Review Article

Pulmonary-Renal Syndrome Due to Goodpasture Disease: Pathophysiology, Diagnosis, and Current Management

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Abstract

Pulmonary-renal syndrome associated with Goodpasture disease is a rare but life-threatening condition characterized by the concurrent presence of diffuse alveolar hemorrhage and rapidly progressive glomerulonephritis. Initially described in 1919 as an apparent post-infectious process, the disease is now recognized as a distinct autoimmune disorder caused by circulating anti-glomerular basement membrane antibodies directed against the α3 chain of type IV collagen. This antigen is shared by the glomerular and alveolar basement membranes, explaining the characteristic dual organ involvement. Advances in immunopathology have established anti-GBM disease as a form of small-vessel vasculitis, with linear immunoglobulin G deposition along the glomerular basement membrane representing a pathognomonic histological feature. The pathogenesis involves loss of immune tolerance in genetically susceptible individuals, particularly those carrying specific human leukocyte antigen alleles, with environmental factors such as smoking and infections acting as potential triggers.

Renal involvement typically manifests as crescentic rapidly progressive glomerulonephritis, which is strongly associated with poor renal outcomes and progression to end-stage kidney disease. Pulmonary involvement, present in approximately half of patients, is dominated by diffuse alveolar hemorrhage and may lead to acute respiratory failure. Diagnosis relies on serological detection of anti-GBM antibodies, assessment of renal function and urinalysis, imaging for pulmonary hemorrhage, and confirmation by kidney biopsy. Management requires urgent stabilization and early initiation of combined immunosuppressive therapy with glucocorticoids and cyclophosphamide, often complemented by therapeutic plasma exchange to remove circulating pathogenic antibodies. Prognosis is closely linked to disease severity at presentation, particularly renal function, respiratory failure, and antibody status. Although outcomes have improved with modern therapy, Goodpasture disease remains associated with significant morbidity and mortality, underscoring the importance of early recognition, accurate diagnosis, and prompt, aggressive treatment.

Key words

Autoimmunity, Type IV collagen, Crescentic nephritis, Plasma exchange, Complement activation, Vasculitis.

Introduction

Pulmonary–renal syndrome is a critical and potentially fatal clinical condition characterized by the simultaneous occurrence of pulmonary hemorrhage and glomerulonephritis, and it is most frequently associated with Goodpasture disease, also known as anti–glomerular basement membrane (anti-GBM) disease. Goodpasture disease is an autoimmune disorder in which circulating antibodies are directed against the α3 chain of type IV collagen located in the basement membranes of glomerular and pulmonary capillaries. This immune-mediated attack leads to rapidly progressive glomerulonephritis and, in approximately 50% of cases, pulmonary hemorrhage, reflecting the shared antigenic target in both organs [1]. Because of its fulminant course, early recognition and aggressive treatment are essential, as delayed intervention is associated with severe outcomes, including progression to end-stage kidney disease and high mortality rates [2, 3].

From a clinical perspective, pulmonary–renal syndrome is defined by the coexistence of renal impairment and diffuse alveolar hemorrhage. Renal involvement is typically manifested by elevated plasma creatinine levels and abnormal urinalysis, while pulmonary involvement presents as alveolar hemorrhage confirmed by clinical, radiological, or bronchoscopic findings. This combination of rapidly progressive renal and respiratory dysfunction constitutes a medical emergency, requiring urgent diagnostic evaluation and immediate therapeutic intervention due to its life-threatening nature [4].

Anti-GBM disease itself represents a distinct form of small-vessel vasculitis characterized by the presence of autoantibodies directed against components of the glomerular basement membrane, resulting in concomitant kidney and lung injury. A hallmark feature of the disease is the linear deposition of immunoglobulin G along the glomerular basement membrane, which can be demonstrated on kidney biopsy using immunofluorescence techniques. In parallel, circulating anti-GBM antibodies are detectable in most patients and play a central role in establishing the diagnosis [1].

Although anti-GBM disease is rare, with an estimated annual incidence ranging from 0.60 to 1.79 cases per million population, its clinical impact is disproportionate to its frequency. The disease accounts for approximately 8.0% of cases of rapidly progressive glomerulonephritis and 12.8% of crescentic glomerulonephritis, underscoring its relevance in severe renal

pathology. Prognostic data further highlight its aggressiveness, with pooled one-year patient survival of 76.2% and kidney survival of only 30.2%, reflecting the high likelihood of irreversible renal damage despite treatment [2].

Historically, untreated anti-GBM disease was almost uniformly fatal; however, the introduction of combined therapeutic strategies, including therapeutic plasma exchange, cyclophosphamide, and glucocorticoids, has markedly improved patient outcomes [1]. The benefits of early intervention are particularly evident in patients who do not require dialysis at presentation, as this subgroup has a substantially higher probability of renal recovery. Conversely, the need for renal replacement therapy at diagnosis and a low proportion of preserved normal glomeruli on kidney biopsy have been identified as strong predictors of poor renal outcome, further emphasizing the importance of prompt diagnosis and aggressive treatment to alter the disease trajectory [5].

The objective of this review is to analyze pulmonary–renal syndrome associated with Goodpasture disease by integrating current evidence on its pathophysiology, clinical presentation, diagnostic strategies, and contemporary management, with the aim of highlighting key prognostic factors and emphasizing the importance of early recognition and timely therapeutic intervention to improve renal and patient outcomes.

Methodology

For the development of this review on pulmonary–renal syndrome associated with Goodpasture disease, a comprehensive analysis of the scientific literature was conducted with the objective of examining its clinical relevance, underlying pathophysiological mechanisms, diagnostic approach, and current management strategies. Emphasis was placed on understanding the immunopathogenesis of anti–glomerular basement membrane disease, the clinical manifestations involving both renal and pulmonary systems, prognostic factors, and the impact of early diagnosis and aggressive treatment on patient outcomes.

The review was based on the consultation of well-established scientific databases, including PubMed, Scopus, and Web of Science, selected for their relevance in nephrology, pulmonology, immunology, and internal medicine. Strict inclusion and exclusion criteria were applied to ensure the quality, relevance, and scientific rigor of the selected literature. Articles published between 2020 and 2025 in English or Spanish were included if they addressed key aspects such as the definition of pulmonary–renal syndrome, the pathophysiology of anti-GBM disease, diagnostic criteria, histopathological findings, therapeutic strategies, and clinical outcomes. Studies lacking peer review, presenting incomplete or insufficient data, or containing duplicated information were excluded. The keywords used in the search strategy included pulmonary–renal syndrome, Goodpasture disease, anti–glomerular basement membrane antibodies, diffuse alveolar hemorrhage, rapidly progressive glomerulonephritis, plasma exchange, and immunosuppressive therapy.

The initial literature search identified 24 relevant sources, encompassing original research articles, systematic reviews, clinical practice guidelines, and consensus documents published by recognized nephrology and vasculitis societies. These sources were critically reviewed to extract and synthesize information related to disease mechanisms, diagnostic tools, prognostic indicators, and the effectiveness of current therapeutic approaches, including immunosuppression and plasma exchange.

Artificial intelligence tools were used as complementary support for the organization and synthesis of information, thematic categorization of the literature, and identification of conceptual relationships across studies. This approach facilitated efficient management of the selected references and contributed to maintaining

coherence and clarity throughout the structure of the review.

The analysis followed a qualitative and comparative approach, with findings organized thematically to identify established knowledge, areas of clinical uncertainty, prognostic determinants, and gaps in current evidence. This methodology allowed for a structured and evidence-based overview of pulmonary–renal syndrome due to Goodpasture disease, highlighting the importance of early recognition, timely therapeutic intervention, and ongoing research to improve renal and patient survival outcomes.

Historical Background and Nomenclature

The syndrome now known as Goodpasture disease was first described in 1919 by Ernest Goodpasture, who reported the association between pulmonary hemorrhage and glomerulonephritis in a young patient. At that time, the condition was initially thought to be related to influenza, reflecting the limited understanding of its underlying mechanisms in the early twentieth century. Over subsequent decades, advances in immunopathology and renal histology progressively clarified the nature of the disease, leading to its recognition as an autoimmune disorder characterized by a targeted immune response against the glomerular basement membrane rather than an infectious process [6].

As scientific knowledge evolved, anti–glomerular basement membrane disease came to be understood as a distinct form of small-vessel vasculitis. This conceptual shift was accompanied by significant progress in diagnostic techniques and therapeutic strategies, which have substantially reduced the historically high mortality associated with the condition [1]. Central to the modern understanding of the disease is the demonstration of linear immunoglobulin G deposition along the glomerular basement membrane, a defining histopathological feature that reflects direct antibody-mediated injury. Complement activation has also been identified as a key contributor to the inflammatory cascade and tissue damage observed in affected kidneys and lungs, further elucidating the mechanisms underlying disease progression [7].

Within this framework, it is important to distinguish between the terms Goodpasture disease and Goodpasture syndrome, which are often used interchangeably but represent different concepts. Goodpasture disease refers specifically to the autoimmune condition defined by the presence of circulating anti-GBM antibodies that directly cause renal and pulmonary involvement [1]. In contrast, Goodpasture syndrome is a broader clinical descriptor encompassing any disorder that presents with the combination of pulmonary hemorrhage and glomerulonephritis, regardless of the underlying etiology, and therefore is not limited to anti-GBM disease alone [6].

Etiology and Immunopathogenesis

Goodpasture disease is fundamentally an autoimmune disorder in which the primary pathogenic mechanism involves the production of anti–glomerular basement membrane antibodies directed against the α3 chain of type IV collagen, a structural component that is essential for the integrity of the glomerular basement membrane and is also present in pulmonary capillaries. The binding of these autoantibodies to their target antigen results in the characteristic renal and pulmonary injury observed in the disease, manifesting as rapidly progressive glomerulonephritis and, in many cases, pulmonary hemorrhage [6, 8]. Central to this process is a loss of immune tolerance, whereby normal regulatory mechanisms fail to prevent the generation of pathogenic antibodies. This breakdown of tolerance permits sustained autoantibody production, which directly drives disease progression and tissue damage [2].

In addition to autoimmune mechanisms, both genetic and environmental factors contribute

significantly to the pathogenesis of Goodpasture disease. Genetic susceptibility is supported by associations with specific human leukocyte antigen alleles, particularly HLA-DRB1*15:01, which have been linked to an increased risk of developing the disease and suggest an inherited predisposition to aberrant immune responses. Environmental exposures further modulate this risk, as factors such as smoking, infections, and contact with hydrocarbons have been identified as potential triggers or exacerbating elements. These exposures are thought to induce injury to the basement membrane, thereby exposing previously hidden epitopes and facilitating an autoimmune response against type IV collagen [8].

The pathogenesis of Goodpasture disease is therefore best understood as the result of a dynamic interaction between genetic susceptibility and environmental influences. In genetically predisposed individuals, environmental insults may act as initiating events that precipitate loss of immune tolerance and the subsequent development of pathogenic anti-GBM antibodies. This interplay underscores the multifactorial nature of the disease and highlights the importance of both intrinsic and extrinsic factors in determining disease onset and progression [8].

Pathophysiology of Pulmonary–Renal Involvement

Renal involvement in anti–glomerular basement membrane disease is primarily driven by antibody-mediated injury directed against structural components of the glomerular basement membrane. The central pathogenic mechanism involves autoantibodies targeting the α3 chain of type IV collagen, a key constituent of the glomerular basement membrane, leading to the characteristic linear deposition of immunoglobulin G along the basement membrane and subsequent activation of the complement system. In addition to this classical antigenic target, autoantibodies directed against laminin-521, another integral component of the glomerular basement membrane, have also been implicated, suggesting that the spectrum of antigenic targets in the disease may be broader than initially recognized [1, 2, 8].

The predominant histopathological manifestation of renal involvement is crescentic rapidly progressive glomerulonephritis. This process is characterized by the rapid formation of cellular crescents within the glomeruli, reflecting severe glomerular injury and leading to a swift decline in renal function [9]. Histological evaluation frequently demonstrates extensive crescent formation, a finding that has been consistently associated with poor renal prognosis and a high likelihood of progression to end-stage kidney disease. The extent of crescent involvement therefore serves as both a marker of disease severity and a predictor of long-term renal outcomes [10, 5].

Complement activation plays a central role in amplifying renal injury in anti-GBM disease. Evidence indicates that all three complement pathways the classical, lectin, and alternative pathways are involved in the disease process, contributing to sustained inflammation and tissue damage. Activation of complement components such as C3 and the terminal complement complex C5b-9 has been shown to correlate with the severity of renal injury, underscoring their role in driving inflammatory cascades that exacerbate glomerular damage and accelerate loss of renal function [7].

Pulmonary involvement mirrors the immunopathological mechanisms observed in the kidney. Autoantibodies directed against components of the alveolar basement membrane, including the α3 chain of type IV collagen, lead to structural disruption of the alveolar capillary barrier, resulting in alveolar injury and hemorrhage. Similar to renal disease, the presence of autoantibodies against laminin-521 has been associated with pulmonary hemorrhage, further supporting its role in mediating lung involvement in anti-GBM disease [1, 2, 6].

Diffuse alveolar hemorrhage represents the most severe pulmonary manifestation of the disease and is often associated with hemoptysis and acute respiratory distress [9]. Its pathogenesis involves immune complex deposition within the pulmonary microvasculature and subsequent complement activation, leading to capillaritis and increased vascular permeability with hemorrhagic leakage into the alveolar spaces [4]. The deposition of pathogenic antibodies along the alveolar basement membrane is therefore directly linked to the development and severity of lung injury. Environmental factors, particularly smoking, have been identified as significant contributors that exacerbate alveolar damage, likely by increasing basement membrane permeability and facilitating antibody access to target antigens [6].

In some patients, the coexistence of anti-GBM antibodies and antineutrophil cytoplasmic antibodies suggests a more complex autoimmune milieu. This dual seropositivity points to an interaction between distinct autoimmune processes that may influence disease expression and severity, particularly in relation to pulmonary involvement [7, 9].

Clinical Manifestations

Renal involvement in Goodpasture disease most commonly presents with hematuria and proteinuria, reflecting underlying glomerular damage. These urinary abnormalities are characteristic features of rapidly progressive glomerulonephritis, which represents a hallmark of renal manifestation in this condition [6, 11]. As the disease progresses, glomerular injury can rapidly worsen, leading to acute kidney injury. Without prompt and effective treatment, a substantial proportion of patients experience irreversible loss of renal function, with studies indicating that up to 60–70% may progress to end-stage renal disease, underscoring the aggressive nature of renal involvement in anti-GBM disease [10, 11].

Pulmonary involvement represents the second major clinical component of the disease and is most often manifested by hemoptysis, dyspnea, and hypoxemia. These symptoms arise as a consequence of diffuse alveolar hemorrhage and are observed in approximately half of patients with anti-GBM disease [1, 11]. Radiological evaluation plays a crucial role in identifying pulmonary involvement, as chest radiography and computed tomography frequently demonstrate diffuse alveolar infiltrates consistent with alveolar hemorrhage. Such imaging findings are essential for supporting the diagnosis and assessing the extent of pulmonary disease in affected patients [12, 13].

In addition to renal and pulmonary manifestations, patients with Goodpasture disease may present with systemic and atypical features that reflect a broader inflammatory response. Constitutional symptoms such as fever, fatigue, and weight loss can occur, although these findings are nonspecific and often overlap with those seen in other forms of systemic vasculitis, potentially complicating the diagnostic process [7, 12]. Furthermore, Goodpasture disease may share clinical and immunological features with other vasculitic syndromes, particularly antineutrophil cytoplasmic antibody–associated vasculitis. This overlap is especially evident in so-called double-positive cases, in which both anti-GBM and ANCA antibodies are present. Such patients are at increased risk of disease relapse and often require prolonged or maintenance immunosuppressive therapy, highlighting the clinical heterogeneity and complexity of disease presentation [1, 11].

Diagnostic Approach

Laboratory evaluation plays a central role in the diagnosis of pulmonary–renal syndrome associated with anti–glomerular basement membrane disease, as it allows for the identification of pathogenic antibodies and the assessment of renal involvement. Detection of circulating anti-GBM antibodies is fundamental to establishing the diagnosis, given their high

diagnostic accuracy. Systematic reviews have reported pooled sensitivity and specificity values of approximately 93% and 97%, respectively, although the overall certainty of evidence remains limited due to potential biases inherent in study designs [15]. In addition to classical anti-GBM antibodies, autoantibodies directed against laminin-521, a novel antigenic target within the glomerular basement membrane, have been identified in roughly one-third of patients. This finding suggests a broader immunological spectrum of the disease and highlights a potential complementary role for these antibodies in understanding disease pathogenesis and refining diagnostic evaluation [2].

Assessment of renal function is equally critical, as kidney involvement is a defining feature of the syndrome. Elevated plasma creatinine levels and abnormal urinalysis findings provide objective evidence of renal impairment. The presence of hematuria and proteinuria, in particular, reflects active glomerular injury and is essential for evaluating the severity and extent of renal damage at presentation [4].

Testing for antineutrophil cytoplasmic antibodies is also of clinical importance, especially in patients who are double seropositive for anti-GBM and ANCA antibodies. This subgroup of patients often exhibits a distinct clinical phenotype that may influence disease course, relapse risk, and therapeutic decisions, thereby necessitating tailored management strategies [7, 16].

Imaging studies are indispensable for the evaluation of pulmonary involvement in pulmonary–renal syndrome. Chest radiography and computed tomography are particularly useful for detecting diffuse alveolar hemorrhage, a hallmark manifestation of pulmonary involvement in anti-GBM disease. Beyond their diagnostic utility, imaging modalities also play an important role in longitudinal disease monitoring, as they allow clinicians to assess progression and evaluate response to treatment, especially with respect to the resolution of pulmonary hemorrhage [1, 4].

Histopathological examination remains the definitive diagnostic modality in anti-GBM disease. Kidney biopsy is considered the gold standard, as it characteristically demonstrates linear immunoglobulin G deposition along the glomerular basement membrane on immunofluorescence microscopy. This finding is pathognomonic and provides definitive confirmation of the diagnosis. In contrast, pulmonary biopsy is rarely performed in routine practice due to its invasive nature and associated risks. Although it may yield additional diagnostic information, its use is generally reserved for selected cases in which the diagnosis remains uncertain, and the potential benefits outweigh the procedural risks [1].

Differential Diagnosis

Goodpasture disease is defined by the presence of circulating anti–glomerular basement membrane antibodies directed against the α3 chain of type IV collagen, which is a key structural component of both glomerular and alveolar basement membranes. The diagnosis is confirmed by kidney biopsy demonstrating linear immunoglobulin G deposition along the glomerular basement membrane and/or by the detection of circulating anti-GBM antibodies in serum. Pulmonary involvement in the form of diffuse alveolar hemorrhage occurs in approximately 50% of cases and represents a major determinant of clinical severity. Given the rapid progression of both renal and pulmonary injury, early diagnosis and immediate initiation of treatment are critical for improving patient and renal prognosis [1, 11].

In the differential diagnosis, antineutrophil cytoplasmic antibody–associated vasculitis represents a major consideration, particularly granulomatosis with polyangiitis and microscopic polyangiitis. These conditions are characterized by the presence of ANCA and can present with pulmonary–renal syndrome, with

diffuse alveolar hemorrhage being a particularly severe manifestation. Alveolar hemorrhage is more frequently observed in microscopic polyangiitis than in granulomatosis with polyangiitis, contributing to diagnostic complexity in acute presentations. Management of ANCA-associated vasculitis typically involves immunosuppressive therapy with glucocorticoids combined with cyclophosphamide or rituximab, and in selected cases, plasma exchange is incorporated into the treatment regimen [17, 18].

Systemic lupus erythematosus must also be considered, as it can manifest with rapidly progressive glomerulonephritis and diffuse alveolar hemorrhage. However, lupus-related pulmonary–renal involvement is usually accompanied by a broader spectrum of systemic manifestations and distinctive serological features, including anti–double-stranded DNA antibodies and hypocomplementemia. Histopathological findings on kidney biopsy further aid in differentiation, as lupus nephritis is characterized by immune complex deposition, in contrast to the linear immunoglobulin G deposition that defines anti-GBM disease [11].

Other autoimmune conditions may also present with rapidly progressive glomerulonephritis and pulmonary involvement, including rheumatoid arthritis and Sjögren's syndrome. In some of these cases, patients may exhibit double seropositivity for anti-GBM and ANCA antibodies, further complicating the diagnostic process [9]. In this context, kidney biopsy remains an indispensable diagnostic tool, as serological testing alone may be insufficient to clearly distinguish between these entities. Histopathological evaluation provides definitive information regarding the underlying pattern of injury and is essential for guiding appropriate therapeutic strategies [11].

Current Management Strategies

Management of pulmonary–renal syndrome due to Goodpasture disease begins with prompt acute stabilization, as both respiratory failure and renal dysfunction can rapidly become life-threatening. Severe pulmonary involvement, particularly diffuse alveolar hemorrhage, often necessitates immediate supportive measures to maintain adequate oxygenation. In advanced cases, mechanical ventilation may be required to manage respiratory failure and ensure gas exchange [19]. Bronchoscopy can be useful to confirm the presence of diffuse alveolar hemorrhage, while supportive care measures such as supplemental oxygen and blood transfusions play a critical role in stabilizing patients during the acute phase of illness [20].

Renal support is equally essential in the acute setting. Renal replacement therapy, including dialysis, is indicated in patients with severe renal impairment or those who present with dialysis dependence. The likelihood of renal recovery in dialysis-dependent patients is significantly reduced, and therapeutic decisions should be guided by the degree of renal injury, kidney biopsy findings, and overall clinical severity. These factors are central to prognostic assessment and help inform the intensity and goals of immunosuppressive therapy [1, 11]

Following stabilization, immunosuppressive therapy constitutes the cornerstone of disease management. High-dose corticosteroids are typically initiated early, often administered as intravenous pulse therapy, to rapidly suppress inflammation and reduce ongoing autoantibody-mediated tissue injury. Corticosteroids are commonly combined with cyclophosphamide, which remains a standard induction agent for achieving disease remission. In selected patients, particularly those with contraindications to cyclophosphamide or concerns regarding fertility preservation, rituximab may be used as an alternative immunosuppressive agent. Once remission is achieved, long-term maintenance therapy may involve agents such as azathioprine, methotrexate, or mycophenolate mofetil to sustain disease control and reduce the risk of relapse [1, 20].

Therapeutic plasma exchange represents a key adjunctive treatment in Goodpasture disease, based on its ability to rapidly remove circulating anti-GBM antibodies from the bloodstream. By reducing the concentration of pathogenic antibodies, plasma exchange directly limits ongoing immune-mediated damage to the glomerular and alveolar basement membranes. This intervention is generally reserved for severe cases, particularly those with significant pulmonary hemorrhage or advanced renal involvement. Treatment protocols usually consist of multiple plasma exchange sessions over several weeks, with the number and frequency individualized according to disease severity and clinical response. However, evidence from the PEXIVAS trial did not demonstrate a significant benefit of plasma exchange in reducing mortality or progression to end-stage renal disease in patients with ANCA-associated vasculitis. Although these findings pertain specifically to ANCA-associated disease, they have implications for the broader use of plasma exchange in related conditions, including Goodpasture disease, and highlight the need for careful patient selection when considering this therapy [19, 21, 22].

Prognosis and Outcomes

Prognosis in pulmonary–renal syndrome associated with Goodpasture disease is influenced by a combination of renal, pulmonary, and systemic factors present at diagnosis. Advanced age and the presence of significant comorbidities, including sepsis and liver failure, have been consistently associated with an increased risk of mortality, reflecting reduced physiological reserve and greater vulnerability to multiorgan dysfunction [23]. In addition, the development of respiratory failure and markedly elevated serum creatinine levels at disease onset are strong predictors of adverse outcomes, including death and progression to end-stage renal disease. These parameters reflect the severity of both pulmonary and renal involvement and are closely linked to irreversible organ damage. Furthermore, the presence of anti-GBM antibody positivity itself has been identified as an independent predictor of mortality in patients presenting with pulmonary–renal syndrome, underscoring the aggressive nature of antibody-mediated disease [7].

Early diagnosis and timely initiation of treatment play a decisive role in modifying disease trajectory and improving outcomes. The combined use of plasmapheresis with immunosuppressive therapy, including cyclophosphamide and glucocorticoids, has been shown to significantly improve survival and renal recovery, particularly in patients who are not dialysis-dependent at presentation [1]. Early intervention limits ongoing immune-mediated injury by rapidly reducing circulating pathogenic antibodies while simultaneously suppressing further antibody production. In this context, the use of high-dose intravenous immunoglobulins prior to plasma exchange has been proposed as an adjunctive strategy, as it may enhance the clearance of pathogenic antibodies and potentially improve the overall efficacy of treatment in selected patients [24].

Long-term outcomes in anti-GBM disease vary according to immunological profile and extent of organ involvement. Classic anti-GBM disease is generally associated with a low risk of relapse once remission is achieved. In contrast, patients who are double positive for anti-GBM and antineutrophil cytoplasmic antibodies exhibit a higher relapse risk and often require prolonged or maintenance immunosuppressive therapy to prevent disease recurrence [1]. Survival analyses indicate that one- and three-year survival rates do not differ significantly among patients with different patterns of lung dysfunction; however, overall prognosis remains particularly poor in those with concomitant interstitial lung disease, highlighting the negative impact of chronic pulmonary involvement on long-term outcomes [7].

Conclusion

Goodpasture disease represents a distinct and severe autoimmune cause of pulmonary–renal syndrome, characterized by antibody-mediated injury against the glomerular and alveolar basement membranes. Advances in immunopathology have clarified its classification as a small-vessel vasculitis and established linear immunoglobulin G deposition as its defining histopathological hallmark, allowing clearer differentiation from other causes of pulmonary hemorrhage and rapidly progressive glomerulonephritis.

The pathogenesis and clinical expression of Goodpasture disease reflect a complex interaction between loss of immune tolerance, genetic susceptibility, and environmental triggers, leading to aggressive renal and pulmonary involvement. Crescentic glomerulonephritis and diffuse alveolar hemorrhage are central determinants of morbidity and prognosis, with disease severity at presentation particularly renal function, respiratory failure, and antibody status strongly influencing outcomes.

Early diagnosis and prompt initiation of combined immunosuppressive therapy and antibody-removal strategies are critical to improving survival and preserving renal function. Despite therapeutic advances, prognosis remains guarded in patients with advanced organ involvement or double seropositivity for anti-GBM and antineutrophil cytoplasmic antibodies, underscoring the need for timely intervention, careful risk stratification, and individualized long-term management.

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