UNINTENTIONAL INTRAVASCULAR INJECTION OF PENICILLIN

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A TECHNIQUE designed to reduce the possibility of accidental entry into a blood vessel while giving an intramuscular injection of penicillin is being used at the venereal disease clinic of the central district of the Los Angeles Health Department.

Many investigators have expressed the view that some severe reactions or sudden death following an intramuscular injection of penicillin may be caused by unintentional injection into a vessel rather than by anaphylaxis (*1–18*). In experiments performed on cats to study the effect of deliberate intravenous injection of penicillin and, if possible, to determine the cause of any reaction that might occur, severe reactions and sometimes death followed (*3*). The median lethal dose of procaine penicillin given intravenously to cats is about 100,000 units per kg. of body weight. Necropsy findings in cats given this dosage suggested that pulmonary embolism played an important role in their reactions to deliberate intravenous injection. During these experiments, for comparison, 10 cats were given 51 intramuscular ininjections, each injection containing 300,000 units of penicillin. No untoward reactions were observed. In light of these experiments Bell and associates stated (*3*): "It is inferred that accidental intravenous injection of suspensions of procaine penicillin is the cause of some of the severe or fatal reactions in man."

The results of these experiments suggest therefore that some fatalities reported in the literature (*2–5*) were caused by entry of some material into a vein rather than by anaphylaxis as previously believed. The same reasoning may apply to reports of nonfatal, severe, or mild reactions suffered by patients who had a history of uneventful penicillin injections. Reports of postmortem examination on persons who died after supposedly intramuscular injection reveal a variety of findings: cerebral edema (*5, 10–12*), edema of the lungs (*2, 5, 11, 13*), and purpura cerebri (*10, 14, 15*).

Inadvertent intravenous injection of other substances may cause reactions identical to those caused by penicillin. For example, Beerman (*16*) stated: "A survey of the literature on fatalities due to bismuth in the treatment of syphilis reveals that intravenous injection is primarily responsible for sudden death and that the deaths are preceded by symptoms of colloidoclastic shock." Fortunately, however, adverse reactions to antibiotics are rare. According to Fasel (*4*), about 1 fatal accident may happen in 1 million injections. Fasel based this computation on Andersen's report of three fatalities which occurred within a 4-year period in Denmark (*5*).

Welch and associates (*17*), in a report of a nationwide survey undertaken with the cooperation of 800 hospitals and 1,500 physicians, stated: "In 1956 about 2,500,000 pounds of antibiotics were produced in the United States of America—penicillin accounts for 960,000 pounds (38 percent). Of a total of 2,995 cases reported as severe reactions, 2,517 were associated with the use of penicillin. Thus, penicillin was involved in 80 percent of all reactions reviewed in this survey." The authors concluded: "It is obvious that penicillin is the antibiotic causing the greatest number of reactions and the one most frequently involved in fatal cases. It is clear also that the oral route is the much safer method of administration, both from the standpoint of numbers of reactions and of mortality. The vast majority of

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reactions to penicillin occurred when the drug was administered intramuscularly."

"A commonly used method of giving an intramuscular injection," according to Bell and associates (*3*), "consists of attaching a needle to the syringe, sucking up the drug to be injected, and inserting the needle on the syringe into the muscle. The plunger is next withdrawn to make sure that no blood enters the barrel of the syringe, and then the injection is made.

"Suspensions of procaine penicillin, however, may block the needle in such a way that, when the plunger is withdrawn, nothing happens; but, when the plunger is advanced, the greater pressure dislodges the block, and the contents of the syringe are injected. For this reason the needle point may be in the lumen of a vein without its being detected." Obviously, this technique is not safe enough.

In 1944 Dattner and associates (*18*) remarked: "Since intravenous injection is fraught with such danger, one understands why every precaution must be taken not to inject into a vein inadvertently. This can be best avoided, first, by choosing the upper outer quadrant of the buttock, thus avoiding the large vessels and the sciatic nerve—and, second, by separate insertion of the needle to ascertain that no vein has been struck. Aspiration alone may sometimes fail because the small size of the vessel causes its collapse on negative pressure."

At the venereal disease clinic of the Los Angeles Health Department's central district, the needle, detached from the syringe, is inserted into the upper outer quadrant of the patient's buttock while he is in a prone position. Because we have seen blood appear in the lumen of the needle as late as 30 seconds after insertion, we leave the needle in place for 1 minute before we attach the syringe and inject the penicillin.

A review of 1,000 injections given at the clinic by this method revealed that blood vessels were inadvertently entered 16 times (roughly 3 times in 200). When this inadvertent entry occurred, the needle was withdrawn and reinserted. During a 3-year period more than 8,000 injections of penicillin were given at the venereal disease clinic, using the technique described above. Not one immediate life-threatening reaction was observed.

In conclusion, I should like to stress the well-known fact that many adverse reactions to penicillin result from hypersensitivity, and these reactions will occur regardless of route of administration. Even minute amounts of the drug in hidden sources, for example, may cause allergic reaction. Such was the experience of a penicillin-sensitive physician who suddenly collapsed after drinking a glass of milk. Emergency measures were required to bring him out of shock. Subsequently, he experienced several other less severe immediate reactions after drinking milk. He has learned to test milk by holding a small amount in his mouth. If there is much penicillin present, he has a peculiar tingling sensation in his mouth. He was reported to have shown a positive immediate reaction to an intracutaneous test with a solution containing 0.001 unit of penicillin per milliliter and to have had a high titer of circulating reagins for this antibiotic (*19*).

Clearly, the physician must not be lulled into a false sense of security because inadvertent intravenous injections have been minimized. He must be prepared to treat appropriately any reactions which follow an injection or even ingestion of penicillin.

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Municipal Waste Treatment Progress

The highest construction level on record for municipal waste treatment facilities, with contract awards of $679 million, was reached in 1963, according to the 1964 summary report of the fourth annual survey of municipal waste treatment needs of the Conference of State Sanitary Engineers. The report contains data from the 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam.

The 1963 construction level for municipal waste treatment facilities was 25 percent over 1962 and 50 percent higher than 1961. Adjusted upward to include other construction costs, this represents a construction level of about $820 million in 1963. Associated with it was Federal aid under the Water Pollution Control and Public Works Acceleration Programs totaling $160 million and $660 million in State and local funds.

The conference reports a steady improvement in the control of pollution from municipal wastes in the 4-year period covered by its annual surveys. In 1963, 850 sewage treatment plants were placed under construction in the areas surveyed.

However, new needs are constantly arising because of population growth, obsolescence of facilities, and reassessment by State water pollution control authorities. The report notes that all available Federal, State, and local resources will be needed simpy to maintain current progress in water pollution abatement.

There are 2,677 communities without sewers in the surveyed areas, as well as 1,462 communities discharging inadequately treated wastes from obsolete or deficient treatment plants. The unsewered communities require collection systems as well as subsequent treatment facilities, to serve some 5.2 million persons; the communities with inadequate sewage treatment require improved facilities to serve some 18.6 million persons. The estimated cost of meeting the total backlog needs of these 5,672 communities is $1.9 billion.