examples of the clinical application of this block. A volume of 25 to 35 cc. of 0.2% Xylocaine HCl is deposited on the anterior lateral aspect of the first lumbar vertebral body. Xylocaine freely spreads through the retroperitoneal tissue and bathes the coeliac plexus.

Individual Nerve Block

Individual nerve block is accomplished by the deposition of a local anesthetic drug either extraneurally or intraneurally at any point along a nerve proximal to its distribution. Although there is really no substitute for accurate needle placement and anatomical deposition of the minimal effective concentration of the drug, it is possible to achieve equally good results using larger volumes of lower concentrations. The latter technique has some advantages in that larger volumes of dilute solutions are less apt to result in high blood levels than small volumes of more concentrated solutions. It furnishes more consistent results with less accuracy demanded of the administrator, and the larger volumes form a depot, thereby giving more prolonged anesthesia and postoperative analgesia. However, accurate needle placement and minimal effective concentrations are, as a rule, desirable, and mandatory in blocks that are to be followed by the deposition of neurolytic drugs.

Table 9 outlines the recommended volumes and concentrations of Xylocaine for the blocks listed.

Xylocaine in Clinical Medicine

DENTISTRY

Xylocaine HCl is rapidly replacing procaine HCl and is today well established as a preferred local anesthetic agent in dentistry. Comfort and safety is afforded the patient, while the dentist is rewarded with conservation of time accrued from the rapid onset of anesthesia and the reliable quality of each block.

Bremer *et al* (1948) state that the intense penetrating and spreading powers of Xylocaine are invaluable in dentistry; after infiltrating at the base of a single tooth, adjacent teeth are often anesthetized also. These same workers emphasize the absence of side effects with Xylocaine. They report that Xylocaine produced excellent analgesia and no systemic effects in 87 patients with histories of repeated severe reactions to procaine. Xylocaine may be used by infiltration, to provide anesthesia of even the anterior mandibular structures.

The termination of dental analgesia is characteristically sudden, like "releasing a blind". Paraesthesiae and uncomfortable disturbances of sensation sometimes arise at the conclusion of a block with procaine, but this did not occur with Xylocaine (Björn and Huldt, 1947).

For routine use, Xylocaine HCl 2% with epinephrine is usually employed. The dosage is as follows:

Terminal analgesia 1 cc. Block analgesia 1.5-2 cc. Surgical treatment 3-5 cc.

The duration of analgesia is largely determined by the content of epinephrine. If epinephrine is not added to the solution, analgesia is short, but the duration increases rapidly in proportion to the strength of epinephrine. Where a particularly powerful and long lasting effect is required, 2% Xylocaine with 1:50,000 epinephrine may be employed.

The efficiency values for Xylocaine and procaine, in terms of the efficiency parameters, defined by Björn, (1947), are given in round values in the following table:

Parameter	Xylocaine-adrenaline	Procaine-adrenaline
Analgesia frequency, %	100	80
Index of analgesia extent	0.9	0.45
Analgesia duration, min.	60	25
Analgesia latency, min.	1.5	2.0

TABLE 6

Approximate efficiency values *for 2% Xylocaine and procaine solutions containing 25 γ/micrograms per ml. adrenaline. Reprinted from Björn, H. and Huldt, S., "IV. The Efficiency of Xylocaine as a Dental Terminal Anesthetic Compared to That of Procaine," Svensk Tandl. — Tidskr., 40:831, 1947.*

OBSTETRICS

Regional anesthesia for the conduct of labor and delivery has enjoyed increased acceptance with obstetricians as they have become aware of its role in lowering the incidence of maternal and infant morbidity and mortality. The rapid onset of anesthesia and the increased incidence of successful and complete blockade related to the combined qualities of Xylocaine HCl has resulted in its increased use in pudendal blocks, caudal blocks, and "saddle block" spinal anesthesia. The increased effectiveness of these latter blocks has been responsible for their more generalized use.

MINOR SURGERY

The number of minor surgical procedures performed in offices and hospitals under regional anesthesia far exceeds the major surgical procedures. The stability of Xylocaine HCl, along with low tissue irritancy, low relative toxicity, and non-sensitivity, has resulted in

its widespread utilization for this purpose. Most hospitals and offices realize the overall economic and practical advantages of this agent and are using it to replace procaine as their standard local anesthetic.

MAJOR SURGERY

Regional anesthesia, unless contraindicated, is used by many surgeons and anesthesiologists for most major surgical procedures. Those who have heretofore relied largely, if not entirely, on general anesthesia are finding more indications for regional block anesthesia. Although an increase in the number of trained anesthesiologists and improved techniques are largely responsible for the more recent interest in regional anesthesia, the introduction of Xylocaine HCl which assures a better quality of anesthesia must also be given due credit for this re-evaluation, renewed interest, and more generalized acceptance. This is particularly true of peridural anesthesia, where the incidence of incomplete anesthesia and prolonged latency period has been remarkably reduced. This technique is applicable for surgery in all areas supplied by the spinal nerves. Brachial plexus block for upper extremity surgery is also more successfully accomplished when Xylocaine HCl is used. Many other areas too numerous on which to elaborate also fall into this latter category.

UROLOGY

The urologist has long searched for a topical anesthetic that would produce the degree of analgesia necessary for the numerous manipulative procedures required in his office and hospital practice that did not warrant general anesthesia. Xylocaine Jelly was especially prepared for this specialty, and its effectiveness has made this agent an indispensible item for the urologist in cystoscopy, passing of sounds, urethral dilitation, catheterization, and other procedures.

NEUROSURGERY

The neurosurgeon utilizes local anesthetics to a considerable degree. Ventriculograms, craniotomies, and laminectomies are frequently performed using only infiltrative techniques. Large volumes of the drugs with and without vasopressors are used, and the importance of selecting an agent with a high anesthetic index such as Xylocaine HCl cannot be over emphasized. Diagnostic and therapeutic blocks are also an integral part of this specialty, and Xylocaine HCl is again effectively employed. The adhibition of peridural anesthesia for laminectomy is increasing and is particularly applicable because of the segmental areas that can be blocked. Low concentrations of epinephrine are usually employed with Xylocaine HCl to provide hemostasis in the vascular areas involved with this technique. Dorsal and cervical cordotomy may be performed in the conscious patient with the distal spinal nerves left intact, thus permitting identification of sectioned sensory tracts as with infiltrative techniques.

OPHTHALMOLOGY AND OTORHINOLARYNGOLOGY

The non-irritating properties of Xylocaine HCl, along with its other superior qualities such as rapid, diffuse analgesia, make its use almost mandatory by this specialty. The ophthalmologist may use subjunctival and retrobulbar injections of Xylocaine HCl for intraocular operations. Akinesia of the orbicularis oculi muscle is obtained by injecting Xylocaine HCl solution over the zygoma at the outer margin of the orbicularis. Topical anesthesia for the cornea and conjunctiva is described on page 43. The otorhinolaryngologist is also able to benefit from the clinical utility of Xylocaine HCl by using topical applications for nasal surgery, bronchoscopy, laryngeal surgery, and surgery of the tympanum (see pages 43 and 44).

INTERNAL MEDICINE

The internist has many clinical problems that indicate the administration of local anesthetic agents. An intravenous drip containing 0.1% to 0.2% Xylocaine HCl may be used for anesthetizing the endocardium in ventricular tachycardias. Also, refractory cardiac arrhythmias may be corrected by the intravenous use of 1 mg./kg. Xylocaine HCl. The esophagus and upper gastro-intestinal tract may be anesthetized by use of Xylocaine Viscous for esophagogastroscopy and the inhibition of hiccups (see page 46). Local infiltration is often used by the internist in performing diagnostic medical procedures such as bone marrow punctures, paracentesis, pneumothorax, pneumoperitineum, and spinal taps.

DERMATOLOGY

The dermatologist has for many years sought an agent which when used in his field of clinical endeavor did not manifest signs and symptoms of irritation and thereby perhaps aggravate a preexisting disorder. Within the realm of toxicity, two other very important factors are considered carefully by the dermatologist; namely, sensitization and allergenicity. To cope with these ever present problems, a preparation of Xylocaine base in water soluble carbowaxes has been introduced. This is commercially available as Xylocaine Ointment 2.5% or 5%. The main difference between these two concentrations is in the onset of action; namely, the 5% concentration has a shorter latency period. Of importance is the fact that Xylocaine Ointment does not depend on the buffering capacity of tissue for release of Xylocaine base as the rapid acting ingredient. Thus, an agent has been prepared which will give the dermatologist ready access to an effective analgesic ointment which is non-irritating, non-sensitizing, non-allergenic, and which does not retard healing. Its indications

cover a wide range of disorders such as: X-ray burns, slow-healing painful abrasions, herpes zoster, eczema, sunburn, and other painful skin conditions.

PROCTOLOGY

The proctologist is continuously confronted with patients suffering from considerable anorectal pain and discomfort. In operative techniques such as hemorrhoidectomy, pilonidal cystectomy, and other surgical procedures about the rectum, Xylocaine HCl has found many uses, whether it is used in peridural (caudal) anesthesia, spinal anesthesia or local infiltration. As for topical application, Xylocaine Ointment, either 2.5% or 5%, or Xylocaine Jelly may be used for control of pain and other unpleasant conditions due to hemorrhoids, pruritis ani, and related anorectal disturbances. The ointment and jelly may also be used to prevent and control pain during examination and instrumentation in sigmoidoscopy and proctoscopy.

INTRAVENOUS ANALGESIA AND ANESTHESIA

In addition to the wide clinical utility of Xylocaine HCl thus far elucidated, intravenous analgesia and anesthesia produced with local anesthetic drugs is probably one of the newest and most interesting technics. Procaine HCl has for many years been used by the intravenous route and has been found to be moderately satisfactory for certain procedures. In the last few years, Xylocaine HCl has received more and more attention as a useful agent when given intravenously. It should be emphasized that this technique of administration is not for beginners. It requires a thorough knowledge of reaction patterns and their treatment.

It has been shown by Gilbert *et al* (1951) that when 0.5% Xylocaine HCl was used as an intravenous drip at 80 drops per minute, effective pain relief was produced for one to ten hours after the intravenous

solution was stopped. This technique has been used in urological, medical, and surgical cases with terminal malignant disease as well as for postoperative analgesia in obstetrical cases.

In England, de Clive-Lowe *et al* (1954, 1958) have combined Xylocaine HCl with succinylcholine and administered these agents by a continuous intravenous drip. In Canada (Desmond, 1957), and in the United States (Steinhaus *et al*, 1958), Xylocaine HCl has been used intravenously as an adjunct to nitrous oxide-thiobarbiturate anesthesia. Thus, Xylocaine HCl, while primarily regarded as a regional anesthetic, functions also as a useful adjunct to general anesthesia.

The advantages found in the field of intravenous analgesia and anesthesia with Xylocaine HCl are as follows:

1. Very low incidence of post-operative nausea, vomiting, and chest complications.
2. Analgesia extends from 8–10 hours post-operatively.
3. No appreciable change in blood pressure or pulse rate.
4. Muscular relaxation which is easily controlled and quickly reversed, of a degree only obtained by high dosage with the other relaxants, necessitating the use of anti-relaxants.
5. Adequate respiratory tidal volume in the presence of excellent relaxation.
6. Marked decrease in the amount of post-operative sedation required.

Also, Xylocaine HCl intravenously as a supplement to nitrous oxide and thiobarbiturate anesthesia has been shown to depress pharyngeal and laryngeal reflexes without marked depression of respiration. This anesthetic combination appears promising for use on patients suffering from bronchial asthma and bronchitis (Steinhaus *et al*, 1958).

When considering the intravenous use of Xylocaine HCl it would be unfortunate to overlook two other areas where this agent has been used intravenously with great success. These two areas include the

prophylaxis and therapeusis of cardiac arrhythmias during cardiac surgery and the treatment of epileptic states by intravenous Xylocaine HCl.

In 1956 Carden and Steinhaus showed that Xylocaine HCl was effective in both normothermic and hypothermic dogs when used directly into the left ventricle in connection with cardiac resuscitation from ventricular fibrillation. Also in 1956, Harris *et al* demonstrated the effects of Xylocaine HCl upon ventricular tachycardia resulting from myocardial infarction in the dog.

These findings, have, in recent years, been transferred into human open-heart surgery, and thus, Hitchcock *et al* (1958, 1959) have shown Xylocaine HCl to be effective in many types of cardiac arrhythmias, both mechanically and non-mechanically induced.

Specifically, as shown by Likoff (1959), premature systoles, paroxysmal supraventricular tachycardias, and paroxysmal ventricular tachycardias have responded well to the intravenous use of Xylocaine HCl.

The problems involved in the treatment of epileptic states have always been a challenge to all investigators. Bernhard *et al* (1955) and Bohm *et al* (1959) have shown that Xylocaine HCl is of great use in the treatment of status epilepticus. It was also found that a barbiturate in doses too small to influence the epileptic attack increases the anticonvulsive effect of Xylocaine HCl. Since the supplementary dose of the barbiturate can be kept so low that the complications of its sedative effects are avoided, this combination therapy is recommended in the treatment of severe status epilepticus.

Thus, by considering the four areas of applicability for intravenous Xylocaine HCl, it can be seen that these technics and this agent have introduced to medical science a new concept of therapy in many fields.

Complications and Sequelae Related to the Local Anesthetic Agents

The administration of drugs by injection always presents a number of potential problems and possible sequelae. Once administered, they cannot be removed, and specific antagonists are seldom available. Tolerance and sensitivity are varied. Control of the drug in regards to distribution and elimination is not always possible and therefore the results not consistently predictable. The administrator must institute proper prophylaxis and be prepared to manage any untoward reaction that might occur.

SYSTEMIC REACTIONS

This is unquestionably the most common complication associated with the administration of local anesthetics. Systemic reactions almost invariably result from high blood levels, but are on very rare occasions due to allergy. These may occur with topical application or with injection. These reactions must also be differentiated from a systemic reaction due to vasoconstrictor drugs.

High blood levels.

High blood levels of the drug accumulate from one or more of the following mishaps; (1) overdosage, (2) rapid absorption, and (3) slow distribution, elimination or destruction. Rapid blood stream accumulation may be due to inherent properties of the drug, injection into a vascular area, and failure to use a vasoconstrictor. Failure