their scope and in their results, but all have the same end in view — the protection of the people. As some have failed to produce the desired result, suitable amendments have been made. Some of the most recent laws are those which promise to be the most efficient, and it would indeed be astounding were a series of failures likely to act in favor of a renewal of the same undertaking. On the contrary, the failure of the earlier attempts at medical legislation has led to the avoidance of the causes of failure, and the reports from various States give encouraging evidence of what has been accomplished.

(To be continued.)

THE INFLUENCE OF ANIMAL EXPERIMENTATION ON MEDICAL SCIENCE:

ABSTRACT OF THE PRESIDENT'S ADDRESS BEFORE THE CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS, AT ITS THIRD TRIENNIAL MEETING, WASHINGTON, D. C., MAY 31, 1894.

BY ALFRED L. LOOMIS, M.D., OF NEW YORK.

THE specific problems with which medical science deals are questions of the relative influence of multiple forces on the production of given results. Only the deepest ignorance can fail to recognize that the forces concerned in the simplest change of inorganic nature are so numerous and their relations so complex that they defy recognition under uncontrollable conditions, while in the organic world the task is even more hopeless. Experimentation, therefore, in which one or more of the involved forces can be controlled, becomes an absolute necessity in all scientific investigation. However clear the mental analysis, however accurate the logical demonstration from cause to effect, it is possible by experiment alone to prove that no involved force has been overlooked. Is it not strange that medicine should be denied the right to follow those imperative methods of scientific research which are so unquestionably accorded to every other science? It is not a little surprising that men with an appreciation of the necessity of experimentation should for so long have preferred to be its subjects, and that even to-day so many refuse to yield the place to animals. For example, in widespread epidemics we note the effects of an infection on perhaps half a million of human beings, with a great sacrifice of human life. On the other hand, we study in laboratories the cause of the epidemics with a comparatively small sacrifice of animal life.

In entering upon the consideration of this subject the author fearlessly laid down this proposition: Every distinct advance, every established principle, and every universally accepted law of medical science has been in the past and will be in the future the direct, if not the immediate result of animal experimentation. He then passed to a review of some of the obvious and conclusive proofs of this proposition.

It is not too much to claim that during the latter half of the present century the results obtained from experiments on animals have done more than all the observations of the preceding centuries to raise medicine from conditions of vagueness to conditions of exactness. From the time of Aristotle, who proved that the blood, brain and spinal marrow in animals have no sensation, down to the present day, animal experimentation has been practised by all investigators who have

gained any definite knowledge of the more important phenomena of animal life.

Galen must be regarded as the pioneer in this line of investigation. By his experiments on living animals he showed that arteries contain blood, that the lungs passively follow the movements of the chest, and that the diaphragm although the most important is not the only muscle of respiration. Further, by section of the spinal-cord and of the recurrent laryngeal nerve, he demonstrated the nervous control of the voice and explained the mechanics of respiration. He also advanced the knowledge of the functions and movements of the alimentary canal and laid the foundation of our knowledge of the functions of the brain and spinal-cord. The results of his experimental work are now as conclusive as when first made, and are the only part of his vast labors which have stood the test of modern investigation.

From Galen's time to Harvey's great discovery, little experimental work was done; and during this time medicine ceased to advance. Harvey's demonstration of the circulation of the blood in 1620 rests entirely on animal experimentation, as is shown by his writings.

The next series of important investigations on animals were applied by Galvani and Volta to the nervous system.

In 1664 Robert Hook, by inflating the lungs of animals by means of a bellows, demonstrated artificial respiration. The experiments of Boyle and of Priestly in the seventeenth century laid the foundation of our knowledge of the respiratory process.

The injection of fluids into the blood-vessels of animals was first done by Dr. Christopher Wren. In 1666 Richard Lower performed the first transfusion, and the following year Dr. Denis performed the same experiment on man.

Haller, in the middle of the eighteenth century, proved that all motion in the human body proceeds in great measure from the brain and spinal-cord. He also demonstrated that irritation of the peripheral end of a severed nerve produced contraction in the muscle to which it was distributed. This was followed by the experiments of Sir Charles Bell. At the beginning of the present century Magendie demonstrated the difference between the anterior and posterior roots of the spinal-cord. His experiments on animals by the injection of various medicinal substances enabled him to lay the foundation of the doctrine that remedies exert their action upon special structures and organs. In this line of work he was followed by Claude Bernard. It is perhaps a conservative statement, that, excluding the medicinal foods, ninety per cent. of all our medication is made definite and valuable by this principle alone. Magendie, Bernard and Loget established by their experiments the doctrine of recurrent sensibility, which was followed by the discovery of Marshall Hall of reflex action of the spinal-cord. The doctrine of vaso-motor action was practically demonstrated by Bernard's experiments.

John Hunter, in 1785, by his experiments on dogs, established the fact that injuries to healthy arteries were soon repaired, and that ulceration after ligation occurred only when the vessel was diseased. The experiments led him to apply ligatures for the cure of aneurism to healthy portions of the arteries. Hunter first learned by experiment on pigeons and young pigs that the growth of bone was from the periosteum.

As we witness some capital operation performed at the present day without pain, almost bloodless, followed neither by fever nor suppuration, we may ask how far these results are due to experimentation on animals. The effect of chloroform was discovered through experimentation on the ant. Simpson practised and perfected his use of chloroform on animals before he placed his first patient in a state of anæsthesia. That other great alleviator of pain was first practised on dogs.

These results are sufficient to exalt animal experimentation to the first place, as a means of scientific advancement.

The first important step in the field of etiology based on animal experimentation was made in 1850, when it was proven that splenic fever could be communicated from animal to animal by inoculation, and the first hint of bacteriological study was given by the discovery constantly in the blood of these animals of little thread-like bodies.

About the same time Virchow made his observations on trichinosis. M. Viyaman inaugurated an important era when he established the fact that tuberculosis was an infectious disease. The invaluable studies of Pasteur introduced us into a new world of knowledge. He not only obtained pure cultures of organisms, but also studied their life-history and placed bacteriological science on a firm basis. The crowning glory of Pasteur's work came with the discovery of the attenuation of bacterial toxic products. It is not possible to point to a work of richer or grander promise, yet it is a work that was possible only by experiments on living animals. The application of Pasteur's doctrine by Mr. Lister to the antiseptic treatment of wounds has been a full confirmation of this principle.

The discovery of the bacillus tuberculosis by Koch marks another brilliant epoch in medical science.

Within the past two decades animal experimentation has accomplished more in the field of cerebral localization than all the preceding centuries of carefully recorded cerebral symptoms studied in the light of post-mortem investigation. It has opened a new field of operation.

From this history, it seems evident that most if not all of the real advances in medicine have been made possible through experimentation. This review of what our profession has done is not a plea for mercy — it is a cause for pride. So long as the moral and spiritual development of mankind remains the supreme purpose of creation, medical science can claim equal honor with the science of God, and in the conflict with physical evil must be the first to meet the foe. Until Infinity repeals the edict which gave man power over all created things, the right to claim the services of the brute can never be denied him who devotes his life to the service of mankind. We glory in our experimental work because we know the tenderness of cruelty, the balm of pain, the life whose birth is only in the throes of death. From the ignorant we expect to receive only censure; but from those who in the valley of the shadow of death have learned to know what manner of men we are, I have faith to believe that the reply will come, "We have trusted you with the lives of our loved ones, we entrust to you God's dumb creatures."

THE Pope has decided that cremation, while heretical in principle, may be allowed under special conditions.

Original Articles.

STRANGULATION OF MECKEL'S DIVERTICULUM CAUSED BY VOLVULUS OF THE ILEUM.¹

BY J. W. ELLIOT, M.D., BOSTON,
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THE patient, a man about thirty years old, was brought to the accident room of the Massachusetts General Hospital, October 17, 1893. He had been sick for four days, with vomiting, chills and abdominal pain. The bowels had moved twice in the previous forty-eight hours. The temperature was 103.6°, pulse 160, respiration 35.

The abdomen was distended, tympanitic and exquisitely tender, especially to the right of, and below the umbilicus. Free fluid was evidently present in the peritoneal cavity. Under ether, a large hard mass was plainly felt in about the middle of the abdomen, just below and slightly to the right of the umbilicus. Both Dr. M. H. Richardson and I considered it a severe case of appendicitis. Dr. Richardson also kindly assisted me with the operation, which proved to be the most difficult and perplexing operation I ever saw.

The abdomen was opened by a vertical incision two inches inside the anterior superior spine of the ileum. A quantity of turbid fluid escaped. The appendix was examined, and found to be normal. On exposing the mass near the middle of the abdomen by extending the incision, it looked like a large dilated and gangrenous knuckle of intestine, but without a mesentery. It sprang from the lower part of the convex surface of the ileum, and was tightly twisted at its point of attachment to the bowel. It extended upwards into a dense mass of adhesions, and when dissected free was found to be attached to the under surface of the umbilicus. It was then evident that we were dealing with a Meckel's diverticulum in a strangulated and gangrenous condition. It was seven inches long, and about the same size as the ileum. During the dissection, the gangrenous diverticulum was ruptured, allowing the escape of a quantity of fæcal-smelling fluid into the peritoneal cavity. The diverticulum was removed, and the opening in the ileum was closed with several Lembert sutures. The ileum at this point was found twisted on itself and held in this abnormal position by adhesions. The gut was not wholly obstructed by the twist. On untwisting the bowel old adhesions were found extending deep into the mesentery so as to shorten it at one point. This contraction of the mesentery seemed to have caused the volvulus of the ileum. The diverticulum having its outer end fixed at the umbilicus, was twisted and strangulated at its base by the turning over of this coil of the ileum. The gangrene of the diverticulum was most intense near the ileum, the end at the umbilicus being only moderately inflamed. This is explained by the fact that the diverticulum has its blood-supply from the mesenteric artery of the ileum.

The operation was severe, causing the pulse to rise to 180 at the end. The patient, already septic at the time of operation (unfortunately the cultures of the turbid fluid found in the abdomen were lost), died of septic peritonitis on the second day.

As is well known, Meckel's diverticulum is due to the persistence or incomplete obliteration of the vitel-

¹ Read at the Congress of American Physicians and Surgeons at Washington, May 31, 1894.