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Medical and Social Aspects of Metabolic Syndrome: Narrative Review and Case Study

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Abstract

Metabolic syndrome—a cluster of interrelated conditions including obesity, hypertension, dyslipidemia, and insulin resistance—is a key precursor to both type 2 diabetes and cardiovascular disease. In regions with rising burdens of non-communicable diseases, diabetes mellitus has become a leading challenge in clinical management. The narrative review presents a detailed case study of a 64-year-old patient who has insulin-dependent type 2 diabetes mellitus with peripheral neuropathy and nephropathy and cardiovascular risk factors. The patient's first presentation, which was defined by hyperglycemia, polyuria, and neuropathic pain, underlined how inadequate his current insulin schedule was. Laboratory and imaging studies revealed a constellation of diabetic complications, including elevated glycated hemoglobin, renal structural abnormalities, and signs of chronic inflammation. A stepwise treatment strategy was employed, shifting from monotherapy to combination therapy, which included insulin optimization alongside antihypertensive and lipid-lowering agents. The research group demonstrated that higher initial doses of NPH insulin led to better early blood sugar control without increasing the risk of hypoglycemia which helped doctors make better treatment choices. The case demonstrates how global blood sugar targets can be achieved through individualized treatment approaches for advanced diabetes management.

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Introduction

Metabolic syndrome (MS) has emerged as a modern-day health paradox—a constellation of seemingly disparate conditions, including abdominal obesity, insulin resistance, hypertension, and dyslipidemia, that collectively form a biochemical "perfect storm." The cluster of metabolic disturbances serves as an early warning system for cardiovascular diseases (CVD), type 2 diabetes, and chronic kidney disease because of the intricate relationship between genetic factors environmental factors, and lifestyle choices (Swarup *et al*., 2025). MS used to be a specialized medical issue but it now represents the worldwide shift from infectious diseases to non-communicable diseases because of urbanization sedentary lifestyles and calorie-dense diets. MS affects more than one billion people worldwide and its prevalence continues to grow in both wealthy and developing nations. The silent nature of this condition which remains symptomless until permanent harm occurs emphasizes the need to transform preventive healthcare approaches. Research now shows that MS speeds up aging mechanisms and brain function deterioration which makes it more than a metabolic condition because it threatens the entire human lifespan (Alberti *et al*., 2009).

The worldwide increase in metabolic syndrome creates a major public health issue because it functions as both a medical condition and a condition that increases disease risk. The prevalence of MS criteria among adults in high-income nations ranges between 20-40% but transitional economies such as Russia show even higher rates reaching 50% in specific demographic groups. The rising numbers of CVD deaths diabetes cases and healthcare costs create economic strain and social instability. The inconsistent early detection of MS persists mainly because resource-limited healthcare settings have fragmented systems that delay necessary interventions (Saklayen, 2018). The pathophysiological complexity of MS which stems from insulin resistance chronic inflammation and adipose tissue dysfunction requires holistic approaches because it cannot be solved by simple methods. The socio-economic effects of the syndrome lead to substantial losses in productivity and premature disabilities which create health disparities across generations and increase social inequality. Research continues to identify gaps in understanding how risk factors differ between regions how lifestyle interventions work differently among various population groups and how MS affects men and women differently. The unknown factors need to be addressed because they represent essential elements for controlling the MS pandemic and its effects (Samson & Garber, 2014).

The research maintains great importance for Kyrgyzstan because it is a lower-middle-income nation experiencing fast epidemiological and socio-economic changes while metabolic syndrome (MS) exists undiagnosed in public health priorities. The research uses Kyrgyzstan's healthcare system as its foundation to study the healthcare disparities between rural and urban areas the limited preventive care access and the increasing non-communicable disease burden. The research examines Kyrgyzstan's special risk situation because the population moves from traditional food consumption to processed foods and develops sedentary habits and high smoking rates while facing healthcare system problems with fragmented primary care and medication shortages. The study presents a clinical case from a Kyrgyzstan regional hospital that will demonstrate the practical challenges of MS diagnosis and management in limited-resource healthcare facilities. The case study reveals how delayed hypertension and insulin resistance detection occurs because of insufficient screening methods which provides practical guidance for local medical practitioners. The research assesses the potential of adapting worldwide MS management guidelines to Kyrgyzstan's healthcare infrastructure through evaluations of cost-efficient approaches such as community health worker programs and mobile screening units. The study connects its findings to Kyrgyzstan's National Health Strategy 2030 which focuses on CVD and diabetes prevention to create policy recommendations that benefit national health initiatives and worldwide MS care equity efforts. The research combines Kyrgyzstan-specific data with clinical narratives to strengthen the evidence for Central Asia while creating a model that other low-resource areas can use to manage dual infectious and metabolic disease burdens. The research connects scientific translation to clinical practice to enable healthcare systems to prevent MS-related health and economic disasters from becoming permanent.

Causes and Risk Factors of Metabolic Syndrome

The development of metabolic syndrome is influenced by many factors, including genetic predisposition, insufficient physical activity, poor nutrition, stress, as well as age, and gender. Epidemiological studies show that the main risk factors are overweight, insulin resistance, and physical inactivity. An increase in calorie intake, especially due to carbohydrates and fats, as well as a decrease in physical activity contribute to the development of obesity and other components of the metabolic syndrome (Kazemi *et al*., 2013).

Genetic Risk Factors

The influence of genetic factors is significant in the emergence of metabolic syndrome. Research indicates that individuals with a familial background of diabetes or cardiovascular conditions exhibit a higher propensity for developing metabolic syndrome. In a significant genetic association study carried out in 2017, it was discovered that certain genes associated with lipid and carbohydrate metabolism play a role in the development of insulin resistance and obesity. For instance, genes that code for enzymes involved in lipid metabolism might elevate the risk of dyslipidemia, while mutations in genes that control appetite and satiety could play a role in the onset of obesity (Pucci *et al*., 2017). A separate investigation indicated that variations in genes associated with inflammatory processes and oxidative stress could play a role in the onset of metabolic syndrome, given the strong connection between these processes and insulin resistance as well as disrupted carbohydrate metabolism (Caballero, 2019).

Environmental and Lifestyle Risk Factors

The development of metabolic syndrome depends heavily on environmental and behavioral factors which include poor dietary habits and physical inactivity and chronic psychosocial stress. Among these, nutritional factors are especially influential. The combination of excessive saturated fats and refined sugars with high-glycemic-index carbohydrates and insufficient dietary fiber consumption leads to the development of metabolic abnormalities. The consumption of high-glycemic foods including sweets and refined carbohydrates worsens insulin resistance while saturated and trans fats lead to the development of visceral adiposity which characterizes metabolic syndrome. VS Malik *et al*. (2010) show that regular consumption of fast food and sugar-sweetened beverages leads to a significant increase in metabolic syndrome development risk (Malik *et al*., 2010). Physical inactivity is another critical contributor. A sedentary lifestyle enables the body to store fat mainly in abdominal areas while simultaneously damaging insulin sensitivity in tissues. The research by J Myers *et al*. (2019) published in Circulation demonstrates that regular physical activity reduces metabolic syndrome risk through its positive effects on lipid profiles and blood pressure management (Myers *et al*., 2019). The metabolic risk factors are significantly influenced by both psychosocial stress and mental health disturbances. The body produces elevated cortisol levels during chronic stress which leads to increased appetite and central fat storage. People with depression tend to engage in unhealthy eating patterns while simultaneously showing decreased physical movement. SM Mohamed *et al*. (2023) found that stress functions as a primary cause of metabolic syndrome development especially when urbanization and social instability occur (Mohamed *et al*., 2023).

Obesity and Insulin Resistance

The main risk factor for developing metabolic syndrome exists in central or abdominal obesity. The metabolically active visceral adipose tissue produces adipokines and pro-inflammatory cytokines which disrupt insulin signaling pathways to create insulin resistance. The dysfunctional adipose tissue creates additional cardiovascular strain while making major changes to carbohydrate and lipid metabolic processes. Numerous studies have established insulin resistance as the fundamental cause of metabolic syndrome development. MS Burhans *et al*. (2018) demonstrated that insulin resistance functions as the fundamental mechanism that drives the development of the syndrome. The presence of excessive visceral fat leads to elevated free fatty acid levels in the blood which damages insulin function in peripheral tissues and results in high blood sugar. The impaired glucose regulation state can eventually develop into type 2 diabetes mellitus which worsens the metabolic issues of the syndrome (Burhans *et al*., 2018).

Hypertension and Dyslipidemia

The two conditions of hypertension and dyslipidemia form essential parts of metabolic syndrome while acting as leading risk factors for cardiovascular disease (CVD). The lipid disorder known as dyslipidemia presents with elevated total cholesterol and triglycerides together with decreased high-density lipoprotein cholesterol (HDL-C) levels. The simultaneous presence of these conditions leads to a significant increase in the risk of developing atherosclerotic cardiovascular events including myocardial infarction and stroke. When hypertension exists together with lipid metabolism problems the risk of such events becomes two to three times higher. The development of atherosclerosis and vascular dysfunction directly results from hypertension (Caballero, 2019). Metabolic syndrome patients frequently develop hypertension and other clinical investigations. The prolonged increase in blood pressure damages blood vessels while causing them to change shape and become less flexible which results in elevated cardiovascular risk. The cardiovascular risk associated with metabolic syndrome becomes worse due to dyslipidemia because it leads to increased lipid oxidation and plaque development. Other epidemiological studies have proven that lipid profile abnormalities particularly high triglycerides and low HDL-C directly lead to increased CVD incidence and other metabolic syndrome-related complications (Siddiqui, 2021).

Age and Gender Differences

The development of metabolic syndrome heavily depends on age which represents an unchangeable risk factor. The aging process leads to worsening insulin resistance together with lipid metabolism dysregulation and increased hypertension rates. Metabolic syndrome risk significantly increases after age 40 while postmenopausal women face additional risk because of hormonal changes and resulting metabolic alterations. The complex condition of metabolic syndrome results from multiple genetic and environmental elements which interact with each other (Erdoğan & Sanlier, 2024). The development of metabolic syndrome results from genetic predisposition together with poor dietary habits and sedentary lifestyle obesity psychosocial stress and age. These risk factors work together to produce an enhanced effect which leads to serious health conditions including cardiovascular disease and type 2 diabetes mellitus. A thorough comprehension of these determinants' separate and combined impacts enables the creation of successful prevention and management approaches for metabolic syndrome (Saltiel & Olefsky, 2017).

Global Epidemiology and Public Health Impact of Metabolic Syndrome

Metabolic syndrome has emerged as one of the major public health problems that affect populations worldwide. The condition comprises several risk factors that exist together: insulin resistance, high blood pressure, abnormal lipid profile, central obesity, and impaired glucose tolerance which collectively increase the risk of cardiovascular diseases (CVD) and type 2 diabetes mellitus. According to the World Health Organization (WHO), metabolic syndrome incidence rates have increased throughout the world, especially in urbanizing and developing countries. The prevalence of metabolic syndrome in developed nations stands at 20–25% of adults whereas developing regions show a prevalence of 15–20%. Along with the United States, Western Europe has seen epidemic rates of the condition resulting from growing obesity rates coupled with an aging society with an inactive lifestyle. Studies estimate that 34% of American adults exhibit at least one clear sign of metabolic syndrome. The growing frequency of metabolic syndrome strains healthcare systems even more and demands quick preventive actions and management plans for both individual and population groups (Matsuzawa *et al*., 2011).

Metabolic syndrome has emerged as a major public health threat throughout Central Asia. Metabolic syndrome cases are increasing in Kazakhstan Uzbekistan Turkmenistan and Kyrgyzstan because of Western eating patterns adoption reduced physical activity and reduced access to preventive care. The prevalence of metabolic syndrome in Kazakhstan has matched developed countries at 30% among adults. The challenges for metabolic syndrome management in Kyrgyzstan consist of low public knowledge about the condition restricted healthcare services and local dietary customs that lead to obesity and associated health problems. The research demonstrates that 25-30% of Kyrgyz adults show symptoms of metabolic syndrome as the country sees increasing rates of diabetes and cardiovascular disease. The prevalence rates in Kyrgyzstan match those of Kazakhstan and Russia but the country lacks effective prevention and intervention programs (Sharma *et al*., 2024).

The condition of metabolic syndrome represents a dual medical and socio-economic issue in Russia. The Russian Society of Cardiology indicates that metabolic syndrome affects 30-35% of adults through excessive calorie consumption together with inadequate physical activity and economic stress. The prevalence rates in Russia and Kazakhstan exceed those of developing nations but remain lower than in the United States and Western European countries. The national programs launched by Russia and Kazakhstan to prevent and detect diseases at early stages have demonstrated effectiveness in controlling disease progression and enhancing treatment outcomes. Kyrgyzstan requires quick public health initiatives including multidisciplinary care access, health education campaigns, and methodical screening techniques in addition to other aspects. Unless thorough early detection and prevention campaigns are carried out, the prevalence of metabolic syndrome in Kyrgyzstan together with Central Asia will probably keep increasing due to urbanization and dietary changes (Siddiqui *et al*., 2024).

Medical and Social Consequences of Metabolic Syndrome

Metabolic syndrome significantly affects the quality of life of patients, reducing their ability to work and increasing morbidity and mortality from cardiovascular diseases. Given the widespread occurrence of metabolic syndrome on a global scale, the socio-economic losses associated with the treatment and prevention of diseases associated with this syndrome are very significant. The social consequences of metabolic syndrome include an increase in the number of people with disabilities, an increase in the incidence rate among the working-age population, as well as an increase in health care costs. According to various studies, patients with metabolic syndrome have higher treatment costs as well as a longer duration of disability compared to people who do not suffer from this syndrome. Metabolic syndrome (MS) is a complex disease, including abdominal obesity, hypertension, insulin resistance, dyslipidemia, and impaired carbohydrate metabolism, which significantly increase the risk of developing cardiovascular diseases, strokes, type 2 diabetes, and other chronic diseases. In this regard, the medical and social consequences of metabolic syndrome have a wide range and relate not only to the health of patients but also to the economic burden on healthcare systems and society as a whole (van der Pal *et al*., 2018).

The main medical consequence of metabolic syndrome is an increased risk of developing chronic diseases such as type 2 diabetes, cardiovascular diseases (CVD), strokes, chronic kidney disease, and others. MS significantly increases the likelihood of developing hypertension, lipid metabolism disorders, and other risk factors for CVD. This contributes to the fact that patients with metabolic syndrome suffer from premature disability and death. Cardiovascular diseases (CVD). Those with metabolic syndrome are twice as likely to have coronary heart disease. Type 2 diabetes. Metabolic syndrome is a major risk factor for developing type 2 diabetes. Moreover, patients with metabolic syndrome have an increased risk of developing diabetic retinopathy and other diabetes complications (Alam *et al*., 2021). Patients with metabolic syndrome have an increased risk of developing chronic kidney disease, which is associated with hypertension, diabetes, and dyslipidemia, which are key components of metabolic. The social consequences of metabolic syndrome are related to its effect on a patient's ability to work and life expectancy, as well as social isolation and psychological state. Reduced ability to work. Patients with metabolic syndrome, especially at the stage of developing diabetes or cardiovascular diseases, often experience a deterioration in performance. Patients with metabolic syndrome lose an average of 15-20% of their working capacity, which leads to significant economic costs for society, including in the form of loss of labor resources and an increase in the number of days of disability (Kim & Yi, 2018).

Social Isolation and Psychoemotional State

People with metabolic syndrome face multiple challenges which include depression anxiety disorders and social isolation. The disease itself produces these psychoemotional disorders through poor health conditions. The development of social isolation together with decreased quality of life occurs when physical health deteriorates through obesity and heart disease (Imam *et al*., 2023). The quality of life is significantly reduced. Metabolic syndrome patients experience a deterioration in their quality of life because their health issues persist while their physical abilities become restricted. These events may result in a decline in self-esteem and a worsening of the psycho-emotional condition. Individuals with metabolic syndrome have a twofold increased risk of experiencing depression and other mental health disorders compared to those without the syndrome (Siddiqui *et al*., 2022). The financial implications of metabolic syndrome manifest in substantial healthcare expenditures, declines in workforce productivity, and heightened social costs. Healthcare expenses. Individuals diagnosed with metabolic syndrome necessitate increased and costlier healthcare services. Managing diseases linked to metabolic syndromes, such as type 2 diabetes and cardiovascular conditions, significantly contributes to the rising healthcare expenses in developed nations. The rising prevalence of metabolic syndrome in Central Asia and Russia highlights the growing significance of this issue. There has been a decline in the efficiency of the workforce. Metabolic syndrome contributes to a higher incidence of health issues and disabilities within the working-age demographic, ultimately diminishing overall productivity (Xu *et al*., 2018).

The growing number of people with metabolic syndrome also leads to an increase in the number of people with disabilities and people in need of constant care. This entails additional social costs for medical care, rehabilitation, and support for such patients. Today, one of the main problems faced by the countries of the world is the insufficient diagnosis and prevention of metabolic syndrome. In developing countries, including Kyrgyzstan and other Central Asian states, the diagnosis of metabolic syndrome and its components is limited due to a lack of access to modern examination methods and a shortage of specialists. In Russia and other CIS countries, despite the availability of basic medical facilities for diagnosis and treatment, patients often seek medical help in the late stages of the disease, which complicates the treatment process and increases the risk of severe complications (Mirrakhimov *et al*., 2024). The medical and social consequences of metabolic syndrome significantly affect the health of the population, the economy of countries, and social structures. The increased risk of developing cardiovascular diseases, type 2 diabetes, disability, and psychoemotional problems in patients requires an integrated approach to the diagnosis, prevention, and treatment of metabolic syndrome. It is important to develop and implement prevention and early detection programs, improve access to medical care, and raise public awareness of risk factors and treatment options (Mirrakhimov *et al*., 2012).

The Influence of Lifestyle and Nutrition on the Development of Metabolic Syndrome

Lifestyle is a critical factor influencing the onset of metabolic syndrome. Insufficient physical activity, inadequate nutrition, elevated stress levels, and poor sleep quality all play significant roles in heightening the risk of metabolic diseases. Recent findings indicate that lifestyle modifications, such as consistent engagement in physical exercise, and balanced nutrition focussing on lower carbohydrate and fat consumption, along with emotional well-being, can greatly diminish the likelihood of developing metabolic syndrome. Individuals experiencing metabolic syndrome frequently encounter psychological challenges, including depression, anxiety disorders, and feelings of social isolation (Faizan Siddiqui & Azaroual, 2024). The complexities of these issues can hinder effective treatment and prevention strategies for diseases linked to metabolic syndrome. Psychological factors, including stress, can exacerbate the pathological condition and diminish the patient's motivation for lifestyle modifications. This underlines the need for a complete treatment plan as well as the prevention of the syndrome. Treating metabolic syndrome requires a comprehensive strategy involving several fields of knowledge. Important areas of focus are changing behavior, applying pharmacological treatments to get ideal blood lipid and glucose levels, and correctly managing blood pressure (Gluvic *et al*., 2017).

In this context, nutritional support plays a crucial role, aiding in the reduction of body weight and the normalization of blood glucose and lipid levels. Kyrgyzstan exhibits distinct socio-economic characteristics, such as a traditional dietary pattern rich in carbohydrates and fats, coupled with a low level of physical activity, which plays a significant role in the rising prevalence of metabolic syndrome within the nation (Heijmans *et al*., 2008). A significant issue is the insufficient awareness within the population regarding the risks linked to metabolic syndrome, resulting in postponed diagnosis and treatment. The presence of metabolic syndrome profoundly affects patients' quality of life, diminishing their work capacity and elevating the risks of morbidity and mortality associated with cardiovascular diseases and diabetes. The rather high incidence of diabetes and cardiovascular disease in Kyrgyzstan causes major socioeconomic consequences related to metabolic syndrome (Fahed *et al*., 2022).

The management of metabolic syndrome nowadays consists of several important elements: changes in lifestyle (such as dietary changes and more physical activity), pharmacological treatments (including antihypertensive drugs and agents to control blood lipid and glucose levels), as well as psychological approaches. Reducing weight and normalizing metabolic processes depend much on nutritional support. Along with improving community-based prevention programs, Kyrgyzstan has a great need to create a system for early metabolic syndrome identification using current diagnosis tools. Improving the general quality of the population depends on active cooperation among academic institutions, medical facilities, and community leaders (Cho *et al*., 2019). Metabolic syndrome is a major obstacle in social as well as medical settings that calls for a comprehensive and varied approach to good diagnosis and treatment. Though knowledge of the pathophysiology and epidemiology of this condition is essential, equally important is to consider how it influences the psycho-social well-being of the patient (Alam *et al*., 2021). This calls for tailored advice for every individual. Improving treatment plans, advancing nutritional support, and increasing public awareness of the risk factors of metabolic syndrome will help to reduce the frequency and social impact linked with this condition. A major medical and social issue that impacts people worldwide, including in Kyrgyzstan, is metabolic syndrome. Inadequate physical activity, poor diet, and psychological problems are some of the factors contributing to the rising prevalence of diabetes and cardiovascular diseases in the country. Early detection, effective treatment, preventative measures, and increasing public awareness of the risks associated with metabolic syndrome are all essential components of a multifaceted approach to addressing this issue (Ferguson-Smith & Patti, 2011).

Case Study: A Comprehensive Management Approach in Type 2 Diabetes Mellitus with Multifactorial Complications

Patient Background

Born in 1953, Patient A arrived at the clinic on July 3, 2018, complaining of dry mouth, frequent urination both during the day and at night (polyuria and nocturia), and lower extremity pain accompanied by numbness has been developing for the past two months. These symptoms suggested an aggravation of chronic metabolic disorders, which drove more clinical investigation.

Medical History

The patient's medical records showed a 10-year history of type 2 diabetes mellitus, for which he had been on a steady insulin regimen—Humulin NPH at 30 units daily and Humulin R at 18 units daily. His health deteriorated recently, and non-compliance with nutritional advice was blamed. There was no appreciable clinical improvement even if symptomatic therapy for peripheral neuropathy, joint pain, hypertension, dyspnoea, and palpitations was given. Particularly hyperglycemia, lower limb edema, and increasing dyspnoea, the sequence of problems called for admission to a regional hospital for thorough evaluation and treatment.

Physical Examination

With a height of 169 cm and a body weight of 90 kg, the patient was determined to have a hypersthenic body type, equivalent to a body mass index (BMI) of 31 kg/m², suggestive of obesity. According to the dermatological assessment, the skin was dry and clean. The respiratory examination turned up vesicular breath sounds devoid of any adventitious noises. A cardiovascular examination revealed a pulse rate of 90 beats per minute with muted but rhythmic heart tones and raised blood pressure recorded at 180/90 mmHg. The gastrointestinal results indicated a soft yet enlarged belly indicative of hepatomegaly and a dry tongue. The spleen was not enlarged whereas the liver could be felt near the brink of the costal arch. Though there was no indication of peripheral edema, observed were increased diuresis and constipation. Both lower limbs have retained symmetric peripheral arterial pulsations.

Laboratory Investigations

As shown in **Table 1**, blood glucose levels ranged from 15.9 to 8.0 mmol/L and postprandial glycemia between 16.7 and 10.9 mmol/L according to laboratory testing. Glycated hemoglobin (HbA1c) was somewhat high at 10.2%, suggesting poor long-term glycaemic management. On a urinalysis, the glucose levels showed to be 0.5%. Renal function was relatively preserved with a blood creatinine level of 68.0 mmol/L. Pointing out dyslipidemia was LDL cholesterol at 4.07 mmol/L and triglycerides at 1.67 mmol/L. Regarding beta-lipoprotein content, 0.55 g/L **(Table 1)**.

Table 1. Biochemical and Hematological Parameters

Test	Result
Blood glucose (range)	15.9 - 8.0 mmol/L
Postprandial glucose	16.7 - 10.9 mmol/L
Glycated hemoglobin (HbA1c)	10.2%
Urine glucose	0.5

Blood creatinine	68.0 mmol/L
LDL cholesterol	4.07 mmol/L
Triglycerides	1.67 mmol/L
Beta-lipoproteins	0.55 g/L
Hemoglobin	126 g/L
Erythrocytes	4.18 x10^12/L
Color index	0.8
Leukocytes	5.1 x10^9/L
ESR	22 mm/h
Neutrophils (s/I)	67%
Lymphocytes	30%
Monocytes	3%

As mentioned in **Table 2**, with erythrocytes tallied as 2–1–2, a urinalysis revealed a specific gravity of 1007, proteinuria at 275 mg/L, and mild leukocyturia (4–8 leukocytes per field). ASL titer of 1:200, total blood protein at 74.2 g/L, rheumatoid factor, and C-reactive protein yielded relative values reported by rheumatological examination. Calculated to be 82 mL/min, the estimated glomerular filtration rate (GFR) using CKD-EPI methodology points to stage 2 chronic renal disease **(Table 2)**.

Table 2. Urinalysis and Rheumatologic Tests

Test	Result
Specific gravity	1007
Protein	275 mg/L
Leukocytes	4-6-8
Erythrocytes	2-1-2
Rheumatoid Factor (RF)	Relative
C-reactive protein (CRP)	Relative
ASL	1:200
Serum protein	74.2 g/L
Estimated GFR (CKD-EPI)	82 mL/min

Imaging and Instrumental Diagnostics

With a horizontal electrical axis of the heart and indications of repolarisation anomalies, electrocardiography (ECG) showed sinus rhythm at 88 beats per minute. Renal and abdominal ultrasonic tests found chronic pancreatitis, chronic cholecystitis, and fatty hepatosis. The kidneys both showed symptoms of chronic pyelonephritis. Especially the left kidney was noticeably atrophic with erratic, uncertain shapes and distortion. Though of normal size (134x50 mm), the right kidney revealed compressed parenchyma. Along with corneal clouding in the right eye, an ophthalmological study verified retinal vascular angiopathy and an immature cataract in the left eye. The existence of sensory-type diabetic peripheral polyneuropathy compromising the lower limbs was determined by neurological examination.

Clinical Management Algorithm

Patients with insulin-dependent type 2 diabetes show many consequences including peripheral neuropathy and diabetic nephropathy. Her poor glycaemic control and great cardiovascular risk led to a systematic treatment plan being started. At first, the treatment strategy took continuous monotherapy's constraints into account. The patient was already on a full dose of Humulin NPH, but glycaemic levels were insufficiently regulated, so insulin dosage had to be changed and further pharmacological agents for blood pressure and cholesterol management had to be included. This method conforms to WHO guidelines for the treatment of complicated type 2 diabetes. Evidence-based guidelines for managing multi-morbidity in diabetes patients directed drug choice. The suggested pharmacologic schedule included Enalapril for blood pressure management, Atorvastatin for lipid reduction, Gliclazide MR and Metformin for enhanced glycaemic control, and Carvedilol with Amlodipine for further cardiovascular support. Still, the choice was to keep Humulin as the main insulin because its proven effectiveness, tolerance, and anti-catabolic qualities were known. Improvements in clinical symptoms including reduced polyuria and thirst with dosage change also helped to justify the ongoing usage of Humulin NPH. Support for this treatment plan came from a retroactive single-center cohort study (Leyte-Marique *et al*., 2022; Turlaev *et al*., 2022; Tuo *et al*., 2022). This trial included 142 patients, and on Day 3 of combination treatment, 35.2% attained euglycemia (Ashokkumar *et al*., 2022; Dadaeva *et al*., 2022; Dipalma *et al*., 2022; Ashurko *et al*., 2024; Shaiba *et al*., 2024). Pre- and post-therapy blood glucose levels were lower in the euglycemic group and their initial NPH dosages standardized by steroid dosage (0.5 U/mg PED) were much greater than in the other group, $p = 0.046$. Especially, the two groups' hypoglycemia incidence did not vary, thereby confirming the safety profile of NPH in acute hyperglycaemic conditions. This supports the conclusion that without additional danger, a more aggressive starting dosage of NPH insulin may help to enable quicker glycaemic stabilization.

Glycemic Control Targets

International recommendations have quite different treatment aims for glycaemic control. With a fasting glucose range of 3.9–7.2 mmol/L and postprandial values <10.0 mmol/L, the American Diabetes Association (ADA, 2021) targets HbA1c at 7.0%. AACE/ACE (2023) and the International Diabetes Federation (IDF, 2022) support lower postprandial thresholds (<7.8 mmol/L) and tougher HbA1c objectives (<6.5%). The Russian Association of Endocrinologists (2024) backs HbA1c objectives of 7.0%, fasting glucose <6.5 mmol/L, and postprandial glucose **(Table 3)**.

Table 3. Comparative Glycemic Control Targets Across Major International Diabetes Guidelines (2021–2024)

Guideline	HbA1c	Fasting Glucose	Postprandial Glucose
ADA (2021)	<7.0%	3.9-7.2 mmol/L	<10.0 mmol/L
IDF (2022)	≤6.5%	<5.5 mmol/L	<7.8 mmol/L
AACE/ACE (2023)	≤6.5%	<6.0 mmol/L	<7.8 mmol/L
Russian Endocrinologists (2024)	<7.0%	<6.5 mmol/L	<8.0 mmol/L

The difficulties in controlling advanced type 2 diabetes mellitus with many systemic problems are best shown by this case study.

Essential was an individualized, multi-pronged treatment combining optimal insulin administration, additional oral medicines, cardiovascular support, and regular monitoring. Strategic decision-making was supported by clinical data and guideline-driven aims, which finally sought to stabilize glycaemic indices, minimize symptoms, and lower long-term hazards (Harmouche *et al*., 2022; Wu *et al*., 2022; Graefen *et al*., 2023; Kiedrowicz *et al*., 2023; Kulkarni *et al*., 2023; Vogel *et al*., 2023; Weerasinghe *et al*., 2023; Bandi *et al*., 2024; Botelho *et al*., 2024; Mendes-Gouvêa *et al*., 2024; Uneno *et al*., 2024).

Conclusion

The structured application of a standardized therapeutic algorithm in the management of this case of insulin-dependent type 2 diabetes mellitus highlights the critical value of individualized, evidence-informed pharmacotherapy. The continuation and adjustment of Humulin NPH, administered in two divided doses (8–20 units in the morning and 18 units at night), alongside prandial Humulin R under carbohydrate exchange unit (XE) guidance, proved a rational decision based on both pathophysiological insight and clinical data. This insulin regimen produced constant post-meal glycaemic control and signs of therapeutic tolerance. This result matches known anabolic effects on muscle and other tissues sensitive to insulin. Given their elevated risk of cardiovascular disease, particularly given their metabolic syndrome and labile hypertension—two disorders for which two distinct kinds of medicine are needed—the patient was prescribed both amlodipine (10 mg) and carvedilol (6.25 mg) concurrently. Amlodipine, a dihydropyridine calcium channel blocker, offers effective arterial vasodilation with minimal impact on cardiac conduction, whereas carvedilol, a non-selective beta-blocker with alpha-blocking properties, complements this mechanism by attenuating sympathetic overactivity and improving endothelial function. Together, these agents stabilize blood pressure, reduce cardiovascular workload, and may even improve insulin sensitivity—benefits particularly critical in this metabolic context. Combining biochemical, hemodynamic, and pharmacokinetic data into a logical, goal-directed action helps this treatment strategy better show the concept of tailored medicine. This case is relevant as it underlines the need for careful monitoring and dynamic dosage modification especially in patients with concomitant microvascular problems and changing glycaemic indices. This paradigm of treatment offers a repeatable road towards better metabolic control and reduced long-term morbidity in high-risk diabetic patients based on competent clinical judgment as existing recommendations move towards more rigorous tailored glycaemic objectives.

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References

Alam, A., Imam, N., Siddiqui, M. F., Ali, M. K., Ahmed, M. M., & Ishrat, R. (2021). Human gene expression profiling identifies key therapeutic targets in tuberculosis infection: a systematic network meta-analysis. *Infection, Genetics and Evolution*, *87*, 104649.

Alam, A., Khan, A., Imam, N., Siddiqui, M. F., Waseem, M., Malik, M. Z., & Ishrat, R. (2021). Design of an epitope-based peptide vaccine against the SARS-CoV-2: a vaccine-informatics approach. *Briefings in Bioinformatics*, *22*(2), 1309-1323.

Alberti, K. G., Eckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., Fruchart, J. C., James, W. P., Loria, C. M., Smith, S. C., Jr, *et al.* (2009). Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; national heart, lung, and blood institute; American heart association; world heart federation; international atherosclerosis society; and international association for the study of obesity. *Circulation, 120*(16), 1640–1645. doi:10.1161/CIRCULATIONAHA.109.192644

Ashokkumar, P., Giri, G. V. V., & Pandya, K. (2022). Parotid abscess-associated facial palsy in hemodialysis patients: Clinical and surgical considerations. *Asian Journal of Periodontics and Orthodontics*, *2*, 47–50. doi:10.51847/naDu2XfBBQ

Ashurko, I., Tarasenko, S., Magdalyanova, M., Bokareva, S., Balyasin, M., Galyas, A., Khamidova, M., Zhornik, M., & Unkovskiy, A. (2024). Studying the level of patients' satisfaction with free gingival grafting and sub-epithelial connective tissue treatment. *Annals Journal of Dental and Medical Assisting,* *4*(1-2024), 16–23. doi:10.51847/Kx7ePFV8HR

Bandi, V., Dey, S. K., & Rao, O. (2024). Factors influencing the physician prescribing behaviour of medicines in developed and developing countries: a systematic review. *Journal of Integrated Nursing and Palliative Care*, *5*, 21–34. doi:10.51847/ZS3boQgksO

Botelho, J., Machado, V., Proença, L., Delgado, A. S., & Mendes, J. J. (2024). A review of exploring the effects of vitamin D deficiency on oral health and facial structures. *International Journal of Dental Research and Allied Sciences*, *4*(2), 1–8. doi:10.51847/QQ4M695DJh

Burhans, M. S., Hagman, D. K., Kuzma, J. N., Schmidt, K. A., & Kratz, M. (2018). Contribution of adipose tissue inflammation to the development of type 2 diabetes mellitus. *Comprehensive Physiology,* *9*(1), 1–58. doi:10.1002/cphy.c170040

Caballero, B. (2019). Humans against obesity: Who will win? *Advances in Nutrition,* *10*(suppl 1), S4–S9. doi:10.1093/advances/nmy055

Cho, D. H., Kim, M. N., Joo, H. J., Shim, W. J., Lim, D. S., & Park, S. M. (2019). Visceral obesity, but not central obesity, is associated with cardiac remodeling in subjects with suspected metabolic syndrome. *Nutrition, metabolism, and cardiovascular diseases: NMCD*, *29*(4), 360–366.

doi:10.1016/j.numecd.2019.01.007

Dadaeva, M. M., Zhuravleva, V. V., Osipchuk, G. V., Djenjera, I. G., Ziruk, I. V., & Povetkin, S. N. (2022). Investigation of the impact of *Aloe arborescens* Mill. extract-based preparations on sperm quality and quantity. *International Journal of Veterinary Research and Allied Sciences*, *2*(1), 24–30. doi:10.51847/m15bxiwdKr

Dipalma, G., Inchingolo, A. D., Fiore, A., Balestriere, L., Nardelli, P., Casamassima, L., Di Venere, D., Palermo, A., Inchingolo, F., & Inchingolo, A. M. (2022). Comparative effects of fixed and clear aligner therapy on oral microbiome dynamics. *Asian Journal of Periodontics and Orthodontics*, *2*, 33–41. doi:10.51847/mK28wdKCIX

Erdoğan, K., & Sanlier, N. (2024). Metabolic syndrome and menopause: the impact of menopause duration on risk factors and components. *International Journal of Women's Health*, 1249-1256.

Fahed, G., Aoun, L., Bou Zerdan, M., Allam, S., Bou Zerdan, M., Bouferraa, Y., & Assi, H. I. (2022). Metabolic syndrome: updates on pathophysiology and management in 2021. *International Journal of Molecular Sciences*, *23*(2), 786. doi:10.3390/ijms23020786

Faizan Siddiqui, M., & Azaroual, M. (2024). Combatting burnout culture and imposter syndrome in medical students and healthcare professionals: a future perspective. *Journal of Medical Education and Curricular Development*, *11*, 23821205241285601.

Ferguson-Smith, A. C., & Patti, M. E. (2011). You are what your dad ate. *Cell Metabolism*, *13*(2), 115–117. doi:10.1016/j.cmet.2011.01.011

Gluvic, Z., Zaric, B., Resanovic, I., Obradovic, M., Mitrovic, A., Radak, D., & R Isenovic, E. (2017). Link between metabolic syndrome and insulin resistance. *Current Vascular Pharmacology*, *15*(1), 30-39.

Graefen, B., Hasanli, S., & Fazal, N. (2023). Behind the white coat: the prevalence of burnout among obstetrics and gynecology residents in Azerbaijan. *Bulletin of Pioneer Research in Medical and Clinical Sciences*, *2*(2), 1–7. doi:10.51847/vIIhM1UG2l

Harmouche, L., Courval, A., Mathieu, A., Petit, C., Huck, O., Severac, F., & Davideau, J. L. (2022). A split-mouth study comparing photodynamic therapy and scaling and root planning in the treatment of chronic periodontitis. *Turkish Journal of Public Health Dentistry*, *2*(2), 23–30. doi:10.51847/0UkmY1pJvP

Heijmans, B. T., Tobi, E. W., Stein, A. D., Putter, H., Blauw, G. J., Susser, E. S., Slagboom, P. E., & Lumey, L. H. (2008). Persistent epigenetic differences associated with prenatal exposure to famine in humans. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(44), 17046–17049. doi:10.1073/pnas.0806560105

Imam, N., Alam, A., Siddiqui, M. F., Veg, A., Bay, S., Khan, M. J. I., & Ishrat, R. (2023). Network-medicine approach for the identification of genetic association of parathyroid adenoma with cardiovascular disease and type-2 diabetes. *Briefings in Functional Genomics*, *22*(3), 250-262. doi:10.1093/bfgp/elac054

Kazemi, T., Sharifzadeh, G., Zarban, A., & Fesharakinia, A. (2013). Comparison of components of metabolic syndrome in premature myocardial infarction in an Iranian population: a case-control study. *International Journal of Preventive Medicine, 4*(1), 110–114.

Kiedrowicz, M., Dembowska, E., Banach, J., Safranow, K., & Pynka, S. (2023). Evaluating periodontal health in type 2 diabetics with chronic complications. *Annals of Orthodontics and Periodontics Special*, *3*, 19–27. doi:10.51847/axdaRLPSoJ

Kim, J. Y., & Yi, E. S. (2018). Analysis of the relationship between physical activity and metabolic syndrome risk factors in adults with intellectual disabilities. *Journal of Exercise Rehabilitation*, *14*(4), 592–597. doi:10.12965/jer.1836302.151

Kulkarni, S., Zope, S., Suragimath, G., Varma, S., & Kale, A. (2023). The influence of female sex hormones on periodontal health: a regional awareness study. *Annals of Orthodontics and Periodontics Special*, *3*, 10–18. doi:10.51847/v4EFMh6WEf

Leyte-Marique, A., Guzmán-Mendoza, R., & Salas-Araiza, M. D. (2022). Ecological roles and insect assemblages in southern Guanajuato grain crops. *Entomology Letters*, *2*(2), 37–46. doi:10.51847/LuXJYmQDEA

Malik, V. S., Popkin, B. M., Bray, G. A., Després, J. P., Willett, W. C., & Hu, F. B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. *Diabetes Care, 33*(11), 2477–2483. doi:10.2337/dc10-1079

Matsuzawa, Y., Funahashi, T., & Nakamura, T. (2011). The concept of metabolic syndrome: contribution of visceral fat accumulation and its molecular mechanism. *Journal of Atherosclerosis and Thrombosis*, *18*(8), 629-639.

Mendes-Gouvêa, C. C., Danelon, M., Vieira, A. P. M., Gallo do Amaral, J., Nunes de Souza Neto, F., Gorup, E. R. C., Delbem, A. C. B., & Barbosa, D. B. (2024). Fluorescent detection of tooth enamel microscopic damage using a silver nanoparticle-based mixture. *Spectroscopy*, *8*, 11. doi:10.51847/1D28fJXeP3

Mirrakhimov, E., Bektasheva, E., Isakova, J., Lunegova, O., Kerimkulova, A., Abilova, S., Neronova, K., Alibaeva, N., Mamatuulu, Y. U., Kudaibergenova, I., et al. (2024). Association of leptin receptor gene Gln223Arg polymorphism with insulin resistance and hyperglycemia in patients with metabolic syndrome. *Archives of Medical Science, 20*(1), 54-60. doi:10.5114/aoms/170121

Mirrakhimov, E., Lunegova, O. S., Kerimkulova, A. S., Moldokeeva, C. B., Nabiev, M. P., & Mirrakhimov, E. M. (2012). Cut off values for abdominal obesity as a criterion of metabolic syndrome in an ethnic Kyrgyz population (Central Asian region). *Cardiovascular Diabetology, 11*, 16. doi:10.1186/1475-2840-11-16

Mohamed, S. M., Shalaby, M. A., El-Shiekh, R. A., El-Banna, H. A., Emam, S. R., & Bakr, A. F. (2023). Metabolic syndrome: Risk factors, diagnosis, pathogenesis, and management with natural approaches. *Food Chemistry Advances, 3*, 100335. doi:10.1016/j.focha.2023.100335

Myers, J., Kokkinos, P., & Nyelin, E. (2019). Physical activity, cardiorespiratory fitness, and the metabolic syndrome.

Nutrients, 11(7), 1652. doi:10.3390/nu11071652

Pucci, G., Alcidi, R., Tap, L., Battista, F., Mattace-Raso, F., & Schillaci, G. (2017). Sex- and gender-related prevalence, cardiovascular risk and therapeutic approach in metabolic syndrome: A review of the literature. *Pharmacological Research, 120*, 34–42. doi:10.1016/j.phrs.2017.03.008

Saklayen, M. G. (2018). The global epidemic of the metabolic syndrome. *Current Hypertension Reports, 20*(2), 12. doi:10.1007/s11906-018-0812-z

Saltiel, A. R., & Olefsky, J. M. (2017). Inflammatory mechanisms linking obesity and metabolic disease. *The Journal of Clinical Investigation*, *127*(1), 1-4.

Samson, S. L., & Garber, A. J. (2014). Metabolic syndrome. *Endocrinology and Metabolism Clinics of North America, 43*(1), 1–23. doi:10.1016/j.ecl.2013.09.009

Shaiba, H., John, M., & Meshoul, S. (2024). Evaluating the pandemic's effect on clinical skill development among dental students. *Annals of Journal of Dental Medicine and Assistance*, *4*(1), 30–37. doi:10.51847/5x6qaXHp5d

Sharma, K., Mohan, S., Hossain, S. A., Shah, S., Konat, A., Shah, K., Mehta, S., Tavethia, J. J., Sarvaiya, J. N., Joshi, S., et al. (2024). Prevalence of traditional cardiovascular risk factors in high-risk Kyrgyzstan population as compared to Indians – An Indo-Kyrgyz cardiometabolic study. *Journal of Family Medicine and Primary Care, 13*(12), 5621–5625. doi:10.4103/jfmpc.jfmpc_712_24

Siddiqui, M. F. (2021). IoMT potential impact in COVID-19: Combating a pandemic with innovation. In K. Raza (Ed.), *Computational Intelligence Methods in COVID-19: Surveillance, Prevention, Prediction, and Diagnosis* (Vol. 923, pp. 349–361). Singapore: Springer. doi:10.1007/978-981-15-8534-0_18

Siddiqui, M. F., Alam, A., Kalmatov, R., Mouna, A., Villela, R., Mitalipova, A., Mrad, Y. N., Rahat, S. A. A., Magarde, B. K., Muhammad, W., et al. (2022). Leveraging healthcare system with nature-inspired computing techniques: an overview and future perspective. *Nature-Inspired Intelligent Computing Techniques in Bioinformatics*, 19-42.

Siddiqui, M. F., Aslam, D., Tanveer, K., & Soudy, M. (2024). The role of artificial intelligence and machine learning in autoimmune disorders. In K. Raza, S. Singh (Eds.), *Artificial Intelligence and Autoimmune Diseases* (Vol. 1133, pp. 61–75). Singapore: Springer Nature. doi:10.1007/978-981-99-9029-0_3

Swarup, S., Ahmed, I., Grigorova, Y., & Zeltser, R. (2025). *Metabolic syndrome*. In *StatPearls*. Treasure Island (FL): StatPearls Publishing. Retrieved May 29, 2025, Available from: http://www.ncbi.nlm.nih.gov/books/NBK459248/

Tuo, Y., Coulibaly, D., Koné, M., Traoré, S., Koné, K., & Koua, K. H. (2022). Insect diversity on inflorescences of four cashew nut varieties (Anacardium occidentale L.) in Niofoin, Côte d'Ivoire. *Entomology Letters*, *2*(2), 19-26. doi:10.51847/CNR21Y49HR

Turlaev, M. U., Shikhnebiev, A. A., Rokhoev, M. M., Mutigullina, K. R., Zakiev, R. R., Baklanova, O. A., & Spartakovich, I. (2022). The role of society and economy in advancing hirudotherapy in Russia. *International Journal of Veterinary Research and Allied Sciences*, *2*(1), 37-43. doi:10.51847/UI6IyFGbqT

Uneno, Y., Morita, T., Watanabe, Y., Okamoto, S., Kawashima, N., & Muto, M. (2024). Supportive care requirements of elderly patients with cancer refer to Seirei Mikatahara General Hospital in 2023. *Journal of Integrated Nursing and Palliative Care*, *5*, 42–47. doi:10.51847/lmadKZ2u1J

van der Pal, K. C., Koopman, A. D., Lakerveld, J., van der Heijden, A. A., Elders, P. J., Beulens, J. W., & Rutters, F. (2018). The association between multiple sleep-related characteristics and the metabolic syndrome in the general population: the New Hoorn study. *Sleep Medicine*, *52*, 51-57.

Vogel, J. P., Nguyen, P. Y., Ramson, J., De Silva, M. S., Pham, M. D., Sultana, S., McDonald, S., Adu-Bonsaffoh, K., & McDougall, A. R. (2023). Studying the effectiveness of various treatment methods effective on postpartum hemorrhage. *Bulletin of Pioneer Research in Medical and Clinical Sciences*, *2*(2), 20–26. doi:10.51847/P4KETj5Mik

Weerasinghe, K., Scahill, S. L., Pauleen, D. J., & Taskin, N. (2023). Examining the uses and priorities of big data in pharmaceuticals. *Bulletin of Pioneer Research in Medical and Clinical Sciences*, *2*(2), 27–32. doi:10.51847/5S8fLd1m1N

Wu, K., Yin, W., Liang, X., & Yang, Z. (2022). The impact of obesity and demographic factors on periapical lesions, dental caries, and oral health in adults. *Turkish Journal of Public Health Dentistry*, *2*(2), 13–22. doi:10.51847/MzsbLBIXDE

Xu, H., Li, X., Adams, H., Kubena, K., & Guo, S. (2018). Etiology of metabolic syndrome and dietary intervention. *International Journal of Molecular Sciences*, *20*(1), 128.