor levels. In both groups, 5 mL fasting peripheral blood was collected before and at 21 d after treatment, followed by centrifugation at 4°C and 3000 × g for 10 minutes, and inflammatory factor levels of tumor necrosis factor α (TNF-α), interleukin 6 (IL-6) and interleukin 10 (IL-10) were detected by Human TNF-α enzyme linked immunosorbent assay (ELISA) kit (Nanjing Senbeijia Biological Technology Co., Ltd., SBJ-H0038-96T), Human IL-6 ELISA kit (Nanjing Senbeijia Biological Technology Co., Ltd., SBJ-H0465-96T) and Human IL-10 ELISA kit (Nanjing Senbeijia Biological Technology Co., Ltd., SBJ-H0480-96T), respectively [14].

(3) Measurement of serum immunoglobulin levels. The serum samples isolated above were obtained and the levels of immunoglobulin G (IgG), immunoglobulin A (IgA), immunoglobulin M (IgM) were assayed by immunoturbidimetry.

(4) Investigation on T-lymphocyte levels. The serum samples isolated above were obtained in ethylene diamine tetraacetic acid (EDTA) and anticoagulant vacuum tubes, anti-CD3-FITC, anti-CD4-FITC and anti-CD8-FITC flow cytometry fluorescent labeled antibodies were added into each tube, each with 20 μL. The mixture was incubated in the dark at 25°C for 30 minutes, followed by centrifugation at 2000 r/min for 10 minutes at 4°C. The supernatant was discarded and 500 μL Phosphate buffered saline (PBS) buffer solution was added to suspend the precipitate, then the solution was centrifuged twice at 2000 r/min at 4°C for 10 minutes. On machine detection, anti-CD3 FITC, anti-CD4 FITC, and anti-CD8 FITC flow cytometry fluorescence labeling were applied to measure the levels of $CD3^+$, $CD4^+$ and $CD8^+$.

Table 1. Comparison of general clinical data between observation group and control group [($\bar{x}$ ± sd), n (%)]

General clinical data	Observation group (n = 50)	Control group (n = 50)	χ^2/*t*-value	*P*-value
Sex			0.162	0.687
Male	27 (54.00)	29 (58.00)		
Female	23 (46.00)	21 (42.00)		
Age (months)	3.78 ± 1.64	3.94 ± 1.19	-0.558	0.578
Weight (kg)	6.91 ± 1.94	7.14 ± 2.03	-0.580	0.563
Place of residence			0.396	0.529
Urban area	34 (68.00)	31 (62.00)		
Rural area	16 (32.00)	19 (38.00)		
Pregnancy age (years)	25.66 ± 3.55	26.32 ± 3.28	-0.965	0.337
Pregnancy condition			0.161	0.688
Primiparity	24 (48.00)	22 (44.00)		
Multiparity	26 (52.00)	28 (56.00)		
Mode of delivery			0.040	0.841
Eutocia	25 (50.00)	26 (52.00)		
Caesarean	25 (50.00)	24 (48.00)		

Ratio of $CD4^+/CD8^+$ = level of $CD4^+$/level of $CD8^+$.

(5) Observation on adverse reactions. The incidence of gastrointestinal reactions, granulocytopenia, thrombocytopenia and phlebitis in both groups during treatment was observed and recorded.

Statistical analysis

SPSS18.0 software was used for statistical data analysis and processing. For comparison of inflammatory factor levels, serum immunoglobulin levels and T-lymphocyte levels, the measurement data was expressed by mean ± standard deviation ($\bar{x}$ ± sd), and the comparison for intragroup before and after treatment were performed by paired sample *t*-test, the comparison for between-group were performed by the independent sample *t*-test. For comparison of clinical efficacy and adverse reactions, the counting data were expressed in n (%), and were compared by χ^2-test. The difference was statistically significant with $P < 0.05$.

Results

Comparison of general clinical data

No significant difference was observed in sex, age, weight, place of residence, pregnancy age, pregnancy condition and mode of delivery between OG and CG (all $P > 0.05$) (**Table 1**).

Comparison of clinical efficacy

After 21 days of treatment with ganciclovir, the overall response rate of the OG was 92% (35 cases apparent and 11 cases improved), which was significantly higher than the overall response rate of 76% (25 cases apparent and 13 cases improved) in the CG ($P = 0.029$), and the results were shown in **Table 2**.

Comparison of inflammatory factor levels

Before treatment, the differences in inflammatory factor levels between the two groups were not significant ($P > 0.05$) [(151.93 ± 29.35) vs (149.03 ± 28.74), (60.06 ± 11.59) vs (58.73 ± 9.71) and (130.35 ± 41.49) vs (131.35 ± 33.26)]. After 21 days of treatment, levels of serum TNF-α and IL-6 both decreased in the two groups and the OG showed significantly lower levels of serum TNF-α and IL-6 than the CG ($P = 0.006$, $P = 0.000$) [(89.42 ± 27.08) vs (102.97 ± 20.60) and (27.09 ± 5.20) vs (39.23 ± 6.53)]. Compared with pre-treatment, levels of IL-10 both increased in the two groups and the OG exhibited significantly higher level of IL-10 than the CG ($P = 0.000$) [(185.99 ± 32.88) vs (152.34 ± 37.62)]. The results were shown in **Figure 2**.

Table 2. Comparison of clinical efficacy between observation group and control group [n (%)]

Group	Apparent	Improved	Ineffective	Overall response rate
Observation group (n = 50)	35 (70.00)	11 (22.00)	4 (8.00)	46 (92.00)
Control group (n = 50)	25 (50.00)	13 (26.00)	12 (24.00)	38 (76.00)
χ^2-value		5.833		4.762
P-value		0.054		0.029

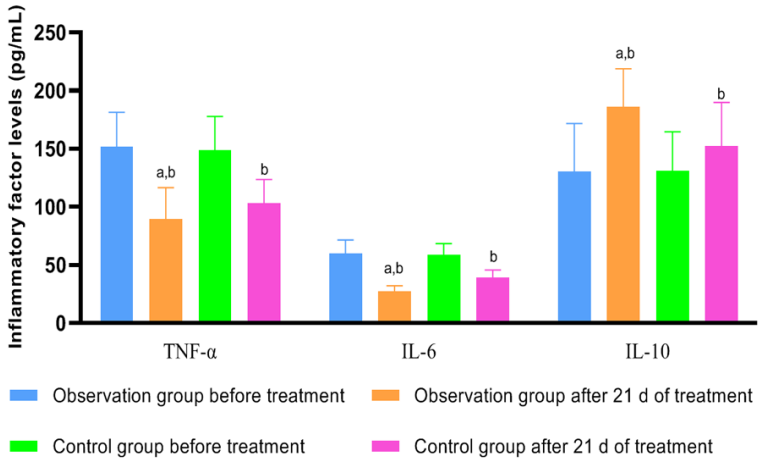

Figure 2. Comparison of inflammatory factor levels between observation group and control group. a represented *P* < 0.05 compared with the control group, b represented *P* < 0.05 compared with the pre-treatment in the same group.

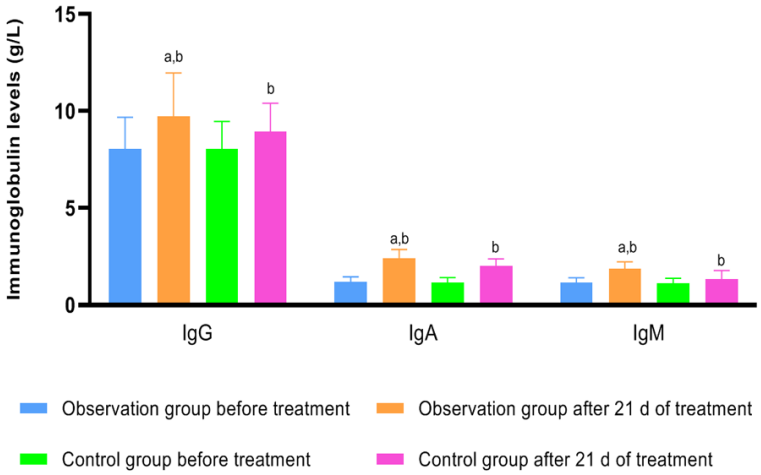

Figure 3. Comparison of immunoglobulin levels between observation group and control group. a represented *P* < 0.05 compared with the control group, b represented *P* < 0.05 compared with the pre-treatment in the same group.

Comparison of immunoglobulin levels

Before treatment, there was no significant difference in the levels of immunoglobulins between the two groups (*P* > 0.05) [(8.04 ± 1.64) vs (8.07 ± 1.40), (1.18 ± 0.28) vs (1.16 ± 0.25) and (1.15 ± 0.25) vs (1.12 ± 0.27)]. After 21 days of treatment, the serum levels of IgG, IgA and IgM both increased in the two groups, and the OG displayed significantly higher levels of IgG, IgA and IgM than the CG (*P* = 0.048, *P* = 0.000, *P* = 0.000) [(9.72 ± 2.25) vs (8.96 ± 1.44), (2.41 ± 0.46) vs (2.00 ± 0.38) and (1.87 ± 0.35) vs (1.35 ± 0.43)]. The results were presented in **Figure 3**.

Comparison of T-lymphocyte levels

Before treatment, no significant difference in T-lymphocyte levels between the two groups was observed (*P* > 0.05) [(48.31 ± 8.77) vs (49.26 ± 10.63), (32.35 ± 6.87) vs (31.08 ± 5.46), (35.34 ± 7.48) vs (36.35 ± 6.85) and (0.96 ± 0.30) vs (0.89 ± 0.25)]. After 21 days of treatment, levels of serum $CD8^+$ both decreased in the two groups and the OG showed significantly lower level of serum $CD8^+$ than the CG (*P* = 0.000) [(25.33 ± 5.67) vs (30.32 ± 6.29)]. Compared with pre-treatment, levels of $CD3^+$, $CD4^+$ and $CD4^+/CD8^+$ ratio increased in the two groups and the OG had significantly higher levels of $CD3^+$, $CD4^+$ and $CD4^+/CD8^+$ ratio than the CG (*P* = 0.000, *P* = 0.000, *P* = 0.000) [(72.39 ± 9.88) vs (63.38 ± 11.24), (42.15 ± 9.24) vs

Table 3. Comparison of immunoglobulin levels between observation group and control group ($\bar{x}$ ± sd)

Group	Time	$CD3^+$ (%)	$CD4^+$ (%)	$CD8^+$ (%)	$CD4^+/CD8^+$
Observation group (n = 50)	Before treatment	48.31 ± 8.77	32.35 ± 6.87	35.34 ± 7.48	0.96 ± 0.30
	21 d after treatment	72.39 ± 9.88[a,b]	42.15 ± 9.24[a,b]	25.33 ± 5.67[a,b]	1.77 ± 0.62[a,b]
Control group (n = 50)	Before treatment	49.26 ± 10.63	31.08 ± 5.46	36.35 ± 6.85	0.89 ± 0.25
	21 d after treatment	63.38 ± 11.24[b]	35.15 ± 7.23[b]	30.32 ± 6.29[b]	1.19 ± 0.30[b]

a represented $P < 0.05$ compared with the control group; b represented $P < 0.05$ compared with the pre-treatment in the same group.

Table 4. Comparison of adverse reactions between observation group and control group [n (%)]

Group	Adverse reactions				Total adverse reactions
	Gastrointestinal reactions	Granulocytopenia	Thrombocytopenia	Phlebitis	
Observation group (n = 50)	4 (8.00)	3 (6.00)	5 (10.00)	7 (14.00)	19 (38.00)
Control group (n = 50)	4 (8.00)	5 (10.00)	3 (6.00)	4 (8.00)	16 (32.00)
χ^2-value	0.000	0.543	0.543	0.919	0.396
P-value	1.000	0.461	0.461	0.338	0.529

(35.15 ± 7.23) and (1.77 ± 0.62) vs (1.19 ± 0.30)]. The results were indicated in **Table 3**.

Comparison of adverse reactions

After 21 days of treatment, no significant difference in the incidence of adverse reactions between the two groups was observed, including gastrointestinal reactions, granulocytopenia, thrombocytopenia, phlebitis, and total adverse reactions ($P > 0.05$), and the results were illustrated in **Table 4**.

Discussions

CMV is one of the most common pathogens in viral infections, and it is mostly in an invisible infection state. Individuals with competent immune function often show self-limiting symptoms after suffering from CMV. However, infants have not yet fully developed and formed a complete immune barrier. Once they are infected with CMV, the virus cannot be completely cleared by the body, and may invade multiple systems and organs to pose a huge threat to the life safety of infants [15, 16]. At present, CMV infection in infants has become a worldwide disease, which brings a significant medical burden on clinical and public health services, it is important to improve effective treatment for early CMV infection in infants [17]. As a new type of nucleoside drug, ganciclovir is a broad-spectrum antiviral drug. It enters the human body through intravenous administration and is converted into ganciclovir phosphate. Under the influence of intracellular kinase in CMV infected cells, it is eventually converted into ganciclovir triphosphate, which inhibits the synthesis of CMV-DNA and terminates the elongation of DNA strand to stop the replication of virus [18]. Yu et al. [19] applied ganciclovir to treat infants with CMV infection, and the results showed that ganciclovir had a significant antiviral effect on CMV infection. In this study, the overall response rate of the OG (92%) was significantly higher than that of CG (76%) after treatment ($P = 0.029$), which was in accordance with the research results of the above research reported by Yu et al., suggesting that compared to routine treatment, the addition of ganciclovir had a better therapeutic effect on CMV infection in infants.

Infection with CMV in infants often results in a series of immune reactions. Inflammation, as an innate immune response, is a basic self-protective response in the human body [20]. However, due to the immaturity of immune system, infants and young children are prone to excessive inflammation [21]. In the immune response process of CMV infection, IL-10 and TNF-α have been found to play an important role in the treatment [22]. TNF-α and IL-6 are cytokines produced by activated monocytes/macrophages, which are crucial regulators of inflammation, playing a remarkable role in pro-inflammatory responses and triggering a series

of immune responses [23, 24]. An appropriate amount of TNF-α promotes the phagocytosis of neutrophil granulocyte, regulates the metabolism and immunity of the body, and increases the ability to resist virus invasion. However, excessive TNF-α results in adhesion of neutrophil granulocyte to endothelial cells to induce the release of IL-1, IL-6 and other cytokines, leading to excessive inflammatory reaction and aggravating the cell damage. In addition, the anti-inflammatory cytokine IL-10 plays a protective part in inhibiting inflammatory responses. Activation of IL-10 inhibits over-expression of TNF-α, IL-6 and IL-8 and dampens inflammation [25]. In the present research, compared to the CG, the levels of serum TNF-α and IL-6 in the OG after treatment of ganciclovir decreased significantly (P = 0.006, P = 0.000), but the level of serum IL-10 increased significantly (P = 0.000). It was indicated that application of ganciclovir could effectively reduce the levels of the pro-inflammatory factors TNF-α and IL-6, as well as increase the level of anti-inflammatory factor IL-10, thereby to reduce the inflammatory response.

Immunoglobulin includes a group of globulins with immune function, which are plasma cells transformed from B lymphocytes stimulated by antigens. Immunoglobulin produces antibodies that specifically bind to the corresponding antigen. IgG is the main component of immunoglobulin and the only antibody that passes through the placenta. It plays a crucial role in activating complement, neutralizing toxins and combating infection in the immune response [26]. The content of IgA in serum is only lower than that of IgG. The mucosal defense system constituted by IgA is an important immune barrier of the body to inhibit the colonization of exogenous pathogenic microorganisms in the respiratory tract and slow down the reproduction rate of the virus [27]. IgM displays the physiological effects such as sterilization, complement activation, agglutination and immune regulation. It also participates in pathological processes of certain hypersensitivity reactions and immune diseases [28]. Hypoimmunoglobulinemia is closely associated with CMV disease. A decrease in immunoglobulin level increases susceptibility to CMV infection and exacerbates CMV infection. Moreover, the stability of immune function and the balance of T cell subgroups are also influenced by CMV infection. The presence of lymphokine activated killer cell (LAK) significantly reduces the activity of natural killer cell (NK) to aggravate the reduction of immunoglobulin level [29, 30]. Zhou et al. [31] concluded that compared to the normal population, a significant reduction of serum IgA level in patients infected with CMV was observed. Another study [32] also reported that the levels of IgG, IgM and IgA significantly decreased in the CMV group. The results of our work were consistent with the results in the above studies reported. After 21 d of treatment with ganciclovir, the serum levels of IgG, IgA, and IgM in both groups increased compared with those before treatment. In addition, the serum levels of immunoglobulin in the OG increased significantly than those in the CG (P = 0.048, P = 0.000, P = 0.000), suggesting that intervention with ganciclovir could increase the serum immunoglobulin levels and restore the immune barrier function of the body in infants suffering from CMV.

Levels of T lymphocyte subgroups are an important indicator of cellular immune function, reflecting the cellular immune status in the body and being of great significance for the diagnosis and observation of curative effect on certain diseases [33]. $CD3^+$ represents the total value of mature T lymphocytes. $CD4^+$ is a notable immune cell in the human immune system, mainly expressed in Th cells, and plays an essential part in regulating the immune response of body [34]. $CD8^+$ is suppressive lymphocyte and has been considered a key mediator in cellular immune response against pathogens for a long time to directly mediate the killing and clearing of cells infected by pathogens in the immune response [35]. CMV infection is the most known inducer of the differentiation of T lymphocytes and results in immune disorders in T lymphocyte subgroups. A decrease in $CD4^+$ levels and an abnormal increase in $CD8^+$ levels occurs, which may be related to CMV replication [36, 37]. Additionally, immune dysregulation and immunosuppression associated with the damage to $CD4^+$ cells and macrophages may increase susceptibility to exogenous bacteria, fungi, or viruses, including Epstein-Barr (EB) virus and human herpesvirus (HHV)-6 [38]. Avila-Agüero et al. [39] found that patients with CMV infection showed lower levels of serum IgG and $CD4^+/CD8^+$ ratios, but most patients recovered after treat-

ment with ganciclovir. The results of our research were similar to the above results. In this study, compared with the CG, the levels of $CD3^+$, $CD4^+$ and $CD4^+/CD8^+$ ratio in the OG significantly increased after treatment with ganciclovir ($P = 0.000$, $P = 0.000$, $P = 0.000$), while the level of $CD8^+$ significantly decreased ($P = 0.000$). It was found that application with ganciclovir could restore the levels of T lymphocytes to normal in infants with CMV and improve the immune function of the body.

It was reported that ganciclovir could initiate some side effects in infants with CMV infection during the treatment process, such as swelling and pain at the injection site, rash, liver function damage and bone marrow suppression, etc., seriously interfering with the prognosis of patients [40]. In our work, no significant difference in the incidence of adverse reactions between the two groups after 21 d of treatment was observed ($P > 0.05$), indicating that the use of ganciclovir for the treatment of CMV infection in infants was safe and reliable.

However, there were still some limitations in this research. Firstly, all subjects enrolled were patients, and no healthy individual was collected. Therefore, the difference between infants suffering from CMV and healthy individuals was not discussed. Secondly, a relatively small number of cases were enrolled in our study, and there were some limitations in the data processing in the experiment, so more cases still need to be collected for validation. Additionally, although ganciclovir has always been the preferred drug for the treatment of CMV infection, it is not sufficient to show moderate antiviral activity on CMV [41]. With the clinical application of new anti CMV drugs, such as letermovir, comparing the efficacy of ganciclovir with other treatment regimens or combination therapies will be included in further studies.

In conclusion, the treatment of infants suffering from CMV infection with ganciclovir can effectively improve clinical efficacy, reduce the inflammatory reactions and enhance the immune function of the body, without increasing the incidence of adverse reactions.

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Disclosure of conflict of interest

None.

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