

# Cortisone

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## Cortisone

**Primary Disciplinary Field(s):** Endocrinology, Pharmacology, Immunology, Dermatology

### 1. Core Definition

Cortisone is a naturally occurring steroid hormone, specifically a glucocorticoid, primarily secreted by the **adrenal glands** located atop the kidneys. As a vital component of the body's intricate endocrine system, its release is modulated by the **hypothalamic-pituitary-adrenal (HPA) axis**, a complex feedback loop that regulates the body's response to stress. Upon secretion, cortisone plays a crucial role in preparing the body for perceived threats by elevating **blood pressure**, increasing heart rate, and influencing glucose metabolism, thereby contributing significantly to the physiological cascade known as the **"fight or flight" response**. This adaptive mechanism is essential for immediate survival, providing rapid energy mobilization and cardiovascular support.

Beyond its acute stress response functions, cortisone's most prominent and therapeutically exploited physiological action is its potent **immunosuppressive** and **anti-inflammatory** capabilities. It achieves this by profoundly influencing the activity of various immune cells and the production of inflammatory mediators. By suppressing the immune system, cortisone effectively mitigates the body's inflammatory reactions, which are often characterized by swelling, pain, redness, and heat. This inherent capacity to dampen inflammation and immune hyperactivity has made synthetic derivatives of cortisone, broadly termed corticosteroids, indispensable in modern medicine, used to manage a vast array of conditions ranging from acute allergic reactions to chronic autoimmune disorders.

In its manufactured form, cortisone is employed through diverse routes of administration, each tailored to specific therapeutic needs. For instance, **injections** are commonly administered directly into affected joints or soft tissues to provide localized and rapid relief from severe pain and inflammation, particularly in conditions like arthritis or bursitis. Oral formulations offer systemic effects, widely prescribed to reduce generalized inflammation and allergic-type reactions affecting multiple body systems. Furthermore, **topical cortisone creams** and ointments are a cornerstone in dermatology, effectively treating localized skin conditions such as rashes, itching, insect bites, and eczema, by reducing inflammation and alleviating discomfort directly at the site of irritation.

### 2. Etymology and Historical Development

The journey to understanding cortisone and its therapeutic potential is a compelling chapter in medical history, deeply intertwined with the exploration of adrenal gland function. Early 20th-century research hinted at the adrenal cortex's vital role in regulating various bodily functions and its connection to stress and inflammation. However, it was not until the mid-20th century that the specific compounds responsible for these effects were isolated and characterized. This pivotal

work laid the foundation for one of the most significant pharmacological breakthroughs of the era, fundamentally altering the treatment landscape for numerous debilitating diseases.

The isolation and structural elucidation of cortisone were the culmination of extensive and collaborative research efforts, most notably by **Edward C. Kendall** and **Tadeus Reichstein**, who independently worked on extracting and purifying compounds from adrenal cortical extracts. Concurrently, **Philip S. Hench**, a clinician, observed the remarkable anti-inflammatory effects of these extracts in patients suffering from rheumatoid arthritis. This convergence of biochemical isolation and clinical observation proved critical. In 1949, Hench, working with Merck & Co., demonstrated the dramatic efficacy of cortisone in treating rheumatoid arthritis, a disease previously managed with limited success. This breakthrough was revolutionary, offering unprecedented relief to patients severely debilitated by chronic inflammation.

The profound impact of this discovery was recognized globally, leading to the awarding of the **Nobel Prize in Physiology or Medicine in 1950** to Edward C. Kendall, Philip S. Hench, and Tadeus Reichstein "for their discoveries relating to the hormones of the adrenal cortex, their structure and biological effects." This recognition underscored cortisone's immediate and transformative influence on medicine. Subsequently, intensive research efforts focused on synthesizing cortisone and developing a range of synthetic corticosteroids, which often possessed enhanced potency, improved selectivity, and varied durations of action, further expanding their therapeutic applications while striving to minimize side effects.

### 3. Key Characteristics

Cortisone is fundamentally classified as a **glucocorticoid steroid hormone**, a member of the broader class of corticosteroids derived from cholesterol. Its characteristic molecular structure, a steroid nucleus with specific functional groups, dictates its biological activity and its ability to interact with cellular receptors. As a natural glucocorticoid, it plays an integral role in mediating a wide array of physiological processes, particularly those related to metabolism, immune response, and the body's adaptation to stress. Understanding these intrinsic characteristics is crucial for comprehending both its endogenous functions and its exogenous therapeutic applications.

The primary mechanism of action for cortisone involves its binding to specific **glucocorticoid receptors (GRs)**, which are intracellular proteins found in nearly all cells of the body. Upon binding, the cortisone-receptor complex translocates into the cell nucleus, where it interacts with specific DNA sequences known as **glucocorticoid response elements (GREs)**. This interaction directly influences gene transcription, either upregulating the expression of anti-inflammatory proteins or downregulating the expression of pro-inflammatory genes, such as those encoding cytokines, chemokines, and adhesion molecules. This intricate gene regulation ultimately leads to the profound **anti-inflammatory** and **immunosuppressive** effects observed with cortisone and

its synthetic analogues.

Beyond its immune-modulating properties, cortisone exerts significant physiological effects across multiple organ systems. Metabolically, it promotes **gluconeogenesis** (glucose production in the liver), increases protein catabolism, and influences lipid metabolism, all contributing to energy mobilization during stress. In the cardiovascular system, it helps maintain vascular tone and enhances the responsiveness of blood vessels to catecholamines, thereby contributing to **blood pressure regulation**. Furthermore, cortisone's influence extends to bone metabolism, affecting calcium absorption and bone formation, and even impacts mood and cognitive function, reflecting its broad systemic reach and its critical role in maintaining physiological homeostasis. The diverse therapeutic forms, including **injections** for localized treatment, **oral medications** for systemic effects, and **topical creams** for dermatological applications, underscore its versatility and wide-ranging clinical utility.

#### 4. Significance and Impact

The discovery and therapeutic application of cortisone, along with its synthetic derivatives, represent one of the most impactful advancements in 20th-century medicine. It ushered in a new era of effective management for a multitude of diseases that were previously untreatable or poorly controlled, profoundly enhancing the quality of life for millions globally. Its significance is multifaceted, extending across various medical disciplines and fundamentally reshaping the approach to inflammatory and immunological disorders.

Foremost among its impacts is the **revolutionized treatment of inflammatory and autoimmune diseases**. Conditions such as **rheumatoid arthritis**, systemic lupus erythematosus, asthma, inflammatory bowel disease, and various vasculitides, which are characterized by chronic and often debilitating inflammation or immune system attacks on the body's own tissues, found unprecedented relief with corticosteroids. Cortisone's ability to swiftly suppress inflammation and modulate immune responses provided rapid symptom control, reduced tissue damage, and enabled patients to regain functionality and mobility, transforming the prognosis for many chronic conditions that once led to severe disability and early mortality.

Beyond autoimmune conditions, cortisone has become a **critical tool in organ transplantation**. The immune system's natural response to a transplanted organ is to recognize it as foreign and mount an attack, leading to organ rejection. Cortisone and other corticosteroids are indispensable components of immunosuppressive regimens used to prevent this rejection, dramatically improving the success rates and long-term viability of organ transplants. Furthermore, its widespread use in **dermatology** for conditions like eczema, psoriasis, and contact dermatitis has provided effective symptomatic relief for a vast number of skin ailments, while its role in managing severe allergic reactions, such as anaphylaxis, highlights its life-saving potential in acute medical emergencies.

The research into cortisone also significantly advanced the scientific understanding of **stress physiology** and the intricate workings of the **hypothalamic-pituitary-adrenal (HPA) axis**. By unraveling how cortisone is produced, regulated, and acts within the body, scientists gained deeper insights into how the body responds to stress, maintains homeostasis, and the pathological consequences when these systems malfunction. This foundational knowledge has been instrumental in the study of stress-related disorders, metabolic syndromes, and chronic inflammatory conditions, continually driving further research into more targeted and safer therapeutic interventions.

## 5. Debates and Criticisms

Despite its profound therapeutic benefits, the use of cortisone and its synthetic analogues is associated with a range of debates and criticisms, primarily stemming from its broad physiological effects and the potential for significant **side effects**, especially with long-term or high-dose administration. The very mechanisms that make cortisone so effective--its powerful immunosuppressive and metabolic actions--are also responsible for its adverse effects, necessitating careful consideration of dosage, duration, and patient monitoring. Balancing therapeutic efficacy with the mitigation of side effects remains a central challenge in corticosteroid therapy.

One of the most significant concerns is the development of **Cushing's syndrome**, a constellation of symptoms resulting from prolonged exposure to high levels of corticosteroids. This can manifest as weight gain (particularly truncal obesity), facial rounding (moon face), skin thinning, easy bruising, muscle weakness, and psychiatric disturbances. Moreover, long-term systemic use can lead to serious metabolic complications, including **hyperglycemia** and an increased risk of developing type 2 diabetes, as well as electrolyte imbalances. The impact on bone health is also a major concern, with chronic use frequently resulting in **osteoporosis** and an increased risk of fractures due to decreased bone formation and increased bone resorption.

Furthermore, cortisone's immunosuppressive properties, while therapeutically beneficial, also render patients more susceptible to **infections**, masking the typical signs of inflammation that would normally alert clinicians to an infection's presence. Chronic use can also suppress the body's natural adrenal gland function, leading to **adrenal insufficiency** if the medication is abruptly discontinued. This necessitates a careful tapering schedule when discontinuing therapy. Other potential side effects include gastrointestinal issues (e.g., peptic ulcers), cataracts, glaucoma, hypertension, and mood disturbances. These concerns highlight the critical importance of a meticulous risk-benefit assessment for each patient, emphasizing the need for the lowest effective dose for the shortest possible duration, and continuous monitoring for adverse reactions. The ongoing research into corticosteroids focuses heavily on developing compounds with improved efficacy and reduced systemic side effect profiles, aiming to uncouple the desired anti-

inflammatory actions from the undesirable metabolic and endocrine consequences.

## Further Reading

[The Nobel Prize in Physiology or Medicine 1950](#)

[Britannica: Cortisone](#)

[NCBI: Glucocorticoids: mechanisms of action and therapeutic considerations](#)

[Mayo Clinic: Cortisone injection \(Side Effects\)](#)

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