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Veterinary Surgery: Orientation and History

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Let noble thoughts come to us from all sides
Rig Veda

ANIMALS AND MAN

Knowledge regarding animals is as old as human civilization. Since time immemorial, man is afflicted with a malady called 'Hunger' and freedom from it has been his principal goal. After relying initially on the food supplied by nature, he soon learned to cultivate some food plants, and eventually to domesticate animals and birds which provided milk, meat, hides, hair and other useful byproducts and services. This progress of man beyond the stage of primitive hunter-gatherer was made possible only by domestication and exploitation of animals. In keeping and raising animals, man eventually came to recognize their ills and ailments, and tried to do something to remedy them. This was the beginning of veterinary medicine in the cultural history of mankind.

Food—the first bond between man and animals—continues to be as important today as it ever was. Since ages, people have lived at subsistence level and have adjusted their diets to the available food. The industrial revolution in Europe created a proletariat that had above subsistence incomes. But being property-less it could not anticipate gain from the labours of its children on the family assets to offset the cost of rearing them. The industrial proletariat therefore, generally practiced artificial birth control and made it possible, for the first time, for capital accumulation to outstrip population growth. It was able to consolidate and to improve its above subsistence incomes to become, in the long run, a large social class that was able to exercise choice in the food it consumed. The evolution of this choice by the populations of industrial countries has been reflected in changing food prices. Higher relative prices of livestock products are taken to reflect a shift in demand from other foods towards livestock products. Increase in demand for livestock products has led to tremendous advances not only in livestock production and processing and marketing of livestock products, but also in veterinary medical science of food animals.

As said earlier, domestication of animals by man is as old as history. It is widely believed that dogs were the first domestic animals. Man kept dogs as pets and companions, and then used them to hunt other animals. The animal-human bond that originated to satisfy man's stomach virtually ended in a lasting love affair. Millions of human hearts and homes are today being warmed by the faithful company of animal companions. Just as the increased demand for foods of animal origin led to tremendous advances in veterinary medicine of food animals, the keeping of pets in each house

hold has led to significant advancement of pet animal medicine.

There have been two major explosions after the atomic bomb explosion of the second world war—the population explosion and the explosion of scientific knowledge. Medical progress in the 20th century has overshadowed that of all previous centuries put together. Many of the most important advances in medical research have depended on experimental investigations that did not involve human subjects. For practical and ethical reasons, many elegant and conceptually illuminating experiments were done only with non-human animal models. Thus sea urchins have helped develop an understanding of human embryology; a desert toad has helped in early determination of pregnancy; rhesus monkeys have contributed towards an understanding of human blood groups; animal behavior has helped the study of human mind. Almost all areas have benefited from animal experimentation. Whether the research involves assessment of new drugs for old diseases or old drugs for new diseases; whether it aims at control of births, or at treatment of infertility; or whether it seeks treatment of cancer, or success in organ transplantation, the medical scientists have a great deal to benefit from the studies on animals. A higher degree of interdisciplinary professional collaboration among the medical and veterinary scientists as envisaged in the concept of **one health** can be very valuable in the alleviation of human and animal suffering in the world. The benefits resulting from the humane use of animals in biomedical research are threefold: For direct help to people, for improved animal welfare, and for increased productivity of food animals. No society can easily ignore these benefits.

It is now over thirty five centuries since the transmissibility of animal disease to human beings was officially recognized by Moses (15th Century B.C.). The *Mosaic Doctrine (Law of Moses) specified that meat which had u*nclean things was unsuitable for human consumption. The flesh of shellfish and crawling creatures was officially declared unfit for human use. The hare and swine were also considered unclean. These very exacting, good laws, described in detail in Exodus and Leviticus, are so complete that actually little has been added to or subtracted from them during the past thirty five centuries.

Healthy animals which have been conserving the physical and mental human health since time immemorial are also prone to acquire diseases that are not only fatal to themselves but are also transmissible to human beings. Animal diseases that are communicable from animal to animal and from animal to man are called zoonoses. There are hundreds of pathogenic agents which are transmissible among animals, and more than 100 animal disease agents can cause infection in man. The list of such intercommunicable diseases (zoonoses) has continued to grow even though many of the earlier diseases have been brought under control.

Bacterial zoonoses include several deadly diseases like anthrax, brucellosis, glanders, leptospirosis, salmonellosis, tuberculosis and rat bite fever etc., which spread to human beings chiefly by occupational exposure, ingestion of contaminated meat and milk and inhalation etc. The viral and rickettsial zoonosis include rabies, yellow fever, Q. fever, different types of encephalitis, rift valley fever, cat scratch fever, cowpox etc. Of the old and best recognized fungi, the dermophytoses or ringworm, ectrothrix trichophyta are derived from animals and are communicable to man. The zoonoses are not limited to bacterial, viral or fungal infections, but include many parasitic diseases. The most important of these are the beef and pork tapeworms, and the hydatid diseases. Apart from these, some protozoan diseases, such as Trypanosomiasis (sleeping sickness in man), are also of great zoonotic importance, especially in Africa. Some poultry diseases can also cause serious illness in man. After learning about the tremendous gains that animals bring to the human welfare, one does get a slightly sick feeling on knowing about zoonoses**.** This is an area where the 'One Health' concept gains great importance.

The renewed interest in the concept of One Health has occurred as a result of the increased emergence of zoonotic infectious diseases over the past decade. The subsequent impacts of these diseases on human, livestock, and wildlife health, as well as the economic effects, have given international health organizations and national governments a greater appreciation of the importance of collaborative efforts in solving health problems. The One Health concept is not new, but under its umbrella, a new generation of veterinarians, physicians, ecologists, biologists, and social scientists is shaping the concept in novel ways. This has led to increased support for One Health initiatives to control disease by international agencies, national governments, and nongovernmental organizations as well as a growing emphasis on One Health concepts in training the veterinary workforce. Veterinary schools are reorganizing veterinary education to better teach students the precepts of One Health. We must explore the evolution and application of the One Health concept from the perspective of the veterinarian. The veterinary profession is positioned to be a strong advocate and leader of One Health. Veterinarians have a long history of involvement with One Health activities, and this involvement has adjusted and shifted with the changing needs of society. A new area of work for veterinarians is ecosystem health, which is becoming more relevant as a result of the impact that the ever-increasing human population is having on the environment that supports them.

The realization of crucial linkages between animals, humans and the environment helps to solve complex zoonotic disease, food safety and environment challenges from the molecular to the ecosystem level. The One Health approach accepts the interconnectedness of different species and their shared habitats, requiring faculty from many disciplines working in concert to optimize outcomes.

Thanks to the inspiration and vision of the pioneers in one health, veterinary students have learned since 1960s to apply the principles of epidemiology, microbiology, virology and other disciplines to veterinary public health and food safety.

THE VETERINARY SURGEON

The word veterinary comes from the *Latin veterinae* meaning "*working animals*". **"Veterinarian"** was first used in print by *Thomas Browne* in 1646. The term "veterinarian" is used in North America and other countries using predominantly *American English*, whereas in the United Kingdom, and countries which are formerly part of the *British Empire* or are part of the *Commonwealth of Nations* tend to use the term veterinary surgeon. A veterinary physician, colloquially called a vet, shortened from veterinarian (*American English*, *Australian English*) or veterinary surgeon (*British English*), is a professional who practices *veterinary medicine* by treating disease, disorder, and injury in non-*human* animals. In many countries, the local nomenclature for a veterinarian is a regulated and protected term, meaning that members of the public without the prerequisite qualifications and/or licensure are not able to use the title. In many cases, the activities that may be undertaken by a veterinarian (such as treatment of illness or surgery in animals) are restricted only to those professionals who are registered as a veterinarian. For instance, in the United Kingdom, as in other jurisdictions, animal treatment may only be performed by registered veterinary physicians and it is illegal for any person who is not registered to call themselves a veterinarian or prescribe any treatment.

Veterinarians treat disease, disorder or injury in animals, which includes *diagnosis*, treatment and aftercare. The scope of practice, specialty and experience of the individual veterinarian will dictate exactly what interventions they perform. Unlike in human medicine, veterinarians must rely primarily on *clinical signs*, as animals are unable to vocalize *symptoms* as a human would. In some cases, owners may be able to provide a *medical history* and the veterinarian can combine this

information along with observations, and the results of pertinent diagnostic tests such as *radiography*, *CT scans*, *MRI*, *blood tests*, *urinalysis* and others. Veterinarians will sometimes consider the appropriateness of *euthanasia* (putting to sleep) if a condition is likely to leave the animal in pain or with a poor quality of life, or if treatment of a condition is likely to cause more harm to the patient than good, or if the patient is unlikely to survive any treatment regimen. As with human medicine, much veterinary work is concerned with *prophylactic treatment*, in order to prevent problems occurring in the future. Common interventions include *vaccination* against common animal illnesses. This may also involve owner education so as to avoid future medical or behavioral issues.

The training of a veterinarian is similar to that of a medical person but is more difficult. Veterinary school education is equal to what medical school students receive and course subjects include anatomy, physiology, pharmacology, microbiology, immunology, pathology, toxicology, biochemistry, surgical techniques, and many more, as well as in-depth courses on specific animal species and body systems, but for a number of animal species instead of just one, as it is in human medicine. It is harder also because he has to be trained not only in the art of healing but also in the inseparable science of animal production and management, and that too not for a single species, as in human medicine, but for a large number of species of domestic animals with different anatomies, physiologies and pathologies. It is harder also because none of these animals are able to describe their symptoms and feelings to us. They are also often uncooperative with their vets and do not obey their instructions. These problems will continue till animals and veterinarians start understanding each others' language. Till then the vets have to compensate themselves with an additional observational ability. In addition to the practice of traditional veterinary medicine based on a transposition of attitudes and behaviors from human medicine, the veterinarians working with food animals and equines are required to investigate disease which their owner recognizes simply as failure to perform or to reach predetermined objectives. This may be subclinical, or clinically recognizable unthriftiness without any specific system oriented clinical signs; or in other situations, the owner may not recognize any abnormality unless productivity is measured, e.g. milk production or growth rate per day.

The early years of the veterinary students are mostly spent in the classroom and laboratory to prepare them for client-owned animal patients. Veterinary students get additional education and experience during clinical rotations, seeing animal patients under the close supervision of experienced mentors. The graduates also undergo an internship programme for a period of six month to a year before they become qualified veterinarians and perform the professional duties. The contents of the course studied may be different in different countries in accordance with some of their special requirement but the basic subject matter is more or less uniform throughout the world. The title of the degree may be different but the essence is same. In Indian Veterinary Schools (often called colleges) the veterinarians receive degree of Veterinary Science & Animal Husbandry (B.V.Sc. & A.H.), while graduates from U.S. veterinary schools, they receive a Doctor of Veterinary Medicine (DVM) or Veterinary Medical Doctor (VMD) degree. The award of a bachelor's degree was previously commonplace in the United States, but the degree name and academic standards were upgraded to match the 'doctor' title used by graduates. The degrees awarded in different countries are different. In the United Kingdom they would be awarded a *Bachelor's degree in Veterinary Science, Surgery or Medicine* e.g. BVS, BVSc, BVetMed or BVMS etc. In Ireland graduates receive a Medicina Veterinaria Baccalaureate (MVB).

Dictionary defines ***Veterinary Surgery*** as that branch of veterinary science which treats diseases, injuries and deformities by manual or operative methods. Veterinary surgery is performed on animals by veterinarians. A veterinarian who specializes in surgery is

often referred to as **Veterinary Surgeon**. However, in many countries it is still the practice to continue the British tradition of having all veterinarians call themselves veterinary surgeon and for the registering legislation to be the Veterinary Surgeons' Act. Most general practice veterinarians in USA, Canada and Europe perform routine surgery such as spaying, castration and minor mass excisions etc., some also perform additional procedures. In the United States and Europe, veterinary surgery is one of 20 veterinary specialties recognized by the American Veterinary Medical Association and the European Board of Veterinary Specialisation, respectively. Those wishing to become board certified must undergo intensive training in a residency program under direct supervision of Board Certified Veterinary Surgeons, including performance of a large number of surgical procedures in such categories as abdominal surgery, surgical treatment of angular limb deformities, arthroscopic surgery, surgery of the foot, fracture fixation, ophthalmic surgery, urogenital surgery, and upper respiratory surgery, etc. Once the minimum requirements of training are met residents are required to pass a rigorous certification examination before being admitted as members (Diplomates) of the American College of Veterinary Surgeons or European College of Veterinary Surgery. The goal of veterinary surgery may be quite different in pets and in farm animals. In the former, situation is a bit like in human beings, and more and more complex operations are performed, with sophisticated anaesthesia techniques. In the latter, the cost of the operation can not usually be allowed to exceed the economic benefit in surgically treating the illness.

Fields of Employment of Veterinarians

The majority of veterinarians in the United States and Canada (about 75% in USA) are employed in private practice treating animals. Small animal veterinarians typically work in veterinary clinics, veterinary hospitals, or both. Large animal veterinarians often spend more time travelling to see their patients at the primary facilities which house them, such as zoos or farms. Other employers include charities treating animals, colleges of veterinary medicine, research laboratories, animal food companies, and *pharmaceutical companies*. In many countries, the government may also be a major employer of veterinarians, such as the *United States Department of Agriculture* or the *State Veterinary Service* in the United Kingdom. State and local governments also employ veterinarians. Departments of Animal Husbandry of the Central and State governments are the major employers of veterinarians in India. Other employers include teaching and research institutions and other scientific organizations, poultry farms, livestock farms, dairy farms, fisheries, zoo and wild animal services, pharmaceutical and food industries, banking and insurance and defense services. Some veterinarians work in a *university* or other laboratory and are responsible for the care and treatment of laboratory animals or any domestic and even exotic animals. Their responsibility is not only for the health and well being of the animals, but also for enforcing humane and ethical treatment of the animals in the facility. Though the number of private practitioners is not very large and most of them work on small animals, their number is steadily growing.

Veterinary specialists are in the minority compared to general practice veterinarians, and tend to be based at points of referral, such as veterinary schools or larger animal hospitals. Unlike human medicine, veterinary specialties often combine both the surgical and medical aspects of a biological system.

Aquatic medicine—mostly refers to veterinary care of fish in aquaculture (like salmon, cod, among other species), but can also include care of aquatic mammals. For certain countries with high economic income from aquaculture, this is an important part of the veterinary field (like Norway, Chile). Other countries (particularly those which are landlocked), might have little or no emphasis on aquatic medicine.

Most veterinarians graduating from veterinary schools in Canada and USA are

women. The current mental image of a veterinarian in these countries is a bright and earnest young woman caring for pets. As little as 50 years ago, veterinarians that treated pets exclusively were rare. In India, female students were not much attracted to the veterinary profession in the 1960s and the 1970s. Since 1980s, there has been more awareness among women, not only in human medicine but also in veterinary medicine and other professional courses. Today women are competing with men to obtain admission to veterinary programs, and some colleges have a women-to-men ratio of 40:60. The veterinarians, whether male or female, by virtue of their hard training on several species of animals, are now a versatile category of professionals who understand the life sciences very closely. They are great contributors to the concept of One Health and are fully trained to apply the principles of epidemiology, microbiology, virology and other disciplines to veterinary public health and food safety.

THE SURGICAL JUDGEMENT

Strictly speaking, surgery is not an exact science. It is a science in as far as it is based on the application of universal principles of anatomy, bacteriology, physiology, pathology and other related disciplines, but it is also an art with regard to actual application of these principles to the specific needs of individual patients under their peculiar circumstances. Any veterinary surgeon having sound training of fundamentals of surgery and high degree of technical competence is adequate in ordinary situations. However, if he has to apply his knowledge and skills into highest potential of healing of all his patients and in the best interest of their owners, he must enter into a complex series of mental, moral and physical acts which, for the purposes of working definition are called surgical judgment. It is a complex concept of a working process in the life of a surgeon and his psychological structure. It is one attribute which surgeons acquire not only during the period of their training but, more importantly, during their whole surgical career. It grows with the experience he gains during practice.

Alleviation of suffering of the patient and prolongation of its life are the sole aims of all therapy. Some of the patients are referred for surgical opinion rather than surgery per se. Motivation for undertaking surgery should be to make an honest appraisal as to whether surgical intervention is advisable in view of the accompanying risks to the patient vis-à-vis the anticipated result of the operation with regard to its post operative utility to the owner. Often a responsible surgical judgment is the decision not to operate. Surgeon's rational fears are a necessary tool of responsible surgery but irrational fears are unnecessary and may sometimes be dangerous. To always be a 'knife happy' surgeon is as bad as being unreasonably timid. If surgery is feasible at all, the only motivation for it should be to conclude that it is necessary for the welfare of the patient and its owner. The latter's views must be respected with regard to his own peculiar economic and sentimental considerations. Owner's anxiety and tension are natural even if they are somewhat neurotic. The owner brings his animal for help, not for censure; he needs your assurance and support to prepare him for surgery of the animal, which may be its most precious possession. The surgeon's authority must not be misused to reduce his self respect and dignity. A good personal rapport with clients is a must and will depend on two cardinal qualities in the surgeon: honesty and tact. The client is entitled to know everything pertinent to the condition and intended course of treatment of the patient which he is capable to understand and able to accept emotionally. His questions must be respectfully answered fully but simply (without indulging in professional jargon).

Surgical judgment and surgical skill are interdependent but not identical qualities. Best results are the product of both. They reflect planning and knowledge to cope up with risk factors and post operative problems. Surgeon, being the fulcrum of responsibility in a surgical situation seeks collaboration with colleagues (e.g. anaesthetist, interns) and

operation theatre staff whenever necessary and desirable in the interest of the patient. During the late postoperative period the surgeon is obliged to keep himself updated on the follow up details of his patients, particularly when the types of surgical procedures in which such information is not well known or which may come in handy for his future surgical approach to comparable problems. This is an obligation that he owes to the patient/client, to himself and to his profession. Most of the new advances employ standard techniques. Some variations are made possible by advances in other fields of knowledge, ranging from physiology to physics, from immunology to electronics, from chemistry to metallurgy and so on. Surgeons must acknowledge the debt owed to other sciences for advances made in surgical advances. Certain originally satisfactory surgical procedures may nevertheless require a fresh experimental and experiential background by every new surgical team, no matter how experienced they may be in other types of surgery. Experimental types of surgery undertaken under controlled conditions are often reported from large university centres. It is important to realize that certain type of 'new' surgery cannot easily be done in the field conditions. To proceed with new surgery on the basis of the publications alone may not be judicious. Moreover, even after successful performance, new procedures must be considered experimental until long after follow up studies have proved their worth.

Surgeons' decision making is a key element of clinical practice, yet has received scant attention in the surgical literature. Sometimes changes in the configuration of surgical training reduce the time spent by trainees in the operating theatre. It is important that this lost experience be replaced with active teaching of decision making, but there seem to have been very few studies that have directly examined the cognitive skills underlying surgical decision making during operations. In human surgery, four decision-making strategies that surgeons may use are discussed: intuitive (recognition-primed), rule based, option comparison and creative. Surgeons' decision making processes should be studied to provide a better evidence base for the training of cognitive skills for the intra operative environment. These strategies are also applicable in veterinary surgery. However, the economics of the surgical situation is an important additional factor that makes surgical judgment more complex in case of veterinary medicine. This is in contrast to the situation in human medicine where life is conserved at all cost. Since no one has been bold enough to place a monitory value on human life, economics are not a factor as they are in veterinary surgery. In case of pets maintained for emotional and sentimental reasons, the situation comes closer to that in human medicine, but the sentiment is often allowed to sway only up to a limit that is determined by the financial status of the animal owner. Sentimental considerations rarely exist in large animal/food animal work in most countries. However, a notable exception to this is the situation in India where tremendous emotional value is placed on cattle. The animals are valued not only in terms of their utility to human beings but as objects of intrinsic worth in themselves.

It may be concluded, both for human and veterinary surgery, that decision making during surgery, particularly during emergency surgery, is a key element in clinical practice that merits better preparation than is currently delivered. Current techniques in surgical training allow little opportunity for reflection, and perhaps there is now place for a more careful scrutiny of surgeons' cognition, using the naturalistic decision research methods. Veterinary surgeons' decision-making processes should be studied to provide a better evidence base for the training of cognitive skills for the paraoperative, intraoperative, postoperative environment that exists today. Laufman (1964) has summarized the spirit of surgical judgment in these words: "Surgical judgment is a distillate of physical, emotional, intellectual and moral capacities; of the training and experience which informed and disciplined them; of an individual's potential to grow,

learn and create; of the capacity to apply known principles to new specific situations; and dedication of the welfare of the patient".

HISTORY OF VETERINARY SURGERY

The veterinary profession is one of the oldest in the world. Through the ages it has been closely allied with human medicine just as it is today. The oldest written record for humanity dating back to Vedic period of about 2000–1800 B.C. is the Veda, which has supplied the most concrete evidence of veterinary art in antiquity. Ayurveda, the ancient Indian System of Medicine, includes both human medicine and veterinary medicine, indicating the fundamental oneness of two closely related subjects. The diseases of animals are often the diseases of man and therefore their histories are intertwined.

Tracing the history of such an old and vast system of healthcare of several species of animals is not an easy task. The Rig Veda and many other treatises on veterinary science were written during the period of about 2000–1800 B.C. The evolution that has taken place since then in the medical sciences of animals and man is of immense magnitude, particularly when we examine the interlinked emergence of surgery and its development to date. Let us briefly examine, step by step, the major developments that have taken place so far.

PREHISTORIC AND STONE AGE MEDICINE

Medicine Man and Shamanism

The art of healing was practiced in one form or the other even in prehistoric and stone age. The man probably began the practice of healing wounds by licking his wounds much as dogs, cats and other animals do. Since he was endowed with greater intelligence than his animal associates, man soon discovered that certain plants, herbs, oils and protective devices aided in the healing of wounds and in treatment of his diseases.

The ancient medicine was in the hands of those who dealt with the supernatural and religious needs of the community. The *Medicine men* (also witch-doctors, shamans) maintained the health of their tribe by gathering and distributing herbs, performing minor surgical procedures, providing medical advice, and supernatural treatments such as charms, spells, and amulets to ward off evil spirits. In Apache society, as would likely have been the case in many others, the medicine men initiate a ceremony over the patient, which is attended by family and friends. It consists of magic formulas, prayers, and drumming. The medicine man then, from patients' recalling of their past and possible offenses against their religion or tribal rules, reveals the nature of the disease and how to treat it. They were believed by the tribe to be able to contact spirits or gods and use their supernatural powers to cure the patient, and, in the process, remove evil spirits.

Medicine has a long history of its association with the supernatural and religious practices. It exists even today among our Christian medical missionaries, although to a much less extent and upon different basis. In ancient times any operation that was done was often supplemented by appeals to the gods, and various forms of exorcism played a large part in the treatment. Though the medicine practiced by witch doctors may be questionable, but surprisingly, some of the medicaments used by these witch doctors were beneficial since we still use a few of the same drugs (quinine, podophyllum, and cocaine).

Ancient veterinary knowledge has also been guided by the changing concepts and beliefs about causes of diseases over the period since antiquity. The earlier theories emerged to define causes of diseases included *demonic theory* (spirituality); *divine wrath* (displeased Supreme Being or punishment of god); *metaphysical medicine* (occult forces beyond the physical universe—moon, planets, stars, earthquakes, floods and comets); *The Universe of Natural law and miasmata theory* (diseases caused by external forces including climate and geological factors and derangement of four humors of body associated with four properties—heat, moisture, dryness and cold; local outbreaks

occurring due to noxious air-miasmas); *the contagion theory* (diseases transmitted by contact or airborne means being taken in via nose or mouth). The approaches to treatment and control of the diseases therefore changed concurrently with changing concepts in succeeding civilizations.

Early man believed in *Demonic theory* of illness and considered disease as an outcome of supernatural power (witches, evil spirits). The treatment included placation, exorcism (forcible expulsion) and evasion through ritual ceremonies and by use of material objects (such as amulets, periapts, talismans, fetishes, totems) that can be carried out or suspended over buildings to keep away the evil spirit. Incantation and special people such as witch doctors were also used. However, despite use of these techniques, draft animals continued to die. The loss of valuable animals in the urban society resulted in development of the first stable period of veterinary medicine characterized by emergence of veterinary specialists such as Egyptian priest healers, and Vedic *Shalihotryas*, who founded the first veterinary hospitals. By now the ancient healers also started using medicinal plants, minerals, organic compounds, zoo therapeutics and trepanning (removal of bone discs from the skull) to cure diseases.

Stone Age Surgery

In order to relieve pressure from bleeding after a blow to the head, surgeons often drill or cut into the skull to allow fluids to drain. But people figured out the advantages of the procedure long before the advent of modern surgery. Trepanation, the removal of bone from the skull, is the most ancient surgical technique known. It was used in prehistoric times for treating fits and insanity. Archeologists have found trepanned skulls dating from the late Neolithic, some 5,000 years ago. Now a team of French and German researchers has suggested that the procedure goes back even further, to at least 7,000 years ago.

When the first prehistoric trepanned skulls came to light, it was not thought that they could be evidence of cranial surgery, and so various more or less plausible alternative explanations were sought in order to account for the making and function of holes. It was also once believed that the practice of trepanation may have begun in the Neolithic period in the realm of veterinary surgery and was subsequently adapted for use in human patients. The operation has been performed on domestic sheep into modern times to treat the disorder known as staggers, in which the animal staggers around due to the presence of the larvae of tapeworms under the scalp. In Romania, e.g. shepherds trepanned their sheep to remove the larvae, apparently with little success in many cases where the larvae had already entered the animal's brain.

Trepanning is amongst few surgical operations to be carried out in prehistoric times (other surgery was rarely undertaken); but medicine men had neither the training nor the specialised equipment required to do surgery on the internal body. The procedure would have taken around 60 minutes in a single session, and if done in several sessions, it could have taken several days to complete.

Many prehistoric peoples, where applicable (geographically and technologically), were able to set broken or fractured bones using clay materials. An injured area was covered in clay, which then set hard so that the bone could heal properly without interference. Also, primarily in the Americas, the pincers of certain ant species were used to close up wounds from infection; the ant was held above the wound until it bit, where its head would be removed allowing the pincers to remain and hold closed the wound. Inscriptions on tombs and on walls of sepulchers in Egypt which date from 2500 B.C. to even earlier times have given unequivocal evidence of proper treatment of fractures by splinting.

Archaeologists in Mehrgarh in Balochistan province in the present day Pakistan discovered that the people of Indus Valley Civilization from the early Harappan periods (c. 3300 BC) had knowledge of medicine and dentistry. The physical anthropologist who carried out the examinations, Professor Andrea

Cucina from the University of Missouri, made the discovery when he was cleaning the teeth from one of the men. Later research in the same area found evidence of teeth having been drilled, dating back 9,000 years.

It may be kept in mind that human societies were isolated in antiquity. Men with relatively high degree of civilized behavior with interest in learning and investigation might not have been at a great distance from places in which Stone Age men were living. But communication of knowledge that involves spoken and written language, travel and peaceful intercourse among men was missing. Advances in medicine were, therefore, intermittent and independently made. Too often progress was lost with destruction of people and their civilization.

RECORDED HISTORY

Recorded history reveals that well developed medical practices existed in ancient civilizations of Babylon, Persia, Egypt, India, China, Greece, and Rome.

The sculptured figures in the museums and ruins of these civilizations show illustrations of individuals with varicose veins, tumours, dropsy, ulcers and obesity—the diseases causing us so much misery and expense even today. Similarly, careful examination of the Egyptian mummies has also revealed that ancient Egyptians had much the same type of diseases that affect us today. Some basic biomedical knowledge emerged and early biomedical theories were propounded during this evolutionary period, particularly in the temple cities of Egypt. Dissections of sacrificed bulls and observations made by the Egyptian priests led them to rudimentary understanding of animal anatomy and physiology by analogy of human anatomy and physiology.

Egyptian and Indian Era

Among those ancient peoples of whose medical practices we have some knowledge, the Egyptian and Hindus stand out as surgeons. The Jews excelled in hygiene and preventive medicine but not surgery. The Egyptian people of the Nile began to influence medicine about 4000 B.C. and the long period of Egyptian civilization produce a worthy medicine in which surgery had a respectable place. They became adept in skull surgery and in the art of embalming. Although the extensive studies made on the embalmed mummies indicated that these ancient Egyptians suffered from the same diseases that people suffer today, surprisingly, in the recorded history of Egypt, we find no information on lesions of diseases discovered during embalming. This may have been intentionally done by the priest who kept the information secret so as to uphold the theory of theological cause of diseases that illness was the result of Divine displeasure.

A worthy medicine in which surgery had a respectable place was the product of a long period of Egyptian civilisation. Two papyri, the Edwin Smith (circa 1700 B.C.) and the Ebers (1500 B.C.) document the sophisticated surgery of our oldest historic phase of medicine. The treatment of accidental wounds, fractures, dislocations, head injuries, operations for circumcision and superficial surgery of the extremities are mentioned in these fragments. There is no evidence, however, that the Egyptians opened the body cavities. The aforesaid Edwin Smith Papyri belonging to ancient Egyptian era also provided strikingly accurate description of circulatory system and other features of human anatomy with central role of heart in circulatory system. These scrolls mention use of several herbs such as senna, flax, oak gall, cedar, pinetar, bayberry, juniper, cyperus, myrrh, lettuce, saffron, watermelon and wheat. Majority of these herbs have been scientifically tested for their medicinal properties. Egyptian civilization ultimately declined and with it medical and surgical practice. The importance of Egyptian medicine is in its contribution to Greek medicine.

Veterinary Knowledge in Ancient India

The knowledge of veterinary medicine was also developing in the other parts of ancient civilizations, including India. Ancient Indians realized the prime importance of looking after

the health of their livestock. The oldest written record for humanity dating back to Vedic period of about 2000–1800 B.C. is the Veda, which has supplied the most concrete evidence of veterinary art in antiquity. The Rig Veda and many other treatises on veterinary science were written during the same period.

The Vedic writings consist of several comprehensive treatises. They pertain not only to medicine of man but also of his beasts. The author of Rigveda, insofar it relates to horses, is said to be Salihotra. His standing and influence can be judged from the fact that veterinary workers are referred to as Salihotriya—after his name. Salihotra is referred to as the Father of Veterinary Science in India. Many other treatises on veterinary science were written during the same period. The Indian system of medicine is known as Ayurveda, a compound word in Sanskrit, meaning literally the science of life. It includes both human medicine and veterinary medicine, indicating the fundamental oneness of two closely related subjects. Vedic sages (*Rishis)* in ancient India closely observed and recorded the behavior of sick animals and learned the self-medication traits of wild animals (*Zoopharmacognosy*). *Atharvaveda* (VIII, 7. 23) mentions '*a wild boar knows the herb which will cure it as does the mongoose*'. The ancient Indian healers used minerals, animal products and earth, besides magico-religious practices to cure diseases. However, use of medicinal herbs was the mainstay of the therapeutic approaches. *CharakSamhita* (700 BC) provides details of 350 herbal medicines, some of which are proven in treatment of many diseases such as *visnaga*-Bishop's weed (*Ammivisnaga)* in asthma. *Ayurveda* prescribed use of herbs, diet, massage, detoxification and meditation for management of illness and listed over 2000 plants with medicinal properties. However, some elements of the *Ayurvedic* disease management approach such as purgation and vomiting, spirituality, meditation and higher thoughts were not possible in veterinary medical practice. Therefore, the uses of medicinal herbs and dietary supplements or dietary changes remained important veterinary Ayurvedic practice. The significance of herbs in ancient Indian veterinary care is underlined by the edict of King *Ashoka,* which stated that *everywhere in the dominion of His Majesty King Priyadarshi, and likewise in the neighboring realms… every where on behalf of His majesty have two kinds of hospital been established; hospitals for men and hospitals for animals. Healing herbs medicinal for man and medicinal for beasts, wherever they were lacking have been imported and planted…"* A*rjuna* (*Terminaliaarjuna*), coral swirl or *kutaja* (*Holarrhenaantidysenterica*), common-bur flower tree or *kadamba* (*Anthocephaluscadamba*), Indian copal tree or *dhupa* (*Vateriaindica*), margosa tree or *neem* (*Azadirachtaindica*), *Asok* tree or *Ashoka* (*Saracaasoca*), and Indian gooseberry or *aamla* (*Phyllanthusemblicasyn Emblicaofficinalis*) were commonly used to treat human and animal diseases. Surgical methods such as application of cautery, removal of foreign bodies and obstructions, surgical grafting, and treatment of fractures, dislocations, and fistula were also used by Vedic people for management of human and animal diseases. *Atharvaveda* (IV, 9.2) also mentions the benefits of different ointments for man, cows and horses.

The veterinarians in ancient India had considerable knowledge of animal anatomy, which was perhaps more precise than human anatomy. The procedure for animal dissection has been described in *Susrutasamhitâ.* Veterinarians, like surgeons, had to be aware of vulnerable regions or vital points called *marma* (derived from Sanskrit *mru* or *murr*and is defined as *maryateitimarmani* i.e. 'there is a likelihood of death or serious health problem on inflicting injury on these points hence called *marma*'). These vital points are anatomically defined as the areas with high vascularity, joining points of tendons, veins, arteries, tendons and bones (joints). Ayurveda defines 107 such points in the human body. Animals may also have similar number of *marma* points. Veterinary profession was one of the most demanding professions and the state funded veterinary services were introduced during the *Mauryan* period. The first

known veterinary hospital with 'indoor patient' facility was erected during the reign of Ashoka the Great (*c.* 269–232 who is famous in history for the establishment of hundreds of veterinary hospitals throughout his kingdom. Similarly, Kaniska (120–162 A.D.) had also shown unforgettable interest in livestock welfare and veterinary development. Interestingly, the ancient Indians associated sick rats with plague, the first suggestion of zoonosis. However, stagnation phase in veterinary medicine in general and veterinary surgery in particular commenced in the Buddhist period and continued in the period of Hindu kings who disliked surgical operations, forbade killing of animals and preached that all diseases were due to previous birth.

The Indian traditional health care system of man and animals is based on scientific evidence and the knowledge on several healing herbs and natural plants used by our ancestors has withstood the latest scientific evaluations. Evidence of the superiority of Hindu surgery is recorded in the *Susruta*, in which an operative manual describing vesicolithotomy and rhinoplasty is found. Incisions and surgical instruments are also described. The Hindus recorded innumerable operative procedures which they did, but their influence on western society was small.

Assyrian and Hebrew Era

The **Assyrians** were Semitic people living in the northern reaches of Mesopotamia; they have a long history in the area, but for most of that history they are subjugated to the more powerful kingdoms and peoples to the south. Under the monarch, Shamshi-Adad, the Assyrians attempted to build their own empire, but Hammurabi soon crushed the attempt and the Assyrians disappeared from the historical stage. After centuries of several subsequent attempts at independence, the Assyrians finally had an independent state of their own since the Hittites did not annex Assyrian cities. For the next several hundred years, the balance of power would shift from the north to the south.

The Assyrian Empire under Hammurabi (2100 B.C.) is of particular interest to vets because at that time veterinary medicine achieved a considerable degree of skill. This was mainly due to the importance of the cavalry in war. The equestrian army found that special care was needed for their horses. Rigid laws to the conduct of veterinary practitioners were enacted and enforced. The last great monarch of Assyria was Ashurbanipal (668–626 BC), who not only extended the empire, but also began a project of assembling a library of tablets of all the literature of Mesopotamia. Thirty thousand tablets still remain of Ashurbanipal's great library in the city of Nineveh; these tablets are our single greatest source of knowledge of Mesopotamian culture, myth, and literature. After Ashurbanipal, the great Assyrian empire began to crumble; the greatest pressure on the empire came from their old and bitter enemies, the Babylonians. Aided by another Semitic people, the Medes, the Babylonians led by Nabopolassar eventually conquered the Assyrian capital of Nineveh and burned it to the ground, ending forever Assyrian dominance in the region.

The odd paradox of Assyrian culture was the dramatic growth in science and mathematics; this can be in part explained by the Assyrian obsession with war and invasion. Among the great mathematical inventions of the Assyrians was the division of the circle into 360 degrees. They were among the first to invent longitude and latitude in geographical navigation. They also developed a sophisticated medical science which greatly influenced medical science as far away as Greece.

The **Biblical Hebrews** may have inherited a number of their beliefs from ancient Mesopotamian cultures, among them a conviction that disease was divine punishment and therefore a mark of sin. This belief was passed on as a basic concept to Christian medieval Europe. Assyro-Babylonian taboos against close proximity to the sick were also continued by the Hebrews. Hebrew reliance on strict codes which controlled virtually all behavior was another Mesopotamian

characteristic. There were, however, important differences between Hebrew and Assyro-Babylonian concepts. For instance, the Biblical Hebrews, although they believed in supernatural causation of disease, did not envision the world as filled with demons and spirits. Hygienic laws were to be obeyed for religious and disciplinary rather than medical reasons. The Hebrews were great hygienists and were well ahead of Egyptians, Babylonians and Assyrians in the control of diseases. It is surprising that these intelligent people also looked to the cause of disease as being the result of divine displeasure. Were they too, intentionally pushing the truth into the background to nourish mysticism and theological concept of etiology?

We made a reference earlier to the *Mosaic Doctrine (Law of Moses)* of the Hebrew era which *specified that meat which had u*nclean things was unsuitable for human consumption. The flesh of shellfish and crawling creatures was also officially declared unfit for human use. Much has been made of a presumably medical basis for the food prohibitions in Jewish tradition, but there may be other explanations. One recent suggestion is that the taboo against pigs was originally related to their competition with humans for water and grain (scarce commodities in a barren land), in contrast to cattle and sheep which consume relatively little water and graze on forage inedible to man. Since transmissible parasitic diseases and infestations such as tapeworm are also found in sheep and cows, singling out trichinosis in pigs would not be wholly logical. However, to discourage the raising of swine so as to conserve water and grain resources for human consumption, a strict religious taboo may have been necessary—considering man's nearly universal agreement on the delectableness of pork. Medical observations may indeed have been at the core of hygienic codes, but the Biblical listing of seemingly unrelated creatures prohibited as food is difficult to associate with purposes entirely hygienic.

Plagues and epidemics were mentioned often in the Bible, with special attention given to leprosy, which was feared and isolated, but, as among the Assyro-Babylonians, many skin diseases considered to be leprosy probably were not. There were, however, references to many other types of illnesses and symptoms in the Bible. Hebrew medical practices were much like those of the peoples among whom they lived. A number of medications were mentioned in the Bible, such as mandrake, balsams, gums, spices, oils, and possibly narcotics, but the relatively limited list of drugs recorded is remarkable when one considers the abundant materia-medica of Mesopotamian and Egyptian physicians.

There was little reference to surgery in the Bible except for ritual circumcision, and that may have come from the Egyptians. Although barbers and other uneducated healers might engage in the accepted practice of bloodletting and minor mechanical procedures, medicine was practiced by professionals called **rophe**, who seem to have participated in both medicine and surgery. The doctors who limited themselves entirely to surgical procedures were referred to as **uman**. There were probably also veterinary surgeons since one was mentioned in the Talmud by name.

Hebrews, Babylonians, and Greeks contributed to a voluminous literature on veterinary medicine. However, most of it was destroyed by the Crusade and by the invasions. In much later times, during the Middle Age, Jews were to be a repository of Greek and Roman learning. In the period of Islamic supremacy they acted as a bridge between the Muslim East and Christian West.

Greek and Roman Era

The medical and surgical practice of the Egyptian declined with the decline of Egyptian civilization. However, the importance of Egyptian medicine is in its contribution to Greek medicine. Instead of dealing with the lesions of the disease, the Greek physicians of the classical period concentrated on clinical observation. They were,

thus, the originators of clinical medicine as we know it today. Two schools of medicine existed in Greece and Alexandria from 500 B.C. to just before the birth and rise of the Western Roman Empire. Best of all is the medicine of the classical period of Greece (460–130 B.C.) as found in the Hippocratic School. This medical era was the precursor of European medicine. Undoubtedly the most outstanding individual in the history of Greek medicine was Hippocrates (450–375 B.C.). He wrote and taught extensively on surgery and his treatment of fractures, dislocations and wounds was especially good in light of what we know today. But most of all, his emphasis on rational conduct based on studied conclusions as opposed to prejudicial or emotional ones elevated medicine to the highest level of the time and set the stage for its place as science. His impact on medical science was so great that the physicians of today consider him as the Father of Medicine. One the greatest medical aphorisms, *vismedicatrixnaturae* comes from Hippocrates. Some historians would have Hippocrates as the father of veterinary medicine also, but most veterinarians do not agree. The writings of Hippocrates indicate that he never intended his oath to include veterinarians, in fact some of his contributions would suggest that he rather looked down on the 'doctors of horses', perhaps even sneering at their efforts. Aristotle (384–323 B.C.) another Greek philosopher, was the originator of modern anatomy and physiology. Many considered him as Father of Zoology. One of the books of Aristotle, Historiaanimalium, is devoted to veterinary medicine. Treatises on horses were also written by Simon of Athens and by Xenophon. Greek Medicine revolved heavily around the theory of the Four Humours and texts by Hippocrates and his followers (Hippocratic Writings), who were all Greek. These ideas and writings were also used in Roman medicine. Roman Medicine also encompassed the spiritual beliefs of the Greek.

The decline of Attic Greece after Poloponnesian wars initiated a shift in medical pre-eminence. Medicine rises and falls with the fate of empires and dynasties. Good medicine is practiced in rich countries. The great city of Alexandria, founded in 332 B.C., was next to forward medicine and particularly anatomy and surgery. It is here that the ligature was used to arrest haemorrhage. Alexandrian medicine was also transitional.

A continuity of Greek medicine to Roman is understandable in the political and social circumstances of the time. The early Romans had a religious, yet fundamental understanding of medicine. Deriving knowledge from the Medical Treatises and Methods of the Greeks, the Etruscans, the Egyptians, the Persians and other conquered peoples, the Romans came up with one of the best and most sophisticated Medical Systems of the Ancient World. The science of medicine and the human body was evolving.

The **Romans** also conquered the city of Alexandria, with its universities and its libraries. In Ancient times, Alexandria was an important centre for learning and its Great Library held countless volumes of information, many of which would have been on medicine. Many Greek medical ideas were adopted by the Romans and Greek medicine had a huge influence on Roman medicine. The first doctors to appear in Rome were Greek, captured as prisoners of war. Greek doctors would later move to Rome because they could make a good living there, or a better one than in the Greek cities. Greek Medicine revolved heavily around the theory of the Four Humours and texts by Hippocrates and his followers (Hippocratic Writings), who were all Greek. These ideas and writings were also used in Roman medicine. Roman Medicine also encompassed the spiritual beliefs of the Greek.

In fact, the Romans almost fully embraced the medical thought of Greeks. Ascleplades (128–56 B.C.) and Galen (131–206A.D.), the Greek physicians working in the Rome, were the greatest individuals in Roman medical history. Apsyrtus flourished as a veterinary teacher and author in this era. His keen observations and excellent writings on equine medicine had great influence on the thoughts of veterinarians living in later years and

particularly those of the Arab era. Another Roman veterinarian, Renatus Vegetius (450–500 A.D.) is credited with being the first author of the Christian Era to write a textbook devoted exclusively to veterinary medicine. He was among the first to urge people to disregard divine displeasure as the cause of diseases, and to base their treatments and concepts of disease on a thorough knowledge of anatomy, surgery and medicine. Because of the book he wrote and the influence he had on veterinary medicine, Vegetius is considered as the father of Veterinary Medicine.

The Roman hospitals were originally built for the military. Under Gaius Marius, the Roman Army became the world's best trained and disciplined force, and some of this rubbed off onto the Medics too. The influence of superstitious quackery lessened and Roman Medicine took on a more practical approach. The fifteen year civil war that directly followed the assassination of Julius Caesar led to significant medical innovations. The war was fought between the best armies of the world and yielded such high levels of injury that the newly emerged emperor, Augustus, formed a professional military medical corps. Before this, doctors had fairly low status. Augustus, realizing that they were key in an empire and especially an army, gave all physicians that joined his new army medical corps dignified titles, land grants, and special retirement benefits! For the next five hundred years, fueled by the motivations and opportunity for medical advancement supplied by the many battles, and supported by the powers that be, this serious group advanced the study and practice of medicine to a level not seen again until late in the nineteenth century.

Ancient Roman medicine was, surprisingly, incredibly similar to that of the late nineteenth century. Like the modern medical practice, Ancient Roman medicine was split among different specialties, such as internists, ophthalmologists, and urologists. All surgical tasks were only preformed by appropriate specialists. Surgeons used practically the same tools as American doctors did only one hundred years ago. Similarly, Ancient Roman surgeons had a wide range of painkillers and sedatives to help in surgery, including extracts of opium poppies (morphine) and of henbane seeds (scopolamine). There is little doubt that the many folk remedies used throughout the Roman Empire were tested in battle by Roman physicians on wounded and ailing soldiers, who sifted through and found the treatments and methods with the most useful effects. Further, the bureaucracy of Rome ensured that the treatments were recorded and taught in the medical school.

The Romans did not yet really understand how germs related to disease, but they did use many of the techniques that killed germs, techniques that were not reinvented until much later. For example, they boiled their tools before use and would not reuse the same tool on a patient before reboiling. Wounds were washed with acetum, which is actually a better antiseptic than Joseph Lister's carbolic acid (Joseph Lister rediscovered antiseptics in the 1860's, based on Louis Pasteur's brand-new germ theory of disease).

The long Greco-Roman period of medicine extended from 150 B.C. until Middle Ages. The great name of the period was Galen, who wrote authoritatively on all medical subjects including on anatomy, pathology, physiology, pharmacology, medicine and surgery. His dogmatic pronouncements and teachings suited the generations that followed him in the period of intellectual stagnation. Galen's early descriptions of wound treatment were good; he used wine for lavage, followed by primary suture with linen thread with good results in clean, contaminated wounds. Later his obsession with wound medicaments and applications supplanted his first technique and was to prevail as a heritage from him during several centuries. Gallen was so influential that his medical writings stifled progress and dominated medicine in the Western world during the middle ages in which scholastic dogmatism was prevalent.

Medieval Period and Arab Era

The Greco-Roman medicine in its best form flourished during the early centuries after the birth of Christ, but deteriorated with the decline of Western Roman Empire (500 A.D.).

The Byzantine Empire, sometimes referred to as the Eastern Roman Empire, survived the *fragmentation and fall of the Western Roman Empire* in the 5th century AD and continued to exist for an additional thousand years until it fell to the *Ottoman Turks* in 1453. This extended the *Roman Empire* in the East during *Late Antiquity* and the *Middle Ages*, but its medicine, which was inherited from Greece, showed no progress. The capital city of this empire was *Constantinople* (modern-day *Istanbul*, originally founded as *Byzantium*). Leaving the Roman Empire and passing into the Middle Ages, or the Medieval Period, we find, in general, a lack of interest in literature, art and medicine. A few men, notably Paracelsus and Fracastoro, tried to refute the dogma of Galen and Hippocrates. Fracastoro propounded an entirely sound theory on the contagiousness of disease, but like so many other theories in those days, his ideas were not noticed.

The rise of Islamic culture and supremacy of Mohammedan Empire is called the **Arabic period of medicine** extending from the seventh to the twelfth century during which they invaded Asia Minor, Egypt, North Africa, Spain and France. The Arabs were quite active in medicine during the wars but contributed little to medicine in an original manner. However, they obtained their knowledge of medicine principally from the Nestorians, a persecuted Christian sect which sought refuge in the desert and brought with them their medical knowledge. They translated Greek and Roman texts into Arabic at this time. These Arabic texts were read and used in Western Europe at a much later period. Surgery cannot be said to have advanced in the Arabic period. It is to the Arabic School of medicine and surgery that the harmful use of cautery in wounds can be attributed. The Arabs lacked a technical background of their own, having very little to draw upon as far as agriculture, animal husbandry and veterinary medicine were considered. Since it was necessary to bring a certain amount of science into these fields, they employed Hebrew scholars to translate the information into Arabic and then added to it during use. A work on agriculture and veterinary medicine by Ibn-al-Awan shows excellent quality of veterinary art of this period.

As far as surgery is concerned, there was no real progress from about 500 to about 1200 A.D. In Western Europe, this time was characterized by a separation of surgery from medicine. The development of medical knowledge, (along with that of letters, art and science), lagged behind because of rapid spread of Christianity and its emphasis on moral philosophy and overpowering religious interest to the neglect of science. Priests were the only scholars. The general education of layman was at low ebb. Nevertheless, the ancient medical literature of Greek, Arab, Chinese and other societies was preserved during these centuries. Finally, at the end of the twelfth century, all priests were forbidden to practice either law or medicine, a rule which is in effect even today in the Roman Church. Secular education at the University of Salerno, beginning in ninth century, resulted in the first great school of medicine in Middle Ages. This university was at the height of its glory between twelfth and fourteenth centuries. The Salerno and other Italian universities had Jews, Arabs and free society teachers on the faculty in medical education of the time.

A trend in late Middle Ages to transfer the responsibility of surgery from physicians to the hands of illiterate barbers was a great deterrent to the advance of surgery. As the Middle Ages closed, surgeons no longer had university rank or medical education. As much of the work was done by semi-ignorant class of persons, surgery ceased to be a science and regressed as an art. In England and European continent, barbers and quacks were the surgeons of the time for a few centuries to come.

With regard to veterinary medicine, the things were no better during that period. The first attempts to organize and regulate the practice of treating animals tended to focus on horses because of their economic significance. In the Middle Ages from around 475 C.E., farriers combined their work in

horse shoeing with the more general task of "horse doctoring". In 1356, the Lord Mayor of London, concerned at the poor standard of care given to horses in the city, requested that all farriers operating within a seven-mile radius of the City of London form a "fellowship" to regulate and improve their practices. This ultimately led to the establishment of the Worshipful Company of Farriers in 1674. Meanwhile, Carlo Ruini's book *AnatomiadelCavallo,* (*Anatomy of the Horse*) was published in 1598. It was the first comprehensive treatise on the anatomy of a non-human species. During the Middle Ages, there are many references to animal plagues and their devastating effects on farmers' productivity. Some of plagues were recorded by individuals like Francois Rabelaias, who recorded the first full description of sheep pox in 1494.

Renaissance (15th and 16th Centuries)

The end of Middle Ages and beginning of Renaissance cannot be fixed with an exact date, since changes were always gradual. At the end of Middle Ages, the stage was set for progress. The fifteenth and sixteenth centuries, the period now usually known as Renaissance, represented the transitional phase of our civilization which bridged the gap between medieval and modern times. It was also the transition period in human and veterinary medicine, when sacramental patterns and divine displeasure as the cause of disease gradually began to disappear, and sensible people began to resort to surgery, medicine, and common sense. The people were weary of tolerating the diseases that afflicted them and their livestock. People whose flocks had been destroyed by anthrax, blackleg, rabies, tetanus, scabies and wound infection demanded action. Pressure was placed upon the state, and that pressure was gradually felt. Fear and superstition were eliminated.

Between the fourteenth and seventeenth centuries, plagues involving both man and animals swept across Europe. It is estimated that 25 million people died of bubonic plague carried by rats from Asia to Europe during the fourteenth century. The appearance of cattle plague (rinderpest) in the seventeenth century resulted in the loss of millions of animals. An estimated 200 million cattle died. The hardship and starvation which followed these animal plagues was indescribable. By the seventeenth century, it was quite apparent that steps had to be taken to prevent further invasions of this dreaded disease which destroyed millions of animals, threatened human health and caused widespread sufferings. Almost simultaneously certain monumental discoveries were made which put medicine on a scientific footing and made it the beneficial science it is today.

In the sixteenth century, autopsies were becoming fairly common and routine *dissections were common place. The printing press, a Chinese discovery, had* made its appearance. This furnished means of dissemination of knowledge throughout the world. Initially only curiosities and rarities were compiled. Men with common sense soon began to devote their attention to the accumulation of knowledge that would give medicine the sound solid footing it needed. In 1543 Vesalius effected a one man revolution in medicine by his publication which brought science to life in the study of anatomy.

Science and literature flourished with incredible vigor in the seventeenth century. In 1628 William Harvey (1578–1657) described the blood vascular system and the circulation of blood through it. He introduced experimental method into medicine and John Hunter (1728–1793) extended it to the study of surgery. The latter, in his zeal for experimental pathology, infected himself with syphilis in order to study the disease which probably was the cause of his death. Anthony Van Leeuwenhoek (1632–1723) was the first to demonstrate the practical importance of the microscope in the study of tissues and other minute subjects. Morgagni (1682–1771) an Italian was the first to attempt to correlate pathological alterations in the dead individual with the symptoms shown by that individual during life.

The Renaissance in Germany and England brought forth a new and progressive medicine. Paracelus, the great German surgeon highly appreciated the healing power of nature. It cannot be said, however, that operative surgery advanced a great deal during the Renaissance, although there was tremendous advance in medical scientific knowledge. The educational status of surgeons in the period was still very low; the art was still in disrepute and separate from established medicine. Ambroise Pare, a gifted but poorly educated barber- surgeon emerged as the great figure of Renaissance surgery. Most significant of his work was his use of ligature on blood vessels and the abolition of cauterization of wounds and hot oil instillation. Towards the end of sixteenth century, progress in surgery finally came about through improvement of educational status of surgeons. With the inclusion of surgery in the curricula of medical schools, surgery resumed a place it had formerly held in the Italian schools of twelfth century. During the sixteenth and seventeenth centuries, there were major advances in understanding human and animal diseases due to inventions such as the microscope and the development of a scientific method of inquiry into things unknown. However, the approach to animal diseases was mostly from the human medicine viewpoint.

Early Modern Times (17th and 18th Centuries)

The seventeenth and eighteenth centuries saw continued scientific progress in the Western world. William Harvey, John Hunter, and Morgagni were among many other contributors of these very productive centuries. The practice of surgery in most places in Europe was still considered inferior to medicine principally because of inadequate education of surgeons and in some parts of Europe barbers were still the principal surgeons in the middle of eighteenth century. Once the medical profession took over the education and practice of surgery, there was a great development in manual skill and surgical technique. The art of operative surgery became highly developed in England during the eighteenth century by Cheselden, Pott, John Hunter and Cooper. Haemostasis by ligature became fully established at the end of eighteenth century.

Modern veterinary medicine originated in France. In 1664 a man named Solleysel published the first complete veterinary classic of this period which marked the decline of the ferrier's control of veterinary medicine. The second dominating veterinarian in France was Bourgelat (1712–1779) who shifted from the practice of law to equine husbandry. He worked on glanders—a deadly disease of horses communicable to man—and was successful in eradicating it from the French army. He was then requested to establish what was to become the world's first veterinary school at Lyon, which opened on January 1, 1762. The second veterinary school was also established by Bourgelat in 1764 at Paris by royal decree. This is one of the most outstanding veterinary schools in existence today and retains the distinction of being one of the dominating centres of veterinary science in the world. It is interesting to note that soon after the establishment of a French veterinary college, others were established in the 1770's in Sweden, Germany (Hanover), Denmark, and Austria (Vienna).

The third prominent French veterinarian of the period was Saint-Bel (1753–1793) who was forced to flee to England during the French Revolution. He established the Veterinary College in London in April 1791 mainly with the efforts of The Odiham Agricultural Society. This school is still in existence, though the brilliant young Saint-Bel died two years later, in 1793, as a result of glanders, a disease he acquired from one of his equine patients. By 1800 most European countries had established a national veterinary school. In 1844, the Royal College of Veterinary Surgeons (RCVS) was founded in Great Britain. By the mid 1800's technology was in place to support effective efforts to understand and treat disease in humans and animals. European ideas and literature were transferred by individuals and imported into the United States during the Colonial period

via scholarly journals, and onsite visits by Americans as they traveled in Europe. Animal health authorities estimate that within one hundred years of the establishment of national veterinary services and schools in Europe several major diseases, such as rinderpest, contagious pleuropneumonia, anthrax and sheep pox had been eradicated or brought under control and millions of lives were saved, thousands of millions of dollars in losses were averted and immeasurable human suffering and illness had been prevented.

The end of eighteenth century and beginning of nineteenth century was the time when French and American revolutions occurred. These political upheavals initially impeded the progress of science and medicine; but set the stage for the birth of modern surgery. The American Revolution brought with it the birth of medical education and improved practice in United States. The changed thinking of people in Europe and elsewhere brought an end to any dogmatic scholasticism that might have still existed over the interpretation of biologic phenomenon. Larrey, the celebrated surgeon of Napoleon's army, is said to have performed more than 200 amputations a day. The speed of surgery on the field prevented serious infection and reduced mortality. However, the mortality due to infection from wounds and military surgery performed under appalling conditions during the war in general was very heavy.

The period was characterized by surgical advancement through individual prowess. The name of Ephraim McDowell stands out for his first ovariotomy performed without anaesthesia in the United States in 1809. The preanaesthetic, preantiseptic surgical period of nineteenth surgery ended with a high development of technical skill. Though it was hindered by a lack of these two boons to surgery, but it was firm in anatomic and pathologic knowledge. The surgeon was at last the surgeon-physician. If the surgeons of the early period of nineteenth surgery could have lived it to its end and have seen the addition of anaesthesia and asepsis to their skills, they would have fulfilled their greatest dreams.

By the end of the nineteenth century, the spread of veterinary educational institutions in all parts of the world had begun. It began in India in 1862 with the establishment of an army veterinary school in Pune and a civil veterinary school in Babugarh (Hapur), in Uttar Pradesh, in 1877. These schools had the limited objective of training Indians to serve as assistants in remount depots and on military farms. **The first veterinary college in the Indian sub-continent was started at Lahore (now in Pakistan) in 1880, then Bombay (now Mumbai) (1886) and Calcutta (now Kolkata) (1892).** These veterinary colleges awarded a diploma based on the adoption of the program of study developed by the Royal College of Veterinary Surgeons, London. The curriculum was based primarily on equine practice. The establishment of a veterinary research laboratory in India was recommended in 1885 and actually took place in 1889 at Pune. As a consequence of frequent famines and cattle plagues, several commissions were appointed toward, the end of the nineteenth century, to address the question of controlling and preventing cattle plague and maintaining the health of bullocks. On their recommendation, a civil veterinary department was established in 1881. With the expansion of the activities of civil veterinary departments in several states, veterinary colleges arose in different centres.

In the United States, a British surgeon—turned veterinarian, George Dadd was an early advocate of rational animal health practices in America. He is considered the author of the first two classics in American veterinary literature—"The Modern Horse Doctor" (Boston 1854) and "The American Cattle Doctor" (1851). His recommendations and teachings were largely ignored by the barely-organized veterinary profession. The American Veterinary Medical Association was founded in 1863. The U.S. Livestock Sanitary Association (now the U.S. Animal Health Association) was established in 1897. Other livestock and poultry organizations

followed. The first United States veterinary school was established in the early 19th century in Boston, New York and Philadelphia. In 1879, Iowa Agricultural College became the first land grant college to establish a school of veterinary medicine. **In England** the veterinary art was formally established in 1791, the year in which provision was made to create the colony of Upper Canada. Graduates of the Edinburgh Veterinary College, founded in 1823 in Scotland, are the first known veterinary practitioners in Canada with a diploma from a chartered school. Probably the only veterinary surgeon in the colony of New Brunswick in 1851 was M.A. Cuming of Saint John, an 1846 graduate of Edinburgh. In **Canada**, farriers without specialized veterinary training, outnumbered trained persons before and long after 1866, the year in which a diploma course began. Andrew Smith, an 1861 graduate of the Edinburgh College, established the first formal course in Toronto (1862). From 1866 to 1908 (when the Ontario Veterinary College was acquired by the provincial government), over 3000 graduates completed the 2-year diploma course. Many of the graduates were from the US and did not remain in Canada; conse-quently, Canada continued to suffer from a lack of veterinary surgeons. Andrew Smith's college, moved from Toronto in 1922, continues today as the Ontario Veterinary College, University of Guelph. In 1866, a second private college with high admission standards was established in Montréal by Duncan Mceachran. It eventually became a faculty of McGill University, closing in 1903 from lack of funds. The French-speaking College which arose from this English-speaking one has been in continuous operation since 1886. Founded by V.T. Daubigny, it united in 1894 with 2 other Québec schools to form the School of Comparative Medicine and Veterinary Science of Montréal. The school was moved to the Agricultural Institute of Oka, Qué, in 1928 and taken over by the Québec government and moved to Saint-Hyacinthe in 1947. It is affiliated with the Université De Montréal. A college founded in 1895 in association with Queens University, Kingston, Ontario, was short-lived, closing in 1899.

In Africa, an impetus to establish veterinary educational institutions was provided by the entry of rinderpest into Africa in 1889. The first veterinary school in Africa was established in Egypt in 1901 at Cairo University, Gaza.

THE MODERN TIMES

Mid 19th Century Onwards

The advances in natural sciences, physics and chemistry during the great scientific era from the beginning of second half of the nineteenth century up to the beginning of twentieth century, continued to affect and induce the parallel gains in medical sciences in the twentieth century too. Thus, in about 100 years or so, there were five highly remarkable developments and discoveries of anesthesia, microbiology, x-rays, blood types and blood transfusion, and penicillin and other antibiotics, which made modern surgery possible. When we add to them, the existence of better educated surgeons with better basic medical knowledge, the result is the surgical practice of today which has accomplished feats beyond the imagination of preceding generations of surgeons.

Anaesthesia: Ether as an anaesthetic was first discovered by an American physician, Crawford W. Long, who used it in a surgical operation in 1842. It was then used in domestic animals in 1846. C.P. Jackson, a Boston physician, appears to be the first to apply ether anaesthesia extensively in animals in 1853. Dadd in 1854 routinely used ether in animals and was the first in the U.S.A. to start a scientific veterinary practice. Horace Wells, a dentist, used nitrous oxide in 1844, for a tooth extraction. This was followed by use of chloroform in man and animals. Chloroform was introduced by Sir James Simpson of Edinburgh In 1847. Open inhalation of ether and chloroform has developed rapidly since beginning, but particularly in the first half of the twentieth century. The development of intratracheal anaesthesia with respiration controlled by

intermittent positive pressure was of primary importance. Chloral hydrate was used some years later at about the time that epidural anaesthesia was being used for the first time. In last part of 19th century spinal anaesthesia, local infiltration and nerve blocking were first introduced. The first spinal anaesthetic was obtained inadvertently by Corning in 1884 by accidental injection of cocaine in subarachnoid space. In 1898, August Bier of Germany produced true spinal anaesthesia in animals. In 1901, Cuille and Sendrail of France induced subarachnoid anaesthesia in horses, cattle and dogs. With the subsequent discovery of procaine hydrochloride by Einhorn in 1905, regional anaesthesia became practical and common. But most important aspect of all these discoveries has been the birth of anaesthesia as a speciality. However, it was in the 1920s that Retzgen, Benesch and Brook applied technique of epidural anaesthesia in large animals. Although paralumbar anaesthesia was introduced in medical science by Sellheim in 1909, the technique was applied to cattle by Farquharson and Formston in 1940. The 1930s saw the advent and development of the barbiturates. In 1940s regional anaesthesia of the flank of cattle was reported. The concept of balanced anaesthesia in animals was developed in the 1950s. The discovery of halothane in 1956 was the real stimulus to the development of inhalation anaesthesia for large animals and it led to the development of equipment for that purpose. More recent developments have included the alpha 2-adenoreceptor agonist and propofol. After the introduction of isoflurane there were further inhalation agents: desflurane and sevoflurane. Muscle relaxants have been known for a number of centuries but it is only since the middle of 20th century they have been used in anaesthesia. Their use in veterinary anaesthesia was investigated and they are now in widespread use in horses, dogs and cats. Discovery of safer inhalant anaesthetic agents and their administration to large animals with specially designed anaesthetic machines contributed a great deal in the progress of large animal surgery under general anaesthesia. Despite these developments in the later half of the 19th century, general anaesthesia in veterinary practice reached its bloom well into the 20th century. In small animal practice, general anaesthesia was widely accepted after the discovery of barbiturates in 1920's and 1930's. However, in large animal practice it was accepted only after the introduction of phenothiazine derivatives in France by Charpantier in 1950.

Antisepsis and Asepsis: In view of the conditions under which human surgery was performed about 125 years back, it is no wonder that the patients were unwilling to accept elective procedures and the conservative physicians were slow to recommend even essential life saving surgery. The surgeons were operating without anaesthesia (after restraining them to operating table) and poor preparation of their hands, instruments and the operating room. Sometimes patients were made drunk with alcohol and drugs, as mentioned in the ancient Hindu Sasruta of the Vedic period.

Publications of Pasteur from 1857 and writings of Lister from 1860s, associated with the science of microbiology, did not become universal up to 30 or 40 years later. Even though there was large literature and thinking on wound putrefaction, there was prejudice in recognizing the concept of environmental bacteria as the cause of infection. The term 'laudable pus' used during the period virtually meant that pus formation was somehow a sign of good healing. Some 20 years after the discovery of ether, Lister introduced his theory and practice of antisepsis and appreciated and taught that wound infection came from outside the body. Sterilisation by boiling was introduced by Von Bergmann in 1886. Credit for aseptic technique should be given to both Bergmann and Lister. By the end of 19th century, the Swiss surgeon Theodor Kocher crystallized the best of surgical thought to make his techniques a heritage; and Halstead's introduction of the use of rubber gloves in operating room became a very important innovation. Although the principles of asepsis were being used worldwide, its adoption in veterinary practice was rather slow, particularly in large animal surgery, at least in developing countries. Its universal

adoption by veterinarians commenced in 1940. From mid 1950s to early 1960s asepsis was a hot topic of discussion in veterinary classrooms in India. As young veterinary surgery teacher, I have myself participated in these discussions and on occasions my defense of the aseptic surgery got a retort like this by several seniors of the time: "I have not followed these rituals of aseptic surgery for all my life and none or very few of my patients died during or soon after surgery". The students of today can understand the loop holes in the above statement. Is death the minimal harm that the patients can suffer? Can we disregard the long period of recovery and loss of their productivity that they might have suffered due to non-adoption of known surgical principles by these surgeons? The animals survived as result of their own luck and powers of resistance, despite best efforts of at least some of their surgeons to the contrary.

Haemostasis: The role of haemostasis can not be overemphasized in the success of surgery. While application of pressure, cautery, ligature and tourniquet was already being used for controlling the haemorrhage, the invention of artery forceps for grasping the vessels and ligating them evolved over a long time would modernize the system. Pean popularized a forceps in 1867 which is still in use. Apart from the important innovation of introducing of the use of rubber gloves in operating room, W.S. Halstead also propagated the concept of maintaining a dry operative field. He insisted on securing the least amount of tissue in the haemostatic forceps so as to leave the least amount of dead tissue in the wound, and also showed the importance of using fine silk sutures because of its non-reactivity, in comparison to using the poor quality of catgut available in his time. He recognized, however, that non-absorbable silk was undesirable in infected wound sites.

Roentgenology: One of the most important developments in medicine which affected 20th century surgery are the diagnostic techniques by roentgen rays. With the discovery of X-rays by Roentgen in 1895, the examination of fractures and localization of foreign bodies were introduced in medical science. Cannon in 1898 described the use of X-rays to study physiology of the gastrointestinal tract. There is hardly any cavity or system that has not been subjected to special examination by radiologists, with or without the use of contrast media. Radiation therapy has followed the diagnostic uses of x-rays.

R. Eberlein of Germany, who is often considered as the father of veterinary radiology, elaborated the use of X-ray» in veterinary practice during the period of 1897-1916. First advancement in veterinary orthopaedics came in 1920 when fluoroscopy of the skeleton was introduced. The concept of splints to correct overriding fractures in dogs was adopted by Schroeder in 1933. In the mean time, discovery of penicillin by Alexan der Fleming in 1929 and development of other antibiotics had made it possible for surgeons to undertake surgery with greater success.

Antibiotics: Surgical successes following the discovery of penicillin in 1929 by Alexander Fleming and subsequent development of other antibiotics, were hitherto impossible. Although, the phenomenal role of antibiotics in the control of surgical infections in that period was undeniably great, it can also not be denied that antibiotic therapy brought with it certain new problems. Unfortunately, antibiotics have been overused, unnecessarily used, and therefore abused. This has led to menace of drug resistance which the professionals are now facing. It may not be untrue to say that some of the surgeons would have used them as a cover for the failings such as inadequate preparation of the patients, operating rooms and their own hands (or arms). Some of the then veterinary surgeons were yet to come to terms with the vigorous demands of modern aseptic surgery that emerged long after they entered the profession. Some of them may not have been fully convinced of the new surgical regime, which the newer generation of surgeons educated and experienced in the later period were religiously following.

The present day surgery has evolved out of the advances in physiology, chemistry and several other life sciences, which are the companions of the present day surgical process. Surgery has also gained immensely from the military surgical experiences of surgeons during the first and second world wars of the 20th century.

Military Surgery: The interstate wars cause an unimaginable devastation to nature and loss of life and injuries to men and animals. They also teach lessons for the future generations. Imagine the times when chemotherapeutic agents to combat virulent infections associated with extensive soft tissue injuries were not available and controlled operations are difficult to perform under war torn field conditions. However, specialties like reconstructive surgery and neurosurgery gained from the war experiences of the first and the second world wars of the 20th century. The experience gained from neurologic deficits produced by selective ablation of brain tissue in animals, served as a stepping stone for rapid extension of neurosurgery to lesions involving the human brain. Harvey Cushing made greatest contribution to surgery by his application of the teachings of Halstead's teachings and techniques of haemostasis to neurosurgery. Cushing was a resident of Halstead. Careful debridement and dressing of wounds using the open technique and followed by secondary closure at an appropriate time, must be considered as an important contribution of both world wars. World War I unintentionally produced a group of men who became surgeons by on-the-job training and who upon their return to civilian life, brought surgery to medium and small-sized cities which never had this service. Regrettable as wars are, the experiences of young qualified surgeons in World War II brought to present-day surgery a wealth that can not be assessed. There were no new scientific and purely medical innovations, except the introduction of chemotherapy and antibiotics, to match the great record in the care of the wounded which was attained in this war. The operative procedures that followed World War II were the natural outcome of the wide experience in trauma gained during the war. In the late 20th century, the importance of the institution in contrast to individual surgeon developed and in view of the complexities of techniques and necessity of trained personnel in all facets of the operation, led to the strengthening of **'team surgery'** to make it more effective. Thus, the science of surgery, which has the basic principles upon which all fields and specialties depend, evolved and deep rooted itself in the 20th century.

INTERNATIONAL VETERINARY DEVELOPMENTS IN 20TH CENTURY

In the twentieth century, progress in veterinary medicine continued to advance. Gradually, educational institutions and associations were founded and evolved to communicate the advances to the veterinary community. Harvard University in Cambridge, Massachusetts and Johns Hopkins University in Baltimore, Maryland were among the first.

In the United States, the USDA Animal and Plant Health Inspection Service (APHIS) began to employ veterinary officers. Their duties were to undertake duties that included control and eradication of major epidemic farm animal diseases, the control of imported and exported animals and animal products, the operation of animal health laboratories and treatment of the animals within them, and other animal welfare matters. Veterinary scientists could undertake basic or clinical research in natural science laboratories within the USDA, with veterinary schools of universities and other governmental and industrial research institutions, and the military.

After World War I, we began to see a lessening of utilitarian uses of the horse, and the beginning of automated agriculture. Many veterinarians then began to turn toward the care of dogs and cats as a means of survival. Until this time, small animal medicine had been a minor part of veterinary medicine.

During the next thirty years, the veterinary profession in the United States blossomed and gradually became an equal member of the medical community. There were efforts on the part of several professional associations to show the public the professional status that veterinarians had achieved.

In the 1940's, 50's, and 60's, the American Veterinary Medical Association, the American Animal Hospital Association, the Associated Serum Producers, Inc. and others were in the midst of various public relations campaigns that stressed how a veterinarian must appear as a professional.

In 1947 in the United States, the Association for Women Veterinarians (AWV) was founded by Mary Knight Dunlap (1910–1992). At that time, the US had about 120 women veterinarians, mainly in and around New York City and in East Lansing, Michigan. The number of women graduating with veterinary degrees rose from 200 in 1963 to 3,213 in 1980, reaching 18,088 in 1995. This change in the position of women veterinarians in the U.S. over the past 50 years is the subject of a book "Our History of Women in Veterinary Medicine: Gumption, Grace, Grit, and Good Humor."

In 1964, German veterinarians and others interested in veterinary history were invited to a symposium on the history of veterinary medicine in Hanover, Germany, sponsored by the German Veterinary Medical Association (DVG) and the German Institute (Fachgebiet) for the History of Veterinary Medicine, established in 1963 within the Veterinary College, Hanover. As a result of this meeting, in 1969, the World Association for the History of Veterinary Medicine (WAHVM) was founded.

In **England** the veterinary art was formally established in 1791, the year in which provision was made to create the colony of Upper Canada. Graduates of the Edinburgh Veterinary College, founded in 1823 in Scotland, are the first known veterinary practitioners in Canada with a diploma from a chartered school. Andrew Smith, an 1861 graduate of the Edinburgh College, established the first formal course in Toronto (1862). From 1866 to 1908 (when the Ontario Veterinary College was acquired by the provincial government), over 3000 graduates completed the 2-year diploma course. Many of the graduates were from the US and did not remain in Canada; consequently, Canada continued to suffer from a lack of veterinary surgeons. Andrew Smith's college, moved from Toronto in 1922, continues today as the Ontario Veterinary College, University of Guelph.

In the 150 years since the founding of the Ontario Veterinary College in **Canada,** the veterinary profession has advanced from a group of poorly trained horse doctors in the second half of the 19th century to the highly skilled, sophisticated profession of today, with its members engaged not only in clinical practice but in such diverse fields as public health, including food safety, ecosystem health, animal behavior and medical research. The veterinary schools have become increasingly involved in research and graduate studies, producing specialists in a wide range of disciplines. As veterinarians became better educated, veterinary medicine achieved professional recognition. Major advances have been made in Canada in the control and eradication of infectious animal diseases, particularly of diseases that can spread from animal to humans. Clinical veterinary practice in Canada has changed considerably over the years. In the late 19th and early 20th centuries, veterinary medicine was essentially an urban profession for the treatment of horses. By 1920, the horse was being replaced by motorized transport, and the emphasis of the veterinary profession changed from the horse to farm livestock, with an increasing focus on preventive medicine. This change was reflected in the relocation of the Ontario Veterinary College from Toronto to Guelph in 1922, and the move of l'École de MédecineVétérinaire de l'Université de Montréal from Montreal to Oka in 1928. A fourth college, the Western College of Veterinary Medicine, established at the University of Saskatchewan in 1963, admitted its first class in 1965. As the 20th century progressed, the emphasis in clinical practice changed again from farm livestock

to companion animals, which is now the predominant type of veterinarian practice in Canada. Accompanying this change has been an increasing role for women in veterinary medicine, and in recent years the enrolment of women in the Canadian veterinary schools has been in the region of 80%. The first woman graduate of OVC was in 1928.

In Hungary, a "Chair for Animal Healing" was established at the Faculty of Medicine in the town of Pest (now an area of the city of Budapest) in 1787 to provide students of medicine and surgery with basic knowledge of animal diseases and their management, an integral part of a general practitioner's activity at that time. In the early 19th century, the rapid expansion of the traditional horse and cattle breeding on the Hungarian plains called for adequate institutional development. Accordingly, in 1851 the Chair for Animal Healing became independent from the Medical Faculty as the "Royal Institute of Veterinary Medicine". In 1899, its status was changed to that of a Royal College with the right to issue the D.V.M. diploma (Doctor Veterinariae Medicinae). As an independent College, this school earned an international reputation in the first half of the 20th century. From 1960 it obtained the status of an independent University. As a part of the countrywide reorganization of higher education in 2000 the University became the Faculty of Veterinary Science, Budapest of the newly founded SzentIstván University, which is also a state university. The program has been continually supervised and accredited by the Hungarian Accreditation Board.

An impetus to establish veterinary educational institutions in **Africa** was provided by the entry of rinderpest into Africa in 1889. The first veterinary school in Africa was established in Egypt in 1901 at Cairo University, Gaza Veterinary Schools were established in South Africa (1920), Sudan (1938) and Kenya (1949). In Nigeria, the veterinary department initially appeared in 1914-15 at Zaria, in the northern province, but further development was prevented by outbreak of First World War. The first independent veterinary department was established at Vom in 1923 largely to deal with immediate problems of rinderpest, which by the end of 1926 was well under way. In 1927, the Government of Nigeria's general policy was to give mass prophylactic vaccination to more than a million cattle every year against rinderpest, contagious bovine pleuropneumonia, black quarter, anthrax and haemorrhagic septicaemia. By 1938, the Second World War caused a break in development once again. In July 1947, the Vom veterinary school turned out the first batch of three veterinary graduates with Vom Licentiate to practice in Nigeria. The first degree awarding veterinary schools were established in 1963 at Ahmadu Bello University, Zaria, and University of Ibadan. A school was added in 1965 at University of Nusukka. Another college of veterinary medicine was established in 1981 at Maiduguri in Borno state. At present colleges also exist in Benue, Ogun and Sokoto. Other schools established in Africa include those at Angola (1963), Mozambique (1963), Zaire (1965), Senegal (1968) and Morocco (1970). **Table 1.1** gives some of the main innovations in animal health that were accomplished between mid-18th century and early 21st century.

VETERINARY DEVELOPMENTS IN INDIA IN 20TH CENTURY

By the end of nineteenth century a stage had been firmly set for a new era of vast expansion of veterinary education and veterinary services, along with drastic improvement in professional standards, in all parts of the world. The speed with which the spread of knowledge and its application in practice took place broke all previous records. It has perhaps rightly been said that the scientific advancements in all areas of scientific study, including medicine and other life sciences, that took place in twentieth century were more than the changes that took place in all the previous centuries put together.

The **'India Papers' section of the 'Medical History of British India'** (website), contains the 6 items, of which item number (4) 'Medicine—Veterinary [ID: 75136762]' is a veterinary collection consisting of 146

Table 1.1: Main Innovations in Animal Health between 1761 and 2011:

Year	Main innovations in animal health accomplished in the world
1761	First veterinary school founded in Lyon, France
1880s	First anthrax vaccine and rabies vaccine developed
1910s	First US veterinary license issued for production of antihogcholera serum
1930s	First foot and mouth disease vaccine developed; 1st brucellosis vaccine developed.
1950s	First veterinary antibiotics licensed in the US and Europe; Development of rinderpest vaccine; Brucellosis virtually eliminated in the US.
1960s	Rabies vaccine widely available in western world, leading to effective control of disease; Discovery of thiabendazone, the 1st benzimidazole anthelmintic.
1970s	Discovery of avermectins revolutionising parasite control in veterinary and human medicine
1980s	Development of new mechanisms for antiparasitics for livestock and pets, as well as products for reproduction management; Development of modern foot and mouth disease vaccine.
1990s	Intense development of modern veterinary therapeutics, better pain management, better anaesthetics for surgery and 1st behavioural medicine for pets.
2000s	Development of west nile virus vaccine for horses; Development of avian flu vaccine in response to human and bird flu pandemic.
2005	1st DNA vaccine authorized, pioneering a new technology now also used in human medicine
2005–10	1st authorised cancer treatment for pets
2011	2011—Rinderpest officially eradicated, only 2nd disease eliminated by global programmes.

volumes dating from 1864 to 1959 and contains the following 3 items:

1. *Veterinary diseases [ID: 75136787]*: Contents: Volumes on surra in horses and camels, other diseases of camels, and a report on the 1864 cattle disease in Calcutta; books about elephant health and disease and extensive information about husbandry and management of working elephants.
2. *Veterinary colleges and laboratories [ID: 75136791]*: Contents: Reports from veterinary colleges and annual reports of the Imperial Bacteriologist; and volumes of the Indian Journal of Veterinary Science and Animal Husbandry covering 1931–1959.
3. *Civil Veterinary Departments [ID: 75136798]*: Reports dated 1887–1950 record activities of the Civil Veterinary Department across India; and minutes, memoirs and ledgers concerning veterinary officers and their work.

These items include extensive research on trypanosomiasis and rinderpest. The reports show how veterinary medicine controlled disease, maintained livestock and alleviated famine. They explore its effect on military and local communities.

Veterinary Education in India

As we mentioned earlier, the first veterinary college in the **Indian subcontinent** was started at Lahore in 1880, then Bombay (1886), Calcutta (1892) and Madras (1903). However, as a result of partition of India in 1947, the colleges in Bombay, Calcutta and Madras remained in India while the college in Lahore went to Pakistan. But a major chunk of staff of the Lahore College shifted to the Indian part of Punjab and formed the founder staff of a Veterinary college in Hissar (which, is now in Haryana). After 1947, Pakistan added three more colleges, one each in Faisalabad, Khan and Tando Jam and now has a total of four veterinary colleges. Bangladesh emerged from the part of Bengal province of India which had gone to Pakistan upon the partition of India in 1947 (East Pakistan) and which later got separated from Pakistan in 1971 to become an independent country, has two veterinary colleges (in Mymensingh and Chittagong).

As far as veterinary education in India is concerned, the fourth veterinary college of the Indian subcontinent established in Madras (now Chennai) was the first to be established

in 20th century in 1903. All These colleges used different nomenclature for the diploma/ degree awarded by them. For example the qualifiers from Lahore, Bombay and Madras colleges were given the title of 'License of Veterinary Practice' or (L.V.P.), 'Graduate of Bombay Veterinary College' or (G.B.V.C.), and 'Graduate of Madras Veterinary College' or (G.M.V.C.), respectively. In 1928 the Royal Commission on Agriculture in the Indian Subcontinent recommended that a degree program modeled on higher education for veterinary surgeons in England, be developed in India, and recommended that one of the existing colleges be upgraded with central assistance to introduce degree-level education. The aim was to achieve a fourfold increase in the employment of veterinary assistant surgeons to cope with the enormous animal disease problems. The Madras Veterinary College took the lead, and began the first Bachelor of Veterinary Science (B.V.Sc.) degree program of Madras University in 1936. Subsequently veterinary degree programs were started in at Patna, Mathura, Bangalore, Trichur, Hyderabad, Tirupathi, Hisar, Ludhiana, and Anand etc. The curriculum of the B.V.Sc. course adopted in most of the veterinary colleges, with certain variations, was that recommended by the FAO/WHO. Later, the title of the degree was changed to Bachelor of Veterinary Science and Animal Husbandry (B.V.Sc. & A.H.).

Post independence, several teams reviewed agricultural education and research. An Agriculture Review Committee, which consisted of eminent scientists from India, the United Kingdom, and the United States, recommended the reorganization of agricultural and veterinary education in India. Based on their report, a series of agricultural universities (State Agricultural Universities - **SAUs**) were established in India. The Uttar Pradesh Agricultural University at Pantnagar, was the first to be established in 1960. It was designed on the so called 'land grant pattern' followed in USA. Punjab Agricultural University followed suit but the implementation in certain other states was either slow or half-hearted for various reasons. The new universities did not always get the full support of their state governments, which stunted their growth, leading to inadequate progress of education and research particularly in their veterinary colleges. The latter received less attention as the agricultural universities were mostly headed by agriculture graduates.

According to a policy paper published by the National Academy of Veterinary Sciences (India) in 2015, it is estimated that the veterinary and animal science colleges/ institutions of the country are producing only around 2,400 veterinary graduates per year, and that, India, at present, has about 34,500 veterinarians in the country against the minimum requirement of 75,000 veterinarians. The anticipated requirement of veterinarians in India by 2035 is estimated to be 125,000. Creation of more veterinary institutions with modern infrastructure facilities matching global standards to expeditiously produce competent human capital with appropriate knowledge, skill and attitude to effectively manage different professional activities is need of the time.

VETERINARY SURGERY IN INDIA IN 20TH SURGERY

In India, modernization of veterinary surgery commenced in mid-1940's post 2nd World War and India's independence from the British rule in 1947. Since post graduation facilities in most of the veterinary subjects were not available in the country at that time, many Indian veterinary graduates went abroad for specialization, either at their own expense or by obtaining financial grants or teaching assistantships offered by the foreign universities, mainly in Europe, Canada and USA. Only a few of them chose to specialize in surgery. Later, Technical Cooperation Mission (TCM) and United States Agency for International Development (USAID) started providing scholarships and travel grants to the faculty members of the sponsoring Indian veterinary colleges to study in the selected American universities on a regular basis. Although very few of them specialized in

veterinary surgery, yet their return to India in mid-1950s provided an impetus to the development of the subject. Some affiliated colleges of the Indian universities started postgraduate programmes. Bombay Veterinary College was the first to start an M.V.Sc. program in veterinary surgery in 1961 and some others soon followed suit. Some real and fast developments in surgical practice and teaching took place in 1960s and 1970s, when Indian veterinarians with specialization in surgery (and allied subjects) either from western countries or from India, joined the profession. By 1960s, Government of India was receiving offers from the governments of many foreign countries to sponsor Indian scientists to their countries for higher education. The Government of India formulated a scheme for cultural exchange of scholars with the foreign countries. Candidates from all over India were selected on the basis of their merit and sent to these countries for fixed tenure. Under this scheme, the sponsoring foreign country paid for the expenses of the candidates in their countries, while Govt. of India bore the travel expenses. Thus, Indian Council of Agricultural Research (ICAR) made the selections in respect of veterinary scientists and sent them to these countries. Later, the University Grants Commission (UGC) and perhaps some other agencies, including the newly formed Agricultural Universities started similar programmes to strengthen and upgrade their faculties. The influx of young blood into the profession with large number of specialists, formation of better funded Agricultural Universities, technical advances that took place in anaesthesia, radiology, surgical physiopathology and overall infrastructural developments (including installation of hydraulic operating tables, X-ray machines and inhalation anaesthesia machines for large animals, and machines for biochemical analysis of blood and other biological materials) put veterinary surgery and radiology in India on a very sound footing. During this period (1960s and 1970s) several veterinary colleges developed Ph.D. programmes in veterinary surgery and had well developed teaching hospitals of their own where all types of clinical and experimental surgery, in both small and large animals, was routinely being done. Most of the institutions also developed instructional animal units/wards/herds for maintaining animals for instructional, research and demonstrational live-animal surgery.

These developments brought Indian veterinary surgeons on par with their western counterparts. They were competent and equipped to perform all small animal surgical operations that were being performed anywhere else in the world. Exchange of books and journals and personal and professional communications among them increased tremendously. Indian surgeons made full use of their skills learnt abroad and gained further experience by applying them to the Indian situation.

With regard to large animal surgery, Indian surgeons went ahead in areas of surgery where others in the world did not find necessary to go ahead. Large animal surgery in most countries is often need-based and/or economy-based, as sentimental considerations rarely exist in large animals, particularly for food animals. However, situation in India is a notable exception, particularly in respect of cattle, as tremendous emotional value is placed on them. The animals are often valued not only in terms of their utility to human beings but as objects of intrinsic worth in themselves. The sanctity that the country gives to cattle may be debatable, but as a veterinary surgeon, I would like to give part of credit for development of some aspects of large animal surgery in the country to this situation. Just as the demands of pet-owning society of the west indirectly led to tremendous advances in small animal medicine and surgery, the demands of the Indian cattle owners to save each life for the sake of life itself, has led to expansion of and advancement in large animal medicine and surgery. As a young veterinary practitioner in India, I have often been placed in a dilemma by the economic considerations and professional limitations to save a seriously ill animal on the one hand

and the earnest and humble pleadings and insistence of the owner on the other to save his animal at any cost even if it was worthless to him in terms of utility. Such confrontations compel one to think, to improvise, to do something, anything , of some help in alleviating the misery of not only the sick animal but also its very caring owner, who is often poor and illiterate. We have often wondered that, had slaughtering of their animals been an acceptable alternative available to such owners, several of the new therapies and procedures that we succeeded in applying later in life would never have been attempted.

Cattle lack oral discrimination and are a sort of greedy eaters. They swallow sharp metallic foreign bodies like wire, nails, pins etc, which lodge themselves in reticulum and during latter's contractions are pushed through its wall, piercing the peritoneum and passing through the diaphragm towards the heart, thereby setting up traumatic reticulo-peritonitis that may subsequently lead to traumatic pericarditis. The diagnosis is based on clinical findings and blood test and is confirmed by radiography, ultrasonography or exploratory laparotomy. This is often referred to as 'hardware syndrome' and is quite common in India. Traumatic reticulo-peritonitis can be cured by a comparatively simple abdominal operation (laparorumenotomy) of manual removal of the foreign body. However, if it is not diagnosed in time or is left untreated, traumatic pericarditis develops, where chances of success may be limited. Veterinary surgeons before early 1950s in most of the rural areas, where absence of facilities for aforesaid confirmatory diagnostic tests and for abdominal surgery and in the face of owner's reluctance to agree to slaughter, had to see several good animals dying a slow death. Except in some rare instances, hardly any veterinarian in the west would attempt heart surgery for traumatic pericarditis in cattle, but in India, the operation has routinely been done from 1960s onwards and veterinarians have been saving an increasing number of animals which would have faced an untimely certain death from the disease and its complications.

Another serious thraco-abdominal disease which Indian veterinary surgeons started encountering in late 1960s onward in buffaloes is herniation of reticulum into the thorax through a rupture in the diaphragm. The disease has rarely been seen in cattle in several countries but has frequently been seen in increasing numbers in Indian buffaloes since 1970s. The disease calls for an effective surgical repair of the diaphragm. There was an initial inhibition to attempt treatment in view of some reports of failures. But in the absence of another alternative, hurdles of lack of suitable anaesthesia and controlled respiration for such large-sized animals were subsequently overcome.

Repair of fractures of long bones of adult bovines are seldom considered feasible or rewarding, in sharp contrast to those in small animals, where use of sophisticated advanced orthopaedic procedures were used routinely. Notwithstanding the handicaps of lack of proper immobilization techniques, uncertain bone healing response and the extent to which normalcy could be achieved, innovative ideas, constant trials, and practice to counter the never ending demand to conserve life for emotional reasons, did overcome these handicaps and did lead to successes. Some of the so called incurable fractures of large animals are now being repaired satisfactorily.

Simultaneous with these and several other successes in operative surgery and as a extension of an overall increase in researches being undertaken in the Indian universities as projects by postgraduate students, many more clinical and experimental publications on non-operative studies appeared in highly respected international journals in the 1980s. The research areas like acid-base status and blood gases, both in healthy and sedated buffaloes, on pathophysiology of bovine septic shock, and on effects of anaesthesia with intermittent positive pressure ventilation during surgical operations like diaphragmatic hernia repair etc were covered in these publications. These studies amplified the understanding of surgical diseases of ruminants in general and buffaloes in

particular. No such publications on buffaloes were available till then. Lately more attention is being paid on the use of veterinary ultrasonography and laparoscopic surgery. However, their use so far is limited only to some teaching hospitals as far as ruminants are concerned.

These are only a few representative examples of operative successes in large animals and on the role of laboratory studies on pathophysiological understanding of surgical diseases and the effects of operative procedures during anaesthesia. Success in new areas of veterinary surgery creates its own demand for further advances and improvements.

The Indian Society for Veterinary Surgery (ISVS) was formed in 1977. It provided a common platform to Indian surgeons to exchange their views on a regular basis. The Society is organizing annual conferences in different parts of the country since then and has been instrumental in ever increasing intra-professional communication that not only led to application of procedures used successfully in one area to the others, but also brought about further improvements in the techniques during the process of this travel of technology. Thus, different types of successful surgeries spread themselves to become simultaneously available in all parts of the country. Many complicated operations are now being done even by the field veterinarians, thanks to ISVS conferences. Despite that, a lot is yet to be achieved towards the development of veterinary surgery in India. A number of factors are contributing to the slow current progress, financial constraints being the major factor. However, veterinary surgeons on their part have to do their best to meet the obligations and challenges. Only zeal, enthusiasm and dedication can take the profession to new heights.

When Indians look back, they have the satisfaction of being pioneers in medical and veterinary profession of ancient times. However, it is the future which must also provide the same satisfaction. To conclude, the words of Smithcors (1958) sound befitting, "As India looks to her own resources to bolster an independent economy and to recreate the glories of her proud past, we may expect her to turn to the writings of past, particularly to find native substitutes for imported drugs. In doing so, much of the history of medicine, both of man and animals, will be brought to life. The full recitation of this story may prove to be one of the most significant events in the entire history of veterinary medicine." These lines today stand not only for India but for all the developing countries.

CURRENT TRENDS

Some of the current trends in the practice of veterinary medicine, particularly in respect of surgery, radiology and allied disciplines, include:

Radio-wave and Laser Surgery

The surgeon's oldest instrument of choice, the scalpel blade, is the main instrument that most veterinarians use for cutting during surgery. It is sharp, sterile and dependable. However, new advances in surgery and technology have allowed for newer instruments to begin replacing the scalpel blade in the hands of some of the veterinary surgeons. Radio-wave and Laser surgery are two of the newer Hi-Tech forms of surgery that can be found at some of the most progressive veterinary hospitals in the west. Both of these new technologies utilize energies generated by sophisticated machines to help do the cutting. These energy waves allow for more precise incisions with less bleeding, less tissue trauma and better results. The surgery and anesthesia time along with surgical complications are reduced improving the outcome of most surgical procedures. These technologies have already become increasing popular for many different types of small animal surgeries, including tumor removal, biopsies, declawing, eye surgery, soft palate surgery and many more. There really is no limit to the available uses of these new 21st Century scalpel blades.

Laparoscopy

It is a minimally invasive procedure that has applications as a diagnostic, therapeutic and prognostic technique. Specialized equipment is necessary to perform equine laparoscopy, and there is a large range of instruments, both disposable and non-disposable available. Laparoscopic procedures described include ovariectomy, cryptorchidectomy, adhesiolysis and herniorrhaphy. Laparoscopy can be performed in a standing or dorsally recumbent position, depending on surgeon preference, patient status and the procedure to be performed.

Stapling Equipment

It is frequently used in gastrointestinal surgery in horses. Advantages include decreased surgical time and a decrease in the risk of contamination. Stapling equipment is often used in creating anastomoses, both in the large and small intestines, as well as in vessel ligation.

New surgical techniques intended to decrease adhesion formation include the use of carboxymethylcellulose and bioresorbable patches. Indwelling abdominal drains can be used for peritoneal lavage following surgery and also appear to decrease the risk of adhesion formation.

Ultrasonography

Ultrasonography is already the second most commonly used imaging format in veterinary practice and its use is fast spreading in all parts of the world. It is also likely to become more advanced in the coming years. However, ultrasonography cannot be used to scan gas-filled or bony tissues and its use is also limited in regard to the depth of tissue that can be examined. Although ultrasound can be used to evaluate most soft tissues, the heart and abdominal organs still constitute the majority of examinations performed in small animals. It is also widely used to evaluate the soft tissues of the musculoskeletal system and is used to detect and evaluate the presence of tears in the tendons and ligaments of the legs in equines. Examination of joints and the margins of bones around the joints in both large and small animals yields information not available from standard radiographic evaluation. Of course, ultrasound cannot be used to evaluate the bones themselves, so the two imaging methods are complementary. Ultrasonography can also be used to direct biopsy instruments to acquire tissue for a specific pathologic diagnosis. This obviates the need for an open surgical exploration in many cases. Lesions buried within large organs such as the liver and kidneys that might not be detectable at surgery may be detected and biopsied with ultrasonographic guidance.

Contrast Ultrasonography

Use of Contrast agents holds great promise for improving both the sensitivity and specificity of ultrasonographic examinations. However, they are extremely expensive, which precludes their use in all but special instances or funded research.

Echocardiography

Echocardiography is ultrasonic evaluation of the heart. In the past, it was done using the M-mode format of displaying ultrasound information, similar to the familiar format of an ECG. However, considerable experience is required to obtain and interpret diagnostic studies.

Digital Radiography Machines

Recent developments in diagnostic imaging have taken the veterinary sector into the 21st century. More practices are taking the next step forward and investing in digital radiography machines.

Most of the veterinary educational institutions in India already have a postgraduate degree programme in veterinary surgery and radiology. There is an immediate need not only to split it into three independent programmes in General Veterinary Surgery, Veterinary Anaesthesia and Veterinary Radiology and Imaging Techniques, but also to introduce new postgraduate programmes

in Orthopaedics, Thoracic and cardiac surgery, Ophthalmology, Neurology, Oncology and various types of Abdominal Surgery (e.g. Gastrointestinal, Urogenital etc.). Scope also exists for commencing species-wise post graduate programmes depending upon region-wise predominance of the species and demands for services of the same species.

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