The adrenal glands are orange-colored endocrine glands which are located on the top of both kidneys. The adrenal glands are triangular shaped and measure about one-half inch in height and 3 inches in length. The adrenal gland is partitioned into two distinctive components: the paler medulla and the darker cortex. Each has its own distinctive function.

The adrenal cortex is devoted to the synthesis of corticosteroid hormones from cholesterol. Some cells belong to the hypothalamic-pituitary-adrenal axis and are the source of cortisol and corticosterone synthesis. Other cortical cells produce androgens such as testosterone, while some regulate water and electrolyte concentrations by secreting aldosterone. In contrast to the direct innervation of the medulla, the cortex is regulated by neuroendocrine hormones secreted by the pituitary gland and hypothalamus, as well as by the renin-angiotensin system.

The adrenal medulla is the core of the adrenal gland, and is surrounded by the adrenal cortex. The chromaffin cells of the medulla, named for their characteristic brown staining with chromic acid salts, are the body's main source of the circulating catecholamines adrenaline (epinephrine) and noradrenaline (norepinephrine). These water-soluble hormones are major hormones underlying the fight-or-flight response. To carry out its part of this response, the adrenal medulla receives input from the sympathetic nervous system through preganglionic fibers originating in the thoracic spinal cord from T5–T11. Because it is innervated by preganglionic nerve fibers, the adrenal medulla can be considered as a specialized sympathetic ganglion. Unlike other sympathetic ganglia, however, the adrenal medulla lacks distinct synapses and releases its secretions directly into the blood.

**Cortisol**

Cortisol belongs to a class of hormones called glucocorticoids, which affect almost every organ and tissue in the body.
Normally, the production of cortisol follows a precise chain of events. First, the hypothalamus, a part of the brain about the size of a small sugar cube, sends corticotropin-releasing hormone (CRH) to the pituitary gland. CRH causes the pituitary to secrete adrenocorticotropic hormone (ACTH), which stimulates the adrenal glands. When the adrenals, receive the ACTH, they respond by releasing cortisol into the bloodstream.

![Diagram of cortisol production](image)

Cortisol performs vital tasks in the body including

- helping maintain blood pressure and cardiovascular function
- reducing the immune system’s inflammatory response
- balancing the effects of insulin, which breaks down glucose for energy
- regulating the metabolism of proteins, carbohydrates, and fats

One of cortisol’s most important jobs is to help the body respond to stress. For this reason, women in their last 3 months of pregnancy and highly trained athletes normally have high levels of the hormone. People suffering from depression, alcoholism, malnutrition, or panic disorders also have increased cortisol levels.

When the amount of cortisol in the blood is adequate, the hypothalamus and pituitary release less CRH and ACTH. This process ensures the amount of cortisol released by the adrenal glands is precisely balanced to meet the body’s daily needs. However, if something goes wrong with the adrenals or the regulating switches in the pituitary gland or hypothalamus, cortisol production can go awry.

**Cushing’s Syndrome**

Cushing’s syndrome is a hormonal disorder caused by prolonged exposure of the body’s tissues to high levels of the hormone cortisol. Sometimes called hypercortisolism, Cushing’s syndrome is relatively rare and most commonly affects adults aged 20 to 50.
People who are obese and have type 2 diabetes, along with poorly controlled blood glucose and high blood pressure, have an increased risk of developing the disorder.

Cushing’s syndrome occurs when the body’s tissues are exposed to high levels of cortisol for too long. Many people develop Cushing’s syndrome because they take glucocorticoids—steroid hormones that are chemically similar to naturally produced cortisol—such as prednisone for asthma, rheumatoid arthritis, lupus, and other inflammatory diseases. Glucocorticoids are also used to suppress the immune system after transplantation to keep the body from rejecting the new organ or tissue. Other people develop Cushing’s syndrome because their bodies produce too much cortisol.

Signs and symptoms of Cushing’s syndrome vary, but most people with the disorder have upper body obesity, a rounded face, increased fat around the neck, and relatively slender arms and legs. Children tend to be obese with slowed growth rates.

Other signs appear in the skin, which becomes fragile and thin, bruises easily, and heals poorly. Purple or pink stretch marks may appear on the abdomen, thighs, buttocks, arms, and breasts. The bones are weakened, and routine activities such as bending, lifting, or rising from a chair may lead to backaches and rib or spinal column fractures.

Women with Cushing’s syndrome usually have excess hair growth on their face, neck, chest, abdomen, and thighs. Their menstrual periods may become irregular or stop. Men may have decreased fertility with diminished or absent desire for sex and, sometimes, erectile dysfunction.

Other common signs and symptoms include

- severe fatigue
- weak muscles
- high blood pressure
- high blood glucose
- increased thirst and urination
- irritability, anxiety, or depression
- a fatty hump between the shoulders

Although it is unlikely you will see a patient with acute hyperadrenal crisis, you are likely to encounter patients who exhibit signs and symptoms of Cushing’s syndrome. It is important to remember that these patients have a higher incidence of cardiovascular disease, including hypertension and stroke. Pay attention to skin preparation when starting IV lines because of skin fragility and susceptibility to infection.

**Addison’s Disease**

Adrenal insufficiency is an endocrine—or hormonal—disorder that occurs when the adrenal glands do not produce enough of certain hormones. Adrenal insufficiency can be primary or secondary.
Primary adrenal insufficiency, also called Addison’s disease, occurs when the adrenal glands are damaged and cannot produce enough of the hormone cortisol and often the hormone aldosterone. Addison’s disease affects one to four of every 100,000 people, in all age groups and both sexes.

Secondary adrenal insufficiency occurs when the pituitary gland—a bean-sized organ in the brain—fails to produce enough adrenocorticotropin (ACTH), a hormone that stimulates the adrenal glands to produce cortisol. If ACTH output is too low, cortisol production drops. Eventually, the adrenal glands can shrink due to lack of ACTH stimulation. Secondary adrenal insufficiency is much more common than Addison’s disease.

The gradual destruction of the adrenal cortex, the outer layer of the adrenal glands, by the body’s immune system causes up to 80 percent of Addison’s disease cases. In autoimmune disorders, the immune system makes antibodies that attack the body’s own tissues or organs and slowly destroy them. Tuberculosis (TB), accounts for less than 20 percent of cases of Addison’s disease in developed countries. When adrenal insufficiency was first identified by Dr. Thomas Addison in 1849, TB was the most common cause of the disease. As TB treatment improved, the incidence of adrenal insufficiency due to TB of the adrenal glands greatly decreased. Less common causes of Addison’s disease are

- chronic infection, mainly fungal infections
- cancer cells spreading from other parts of the body to the adrenal glands
- amyloidosis, a disease that causes abnormal protein buildup in, and damage to, various organs
- surgical removal of the adrenal glands
- AIDS-associated infections
- bleeding into the adrenal glands
- genetic defects including abnormal adrenal gland development, an inability of the adrenal gland to respond to ACTH, or a defect in adrenal hormone production

Secondary adrenal insufficiency can be traced to a lack of ACTH. Without ACTH to stimulate the adrenal glands, the adrenals’ production of cortisol drops. Aldosterone production is not usually affected.

Adrenal insufficiency occurs when at least 90 percent of the adrenal cortex has been destroyed. As a result, often both cortisol and aldosterone are lacking. Sometimes only the adrenal glands are affected. Sometimes other endocrine glands are affected as well, as in polyendocrine deficiency syndrome.

The symptoms of adrenal insufficiency usually begin gradually. The most common symptoms are

- chronic, worsening fatigue
- muscle weakness
• loss of appetite
• weight loss

Other symptoms can include

• nausea
• vomiting
• diarrhea
• low blood pressure that falls further when standing, causing dizziness or fainting
• irritability and depression
• a craving for salty foods due to salt loss
• hypoglycemia, or low blood glucose
• headache
• sweating
• in women, irregular or absent menstrual periods

Hyperpigmentation, or darkening of the skin, can occur in Addison’s disease but not in secondary adrenal insufficiency. This darkening is most visible on scars; skin folds; pressure points such as the elbows, knees, knuckles, and toes; lips; and mucous membranes such as the lining of the cheek.

Because the symptoms progress slowly, they are often ignored until a stressful event like an illness or accident causes them to worsen. Sudden, severe worsening of symptoms is called an Addisonian crisis, or acute adrenal insufficiency. In most cases, symptoms of adrenal insufficiency become serious enough that people seek medical treatment before a crisis occurs. However, sometimes symptoms first appear during an Addisonian crisis.

Symptoms of an Addisonian or “adrenal” crisis include

• sudden, penetrating pain in the lower back, abdomen, or legs
• severe vomiting and diarrhea
• dehydration
• low blood pressure
• loss of consciousness

If not treated, an Addisonian crisis can be fatal.

Your patient may reveal the presence of Addison’s disease during the history, or the signs and symptoms just discussed may lead you to suspect the presence of Addison’s. Treatment for a patient suspected to be in Addisonian crisis should focus on emergency management of maintenance of the ABC’s and close monitoring of cardiac and oxygenation status as well as blood glucose level. Hypoglycemia should be treated per protocol. A base line ECG should be obtained to check for dysrhythmias related to electrolyte imbalance. Be aggressive in fluid resuscitation. Contact medical control for specific orders as needed. Transport your patient without delay to an appropriate facility for definitive treatments.
Post Test

Name: _______________________ (Please Print)
Dept: _______________________
Date: _______________________
Level of Practice:_______________

1. Cortisol belongs to a class of hormones called ______________________.

2. List 4 tasks performed by cortisol.
   A. _______________________________________
   B. _______________________________________
   C. _______________________________________
   D. _______________________________________

3. Cushing’s syndrome results from ____________________________________________.

4. People who are at risk for developing Cushing’s syndrome include:
   A. _______________________________________
   B. _______________________________________

5. Most people with Cushing’s syndrome exhibit: ________________________,
   ________________________, ________________________, and
   ________________________.

6. List 4 additional signs and symptoms you may see with Cushing’s
   A. _______________________________________
   B. _______________________________________
   C. _______________________________________
   D. _______________________________________

7. Patients with Cushing’s syndrome have a higher incidence of hypertension and
   stroke.
   A. True
   B. False
8. Addison’s disease occurs when people

9. Symptoms of adrenal crisis include:
   A. __________________________________________
   B. __________________________________________
   C. __________________________________________
   D. __________________________________________
   E. __________________________________________.

10. Discuss your plan of care specific to treating a patient in Addisonian crisis.

If you are NOT a member of the McHenry Western Lake County EMS System, Please include your address on each optional quiz turned into our office. Our mailing address is: Northwestern Medicine – McHenry Hospital EMS, 4201 Medical Center Drive, McHenry, Illinois 60050. We will forward to your home address verification of your continuing education hours.

If you ARE a member of our EMS System, your credit will be added to your Image Trend record. Please refer to Image Trend to see your current list of continuing education credits. Any questions regarding this can be addressed to Cindy Tabert at 224-654-0160. Please fax your quiz to Cindy Tabert at 224-654-0165.