

DEPO-MEDROL

(Methylprednisolone acetate)

1. NAME OF THE MEDICINAL PRODUCT

DEPO-MEDROL

2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Methylprednisolone acetate 40 mg/mL and 80 mg/2 mL

3. PHARMACEUTICAL FORM

Sterile aqueous suspension for injection.

4. CLINICAL PARTICULARS

4.1. THERAPEUTIC INDICATIONS

A. FOR INTRAMUSCULAR ADMINISTRATION

When oral therapy is not feasible and the strength, dosage form, and route of administration of the drug reasonably lend the preparation to the treatment of the condition, the intramuscular use of methylprednisolone acetate is indicated as follows:

1. Endocrine Disorders

Primary or secondary adrenocortical insufficiency (hydrocortisone or cortisone is the drug of choice; synthetic analogs may be used in conjunction with mineralocorticoids where applicable; in infancy, mineralocorticoid supplementation is of particular importance).

Acute adrenocortical insufficiency (hydrocortisone or cortisone is the drug of choice, mineralocorticoid supplementation may be necessary, particularly when synthetic analogs are used).

- Congenital adrenal hyperplasia
- Hypercalcemia associated with cancer
- Nonsuppurative thyroiditis

2. Rheumatic Disorders

As adjunctive therapy for short-term administration (to tide the patient over an acute episode or exacerbation) in:

- Post-traumatic osteoarthritis
- Epicondylitis
- Synovitis of osteoarthritis
- Acute non-specific tenosynovitis

- Rheumatoid arthritis, including juvenile rheumatoid arthritis (selected cases may require low-dose maintenance therapy)
- Psoriatic arthritis
- Acute gouty arthritis
- Ankylosing spondylitis
- Acute and subacute bursitis

3. **Collagen Diseases**

During an exacerbation or as maintenance therapy in selected cases of:

- Systemic lupus erythematosus
- Systemic dermatomyositis (polymyositis)
- Acute rheumatic carditis

4. **Dermatologic Diseases**

- Pemphigus
- Bullous dermatitis herpetiformis
- Severe erythema multiforme (Stevens-Johnson syndrome)
- Severe seborrheic dermatitis
- Exfoliative dermatitis
- Mycosis fungoides
- Severe psoriasis

5. **Allergic States**

Control of severe or incapacitating allergic conditions intractable to adequate trials of conventional treatment in:

- Bronchial asthma
- Drug hypersensitivity reactions
- Contact dermatitis
- Urticarial transfusion reactions
- Atopic dermatitis
- Acute non-infectious laryngeal edema (epinephrine is the drug of first choice)
- Serum sickness

6. **Ophthalmic Diseases**

Severe acute and chronic allergic and inflammatory processes involving the eye, such as:

- Herpes zoster ophthalmicus
- Drug hypersensitivity reactions
- Iritis, iridocyclitis
- Anterior segment inflammation
- Chorioretinitis
- Allergic conjunctivitis
- Diffuse posterior uveitis
- Allergic corneal marginal ulcers

- Optic neuritis
- Keratitis

7. Gastrointestinal Diseases

To tide the patient over a critical period of the disease in:

- Ulcerative colitis (systemic therapy)
- Regional enteritis (systemic therapy)

8. Respiratory Diseases

- Fulminating or disseminated pulmonary tuberculosis when used concurrently with appropriate anti-tuberculous chemotherapy
- Symptomatic sarcoidosis
- Berylliosis
- Loeffler's syndrome not manageable by other means
- Aspiration pneumonitis

9. Hematologic Disorders

- Acquired (autoimmune) hemolytic anemia
- Erythroblastopenia (RBC anemia)
- Secondary thrombocytopenia in adults
- Congenital (erythroid) hypoplastic anemia

10. Neoplastic Diseases

For palliative management of:

- Leukemias and lymphomas
- Acute leukemia of childhood

11. Edematous States

To induce diuresis or remission of proteinuria in the nephrotic syndrome, without uremia, of the idiopathic type or that due to lupus erythematosus

12. Miscellaneous

- Tuberculous meningitis with subarachnoid block or impending block when used concurrently with appropriate anti-tuberculous chemotherapy
- Trichinosis with neurologic or myocardial involvement

B. FOR INTRA-SYNOVIAL OR SOFT TISSUE ADMINISTRATION (including peri-articular and intrabursal) SEE SECTION 4.4 SPECIAL WARNINGS AND PRECAUTIONS FOR USE

Methylprednisolone acetate is indicated as adjunctive therapy for short-term administration (to tide the patient over an acute episode or exacerbation) in:

- Synovitis of osteoarthritis

- Epicondylitis
- Rheumatoid arthritis
- Acute non-specific tenosynovitis
- Acute and subacute bursitis
- Post-traumatic osteoarthritis
- Acute gouty arthritis

C. FOR INTRALESIONAL ADMINISTRATION

Methylprednisolone acetate is indicated for intralesional use in the following conditions:

Keloids, localized hypertrophic, infiltrated, inflammatory lesions of:

- Lichen planus, psoriatic plaques
- Discoid lupus erythematosus
- Necrobiosis lipodica diabetorum
- Granuloma annulare
- Lichen simplex chronicus (neurodermatitis)
- Alopecia areata

Methylprednisolone acetate may also be useful in cystic tumors or an aponeurosis or tendon (ganglia).

D. FOR INTRARECTAL INSTALLATION

Ulcerative colitis

4.2. POSOLOGY AND METHOD OF ADMINISTRATION

Because of possible physical incompatibilities, methylprednisolone acetate should not be diluted or mixed with other solutions. Parenteral suspensions should be inspected visually for any foreign particulate matter and discoloration prior to administration whenever drug product and container permit.

Administration for Local Effect

Therapy with methylprednisolone acetate does not obviate the need for the conventional measures usually employed. Although this method of treatment will ameliorate symptoms, it is in no sense a cure, and the hormone has no effect on the cause of the inflammation.

1. Rheumatoid and Osteoarthritis

The dose for intra-articular administration depends upon the size of the joint and varies with the severity of the condition in the individual patient. In chronic cases, injections may be repeated at intervals ranging from one to five or more weeks depending upon the degree of relief obtained from the initial injection.

The doses in the following table are given as a general guide.

Table 1. General guide for dosage

Size of Joint	Example	Range of Dosage
Large	Knees Ankles Shoulders	20-80 mg
Medium	Elbows Wrists	10-40 mg
Small	Metacarpophalangeal Interphalangeal Sternoclavicular Acromioclavicular	4-10 mg

Procedure

It is recommended that the anatomy of the joint involved be reviewed before attempting intra-articular injection. In order to obtain the full anti-inflammatory effect, it is important that the injection be made into the synovial space. Employing the same sterile technique as for a lumbar puncture, a sterile 20 to 24 gauge needle (on a dry syringe) is quickly inserted into the synovial cavity. Procaine infiltration is elective. The aspiration of only a few drops of joint fluid proves the joint space has been entered by the needle. The injection site for each joint is determined by that location where the synovial cavity is most superficial and most free of large vessels and nerves. With the needle in place, the aspirating syringe is removed and replaced by a second syringe containing the desired amount of methylprednisolone acetate. The plunger is then pulled outward slightly to aspirate synovial fluid and to make sure the needle is still in the synovial space. After injection, the joint is moved gently a few times to aid mixing of the synovial fluid and the suspension. The site is covered with a small sterile dressing.

Suitable sites for intra-articular injection are the knee, ankle, wrist, elbow, shoulder, phalangeal, and hip joints. Since difficulty is occasionally encountered in entering the hip joint, precautions should be taken to avoid any large blood vessels in the area. Joints not suitable for injection are those that are anatomically inaccessible, such as the spinal joints and those like the sacroiliac joints that are devoid of synovial space. Treatment failures are most frequently the result of failure to enter the joint space. Little or no benefit follows injection into surrounding tissue. If failures occur when injections into the synovial spaces are certain, as determined by aspiration of fluid, repeated injections are usually futile.

Local therapy does not alter the underlying disease process, and whenever possible, comprehensive therapy, including physiotherapy and orthopedic correction should be employed.

Following intra-articular corticosteroid therapy, care should be taken to avoid overuse of joints in which symptomatic benefit has been obtained. Negligence in this matter may permit an increase in joint deterioration that will more than offset the beneficial effects of the steroid.

Unstable joints should not be injected. Repeated intra-articular injection may in some cases result in instability of the joint. X-ray follow-up is suggested in selected cases to detect deterioration.

If a local anesthetic is used prior to injection of methylprednisolone acetate, the anesthetic package insert should be read carefully and all the precautions observed.

2. Bursitis

The area around the injection site is prepared in a sterile way, and a wheal at the site made with 1 percent procaine hydrochloride solution. A 20 to 24 gauge needle attached to a dry syringe is inserted into the bursa

and the fluid aspirated. The needle is left in place, and the aspirating syringe changed for a small syringe containing the desired dose. After injection, the needle is withdrawn and a small dressing applied.

3. Miscellaneous

Ganglion, Tendinitis, Epicondylitis.

In the treatment of conditions such as tendinitis or tenosynovitis, care should be taken, following application of a suitable antiseptic to the overlying skin, to inject the suspension into the tendon sheath rather than into the substance of the tendon. The tendon may be readily palpated when placed on a stretch. When treating conditions such as epicondylitis, the area of greatest tenderness should be outlined carefully and the suspension infiltrated into the area. For ganglia of the tendon sheaths, the suspension is injected directly into the cyst. In many cases, a single injection causes a marked decrease in the size of the cystic tumor and may effect disappearance.

The dose in the treatment of the various conditions of the tendinous or bursal structures listed above varies with the condition being treated and ranges from 4 to 30 mg. In recurrent or chronic conditions, repeated injections may be necessary.

The usual sterile precautions should be observed with each injection.

4. Injections for Local Effect in Dermatologic Conditions

Following cleansing with an appropriate antiseptic such as 70% alcohol, 20 to 60 mg is injected into the lesion. It may be necessary to distribute doses ranging from 20 to 40 mg by repeated local injections in the case of large lesions. Care should be taken to avoid injection of sufficient material to cause blanching, since this may be followed by a small slough. One to four injections are usually employed, the intervals between injections varying with the type of lesion being treated and the duration of improvement produced by the initial injection.

Administration for Systemic Effect

The intramuscular dosage will vary with the condition being treated. When a prolonged effect is desired, the weekly dose may be calculated by multiplying the daily oral dose by 7 and given as a singular intramuscular injection.

Dosage must be individualized according to the severity of the disease and response of the patient. For infants and children, the recommended dosage will have to be reduced, but dosage should be governed by the severity of the condition rather than by strict adherence to the ratio indicated by age or body weight.

Hormone therapy is adjunct to, and not a replacement for, conventional therapy. Dosage must be decreased or discontinued gradually when the drug has been administered for more than a few days. The severity, prognosis and expected duration of the disease and the reaction of the patient to medication are primary factors in determining dosage. If a period of spontaneous remission occurs in a chronic condition, treatment should be discontinued. Routine laboratory studies, such as urinalysis, two-hour postprandial blood sugar, determination of blood pressure and body weight, and a chest X-ray should be made at regular intervals during prolonged therapy. Upper GI x-rays are desirable in patients with an ulcer history or significant dyspepsia.

In patients with the adrenogenital syndrome, a single intramuscular injection of 40 mg every two weeks may be adequate. For maintenance of patients with rheumatoid arthritis, the weekly intramuscular dose will vary from 40 to 120 mg. The usual dosage for patients with dermatologic lesions benefitted by systemic

corticoid therapy is 40 to 120 mg of methylprednisolone acetate administered intramuscularly at weekly intervals for one to four weeks. In acute severe dermatitis due to poison ivy, relief may result within 8 to 12 hours following intramuscular administration of a single dose of 80 to 120 mg. In chronic contact dermatitis, repeated injections at 5 to 10 day intervals may be necessary. In seborrheic dermatitis, a weekly dose of 80 mg may be adequate to control the condition.

Following intramuscular administration of 80 to 120 mg to asthmatic patients, relief may result within 6 to 48 hours and persist for several days to two weeks.

If signs of stress are associated with the condition being treated, the dosage of the suspension should be increased. If a rapid hormonal effect of maximum intensity is required, the intravenous administration of highly soluble methylprednisolone sodium succinate is indicated.

Intrarectal Administration

Methylprednisolone acetate in doses of 40 to 120 mg administered as retention enemas or by continuous drip three to seven times weekly for periods of two or more weeks, have been shown to be a useful adjunct in the treatment of some patients with ulcerative colitis. Many patients can be controlled with 40 mg of methylprednisolone acetate administered in from 30-300 mL of water depending upon the degree of involvement of the inflamed colonic mucosa. Other accepted therapeutic measures should, of course, be instituted.

4.3. CONTRAINDICATIONS

Methylprednisolone acetate is contraindicated:⁶

- in patients who have systemic fungal infections
- in patients with known hypersensitivity to methylprednisolone or any component of the formulation
- for use by the intrathecal route of administration
- for use by the epidural route of administration⁸
- for use by the intravenous route of administration

Administration of live or live-attenuated vaccines is contraindicated in patients receiving immunosuppressive doses of corticosteroids.

4.4. SPECIAL WARNINGS AND PRECAUTIONS FOR USE MGPC (Myristyl-gamma-picolinium chloride)⁴¹ formulation

This product is not suitable for multidose use. Following administration of the desired dose, any remaining suspension should be discarded.

Multidose use of methylprednisolone acetate from a single vial requires special care to avoid contamination. Although initially sterile, any multidose use of vials may lead to contamination unless strict aseptic technique is observed. Particular care, such as use of disposable sterile syringes and needles, is necessary.

While crystals of adrenal steroids in the dermis suppress inflammatory reaction, their presence may cause disintegration of the cellular elements and physicochemical changes in the ground substance of the connective tissue. The resultant infrequently occurring dermal and/or subdermal changes may form depressions in the skin at the injection site. The degree to which this reaction occurs will vary with the amount of adrenal steroid injected. Regeneration is usually complete within a few months or after all crystals of the adrenal steroid have been absorbed.

In order to minimize the incidence of dermal and subdermal atrophy, care must be exercised not to exceed recommended doses in injections. Multiple small injections into the area of the lesion should be made whenever possible. The technique of intra-synovial and intramuscular injection should include precautions against injection or leakage into the dermis. Injection into the deltoid muscle should be avoided because of a high incidence of subcutaneous atrophy.

Methylprednisolone acetate should not be administered by any route other than those listed under section **4.1 Therapeutic Indications**. It is critical that, during administration of methylprednisolone acetate, appropriate technique be used and care taken to assure proper placement of drug.

Severe medical events have been reported in association with the intrathecal/epidural routes of administration (see section **4.8 Undesirable Effects**). Appropriate measures must be taken to avoid intravascular injection.⁸

General Warnings and Precautions

The following additional precautions apply for parenteral corticosteroids. Intra-synovial injection of a corticosteroid may produce systemic as well as local effects.

Appropriate examination of any joint fluid present is necessary to exclude a septic process.

A marked increase in pain accompanied by local swelling, further restriction of joint motion, fever, and malaise are suggestive of septic arthritis. If this complication occurs and the diagnosis of sepsis is confirmed, appropriate antimicrobial therapy should be instituted.

Local injection of a steroid into a previously infected joint is to be avoided.

Corticosteroids should not be injected into unstable joints.

Sterile technique is necessary to prevent infections or contamination.

The slower rate of absorption by intramuscular administration should be recognized.

Immunosuppressant Effects/Increased Susceptibility to Infections

Corticosteroids may increase susceptibility to infection, may mask some signs of infection, and new infections may appear during their use. There may be decreased resistance and inability to localize infection when corticosteroids are used. Infections with any pathogen, including viral, bacterial, fungal, protozoan or helminthic organisms, in any location in the body, may be associated with the use of corticosteroids alone or in combination with other immunosuppressive agents that affect cellular immunity, humoral immunity, or neutrophil function.² These infections may be mild, but can be severe and at times fatal. With increasing doses of corticosteroids, the rate of occurrence of infectious complications increases.³

Do not use intra-synovially, intrabursally or intratendinous administration for local effect in the presence of acute infection.³⁹

Persons who are on drugs which suppress the immune system are more susceptible to infections than healthy individuals. Chicken pox and measles, for example, can have a more serious or even fatal course in non-immune children or adults on corticosteroids.⁶

Administration of live or live-attenuated vaccines is contraindicated in patients receiving immunosuppressive doses of corticosteroids. Killed or inactivated vaccines may be administered to patients

receiving immunosuppressive doses of corticosteroids; however, the response to such vaccines may be diminished. Indicated immunization procedures may be undertaken in patients receiving non-immunosuppressive doses of corticosteroids.

The use of corticosteroids in active tuberculosis should be restricted to those cases of fulminating or disseminated tuberculosis in which the corticosteroid is used for the management of the disease in conjunction with appropriate antituberculosis regimen.

If corticosteroids are indicated in patients with latent tuberculosis or tuberculin reactivity, close observation is necessary as reactivation of the disease may occur. During prolonged corticosteroid therapy, these patients should receive chemoprophylaxis.

Kaposi's sarcoma has been reported to occur in patients receiving corticosteroid therapy. Discontinuation of corticosteroids may result in clinical remission.

The role of corticosteroids in septic shock has been controversial, with early studies reporting both beneficial and detrimental effects. More recently, supplemental corticosteroids have been suggested to be beneficial in patients with established septic shock who exhibit adrenal insufficiency. However, their routine use in septic shock is not recommended. A systematic review of short-course high-dose corticosteroids did not support their use. However, meta-analyses and a review suggest that longer courses (5-11 days) of low-dose corticosteroids might reduce mortality, especially in patients with vasopressor-dependent septic shock.^{9,10,11,12,13}

Immune System Effects

Allergic reactions may occur. Because rare instances of skin reactions and anaphylactic/anaphylactoid reactions have occurred in patients receiving corticosteroid therapy,⁴ appropriate precautionary measures should be taken prior to administration, especially when the patient has a history of allergy to any drug.

Endocrine Effects

In patients on corticosteroid therapy subjected to unusual stress, increased dosage of rapidly acting corticosteroids before, during and after the stressful situation is indicated.

Pharmacologic doses of corticosteroids administered for prolonged periods may result in hypothalamic-pituitary-adrenal (HPA) suppression (secondary adrenocortical insufficiency). The degree and duration of adrenocortical insufficiency produced is variable among patients and depends on the dose, frequency, time of administration, and duration of glucocorticoid therapy. This effect may be minimized by use of alternate-day therapy.⁶

In addition, acute adrenal insufficiency leading to a fatal outcome may occur if glucocorticoids are withdrawn abruptly.

Drug-induced secondary adrenocortical insufficiency may therefore be minimized by gradual reduction of dosage. This type of relative insufficiency may persist for months after discontinuation of therapy; therefore, in any situation of stress occurring during that period, hormone therapy should be reinstated.

A steroid "withdrawal syndrome," seemingly unrelated to adrenocortical insufficiency, may also occur following abrupt discontinuance of glucocorticoids. This syndrome includes symptoms such as anorexia, nausea, vomiting, lethargy, headache, fever, joint pain, desquamation, myalgia, weight loss, and/or hypotension. These effects are thought to be due to the sudden change in glucocorticoid concentration rather than to low corticosteroid levels.^{6,14}

Because glucocorticoids can produce or aggravate Cushing's syndrome, glucocorticoids should be avoided in patients with Cushing's disease.⁶

There is an enhanced effect of corticosteroids on patients with hypothyroidism.⁶

Metabolism and Nutrition

Corticosteroids, including methylprednisolone, can increase blood glucose, worsen pre-existing diabetes, and predispose those on long-term corticosteroid therapy to diabetes mellitus.⁶

Psychiatric Effects

Psychic derangements may appear when corticosteroids are used, ranging from euphoria, insomnia, mood swings, personality changes, and severe depression to frank psychotic manifestations. Also, existing emotional instability or psychotic tendencies may be aggravated by corticosteroids.

Potentially severe psychiatric adverse reactions may occur with systemic steroids. Symptoms typically emerge within a few days or weeks of starting treatment. Most reactions recover after either dose reduction or withdrawal, although specific treatment may be necessary.

Psychological effects have been reported upon withdrawal of corticosteroids; the frequency is unknown. Patients/caregivers should be encouraged to seek medical attention if psychological symptoms develop in the patient, especially if depressed mood or suicidal ideation is suspected. Patients/caregivers should be alert to possible psychiatric disturbances that may occur either during or immediately after dose tapering/withdrawal of systemic steroids.⁶

Nervous System Effects

Corticosteroids should be used with caution in patients with seizure disorders.

Corticosteroids should be used with caution in patients with myasthenia gravis (Also see myopathy statement in Musculoskeletal Effects section).^{6,39}

There have been reports of epidural lipomatosis in patients taking corticosteroids, typically with long-term use at high doses.^{14,15,16,17,18,19,20,21}

Ocular Effects

Prolonged use of corticosteroids may produce posterior subcapsular cataracts and nuclear cataracts (particularly in children), exophthalmos, or increased intraocular pressure, which may result in⁶ glaucoma with possible damage to the optic nerves, and may enhance the establishment of secondary ocular infections due to fungi or viruses.

Corticosteroids should be used cautiously in patients with ocular herpes simplex because of possible corneal perforation.³⁹

Corticosteroid therapy has been associated with central serous chorioretinopathy, which may lead to retinal detachment.^{22,23,24,25,26,27}

Cardiac Effects

Adverse effects of glucocorticoids on the cardiovascular system, such as dyslipidemia and hypertension, may predispose treated patients with existing cardiovascular risk factors to additional cardiovascular effects if high doses and prolonged courses are used. Accordingly, corticosteroids should be employed judiciously in such patients and attention should be paid to risk modification and additional cardiac monitoring if needed.⁶

Systemic corticosteroids should be used with caution, and only if strictly necessary, in cases of congestive heart failure.⁵

Vascular Effects

Thrombosis including venous thromboembolism has been reported to occur with corticosteroids. As a result corticosteroids should be used with caution in patients who have or may be predisposed to thromboembolic disorders.⁴⁸

Corticosteroids should be used with caution in patients with hypertension.⁶

Gastrointestinal Effects

High doses of corticosteroids may produce acute pancreatitis.⁶

There is no universal agreement on whether corticosteroids *per se* are responsible for peptic ulcers encountered during therapy; however, glucocorticoid therapy may mask the symptoms of peptic ulcer so that perforation or hemorrhage may occur without significant pain.⁶ Glucocorticoid therapy may mask peritonitis or other signs or symptoms associated with gastrointestinal disorders such as perforation, obstruction or pancreatitis⁵³. In combination with NSAIDs, the risk of developing gastrointestinal ulcers is increased.^{28,29}

Corticosteroids should be used with caution in non-specific ulcerative colitis if there is a probability of impending perforation, abscess or other pyogenic infection. Caution must also be used in diverticulitis, fresh intestinal anastomoses, active or latent peptic ulcer when steroids are used as direct or adjunctive therapy.

Hepatobiliary Effects

Hepatobiliary disorders have been reported which may be reversible after discontinuation of therapy. Therefore appropriate monitoring is required.⁵³

Musculoskeletal Effects

An acute myopathy has been reported with the use of high doses of corticosteroids, most often occurring in patients with disorders of neuromuscular transmission (e.g., myasthenia gravis) or in patients receiving concomitant therapy with anticholinergics, such as neuromuscular blocking drugs (e.g., pancuronium). This acute myopathy is generalized, may involve ocular and respiratory muscles, and may result in quadriparesis. Elevations of creatine kinase may occur. Clinical improvement or recovery after stopping corticosteroids may require weeks to years.

Osteoporosis is a common but infrequently recognized adverse effect associated with a long-term use of large doses of glucocorticoid.⁶

Renal and Urinary Disorders

Caution is required in patients with systemic sclerosis because an increased incidence of scleroderma renal crisis has been observed with corticosteroids, including methylprednisolone.⁵⁷

Corticosteroids should be used with caution in patients with renal insufficiency.⁶

Investigations

Average and large doses of hydrocortisone or cortisone can cause elevation of blood pressure, salt and water retention, and increased excretion of potassium. These effects are less likely to occur with the synthetic derivatives except when used in large doses.⁷ Dietary salt restriction and potassium supplementation may be necessary. All corticosteroids increase calcium excretion.⁶

Injury, Poisoning and Procedural Complications

Systemic corticosteroids are not indicated for, and therefore should not be used to treat, traumatic brain injury;^{47,49} a multicenter study revealed an increased mortality at 2 weeks and 6 months after injury in patients administered methylprednisolone sodium succinate compared to placebo. A causal association with methylprednisolone sodium succinate treatment has not been established.^{49,50,51}

Other

Since complications of treatment with glucocorticoids are dependent on the amount of the dose and the duration of treatment, a risk/benefit decision must be made in each individual case as to dose and duration of treatment as to whether daily or intermittent therapy should be used.

Aspirin and nonsteroidal anti-inflammatory agents should be used cautiously in conjunction with corticosteroids.⁶

Pheochromocytoma crisis, which can be fatal, has been reported after administration of systemic corticosteroids. Corticosteroids should only be administered to patients with suspected or identified pheochromocytoma after an appropriate risk/benefit evaluation.⁴⁰

Use in Children

Growth and development of infants and children on prolonged corticosteroid therapy should be carefully observed.⁶ Growth may be suppressed in children receiving long-term, daily-divided dose glucocorticoid therapy. The use of such a regimen should be restricted to those most serious indications.

Infants and children on prolonged corticosteroid therapy are at special risk from raised intracranial pressure.⁶

High doses of corticosteroids may produce pancreatitis in children.⁶

4.5. INTERACTION WITH OTHER MEDICINAL PRODUCTS AND OTHER FORMS OF INTERACTION

Methylprednisolone is a cytochrome P450 enzyme (CYP) substrate and is mainly metabolized by the CYP3A enzyme. CYP3A4 is the dominant enzyme of the most abundant CYP subfamily in the liver of adult humans. It catalyzes 6 β -hydroxylation of steroids, the essential Phase I metabolic step for both endogenous and synthetic corticosteroids. Many other compounds are also substrates of CYP3A4, some of which (as well as other drugs) have been shown to alter glucocorticoid metabolism by induction (upregulation) or inhibition of the CYP3A4 enzyme (**Table 2**).⁶

CYP3A4 INHIBITORS – Drugs that inhibit CYP3A4 activity generally decrease hepatic clearance and increase the plasma concentration of CYP3A4 substrate medications, such as methylprednisolone. In the presence of a CYP3A4 inhibitor, the dose of methylprednisolone may need to be titrated to avoid steroid toxicity (**Table 2**).⁶

CYP3A4 INDUCERS – Drugs that induce CYP3A4 activity generally increase hepatic clearance, resulting in decreased plasma concentration of medications that are substrates for CYP3A4. Co-administration may require an increase in methylprednisolone dosage to achieve the desired result (**Table 2**).⁶

CYP3A4 SUBSTRATES – In the presence of another CYP3A4 substrate, the hepatic clearance of methylprednisolone may be affected,³⁹ with corresponding dosage adjustments required. It is possible that adverse events associated with the use of either drug alone may be more likely to occur with co-administration (**Table 2**).⁶

NON-CYP3A4-MEDIATED EFFECTS – Other interactions and effects that occur with methylprednisolone are described in Table 2 below.⁶

Table 2. Important drug or substance interactions/effects with methylprednisolone

Drug Class or Type - DRUG or SUBSTANCE	Interaction or Effect
Antibacterial - ISONIAZID	CYP3A4 INHIBITOR. In addition, there is a potential effect of methylprednisolone to increase ³⁹ the acetylation rate and clearance of isoniazid. ⁶
Antibiotic, Antitubercular - RIFAMPIN	CYP3A4 INDUCER
Anticoagulants (oral)	The effect of methylprednisolone on oral anticoagulants is variable. There are reports of enhanced as well as diminished effects of anticoagulants when given concurrently with corticosteroids. Therefore, coagulation indices should be monitored to maintain the desired anticoagulant effects.
Anticonvulsant - CARBAMAZEPINE	CYP3A4 INDUCER (and SUBSTRATE)
Anticonvulsants - PHENOBARBITAL - PHENYTOIN	CYP3A4 INDUCERS
Anticholinergics - NEUROMUSCULAR BLOCKERS	Corticosteroids may influence the effect of anticholinergics. 1) An acute myopathy has been reported with the concomitant use of high doses of corticosteroids and anticholinergics, such as neuromuscular blocking drugs (see section 4.4 Special Warnings and Precautions for Use, Musculoskeletal Effects , for additional information)

Drug Class or Type - DRUG or SUBSTANCE	Interaction or Effect
	2) Antagonism of the neuromuscular blocking effects of pancuronium and vecuronium has been reported in patients taking corticosteroids. This interaction may be expected with all competitive neuromuscular blockers.
Anticholinesterases	Steroids may reduce the effects of anticholinesterases in myasthenia gravis. ^{32,33,34,35}
Antidiabetics	Because corticosteroids may increase blood glucose concentrations, dosage adjustments of antidiabetic agents may be required.
Antiemetic - APREPITANT - FOSAPREPITANT	CYP3A4 INHIBITORS (and SUBSTRATES)
Antifungal - ITRACONAZOLE - KETOCONAZOLE	CYP3A4 INHIBITOR (and SUBSTRATE)
Antivirals - HIV-PROTEASE INHIBITORS	CYP3A4 INHIBITORS (and SUBSTRATES) 1) Protease inhibitors, such as indinavir and ritonavir, may increase plasma concentrations of corticosteroids. 2) Corticosteroids may induce the metabolism of HIV-protease inhibitors, resulting in reduced plasma concentrations. ^{30,31}
Aromatase Inhibitor - AMINOGLUTETHIMIDE	Aminoglutethimide-induced adrenal suppression may exacerbate ³⁹ endocrine changes caused by prolonged glucocorticoid treatment.
Calcium Channel Blocker - DILTIAZEM	CYP3A4 INHIBITOR (and SUBSTRATE)
Contraceptives (oral) -ETHINYL ESTRADIOL/NORETHINDRON E	CYP3A4 INHIBITOR (and SUBSTRATE)
- GRAPEFRUIT JUICE	CYP3A4 INHIBITOR ^{30,36}
Immunosuppressant - CYCLOSPORINE	CYP3A4 INHIBITOR (and SUBSTRATE) 1) Mutual inhibition of metabolism occurs with concurrent use of cyclosporine and methylprednisolone, which may increase the plasma concentrations of either or both drugs. Therefore, it is possible that adverse events associated with the use of either drug alone may be more likely to occur upon co-administration. 2) Convulsions have been reported with concurrent use of methylprednisolone and cyclosporine.
Immunosuppressant - CYCLOPHOSPHAMIDE - TACROLIMUS	CYP3A4 SUBSTRATE
Macrolide Antibacterial - CLARITHROMYCIN - ERYTHROMYCIN	CYP3A4 INHIBITOR (and SUBSTRATE)
Macrolide Antibacterial - TROLEANDOMYCIN	CYP3A4 INHIBITOR

Drug Class or Type - DRUG or SUBSTANCE	Interaction or Effect
NSAIDs (nonsteroidal anti-inflammatory drugs) - high-dose ASPIRIN (acetylsalicylic acid)	1) There may be increased incidence of gastrointestinal bleeding and ulceration when corticosteroids are given with NSAIDs. 2) Methylprednisolone may increase the clearance of high-dose aspirin, which can lead to decreased salicylate serum levels. Discontinuation of methylprednisolone treatment can lead to raised salicylate serum levels, which could lead to an increased risk of salicylate toxicity. ³⁹
Potassium-depleting agents	When corticosteroids are administered concomitantly with potassium-depleting agents (i.e., diuretics), patients should be observed closely for development of hypokalemia. There is also an increased risk of hypokalemia with concurrent use of corticosteroids with amphotericin B, xanthines, or beta2 agonists. ^{6,39}

4.6. FERTILITY, PREGNANCY AND LACTATION

Fertility

Corticosteroids have been shown to impair fertility in animal studies (see section **5.3 Preclinical Safety Data**).^{39,47}

Pregnancy

Some animal studies have shown that corticosteroids, when administered to the mother, may cause fetal malformations. However, corticosteroids do not appear to cause congenital anomalies when given to pregnant women.

Since adequate human reproductive studies have not been done with methylprednisolone acetate, this medicinal product should be used during pregnancy only after a careful assessment of the benefit-risk ratio to the mother and fetus.⁵³

Corticosteroids readily cross the placenta. One retrospective study found an increased incidence of low birth weights in infants born of mothers receiving corticosteroids.⁶ In humans, the risk of low birth weight appears to be dose related and may be minimized by administering lower corticosteroid doses.⁵⁵

Infants born of mothers who have received substantial doses of corticosteroids during pregnancy must be carefully observed and evaluated for signs of adrenal insufficiency, although neonatal adrenal insufficiency appears to be rare in infants who were exposed *in utero* to corticosteroids.⁶

Cataracts have been observed in infants born to mothers treated with long-term corticosteroids during pregnancy.⁶

There are no known effects of corticosteroids on labor and delivery.

Lactation

Corticosteroids are excreted in breast milk.

Corticosteroids distributed into breast milk may suppress growth and interfere with endogenous glucocorticoid production in nursing infants. This medicinal product should be used during breast feeding only after a careful assessment of the benefit-risk ratio to the mother and infant.⁵³

4.7. EFFECTS ON ABILITY TO DRIVE AND USE MACHINES

The effect of corticosteroids on the ability to drive or use machinery has not been systematically evaluated. Undesirable effects, such as dizziness, vertigo, visual disturbance, and fatigue are possible after treatment with corticosteroids. If affected, patients should not drive or operate machinery.⁶

4.8. UNDESIRABLE EFFECTS

The following adverse reactions have been reported with the following contraindicated routes of administration: Intrathecal/Epidural: Arachnoiditis, functional gastrointestinal disorder/bladder dysfunction, headache, meningitis, paraparesis/paraplegia, seizure, sensory disturbance.^{39,53}

Table 3. Adverse Drug Reaction Table	
System Organ Class (MedDRA v. 18.0)	Adverse Drug Reactions
<i>Infections and infestations</i>	Opportunistic infection; Infection; Peritonitis [#] ; Injection site infection
<i>Blood and lymphatic system disorders</i>	Leukocytosis ^{44,45}
<i>Immune system disorders</i>	Drug hypersensitivity; Anaphylactic reaction; Anaphylactoid reaction ⁵³
<i>Endocrine disorders</i>	Cushingoid; Hypopituitarism; Steroid withdrawal syndrome
<i>Metabolism and nutrition disorders</i>	Metabolic acidosis ⁵³ ; Sodium retention; Fluid retention; Alkalosis hypokalaemic; Dyslipidaemia; Glucose tolerance impaired; Increased insulin requirement (or oral hypoglycemic agents in diabetics); Lipomatosis; Increased appetite (which may result in Weight increased)
<i>Psychiatric disorders</i>	Affective disorder (including Depressed mood, Euphoric mood, Affect lability, Drug dependence, Suicidal ideation); Psychotic disorder (including Mania, Delusion, Hallucination, and Schizophrenia); Mental disorder; Personality change; Confusional state; Anxiety; Mood swings; Abnormal behaviour; Insomnia; Irritability ⁵³
<i>Nervous system disorders</i>	Epidural lipomatosis; Intracranial pressure increased (with Papilloedema [Benign intracranial hypertension]); Seizure ⁵⁶ ; Amnesia; Cognitive disorder; Dizziness; Headache
<i>Eye disorders</i>	Chorioretinopathy ⁵⁶ ; Blindness [†] ; Cataract; Glaucoma; Exophthalmos
<i>Ear and labyrinth disorders</i>	Vertigo
<i>Cardiac disorders</i>	Cardiac failure congestive (in susceptible patients)
<i>Vascular disorders</i>	Thrombosis ⁴⁸ ; Hypertension; Hypotension
<i>Respiratory, thoracic and mediastinal disorders</i>	Pulmonary embolism ⁴⁸ ; Hiccups
<i>Gastrointestinal disorders</i>	Peptic ulcer (with possible Peptic ulcer perforation and Peptic ulcer haemorrhage); Intestinal perforation; Gastric haemorrhage; Pancreatitis; Oesophagitis ulcerative; Oesophagitis; Abdominal distention; Abdominal pain; Diarrhoea; Dyspepsia; Nausea
<i>Skin and subcutaneous tissue disorders</i>	Angioedema; Hirsutism; Petechiae; Ecchymosis; Skin atrophy; Erythema; Hyperhidrosis; Skin striae; Rash; Pruritus; Urticaria; Acne; Skin hyperpigmentation; Skin hypopigmentation

Table 3. Adverse Drug Reaction Table	
System Organ Class (MedDRA v. 18.0)	Adverse Drug Reactions
<i>Musculoskeletal and connective tissue disorders</i>	Muscular weakness; Myalgia; Myopathy; Muscle atrophy; Osteoporosis; Osteonecrosis; Pathological fracture; Neuropathic arthropathy; Arthralgia; Growth retardation
<i>Reproductive system and breast disorders</i>	Menstruation irregular
<i>General disorders and administration site conditions</i>	Abscess sterile; Impaired healing; Oedema peripheral; Fatigue; Malaise; Injection site reaction
<i>Investigations</i>	Intraocular pressure increased; Carbohydrate tolerance decreased; Blood potassium decreased; Urine calcium increased; Alanine aminotransferase increased; Aspartate aminotransferase increased; Blood alkaline phosphatase increased; Blood urea increased; Suppression of reactions to skin tests*
<i>Injury, poisoning and procedural complications</i>	Spinal compression fracture; Tendon rupture

† Rare instances of blindness associated with intralesional therapy around the face and head.

* Not a MedDRA PT.

Peritonitis may be the primary presenting sign or symptom of a gastrointestinal disorder such as perforation, obstruction or pancreatitis (see section 4.4 Special Warnings and Precautions for Use).⁵³

4.9. OVERDOSE

There is no clinical syndrome of acute overdosage with methylprednisolone acetate.

Reports of acute toxicity and/or death following overdosage of corticosteroids are rare. In the event of overdosage, no specific antidote is available; treatment is supportive and symptomatic.⁶

Methylprednisolone is dialyzable.⁶

5. PHARMACOLOGICAL PROPERTIES

5.1. PHARMACODYNAMIC PROPERTIES

Methylprednisolone is a potent anti-inflammatory steroid. It has greater anti-inflammatory potency than prednisolone and less tendency than prednisolone to induce sodium and water retention.⁶

5.2. PHARMACOKINETIC PROPERTIES⁶

Absorption

One in-house study of eight volunteers determined the pharmacokinetics of a single 40 mg intramuscular dose of DEPO-MEDROL. The average of the individual peak plasma concentrations was 14.8 ± 8.6 ng/mL, the average of the individual peak times was 7.25 ± 1.04 hours, and the average area under the curve (AUC) was 1354.2 ± 424.1 ng/mL x hrs (Days 1-21).

Distribution

Methylprednisolone is widely distributed into the tissues, crosses the blood-brain barrier, and is secreted in breast milk. Its apparent volume of distribution is approximately 1.4 L/kg.³⁷ The plasma protein binding of methylprednisolone in humans is approximately 77%.

Metabolism

In humans, methylprednisolone is metabolized in the liver to inactive metabolites; the major ones are 20 α -hydroxymethylprednisolone and 20 β -hydroxymethylprednisolone. Metabolism in the liver occurs primarily via the CYP3A4. (For a list of drug interactions based on CYP3A4-mediated metabolism, see section **4.5 Interaction with Other Medicinal Products and Other Forms of Interaction.**)

Methylprednisolone, like many CYP3A4 substrates, may also be a substrate for the ATP-binding cassette (ABC) transport protein p-glycoprotein, influencing tissue distribution and interactions with other medicines.^{38,30}

Elimination

The mean elimination half-life for total methylprednisolone is in the range of 1.8 to 5.2 hours. Total clearance is approximately 5 to 6 mL/min/kg.

5.3. PRECLINICAL SAFETY DATA

Based on conventional studies of safety pharmacology, repeated-dose toxicity, no unexpected hazards were identified. The toxicities seen in the repeated-dose studies are those expected to occur with continued exposure to exogenous adrenocortical steroids.⁶

Carcinogenic potential

Methylprednisolone has not been formally evaluated in rodent carcinogenicity studies. Variable results have been obtained with other glucocorticoids tested for carcinogenicity in mice and rats. However, published data indicate that several related glucocorticoids including budesonide, prednisolone, and triamcinolone acetonide can increase the incidence of hepatocellular adenomas and carcinomas after oral administration in drinking water to male rats. These tumorigenic effects occurred at doses which were less than the typical clinical doses on a mg/m² basis.⁵²

Mutagenic potential

Methylprednisolone has not been formally evaluated for genotoxicity. However, methylprednisolone sulfonate, which is structurally similar to methylprednisolone, was not mutagenic with or without metabolic activation in *Salmonella typhimurium* at 250 to 2,000 μ g/plate, or in a mammalian cell gene mutation assay using Chinese hamster ovary cells at 2,000 to 10,000 μ g/mL. Methylprednisolone sulfonate did not induce unscheduled DNA synthesis in primary rat hepatocytes at 5 to 1,000 μ g/mL. Moreover, a review of published data indicates that prednisolone farnesylate (PNF), which is structurally similar to methylprednisolone, was not mutagenic with or without metabolic activation in *Salmonella typhimurium* and *Escherichia coli* strains at 312 to 5,000 μ g/plate. In a Chinese hamster fibroblast cell line, PNF produced a slight increase in the incidence of structural chromosomal aberrations with metabolic activation at the highest concentration tested 1,500 μ g/mL.⁵²

Reproductive toxicity

Corticosteroids have been shown to reduce fertility when administered to rats.⁴⁷ Male rats were administered corticosterone at doses of 0, 10, and 25 mg/kg/day by subcutaneous injection once daily for 6 weeks and mated with untreated females. The high dose was reduced to 20 mg/kg/day after Day 15. Decreased copulatory plugs were observed, which may have been secondary to decreased accessory organ weight. The numbers of implantations and live fetuses were reduced.⁵²

Corticosteroids have been shown to be teratogenic in many species when given in doses equivalent to the human dose. In animal reproduction studies, glucocorticoids such as methylprednisolone have been shown to increase the incidence of malformations (cleft palate, skeletal malformations), embryo-fetal lethality (e.g., increase in resorptions), and intra-uterine growth retardation.^{6,39,52}

6. PHARMACEUTICAL PARTICULARS

6.1. LIST OF EXCIPIENTS

Not available

6.2. INCOMPATIBILITIES

Not available

6.3. SHELF LIFE

DEPO-MEDROL should not be used beyond the expiry date.

6.4. SPECIAL PRECAUTIONS FOR STORAGE

Store at controlled room temperature 15°C-30°C.

6.5. HOW SUPPLIED

DEPO-MEDROL is available in the following package size:

DEPO-MEDROL is Sterile Aqueous Suspension 40 mg/mL in 1x1 mL vial and 80 mg/2 mL in 1x2 mL vial

Depo-Medrol/LPD/PK-14

According to CDS V 16 dated: 22 October 2020; Supersedes: CDS V 15 dated: 28 September 2020

Marketed by:

Pfizer Pakistan Ltd.

Please visit our website www.pfizerpro.com.pk for latest version of Product leaflet.

7. REFERENCES

2. Fekety R. Infections associated with corticosteroids and immunosuppressive therapy. In: Gorbach SL, Bartlett JG, Blacklow NR, eds. *Infectious Diseases*. Philadelphia: WB Saunders Company 1992:1050-1051.
3. Stuck AE, Minder CE, Frey FJ. Risk of infectious complications in patients taking glucocorticoids. *Rev Infect Dis* 1989;11(6):954-963.
4. Torres MJ and Canto G. Hypersensitivity reactions to corticosteroids. *Curr Opin Allergy Clin Immunol* 2010; 10:273-9.
5. Anonymous. Corticosteroids-Glucocorticoids: Susceptibility factors. In: Aronson JK, editor. *Meyler's Side Effects of Drugs: The International Encyclopedia of Adverse Drug Reactions and Interactions*. 15th ed. Amsterdam: Elsevier: 2006; p.906-58.
6. Pfizer Clinical Overview for Methylprednisolone Acetate to Support Core Data Sheet Revisions June 2012.
7. Fardet L, Kaasar A, Cabane J, *et al*. Corticosteroid induced Adverse events in Adults Frequency, Screening and Prevention. *Drug Saf* 2007; 30:861-81.
8. Nelson and Landau. *J Neurol Neurosurg Psychiatry* 2001; 70: 433-43.
9. Sprung C, Caralis P, Marcial E, *et al*. The effects of high-dose corticosteroids in patients with septic shock. *N Engl J Med* 1984; 311: 1137-43.
10. Bone R, Fisher C Jr, Clemmer T, *et al*. A controlled clinical trial of high-dose methylprednisolone in the treatment of severe sepsis and septic shock. *N Engl J Med* 1987; 317: 653-8.
11. Anonymous. Effect of high-dose glucocorticoid therapy on mortality in patients with clinical signs of systemic sepsis. *N Engl J Med* 1987; 317: 659-65.
12. Annane D, *et al*. Corticosteroids for treating severe sepsis and septic shock. Available in: *The Cochrane Database of Systematic Reviews*; Issue 1. Chichester: John Wiley; 2004 (accessed 12/05/05).
13. Burry LD, Wax RS. Role of corticosteroids in septic shock. *Ann Pharmacother* 2004; 38: 464-72.
14. Braunwald E, Fauci AS, Isselbacher KJ, *et al*. (editors). *Prednisone Adverse Reactions*. *Harrison's Online: Drug Database* 2001-2202. The McGraw Hill Companies: 2001-2002.
15. Lee M, Lekias J, Gubbay S.S, *et al*. Spinal cord compression by extradural fat after renal transplantation. *Med. J.Aus* 1975; 1: 201-3.
16. Butcher D and Sahn S. Epidural lipomatosis: a complication of corticosteroid therapy. *Ann Intern Med* 1979; 90: 60.
17. Buthiau D, Piette J, Ducerveau M *et al*. Steroid-induced Epidural Lipomatosis: CT Survey. *J Comput Assist Tomogr* 1988; 12 : 501-3.
18. Heirhozer J, Benndorf G, Lehmann T, *et al*. Epidural lipomatosis: case report and literature review. *Neuroradiology* 1996; 38: 343-8.

19. Moller J, Cron R, Young D, *et al.* Corticosteroid-induced spinal epidural lipomatosis in the pediatric age group: report of a new case and updated analysis of the literature. *Pediatr Rheumatol* 2011; 9: 5.
20. Kano K, Kyo K, Ito S, *et al.* Spinal epidural lipomatosis in children with renal diseases receiving steroid therapy. *Pediatr Nephrol* 2005; 20: 184-9.
21. Brennan RC, Helton KJ, Pei D, *et al.* Spinal epidural lipomatosis in children with hematologic malignancies. *Ann Hematol* (2011) 90:1067-1074.
22. Haimovici R, *et al.* Risk Factors for Central Serous Chorioretinopathy: A Case–Control Study. *Ophthalmology* 2004; 111: 244–9.
23. Tittl M, *et al.* Systemic Findings Associated With Central Serous Chorioretinopathy. *Ophthalmology* 1999; 128: 163-9.
24. Carvalho-Recchia C, Yannuzzi L, Negrao S, Spaide R, Freund K, Rodriguez-Coleman H *et al.* Corticosteroids and central serous chorioretinopathy. *Ophthalmology* 2002; 109: 1834–7.
25. Levy J, *et al.* Central Serous Chorioretinopathy: A Complication of Glucocorticoid Excess. *The Endocrinologist* 2004; 14: 307–9.
26. Bouzas E, *et al.* Central Serous Chorioretinopathy and Glucocorticoids. *Surv Ophthalmol.* 2002; 47: 431–48.
27. Koyama M *et al.*, Seventeen Cases of Central Serous Chorioretinopathy Associated with Systemic Corticosteroid Therapy. *Ophthalmologica* 2004; 218: 107–10.
28. Spiro H. Is the steroid ulcer a myth? *N Engl J Med* 1983; 309: 45-7.
29. Guslandi M, Tittobello A. Steroid ulcers: A myth revisited. *BMJ* 1992; 304: 655-6.
30. Horn J, Hansten P. Get to know an enzyme: CYP3A4. *Pharm Times* 2008; 74: 37.
31. Anonymous. Indinavir sulfate: Interactions: Corticosteroids. In: Martindale: The Complete Drug Reference, London: Pharmaceutical Press; 2009: 9 pages. Electronic version, Thomson Reuters (Healthcare) Inc. (Accessed August 23, 2010).
32. Anonymous. Corticosteroids: Interactions of corticosteroids. In: Martindale: The Complete Drug Reference. Pharmaceutical Press; 2011: 146 pages. Electronic version, Thomson Reuters (Healthcare) Inc. (Accessed 12 August 2011)
33. Patten B, Oliver K, Engel W, *et al.* Adverse interaction between steroid hormones and anticholinesterase drugs. *Neurology* 1974; 24: 442-9.
34. Bradamante V, Kunec-Vajic E. Effect of glucocorticoids on plasma cholinesterase in the rat. *Biomed Biochim Acta* 1987; 4: 439-43.
35. Brunner N, Namba T, Grob D, *et al.* Corticosteroids in management of severe, generalized myasthenia gravis: effectiveness and comparison with corticotropin therapy. *Neurology* 1972; 22: 603-10.

36. Varis T, Kivisto K, Neuvonen P. Grapefruit juice can increase the plasma concentrations of oral methylprednisolone. *Eur J Clin Pharmacol* 2000; 569: 489-93.
37. Szeffler S, Ebling W, Georgitis J, *et al.* Methylprednisolone versus prednisolone pharmacokinetics in relation to dose in adults. *Eur J Clin Pharmacol* 1986; 30: 323-9.
38. Kuypers DRJ, Claes K, Evenepoel P, *et al.* Time-related clinical determinants of long-term tacrolimus pharmacokinetics in combination therapy with mycophenolic acid and corticosteroids. *Clin Pharmacokinet* 2004; 43:741-62.
39. Pfizer Inc. Methylprednisolone acetate April 2013 Clinical Overview to Support Core Data Sheet Revisions. April 2013.
40. Pfizer Inc. Corticosteroid Clinical Overview to Support Core Data Sheet Revisions for addition of Pheochromocytoma Warning July 2013.
41. Pfizer Inc. Methylprednisolone acetate Clinical Overview to Support Core Data Sheet Revisions. Nov 2013.
44. Pfizer Inc. Corticosteroids Clinical Overview to support the addition of Leukocytosis under section 4.8 of the Core Data Sheet, March 2014.
45. Pfizer Inc. methylprednisolone, methylprednisolone sodium succinate, and methylprednisolone acetate Clinical Overview to support the addition of adverse drug reaction frequency to core data sheet, March 2014.
47. Pfizer Inc. Corticosteroids Clinical Overview to support the addition of a warning on the use of corticosteroids in traumatic brain injury under section 4.4, update Fertility information in sections 4.6 and 5.3, and removal of short-term statement in section 5.3 of the core data sheet, April 2014.
48. Pfizer Inc. Corticosteroids Clinical Overview to support the addition of thrombosis including venous thromboembolism under Section 4.4 and thrombosis and pulmonary embolism to section 4.8 of the Hydrocortisone sodium succinate and methylprednisolone (acetate, acetate with lidocaine, sodium succinate, and tablets) Core Data Sheets, September 2014.
49. Pfizer Inc. Corticosteroids Clinical Overview to Support the Modification of a Warning on the use of High Doses of Corticosteroids in the Treatment of Traumatic Brain Injury under Section 4.4 of the Core Data Sheets, September 2014.
50. CRASH trial collaborators. Effect of intravenous corticosteroids on death within 14 days in 10,008 adults with clinically significant head injury (MRC CRASH trial): randomized placebo-controlled trial. *The Lancet* 2004; 364: 1321-1328.
51. Sauerland S, Maegele M. A CRASH landing in severe head injury. *The Lancet* 2004; 364: 1291-1292.
52. Methylprednisolone Module 2.4. Nonclinical Overview (to support CDS update).
53. 2.5 Clinical Overview To Support Updates to Sections 4.4, 4.5, 4.6, and 4.8 of the Methylprednisolone (Methylprednisolone Tablets, Methylprednisolone Acetate Sterile Aqueous Suspension,

Methylprednisolone Acetate with Lidocaine Sterile Aqueous Suspension, and Methylprednisolone Sodium Succinate Sterile Powder for Injection) Core Data Sheets, January 2016.

55. 2.5 Clinical Overview Methylprednisolone (methylprednisolone, methylprednisolone acetate, methylprednisolone acetate with lidocaine, methylprednisolone sodium succinate) To Support Changes to the Core Data Sheet (CDS) Section 4.6 Fertility, pregnancy and lactation, January 2016.
56. 2.5 Clinical Overview Updates to Section 4.8 Undesirable Effects of the Core Data Sheets (Methylprednisolone, Methylprednisolone Acetate, and Methylprednisolone Sodium Succinate), January 2016.
57. 2.5 Clinical Overview to Support Update to Section 4.4 of the Methylprednisolone (Methylprednisolone Tablets, Methylprednisolone Acetate Sterile Aqueous Suspension, Methylprednisolone Acetate with Lidocaine Sterile Aqueous Suspension, and Methylprednisolone Sodium Succinate Sterile Powder for Injection) Core Data Sheets, December 2017.
59. 2.5 Clinical Overview to Support the Deletion of the Indication for Acute Exacerbations of Multiple Sclerosis in the Core Data Sheet, September 2020.
60. 2.5 Clinical Overview, Deletion of the Indication “ Seasonal or Perennial Allergic Rhinitis” from the Core Data Sheets, October 2020.