
Pharmaceutical Dosage Forms and Drug Delivery Systems

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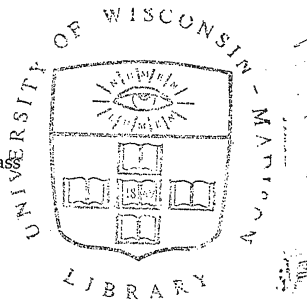
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Accurate indications, adverse reactions, and dosage schedules for drugs are provided in this book, but it is possible they may change. The reader is urged to review the package information data of the manufacturers of the medications mentioned.

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Parenteral Medications and Sterile Fluids

CONSIDERED IN this chapter are important pharmaceutical dosage forms that have the common characteristic of being prepared to be sterile; that is, free from contaminating microorganisms. Among these sterile dosage forms are the various small- and large-volume injectable preparations, irrigation fluids intended to bathe body wounds or surgical openings, dialysis solutions, biological preparations as vaccines, toxoids, antitoxins, and blood replenishment products. Sterility in these preparations is of utmost importance because they are placed in direct contact with the internal body fluids or tissues where infection can easily arise. Ophthalmic preparations which are also prepared to be sterile will be discussed separately in Chapter 11.

Injections

Injections are sterile, pyrogen-free preparations intended to be administered parenterally. The term *parenteral* refers to the injectable routes of administration. The term has its derivation from the Greek words *para* and *enteron*, meaning outside of the intestine, and denotes routes of administration other than the oral route. *Pyrogens* are fever-producing organic substances arising from microbial contamination and are responsible for many of the febrile reactions which occur in patients following intravenous injection. Pyrogens and the determination of their presence in parenteral preparations will be discussed later in this chapter. In general, the parenteral routes of administration are undertaken when rapid drug action is desired, as in emergency situations, when the patient is uncooperative, unconscious, or unable to accept or tolerate medication by the oral route, or when the drug itself is ineffective by other routes. With the exception of insulin injections, which are commonly self-administered by diabetic patients, most injections are administered by the physician, his as-

sistant, or nurse in the course of medical treatment. Thus injections are employed mostly in the hospital, extended care facility, and clinic and less frequently in the home. An exception would be in *home health care* programs in which health professionals pay scheduled visits to patients in their homes, providing needed treatment, including intravenous medications. These programs enable patients who do not require or are unable to pay for more expensive hospitalization to remain in the familiar surroundings of their homes while receiving appropriate medical care. The pharmacist supplies injectable preparations to the physician and nurse, as required for their use in the institutional setting, clinic, office, or home health care program.

Perhaps the earliest injectable drug to receive official recognition was the hypodermic morphine solution which appeared first in the 1874 addendum to the 1867 British Pharmacopeia, and later, in 1888 in the first edition of the National Formulary of the United States. Today, there are literally hundreds of drugs and drug products available for parenteral administration.

Interesting historical accounts of the origin and development of injection therapy may be found in the references cited.

Parenteral Routes of Administration

Drugs may be injected into almost any organ or area of the body, including the joints (*intra-articular*), a joint-fluid area (*intrasynovial*), the spinal column (*intraspinial*), into spinal fluid (*intrathecal*), arteries (*intra-arterial*), and in an emergency, even into the heart (*intracardiac*). However, most commonly injections are performed into a vein (*intravenous, I.V.*), into a muscle (*intramuscular, I.M.*), into the skin (*Intradermal, I.D., intracutaneous*), or under the skin (*subcutaneous, S.C., Sub-Q, S.Q., hypodermic, "Hypo."*) (Fig. 8-1).

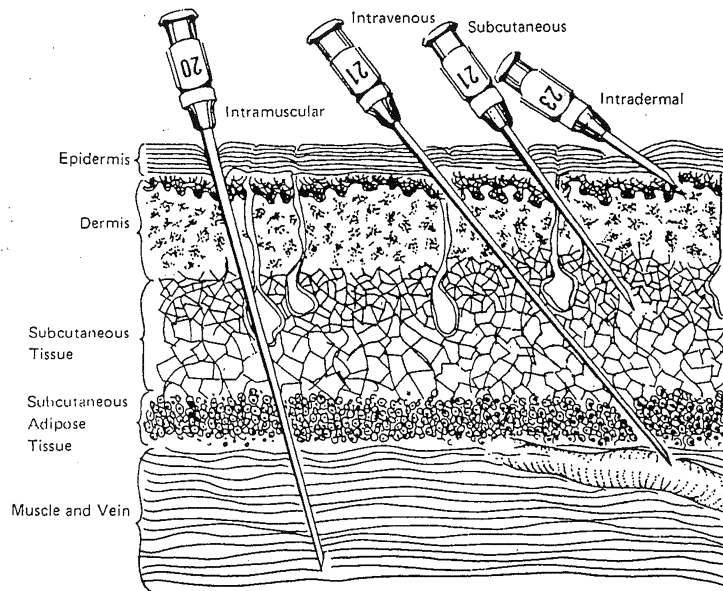


Fig. 8-1. Routes of parenteral administration. Numbers on needles indicate size or gauge of needle based on outside diameter of needle shaft. (Turco, S. and King, R.E., *Sterile Dosage Forms: Their Preparation and Clinical Applications*. 3rd Ed., Courtesy of Lea & Febiger, 1987.)

Intravenous Route

The intravenous injection of drugs had its scientific origin in 1656 in the experiments of Sir Christopher Wren, architect of St. Paul's Cathedral and amateur physiologist. Using a bladder and quill for a syringe and needle, he injected wine, ale, opium, and other substances into the veins of dogs and studied their effects. Intravenous medication was first given to man by Johann Daniel Major of Kiel in 1662, but was abandoned for a period because of the occurrence of thrombosis and embolism in the patients so treated. The invention of the hypodermic syringe toward the middle of the 19th century created a new interest in intravenous techniques and toward the turn of the century, intravenous administration of solutions of sodium chloride and glucose became popular. Today, the intravenous administration of drugs is a routine occurrence in the hospital, although there are still recognized dangers associated with the practice. Thrombus and embolus formation may be induced by intravenous needles and catheters, and the possibility of particulate matter in parenteral solutions poses concern for those involved in the

development, administration, and use of intravenous solutions.

Intravenously administered drugs provide rapid action compared to other routes of administration and because drug absorption is not a factor, optimum blood levels may be achieved with the accuracy and immediacy not possible by other routes. In emergency situations, the intravenous administration of a drug may be a life-saving procedure because of the placement of the drug directly into the circulation and the prompt action which ensues. On the negative side, once a drug is administered intravenously, it cannot be retrieved. In the case of an adverse reaction to the drug, for instance, the drug cannot be easily removed from the circulation as it could, for example, by the induction of vomiting following the oral administration of the same drug.

Although most superficial veins are suitable for venipuncture, the veins of the antecubital area (situated in front of the elbow) are usually selected for direct intravenous injection. The veins in this location are large, superficial and easy to see and enter. Most clinicians insert the needle with the bevel facing upward, at the most

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