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CASE REPORT

Recurrent Checkpoint Inhibitor-Related Pneumonitis Refractory to Corticosteroid Treatment: A Case Report and Literature Review

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Background: Immune checkpoint inhibitors (ICIs) are antibodies that activate the immune system to kill tumor cells and have been widely used in oncology. However, dysregulated immune activation may result in the attack of normal tissues and organs, leading to immune-related adverse events (irAEs). Corticosteroid-refractory irAE pneumonitis severely threatens patient survival and is characterized by a lack of high-level evidence-based management guidelines, highlighting the need for increased scrutiny in this area.

Case Presentation: This article presents the diagnosis and treatment of a patient with lung squamous cell carcinoma who developed recurrent corticosteroid-refractory grade 3 checkpoint inhibitor- related pneumonitis (CIP) during treatment with the ICI tislelizumab. The management approach included the use of intravenous immunoglobulin (IVIG) and mycophenolate mofetil (MMF). The case is thoroughly analyzed and discussed, accompanied by a review of relevant literature.

Conclusion: IVIG and MMF showed effectiveness in corticosteroid-refractory CIP, and further investigation is warranted to establish standardized guideline and to optimize therapeutic drug monitoring for immunosuppressive agents.

Keywords: immune checkpoint inhibitors, corticosteroid-refractory, pneumonitis, mycophenolate mofetil

Introduction

In recent years, significant advancements have been achieved in the field of oncology through the development of immunotherapy. Various immune checkpoint inhibitors (ICIs) have been developed, which activate the immune system to restore normal function and kill tumor cells, offering more treatment options for patients.[1] However, aberrant immune activation may attack normal tissues and organs, leading to immune-related adverse events (irAEs) and posing serious threats to patient health.[2] Early diagnosis and appropriate management of irAEs are critical.

Checkpoint inhibitor-related pneumonitis (CIP) is the most prevalent corticosteroid-refractory irAE in lung cancer patients and is frequently associated with high mortality. Management typically requires combination immunosuppressive therapy. Compared to other corticosteroid-refractory irAEs, CIP exhibits lower response rates to immunosuppressants, thereby complicating therapeutic efforts.[3] Currently, there is a paucity of prospective or comparative studies to establish optimal treatment strategies for corticosteroid-refractory CIP. Mycophenolate mofetil (MMF), an oral immunosuppressant, is commonly used in irAE cases such as immune hepatitis and myocarditis but is rarely reported for CIP, with no standardized dosing or monitoring protocols. This case report details the diagnosis and treatment of recurrent corticosteroid-refractory CIP, including MMF use and blood concentration monitor, and provides a literature review.

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Case Presentation

Patient History and Baseline Status

A 59-year-old male patient with a medical history of gastric ulcer and type 2 diabetes presented with progressively worsening cough and hemoptysis over six years.

Clinical Course and Diagnostics

In February 2023, he was diagnosed with right lung squamous cell carcinoma (LUSC), classified as cT4N3M1a stage IV, with a tumor PD-L1 score (TPS) of 35%. From February 10 to March 8, 2023, he received first-line therapy comprising tislelizumab, albumin-bound paclitaxel (nab-paclitaxel) and carboplatin, achieving a partial response (PR) after two cycles. In March 2023, he developed grade 2 CIP, which was alleviated with methylprednisolone. In May 2023, he developed hypothyroidism secondary to immunotherapy, managed with levothyroxine. From May 16 to July 31, 2023, he continued chemotherapy (cycles 3–6) without immunotherapy. After six cycles, PET/CT showed sustained PR, though retroperitoneal lymph nodes exhibited progressive metabolic activity. Considering the patient's high PD-L1 expression and previously manageable irAEs, immunotherapy was rechallenged. From August 31, 2023, to January 23, 2024, he received half-dose tislelizumab combined with nab-paclitaxel (cycles 1–6), maintaining PR. Subsequent maintenance therapy (cycles 7–16) with half-dose tislelizumab also maintained PR (Figure 1).

Following the final treatment in November 2024, the patient presented exacerbation of symptoms, including a worsening cough with white sputum and orthopnea. On December 9, 2024, he was admitted with bilateral coarse crackles. Laboratory examination showed an elevated C-reactive protein level, normal procalcitonin levels, and hypoxemia with PaO_2/FiO_2 ratio (P/F ratio) of 260. Computed tomography (CT) scans demonstrated diffuse bilateral infiltrates affecting more than 50% lung tissue, consistent with grade 3 CIP. Tests and examinations excluded heart failure and the patient was unable to cooperate with tracheoscopy.

Stepwise Treatments

Initial treatment included methylprednisolone 60mg daily, moxifloxacin, and levothyroxine adjustment. By December 10, 2024, the patient's condition had deteriorated further, with decrease of P/F ratio to 206. Sputum smear was negative for infection. Methylprednisolone dosage was increased to 120mg daily. Given the anticipated long-term use of corticosteroids, trimethoprim-sulfamethoxazole (TMP/SMZ 80 mg/400 mg) was prescribed at one tablet daily to prevent pneumocystic Carinii pneumonitis. On December 12, 2024, the patient's cough intensified with the P/F ratio declined to 200, indicating a downward trend. This was considered to be corticosteroid-refractory CIP. Intravenous immunoglobulin (IVIG) was administered at a dosage of 400mg/kg (actual dose 25g) daily for 5 days, along with MMF capsules at 1g twice daily (bid) orally. The metabolite mycophenolic acid (MPA) was monitored (refer to detailed in discussion). Next generation sequencing of the patient's sputum detected a low number of viral sequences without evidence of infection; therefore, antibiotics were discontinued. On December 13, 2024, the patient's cough significantly relieved with P/F ratio increasing to 248. Consequently, the dosage of methylprednisolone was tapered to 80mg daily. By December 19, the P/F ratio had normalized to 352, and CT scans indicated significant resolution of inflammation. Corticosteroid were gradually tapered and completely discontinued on January 31, 2025. MMF was discontinued on January 6, 2025, due to self-administered cessation after 15 days.

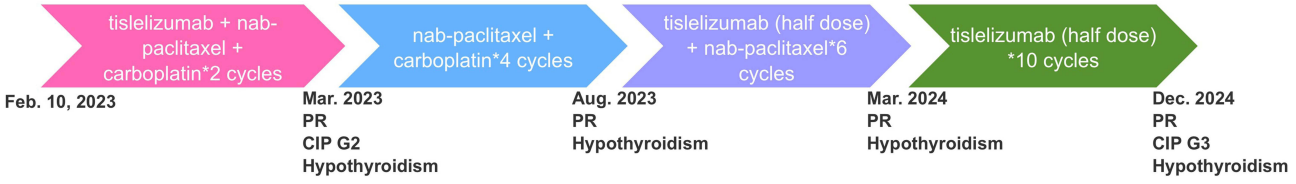

Figure 1 The history of the patient's antitumor therapy.

Outcomes

On March 19, 2025, PET/CT revealed that CIP had nearly achieved complete remission, and antitumor therapy with nab-paclitaxel was restarted (Figure 2). The last follow-up was in June 2025. To date, the patient has completed 3 cycles of nab-paclitaxel treatment, and the disease has remained stable.

Discussion

The Current Treatment of CIP

Severe CIP is a rare but explosive and fatal serious adverse event, accounting for 35% of the death events related to PD-1/PD-L1 inhibitors.[4] In patients with non-small cell lung cancer undergoing monotherapy with PD-1/PD-L1 inhibitors, the incidence of pneumonitis is observed to be below 5%, with the incidence of grade 3 or higher pneumonitis is 0–1.7%. Notably, patients receiving PD-1 inhibitors monotherapy exhibit a higher incidence of immune-related pneumonitis compared to those receiving PD-L1 inhibitors.[5] Furthermore, individuals with non-small cell lung cancer and renal cancer demonstrate greater susceptibility to immune-related pneumonitis than those with malignant melanoma, The incidence of pneumonitis in combination therapy is higher than that in monotherapy with PD-1/PD-L1 inhibitors.[6] In this case, the patient experienced CIP on two occasions during the treatment of squamous cell lung cancer. The initial occurrence transpired approximately 46 days following the administration of tislelizumab, aligning with the typical timeline for the onset of immune adverse reactions. Based on the medical history, laboratory tests, examinations and existing literature, the second occurrence can be diagnosed as recurrent CIP. According to the "Guidelines for the Collection and Reporting of Individual Adverse Drug Reactions" and the Common Terminology Criteria for Adverse Events (CTCAE 5.0), the evaluation of the correlation between tislelizumab and CIP is "definite", and the severity grade of this case of CIP is grade 3.[7] Glucocorticoids are the primary treatment for CIP, and early intervention with glucocorticoids is a critical component of the comprehensive management of immune-related toxicity.[8,9] Despite the administration of an adequate dosage of glucocorticoids, the patient's CIP continued to progress after 48 hours, consistent with corticosteroid-refractory CIP.

For corticosteroid-refractory CIP, current guidelines and consensus recommend the selective addition of IVIG, tocilizumab, infliximab, mycophenolate mofetil, etc. for treatment.[10–12] However, there remains a paucity of high-quality evidence to definitively establish the optimal therapeutic approach for corticosteroid-refractory CIP.

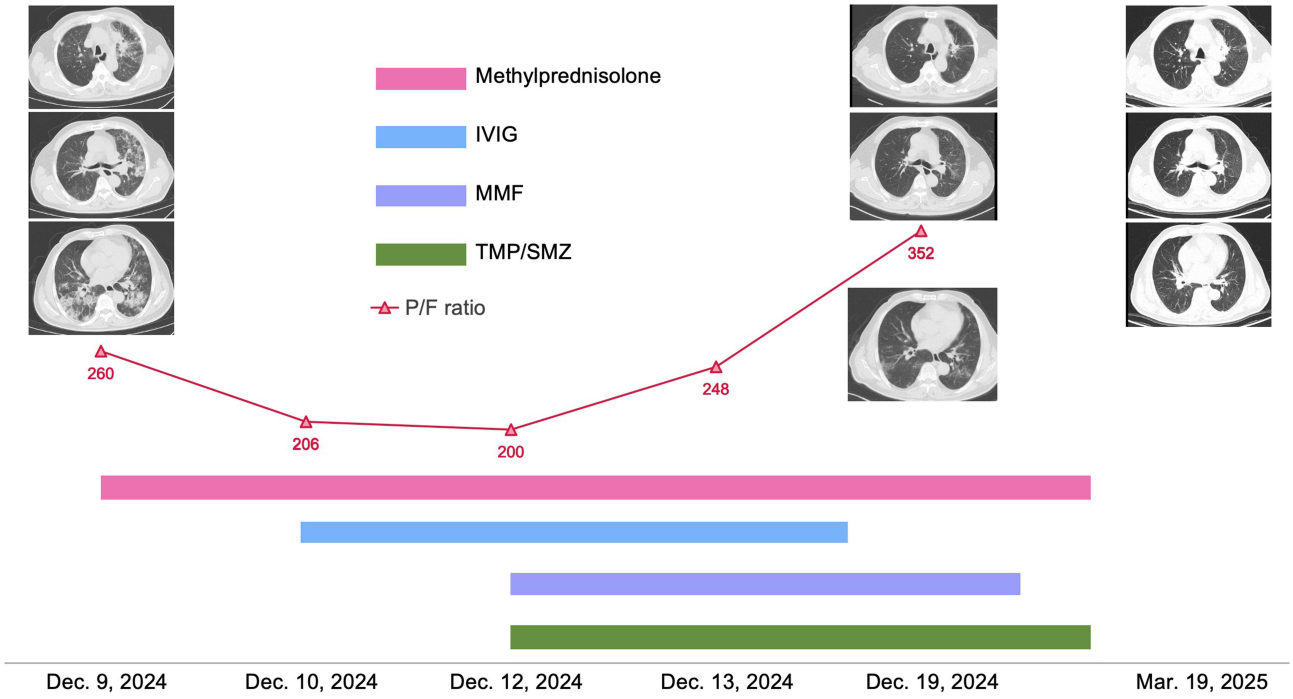

Figure 2 The history of recurrent corticosteroid-refractory CIP therapy.

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Consequently, the treatment of corticosteroid-refractory CIP often relies on the experience and capabilities of the medical team. Nevertheless, retrospective studies and case reports can provide valuable insights and inform clinical practice.

Literature Review

In a retrospective study, 12 patients with corticosteroid-refractory CIP were analyzed. Of these, 7 patients received IVIG treatment, 2 patients received infliximab treatment, and 3 patients received the combined treatment of IVIG and infliximab. The study found that 8/12 (75%) patients succumbed to CIP or infectious complications, including 3 patients who received IVIG treatment and all 5 patients who received infliximab treatment.[13] This study indicated significant variability in the clinical course and outcomes for patients with corticosteroid-refractory CIP. Notably, patients who received IVIG monotherapy exhibited improvement in oxygen requirements and the level of care, alongside a reduced mortality rate. Conversely, those treated with regimens containing infliximab experienced poorer outcomes. Additionally, a case report documented the use of IVIG for treating corticosteroid-refractory CIP, wherein the patient's condition markedly improved within 72 hours post-administration of IVIG, and stabilized following ongoing glucocorticoid therapy.[14] A single-center retrospective study showed that 34 patients with corticosteroid-refractory CIP (88.2% with lung cancer) were treated with tocilizumab, including 12 patients with grade 3–4 pneumonitis. The results showed that 79.4% of the patients (27/34) showed clinical improvement, and most patients only required a single dose or two doses of treatment.[15] In addition, a series of case reports indicated that most patients with corticosteroid-refractory irAE could benefit from tocilizumab treatment.[16] A retrospective study analyzed the efficacy of 26 patients with CIP treated with a combination of glucocorticoids and immunosuppressants. The results showed that when infliximab was used as the initial immunomodulator, the improvement rate for persistent pneumonitis was merely 20% (4 out of 20), with a 90-day survival rate of 35% (7 out of 20). In contrast, mycophenolate mofetil demonstrated a superior response, with an improvement rate of 83% (5 out of 6) and a 100% 90-day survival rate (6 out of 6).[17] Furthermore, several retrospective studies have shown that the efficacy of infliximab in the treatment of CIP is limited, with some studies reporting negligible or even adverse outcomes, including the aforementioned two retrospective analyses.[18] Therefore, there is some controversy about the application of infliximab in the treatment of CIP in the real world. In the treatment of steroid-refractory CIP, IVIG is recommended as a reasonable alternative to infliximab.[19] We reviewed the reports of mycophenolate mofetil used in the treatment of CIP (Table 1), in which 2 cases achieved complete remission of CIP following combined therapy of mycophenolate mofetil and glucocorticoids. Additionally, a systematic review recommends the combined treatment of MMF and IVIG for corticosteroid-refractory CIP, by summarizing the existing evidence on steroid-refractory irAE and evaluating the guidelines related to irAE.[20] Thus, IVIG appears to be a relatively effective and safe option for corticosteroid-refractory CIP, and the immunosuppressant combined on this basis needs to be carefully selected. Based on the available clinical data and the urgency of the patient's condition, which could not wait for a long infection

Table 1 Summary of Cases Treated with MMF for CIP

No.	Disease	ICIs	CIP Status	MMF Dosage	Combined Immune Modulators	CIP Outcome
1[21]	ES-SCLC	Sintilimab	Grade 2 relapsed to Grade 3 with fungal and bacterial infections	1.5g bid	Methylprednisolone, Infliximab	Poorly controlled CIP, death, survival 76 days
2[21]	LUSC Stage IV	Sintilimab	Grade 3 relapse with fungal and bacterial infections	1g bid	Methylprednisolone, IVIG (not used during relapse)	Initial response, poorly controlled CIP after relapse, death, survival 58 days
3[22]	LUSC Stage IVB	Pembrolizumab	Grade 2 steroid-resistant, relapsed to Grade 3	1g qd	Prednisolone	Complete remission, no recurrence of CIP or lung cancer
4[22]	LUSC Stage IVA	Pembrolizumab	Grade 3 steroid-resistant, relapse	1g qd	Prednisolone	Complete remission, no CIP recurrence, but lung cancer progressed

(*Continued*)

Table 1 (Continued).

No.	Disease	ICIs	CIP Status	MMF Dosage	Combined Immune Modulators	CIP Outcome
5[23]	LS-SCLC	Atezolizumab	Grade 3 with radiation-related pneumonia and bacterial infection	1g bid	Methylprednisolone, Infliximab, IVIG	Significant symptom relief, radiological improvement, but liver metastasis progressed
6[24]	LUSC Stage IIB	Atezolizumab	Grade 4 with Klebsiella pneumoniae infection	1g bid	Methylprednisolone, IVIG	Significant symptom relief, radiological improvement
7[25]	LUSC	Pembrolizumab	Grade 4 with cytomegalovirus infection	NA	Prednisone, IVIG	Disease worsened, death
8[26]	Melanoma Stage IV	Pembrolizumab	Pneumonia relapse after steroid tapering	Bid	Prednisone, Infliximab	Steroid and MMF-resistant, rapid and durable response to infliximab, melanoma-maintained remission

Abbreviations: ES-SCLC, Extensive-Stage Small Cell Lung Cancer; LUSC, Lung Squamous Cell Carcinoma; LS-SCLC, Limited-Stage Small Cell Lung Cancer; NA, Not Available.

screening, and considering that the combined medication would bring more benefits, in this case, the treatment with intravenous human immunoglobulin combined with MMF capsules was initiated as soon as possible. After the treatment, the CIP achieved complete remission.

TDM for MMF

After oral administration, MMF is rapidly and completely metabolized into mycophenolic acid (MPA), which has immunosuppressive activity. However, significant inter-individual variability exists in the pharmacokinetics of MMF, and a certain correlation has been observed between drug exposure and both therapeutic efficacy and adverse reactions. Consequently, therapeutic drug monitoring (TDM) is deemed essential for MMF. Presently, most reports on the use of MMF for the treatment of irAE do not incorporate MMF monitoring, with only a single case describing the use of MMF in treating autoimmune hepatitis has attempted this.[27] MMF is well-documented in the context of kidney transplantation, and its blood concentration reference range is also constructed based on the correlation between the combined medication for kidney transplantation outcomes. The application of MMF for irAE is relatively recent, and there remains a paucity of clinical research and data in this area. Therefore, only the treatment range for kidney transplantation can be referred to currently.

The T_{max} of oral administration of mycophenolate mofetil range from 0.5 to 1 hour, with a half-life of 17.9 (±6.5) hours. TDM can be conducted once steady-state blood concentration is achieved by the 5th day. According to the relevant guidelines and consensus, the pharmacokinetic parameter used for the TDM of MMF is MPA-AUC, and the formula of the "three-point method" [30 minutes before drug administration (C_0 trough concentration), 0.5 hour after drug administration ($C_{0.5}$ peak concentration) and 2 hours after drug administration (C_2)] is used for calculation.[28,29] In this case, the patient received oral mycophenolate mofetil 1g twice daily on December 12, 2024, and blood samples were collected 0.5 hour before drug administration, 0.5 hour after drug administration and 2 hours after drug administration for laboratory testing on December 17, 2024. The test indicated that the C_0 of MPA was 1.74 μg/mL, $C_{0.5}$ was 8.75 μg/mL, and C_2 was 2.31 μg/mL. The MPA-AUC was 47.6 mg·h/L when combined with tacrolimus, and 35.8 mg·h/L when combined with cyclosporine A. According to the recommended formula for calculation, the MPA-AUC has met the reference range in the guidelines of kidney transplantation (30–60 mg·h/L), and it can be considered that a satisfactory immunosuppressive effect can be achieved, but it should be noted that this range is based on the rejection reaction of kidney transplantation, and its reference value for irAE may be limited. From the drug safety standpoint, the MPA-AUC determined via the AUC method does not exceed the upper limit of the standard range, with a trough concentration of 1.74 μg/mL, which falls within the guideline-specified standard range for the trough concentration (1.0–3.5 μg/mL). Based on indirect evidence, the drug was deemed to be within a safe and effective range. However, establishing standardized TDM criteria for MMF in irAEs requires further clinical data.

Recommendations

This article presents a case involving a patient diagnosed with LUSC who experienced recurrent Grade 3 immune-related pneumonitis during treatment with tislelizumab, which was refractory to corticosteroids. Throughout the diagnostic and treatment process, comprehensive evaluation was conducted to assess the potential presence of concurrent infections, heart failure, or other complications. Ultimately, the CIP was alleviated with a regimen combining corticosteroids, IVIG, and MMF. A literature review was conducted to highlight the importance of early identification and timely, appropriate medication use for CIP. The use of immunosuppressive agents requires a balance between efficacy and adverse effects. Currently, there is insufficient evidence to recommend a specific immunosuppressive agent to be combined with corticosteroids, nor are there established standards for drug concentration monitoring. In this case, therapeutic drug monitoring was analyzed based on evidence from the clinical application of anti-rejection drugs in transplantation. Future research will require more epidemiological data and prospective studies to furnish additional evidence. Given the absence of standardized diagnostic and treatment for corticosteroid-refractory CIP, a preliminary diagnostic and treatment workflow is proposed based on this work and relevant guidelines (Figure 3).[12,30–33] This study aims to

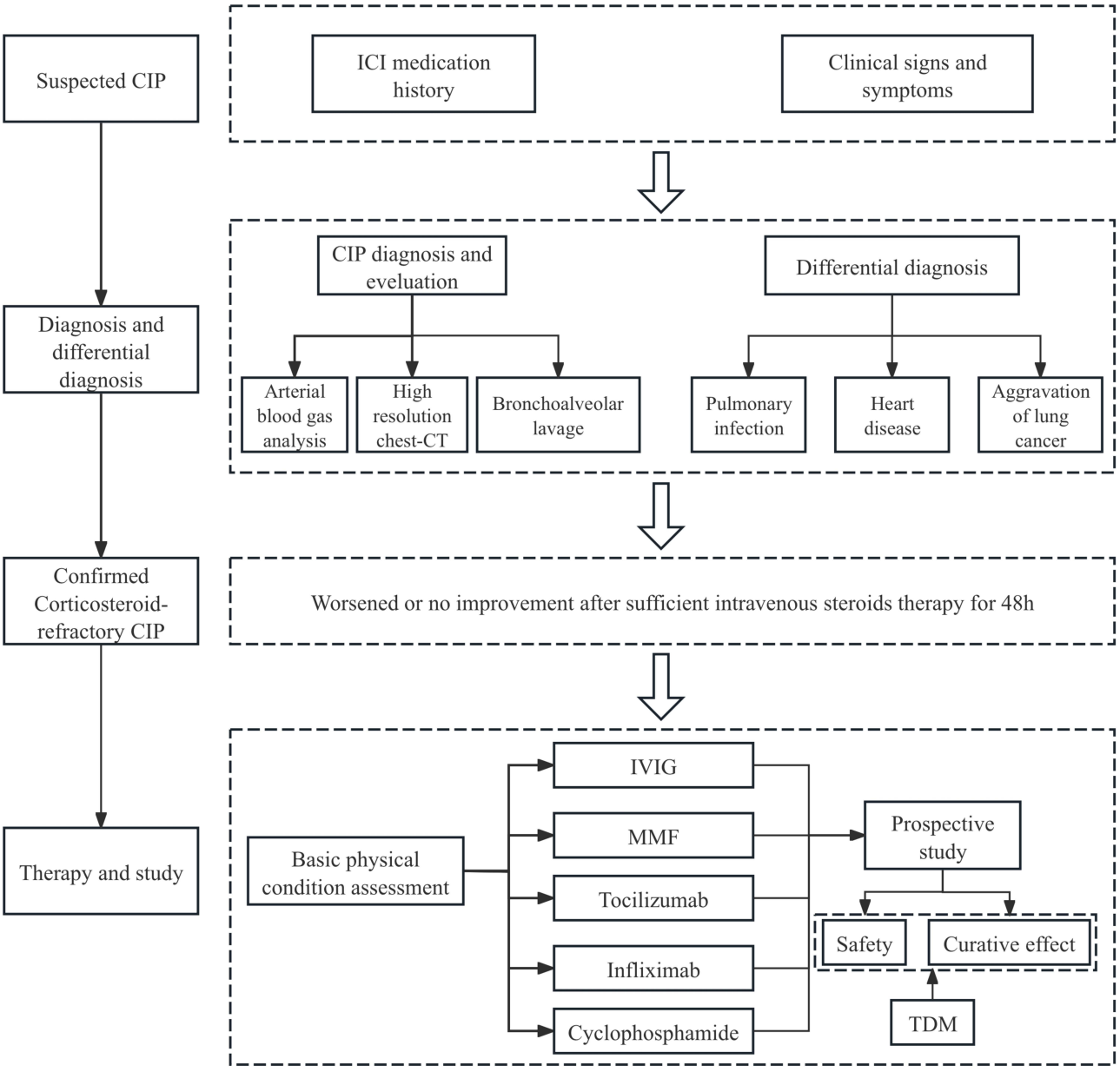

Figure 3 Recommendation of the diagnosis and treatment process of corticosteroid-refractory CIP.

enhance clinical awareness and management expertise regarding immune-related pneumonitis, thereby facilitating accurate clinical diagnosis and the development of rational treatment plans to optimize patient outcomes and minimize adverse effects.

Conclusion

In conclusion, this case highlights the effective management of recurrent corticosteroid-refractory CIP with IVIG and MMF, emphasizing the importance of early diagnosis and tailored treatment strategies. Further investigation is warranted to establish standardized guideline for the management of corticosteroid-refractory CIP and to optimize therapeutic drug monitoring for immunosuppressive agents.

Ethics

Informed consent for publication of the patient's deidentified case details was obtained from the patient before submission. This study was approved by the medical ethics committee of Peking University Third Hospital (IRB number: M20250470).

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Disclosure

The authors report no conflicts of interest in this work.

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