

Needles and Pincushions:

A review of commonly used injectable medication delivery routes.

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Learning Objectives

- Discuss the history of injections.
- Discuss advantages/disadvantages of injectable medications.
- Discuss Pharmacokinetic issues for injectable medicines.
- Discuss differences between injectable delivery systems.
- Discuss delivery systems in illicit drug use.

This inservice will deal with why and how injections came to be a part of the medical arsenal against illness.

We will discuss advantages and disadvantages of injections.

We will discuss how physiology plays a role in how medications are ordered and administered.

We will examine various types of injectable systems.

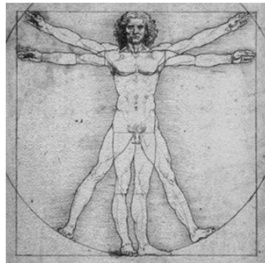
Finally, we will discuss the use of illicit drugs in the community.

This is a pin (needle).



For Illustration Only

This is a pincushion.



This is the pin in the pincushion



Introduction

There are thousands of drugs on the market. A good number are injectable medications. Providers count on the availability of injectables for effective treatment of their patients. The complexity of the patient will often dictate the providers course. For example, a patient with a bowel obstruction will not be able to tolerate oral medications. Consequently, an injectable route is preferred. Centers of pharmacy excellence take these instances into account and plan accordingly. Some diagnoses actually encourage patient self medication (Diabetes, DVT). Allowing patients to have an active role in their own care leads to increased compliance which leads to improved outcomes.

Where did this all start? Who first had the idea of sticking a hollow metal tube into the body to place a foreign substance there? Why? Are injectables safe?

The Dark Ages

As long as humans have walked the Earth, there have been illnesses. Today we know that many illnesses are caused by germs. But that wasn't always the case. Before the invention of the microscope (von Leeuwenhoek) and discovery of germs (Pasteur, Koch) and the promotion of antiseptics (Lister), many illnesses were thought to be the work of demons or hexes. As science improved theories for illnesses evolved to be caused by bad humors (fluids), or bad air (Miasmatic theory). Therapies involved letting out harmful fluids by bleeding, trepanning, or leeching. One would visit the barber-surgeon much like we visit our PCP's today. The Miasmatic theory of disease was prevalent until being supplanted by the Germ theory of disease in the mid 19th century. As soon as germs were proven to exist and cause diseases. Medicine began searching for methods to combat them.

Drugs have always been a part of the cure but were usually in the form of herbs, berries, teas, and poultices. These items were compounded by the village apothecary (or in earlier times a good-wife/shaman/curandera) and were at best ineffective. Occasional discoveries of different plant properties would yield a pharmacological gem (foxglove), but often times the cures were toxic to the patient (nuxvomica).

The Classical Age

Attempting to inject substances into the circulatory system is not a new idea.

1628 William Harvey described the circulation of blood in the body.

1656 Sir Christopher Wren used a quill (as the cannula) and a bladder (as the IV bag) to inject wine, ale, and opium into dogs.

1662 First injection into a human occurred.

1667 The first blood transfusion from an animal to a human was attempted with fatal results. This resulted in an edict of the church and parliament prohibiting animal-to-human transfer. A 150-year silence followed with little progress made in the practice of intravenous therapy.

Age of Enlightenment

•1818 an English obstetrician, James Blundell, revived the idea of using transfusions for hemorrhage during childbirth and he proved that only human blood was safe.

1831, an outbreak of cholera spread to Asia and Europe from India . Dr. Thomas Latta of Scotland was able to successfully use IV saline to restore blood to natural specific gravity and overcome the effects of the cholera-induced diarrhea.

• 1873 Edward Hodder in Canada infuses milk to cholera patients.

•1869 Menzl and Perco in Vienna inject fats subcutaneously in dogs.

•1896 Beidl and Krauts infuse glucose in humans, see febrile reactions.

The result of all of these experiments is fundamental understanding of what the body can tolerate.

Age of Addiction

1850 Previously-held belief that opiate dependence and addiction, often called "the opium appetite," was due to the drug's action on the digestive system—just like any hunger or thirst—caused doctors to opt to inject morphine rather than administer it orally in the hope that addiction would not develop.

1853 Alexander Wood invents the hypodermic syringe with a hollow pointed needle. At about the same time Charles Gabriel Pravaz makes a similar syringe called the Pravaz syringe.

Welcome to the 20th Century

1940's Massachusetts General has the first RN IV Therapist

1945 The first flexible plastic IV catheter inserted by cut down .

1949 Arthur Smith patents 8 different disposable syringes.

1954 Becton, Dickinson and Company create the first mass produced glass syringe and needle.

1955 Roehr makes plastic disposable hypodermic syringe.

1957 A steel needle with foldable wings for grips introduced.

1965-first TPN administered by Dudrick.

1975- development of tunneled central venous catheter (CVC)

1982-Implanted ports for long term access (Port-a-Cath)

1986-PICC lines see renewed interest due to advances in technology.

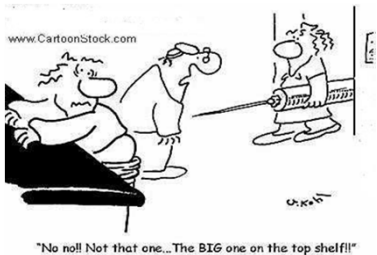
21st Century injections

Today, injections are sterile pyrogen free preparations intended to be administered parenterally. The word parenteral stems from two Greek words *para* and *enteron* meaning outside of the intestine and is understood to be routes other than oral.

Drugs can be injected into almost any organ or part of the body including the following:

*Intraarticular Intra-arterial Intraspinal Transdermal
Intrasyovial Intracardiac Intrathecal Intracavernous
Intravitreous Intraosseous Intradermal Intracerebral*
and of course the most widely recognized
Intravenous Subcutaneous Intramuscular.

Bel•o•ne•pho•bia -An abnormal fear of sharply pointed objects, especially needles.



"No no! Not that one... The BIG one on the top shelf!"

Why should I get stuck?

- Speed: Rapid onset of action
(15-30 seconds for IV, 3-5 minutes for IM and Sub-Q)
- 100% bioavailability (eliminates first pass effect)
- Suitable for drugs not absorbed by the gut or too irritating
(anti-cancer)
- One injection can be formulated to last days or even months
(e.g., Leupron Depot)
- IV can deliver medication continuously
(e.g., hydromorphone PCA or D5LR for fluid repletion)

What are the risks?

- Infection
- Electrolyte imbalance
- Phlebitis
- Extravasation
- Infiltration
- Embolism
- Fluid overload

Pharmacokinewhat???

PK, or pharmaco kinetics, is the term used to describe how drugs enter the body are distributed and eliminated.

Kinetics can be applied to any route of administration, but special circumstances apply to injectables.

Injections are 100% bioavailable. Drugs do not have to be absorbed by the GI system to work. 100% of the drug is available right now.

Injections are not subject the first pass effect. That is, drugs do not need to be activated by the liver to be effective. Also, the liver does not have the initial opportunity to de-activate drugs, which increases the chance of toxicity.

Choices, Choices, Choices

Choice of administration depends on a number of factors.

The most important of which is duration of therapy.

Drugs can be given via temporary peripheral lines (INT), temporary subcutaneous infusion, by IM injection, or subcutaneous injection.

Therapies that may be ongoing may require a semi-permanent vascular access device such as venous catheters (Central Line, Midline, PICC) or implanted ports (Port-a-Cath). The latter requiring specialized training, tubing and equipment.

Short term therapies do no warrant the complexity of a central line. Providers seeing patients during office hours most frequently order injections by the Sub-dermal, Sub-Q and IM routes. In rare cases IV meds may be administered in the office. Specialized clinics offering IV infusion of medications (including Chemotherapy) are called Infusion centers. These clinics have specialized staff trained to address complex drug infusions. (Tysabri)

INT (peripheral line)

A peripheral line is the most basic form of IV access. Placing a peripheral line involves inserting a cannula into a suitable vein. In adults long straight veins in the upper extremities are preferred. After placement of the cannula the site must be evaluated daily for signs of infection. Catheters must be changed every 72-96 hours to prevent phlebitis. If a catheter does not have constant infusion flowing, an anticoagulant flush is required to prevent fibrin deposits from forming.



Photos from nursing-resource.com

CVC Central Venous Catheter

Central lines are indicated for venous access when peripheral sites are unavailable or contraindicated. Provides access for hemodialysis or plasmapheresis. Good for sclerosing agents such as chemotherapy or hypertonic solutions such as parenteral nutrition. All types of central catheters are inserted into large veins in the neck (internal/external jugular), chest (subclavian), or groin (femoral).



Triple lumen CVC
from lymphomajournal.com

PICC Peripherally Inserted Central Catheter

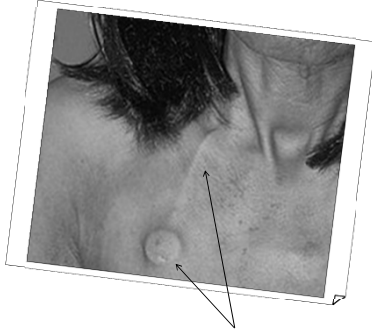
A PICC is a long, slender, small, flexible tube that is inserted into a peripheral vein, typically in the upper arm, and advanced until the catheter tip terminates in a large vein in the chest near the heart to obtain intravenous access. It is similar to other central lines as it terminates into a large vessel near the heart. However, unlike other central lines, its point of entry is from the periphery of the body ♦ the extremities. And typically the upper arm is the area of choice.



Photo from cs.cmu.edu

Implanted Ports

Implanted ports consist of a small reservoir, similar to a metal or plastic cup, covered by a self-sealing silicone cap or septum. A silicone catheter is attached to the port and is threaded into the superior vena cava. Non-coring (Huber) needles are used to access the port through the self-sealing septum, which allows a finite number of punctures depending on individual port specifications. The non-coring needle bevel cuts with a straight line, rather than the circular cut made by a standard needle.



Peripherally Inserted Central Catheters (PICCs) and Implanted ports (Port-a-Cath) are often seen in the Home Infusion setting as a good solution to long term home antibiotics and TPN infusion.

A whole new industry in Home Infusion has been quite successful in the last 20 years. Estimates state that as baby boomers continue to age and demand control over their own healthcare, Home infusion will continue to grow.



The Dark Side

In recreational drug use, **injection** is a method of introducing a drug into the body with a hollow needle and a syringe which is pierced through the skin into the body (usually intravenous, but also intramuscular or subcutaneous). This act is often colloquially referred to as *shooting, slamming, pinging up, blasting or banging.*

In some cases, ampoules or vials with sterile solution are available to users. The most popular injected drugs in illicit drug abuse use are opioids, anabolic steroids, stimulants, depressants, dissociative hallucinogens, other hallucinogens, and anticholinergics.

The Dark Side

Mixing drugs in the syringe is observed in some cases. The "speedball" was invented circa 1906 by Harry Thaw in New York City and became popular in different locations at different times during the 20th Century. Commonly, the speedball includes an opioid like heroin, morphine, methadone, hydromorphone, oxymorphone, or pentazocine plus a stimulant, usually cocaine but often methamphetamine. The addition of caffeine as a third ingredient is not unheard of.

Scary, Scary

Of all the ways to ingest drugs, injection, by far, carries the most risks as it bypasses the body's natural filtering mechanisms against viruses, bacteria and foreign objects. Viruses such as HIV and Hepatitis C are prevalent among IV drug users in many countries, mostly due to small groups sharing injection equipment combined with a lack of proper sterilization. Other health problems such as cotton fever, phlebitis, abscesses, vein collapse, ulcers, malaria, gas gangrene, tetanus, septicemia, thrombosis, and embolism arise from poor hygiene and injection technique. Fragments from injection of pills are known to clog the small blood vessels of the lungs and brain. Hitting arteries and nerves is dangerous, painful, and presents its own spectrum of problems.

Reducing Risks

Harm reduction is an approach to public health intended to be a progressive alternative to complete abstinence. While it does not condone the taking of illicit drugs, the idea is to reduce the harms arising from their use, both for the person taking illicit drugs and the wider community.

A prominent method for addressing the issue of disease transmission among users is the needle exchange program, in which facilities are available to exchange used injection equipment for safe sterile equipment, often without a prescription or fee. Such establishments also tend to offer free condoms to promote safe sex and reduce disease transmission. The idea is to slow disease transmission and promote public health by reducing the practice of sharing used needles. In countries where harm reduction programs are limited or non-existent, it is quite common for an IV user to use a single needle repeatedly or share with other users. It's also quite uncommon for a sterilizing agent to be used.

Injections for Technicians

- 1-What advances did the acceptance of Germ Theory make?
- 2-Why is First pass effect is so important for injectable medications?
- 3-Explain differences between Peripheral vs Central venous access.
- 4-List four different areas of the body where drugs may be injected.
- 5-Why are safe exchange programs so important to the community?

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