

tion and protection. Nor does it need further argument to show the wisdom of establishing laboratories of hygiene at many points over the country, of equipping them amply with the ablest men and the finest apparatus, and of endowing them liberally, so that the search after the yet unknown causes of disease, and after the best methods to prevent the development of such causes as are known, may be prosecuted with ceaseless vigor.

It is easy now to get a hearing for these views, when public comfort is disturbed, the public purse threatened, and the public conscience awake and sensitive. At this moment our great commercial communities are reposing in confidence upon the sanitary measures adopted by our governments, in accordance with medical advice, for the restriction and exclusion of two dreaded pestilences, cholera and yellow fever. Recall with me the popular terror of last summer. Recall the hideous loss of life and the disastrous effects on commerce caused by former invasions of these diseases when the communities afflicted were smaller and less wealthy than are ours at present. We do not have to seek back to the Middle Ages for pictures of desolation wrought by infectious disease. Recall that tragic story of the great yellow fever epidemic in Philadelphia just one hundred years ago, as told by Rush. Try to estimate the result if cholera had effected a lodgment in New York city in July, 1892, and having found favoring local and climatic conditions, had, as on former occasions, spread its deadly germs to the north and south and west. The fair White City that was rising by that distant lake, under the magic wands of Art and Industry, would have been stricken with a fatal blow. No computation can well exceed the loss that would have fallen on this country. The entire people gazed with bated breath at the struggle waging in New York harbor, and universal thanksgiving arose when the dread invader was finally repulsed by the vigorous and sustained efforts of the sanitary authorities. That we, in America, are not to-day witnessing the aggravated recurrence of the epidemic, in accordance with unvarying precedent, can be due only to the continuance of these same efforts, reinforced with large authority, and aided by more efficient local sanitation. When this gratifying result is associated with the success which for some years has attended our efforts for the exclusion of yellow fever, no further argument can be needed to urge the adoption of such uniform measures as will for the future afford most sure protection against these diseases. These instances exhibit in the most striking manner the need and the value of the international sanitary agreements this Congress may do much to promote. But there will occur to all of us many other important questions to be solved only by earnest and united work. Nor can this work be accomplished until Bowditch's cry for organization is far more fully answered than it has yet been. Nothing but organization and coöperation, and, yet more, the establishment in the government of every civilized nation of a department of public health, will secure the continuous and forcible attention which the magnitude of this enterprise demands. There should be, and the day cannot be far distant when there shall be, in the cabinet of every government here represented, a secretary of public health, of rank, influence, and prerogative equal to that of any other cabinet officer.

Here, then, is the last and greatest service to be rendered to science and to the nation by our Congress. Our combined influence will be irresistible when used in advocacy of higher education; in carrying out large plans for the scientific study of our national life, as affected by social and climatic influences; in the adoption of remedies and remedial measures of demonstrated merit, and in the insistence upon a fuller recognition of the lofty function of preventive medicine. "*Salus Sanitasque Reipublicæ, suprema lex.*" Let us acquire here a closer touch with each other, a deeper faith in our profession and its noble destiny, and a stronger determination to labor in brotherly coöperation for the loftiest ideals of service to science and the race.

ADDRESS TO MEMBERS OF THE PAN-AMERICAN MEDICAL CONGRESS.

BY BRIGADIER GENERAL GEORGE M. STERNBERG,

SURGEON GENERAL U. S. ARMY.

EXECUTIVE PRESIDENT OF THE SECTION ON MILITARY MEDICINE AND SURGERY.

Washington, D. C., Sept. 6th, 1893.

Gentlemen:—We are assembled for the purpose of discussing questions relating to military medicine and surgery; to consider what progress has been made in the treatment of camp diseases and of gunshot wounds as a result of recent discoveries relating to the etiology of infectious diseases and of traumatic infections; to profit by the experience of those who have had experience in the care of wounded men upon the field of battle and of the sick of armies engaged in actual warfare; to deliberate as to the best methods of transporting the wounded from the firing line and of rendering them the immediate assistance which may be required to save life; to compare the injuries inflicted by firearms now in use with those which came under our observation when a larger bullet with a much less initial velocity was the missile which caused a majority of the wounds we were called upon to treat.

All of these questions are interesting to us as military surgeons and of vast importance so far as the victims of future wars are concerned. It is true that peace prevails everywhere in the new world; that a most friendly feeling exists among the republics of North and South America; and that the modern way of settling disputes between nations is by arbitration rather than by a resort to arms. But so long as armies exist and deadly weapons are manufactured it will be the duty of the military surgeon to be prepared to render efficient aid to those who fall in battle, and to give the victims of those "camp diseases" which sap the strength of armies the benefit of the most efficacious treatment.

A still more important part of the duty of the medical officer in garrison or in the field consists in the sanitary supervision of the command with which he is serving; for, without doubt, most of the sickness which prevails among soldiers, and especially among new levies of troops, is due to insanitary conditions, and is preventable to a greater or less extent according to circumstances. But the subject of military hygiene does not properly come within the province of this Section, and we simply refer to its importance *en passant*.

We are, however, especially interested in the subject of the transportation of wounded men from the

field of battle. And in future wars we will have to meet new conditions, arising from the use of weapons having an extremely long range and from the nature of the wounds inflicted by bullets of small caliber projected with enormous velocity. Men will be disabled in great numbers within very brief periods of time, and of those struck by these missiles a large portion will require to be promptly removed from the field of action, for a smaller proportion will be killed outright.

Under these circumstances it is evident that our organization for the purpose of rendering first aid to the wounded and transporting them to the field hospitals must be carefully considered, and that the most efficient service will require a corps of assistants especially trained for this duty.

This matter has already received the careful attention of medical officers in the United States army, and we have now an organization designed to perform these duties, with the assistance of "company bearers" who also receive special training with reference to first aid, litter drill, etc. In time of peace our enlisted men of the "hospital corps" perform the duties of nurses, cooks and attendants in post hospitals, and they are regularly drilled in the most approved methods of handling wounded men and removing them from the field of battle.

A manual of drill for the hospital corps has been prepared by a board of medical officers and approved by the secretary of war. It will shortly be published "for the information and government of the army and for the observance of the militia of the United States." A demonstration of the litter and ambulance drills, as directed by this manual, will be made by Major Hoff of the medical department of the army, English speaking secretary of this Section, who was one of the medical officers to whom the duty of preparing the manual was intrusted. After this demonstration I hope we may have a free discussion of the merits of the system, as compared with the older, haphazard way of caring for wounded men which prevailed during our civil war. There are many present whose experience upon the field of battle will enable them to judge of the advantages which are likely to result from system and previous training in handling wounded men; and also as to the practicability of carrying out, upon the firing line, the methods which have been adopted.

The results obtained by our military surgeons during the late war are summarized in the accompanying table, which has been prepared, at my request, by Major Charles Smart, Surgeon U. S. A., from the data on file in the surgeon general's office. The table also shows the number of amputations and excisions made by medical officers of the army since the war and the percentage of mortality from the same. It will be seen that the mortality rate has been considerably reduced. This is no doubt partly due to improved methods of treatment, and especially to antiseptic surgery, although a considerable proportion of the operations made since the war were made before the general adoption of antiseptic methods, or under circumstances which did not admit of the strict application of these methods.

For the purpose of showing the enormous responsibility of the medical department of an army in time of war the following figures are given, showing the total number of cases treated in the armies of the United States during the late war, as given in

the "Medical and Surgical History of the War of the Rebellion." The figures relate to white troops only, and are for the period from May 1, 1861 to June 30, 1866:

TABLE SHOWING THE NUMBER OF AMPUTATIONS AND EXCISIONS OF THE EXTREMITIES DURING THE WAR OF THE REBELLION AND THE PERIOD 1866-1891, WITH PERCENTAGES OF MORTALITY.

UPPER EXTREMITY.				
	During the War.		Since the War.	
	Number of Cases.	Percentage of Mortality.	Number of Cases.	Percentage of Mortality.
Amputations:—				
Shoulder	852	28.5	7	14.3
Arm	5,456	23.6	62	19.4
Elbow	36	8.4	1	...
Forearm	1,747	13.9	57	8.8
Wrist	68	10.6	10	...
Fingers, with or without metacarpals	7,842	2.6	830	.1
Total	*16,001	...	967	...
Excisions:—				
Clavicle or scapula, partial	80	2.7	1	...
Shoulder	885	34.8	5	20.0
Humerus	696	28.5	11	...
Elbow	626	23.7	5	20.0
Bones of forearm	986	11.2	7	...
Wrist	96	15.6	1	...
In hand	116	8.6	22	4.5
Total	3,485	...	52	...
LOWER EXTREMITY.				
	During the War.		Since the War.	
	Number of Cases.	Percentage of Mortality.	Number of Cases.	Percentage of Mortality.
Amputations:—				
Hip	66	83.3	4	75.0
Thigh	6,229	53.8	63	41.3
Knee	189	56.6	7	...
Leg	5,452	32.9	87	20.7
Ankle	161	25.1	21	9.5
Partial, of foot	1,518	5.7	182	...
Total	*13,615	...	364	...
Excisions:—				
Hip	66	88.6	6	33.3
Femur	175	69.4	3	33.3
Knee	57	81.4
Bones of leg	387	28.2	6	16.7
Ankle	33	29.0	3	...
Bones of foot	97	19.3	6	...
Total	815	...	24	...

*In addition to the amputations reported above as performed for gunshot fracture during the war, there were 583 amputations of parts of the lower extremity, with a mortality of 25.5 per cent., and 195 of the upper, with 10 per cent. mortality on account of extensive flesh wounds, in which the fatality was due mainly to shock.

The total number of cases recorded in reports of sick and wounded was 5,825,480, with a total mortality of 166,623. The total number of gunshot wounds was 230,018, with a mortality of 32,907. (The total number killed in battle was 42,724.) The total number of deaths from disease was 157,004, the principal causes of mortality being; typhoid fever 27,056+ typho-malarial fever 4,059=31,115; chronic diarrhoea, 27,558; inflammation of lungs, 14,738; consumption, 5,286; small-pox, 4,717; measles, 4,246; acute dysentery, 4,084; chronic dysentery, 3,229; remittent fever, 3,853. No doubt many of the deaths attributed to "remittent fevers" were in fact due to typhoid infection, which in this war, as in many of those which preceded it, proved to be nearly as fatal to the troops engaged as the bullets of the enemy.

No question is more important for the medical officer than that which relates to the prevention of typhoid fever and the various forms of intestinal

flux which in the past have caused such enormous losses to armies engaged in active field operations. No doubt a very large proportion of the sickness from these causes could be prevented by the simple prescription—boil all water used for drinking purposes which does not come from a source that is unquestionably pure.

But the question of the prevention of these camp diseases so destructive to armies, and especially to new levies of troops in warm climates, belongs to the Section on Military Hygiene, and I must restrict myself to topics which come strictly within the province of military medicine and surgery.

I therefore ask your attention for a short time to a subject which has been of great interest to military surgeons in the past but which, in the light of our present knowledge, should be interesting to us rather from an historical than from a therapeutic point of view. I refer to the question of traumatic infections. Hospital gangrene, erysipelas, septicemia and tetanus have no longer the terror for us that they had for our predecessors, for the etiology of these traumatic infectious diseases has been elucidated by researches made during the past fifteen years and, knowing the cause, the proper measures of prevention are apparent and are systematically applied whenever this is practicable.

That the infectious diseases mentioned result from the introduction into wounds of pathogenic bacteria is now definitely settled, and in the case of erysipelas and tetanus we know the specific characters of the parasitic invader which gives rise to these forms of wound infection. But no such demonstration has been made as regards hospital gangrene, probably because bacteriologists have had no opportunities for investigating this disease since the introduction of Koch's admirable methods of research. The writer, while in charge of the surgical wards of a large general hospital at Portsmouth Grove, R. I., in 1862, witnessed a typical epidemic of this disease which served as a lesson never to be forgotten. The two wards devoted to the treatment of surgical cases were filled with wounded men from the Army of the Potomac. A considerable proportion of the cases were simple flesh wounds, progressing favorably to a cure by granulation and cicatrization. Others were of a more serious character and were attended with profuse suppuration. The hospital was favorably located on Narragansett bay; supplies of all kinds were abundant; nurses were in sufficient number and attentive but the medical officer in charge was young and inexperienced. Under his direction the wounds were systematically cleansed and dressed with absorbent lint, etc. Nature seemed to be fully equal to the work of repair, except in those cases where a mistaken conservatism at the field hospital had left compound fractures to her unaided efforts. In such cases profuse suppuration, and septic toxemia sapped the strength of strong men. Possibly it was in such a case that the mischief commenced. Doubtless it was from one or more initial cases that the infection was carried by the sponges of willing but ignorant attendants to a considerable number of wounds which up to this time were progressing rapidly towards cicatrization. The result was a conflagration. Wounds previously healthy became inflamed, painful and angry looking, and within two or three days the cause of this change

was apparent. The area of inflammation involving the previously healthy tissues rapidly extended and sloughs formed, sometimes as large as a man's hand and extending deeply among the muscles and along the planes of cellular tissue. Fortunately the infectious nature of the malady was quickly recognized and the measures adopted arrested its progress. It is hardly necessary to say that these measures included the removal of those not yet infected from the overcrowded surgical wards, a general cleaning up, whitewashing of walls, etc., and the necessary precautions relating to the conveyance of infection by sponges, etc. The treatment of the gangrenous wounds consisted in deep cauterization by means of nitric acid applied with a swab, the removal of necrosed tissue as soon as practicable, and the application of charcoal poultices. Goldsmith's bromin treatment had not yet been suggested. Under the treatment adopted the local extension of the disease was promptly arrested, and as soon as the sloughs had separated healthy granulations sprang up and in time repaired the mischief which had so quickly occurred.

This brief account of an epidemic of hospital gangrene witnessed by myself is intended to serve as an introduction to some remarks upon the history and etiology of this affection.

It is altogether probable that it was known to Celsus, who has described a condition of wounds not properly treated, which appears to be identical with the affection known to us as hospital gangrene. *Ætius*, who wrote in the fifth century, refers briefly to a similar affection. Some of the ancient authors appear to have described the form of wound infection under consideration by the name of "carbuncle." *Rolandus*, who wrote in the twelfth century, had a chapter in his third book on wounds, entitled "De Carbunculo supervenienti vulnere." *Alphonsus Terrus*, who, in 1534, published one of the first treatises upon gunshot wounds, was of the opinion that all wounds of this class were poisoned by the gunpowder. He gives an account of the results of such supposed poisoning which makes it appear probable that he encountered hospital gangrene. He recommended the actual cautery as a cure for this condition, and also as a preventive. *Ambrose Paré* combated the idea that gunshot wounds were poisoned by gunpowder or burned by the ball, and attributed the unhealthy condition into which such wounds were sometimes observed to fall, to a "corrupted state of the atmosphere." He remarks that, owing to this cause, "Nous en sommes devenus sages par l'expérience de tant de plaies, lesquelles lors que je m'efforçais à les guérir, rendoient une telle et si grande puanteur, indice et temoignage tres certain de pourriture et infection, que les assistans ne la pouvoient sentir qu'à contrecœur, et avec bien grande difficulté."

Paré's treatment of hospital gangrene consisted in the application of an ointment containing pulverized alum, verdigris, and sulphate of copper. It does not appear to have been very successful, as he reports that in many of the wounded in the battle of St. Denis the wounds fell into putrefaction and were accompanied by putrid fever and other serious accidents, and nearly all the wounded died, although their wounds may have been slight and they were supplied with everything necessary for their proper sustenance and treatment. According to *Paré* the

wounds made by swords, pikes and lances became affected with gangrene (les pourritures) as well as those made by firearms.

La Motte, who wrote his "Complete Treatise on Surgery" early in the seventeenth century, gives a very complete account of hospital gangrene. He says: "On prend ce mot" (gangrène), "properment pour un disposition a la mortification qui est ce qu'on appelle vulgairement *pourriture* a l'Hotel Dieu de Paris, laquelle survient et accompagne presque toutes les playes qui sont traités dans cet Hôpital, et la plus grande partie des absces que l'on y ouvre, a cause de l'air corrompu qui y regne et que ces blessez y respirent."

The practice of surgery in a hospital where the opening of an abscess was likely to be followed by rapidly spreading gangrene must have been rather discouraging, and so long as the idea prevailed that this resulted from "a corrupted condition of the air," rather than from direct infection conveyed from wound to wound by instruments, sponges, etc., there was little chance of eradicating the evil.

Ponteau, who wrote in 1783, referring to the prevalence of gangrene in French hospitals, raises the question whether such institutions are not, on the whole, more pernicious than useful to mankind. What would these surgeons of two hundred years ago have thought of our laparotomies for removal of the appendix, etc.; of our operations upon the principal joints; and of the absence of "surgical fever" after serious operations made antiseptically or with aseptic precautions?

Mr. John Bell, in his "Principles of Surgery" published in 1799, says:

"There is no hospital, however airy or well regulated, where this epidemic ulcer is not found at times." (p. 112). "He must indeed be ignorant who disputes this hospital sore being a general disease of the system; he must have observed very little who does not know it to be absolutely an infection." (p. 117). "Is the surgeon to seek for washings and dressings, use ointments and plasters, and expend butts of wine to cure such a disease? No; let him bear this in mind that no dressings have ever been found to stop this ulcer—but, on the other hand, that out of the circle of the hospital the patients are safe; carry them anywhere, and at any expense, even to a stable or a dunghill." (p. 118).

No doubt this was good advice in the absence of any exact knowledge as to methods of disinfection, for even if the infectious material was destroyed in the wounds by the actual cautery, or by applications of fuming nitric acid, there was always danger of re-infection so long as the patient remained in the infected hospital wards.

The total number of cases of gangrene reported during our civil war, as occurring among the wounded of the Union armies, was 2,642. Of these, four cases occurred in 1861; 223 in 1862; 623 in 1863; 1,611 in 1864, and 135 in 1865. 1,361 cases terminated in recovery, and 1,142 were fatal; but in a considerable number of the fatal cases death was due to the original injury or to other complications—septicemia, hemorrhage, etc.

For details with reference to the principal epidemics of hospital gangrene during the war I must refer to the interesting reports of Acting Assistant Surgeon W. W. Keene, U. S. A.; Surgeon J. H. Brinton, U. S. V.; Surgeon M. Goldsmith, U. S. V.; Assistant Surgeon William Thomson, U. S. A., and others, extracts from which will be found in the third surgical volume of the "Medical and Surgical History of the War."

The facts detailed in these reports correspond with those previously observed in various parts of the world, and show that hospital gangrene is a local disease due usually to the infection of wounds from previous cases.

This brings us to the question as to the origin of the primary cases in an epidemic, a question which is of special interest, not only as regards this disease, but in its bearing upon the etiology of other local infectious processes.

Do epidemics originate *de novo* as a result of an increased pathogenic power on the part of some common putrefactive microorganism, or is there a specific "germ" of hospital gangrene? The former supposition appears to me to be more in consonance with the facts relating to the origin of epidemics, and is sustained by extended experimental researches which show that the pathogenic potency of many bacteria is greatly intensified by cultivation in albuminous fluids and under favorable conditions. This is true of the pus cocci, which may thrive upon the surface of the body of healthy persons or upon mucous surfaces as harmless parasites; but which under favorable conditions may invade the tissues producing acute abscesses, erysipelatous inflammations or gangrenous sloughs, according to the pathogenic potency of the micrococcus and the degree of vital resisting power on the part of the tissues. The streptococcus pyogenes from a malignant case of erysipelas or from the abdominal cavity of an individual who has succumbed to puerperal peritonitis may give rise, when introduced beneath the skin of a healthy person, to the most violent local inflammation and to general septicemia. But if cultivated for a length of time in unfavorable artificial media its pathogenic potency may be so reduced that it gives rise to a local abscess only.

The same has been demonstrated, by experiments upon the lower animals, to be true as regards certain bacteria found in putrefying material. Some of these when injected beneath the skin of a mouse, a rabbit, or a guinea pig, give rise to a rapidly fatal septicemia; others cause an extensive inflammatory œdema in the vicinity of the point of inoculation; still others to a progressive gangrene. By inoculating from animal to animal, the virulence of the pathogenic microorganism inducing these morbid phenomena is increased, so that the smallest fraction of a drop of blood, or of bloody serum from the subcutaneous tissues of an animal recently dead from such an inoculation suffices to kill another animal of the same species within a brief period. But there is another element which influences the result when virulent putrefactive material is introduced beneath the skin of an animal for experimental purposes, or into an open wound by accident, i. e., the vital resisting power of the tissues. The body of a dead animal under favorable conditions of temperature is quickly invaded by putrefactive bacteria. But in the living animal such invasion is successfully resisted in many cases, even when putrefactive bacteria are brought in contact with open wounds. This is especially true as regards carnivorous animals, while the herbivora are especially susceptible to local or general infection when putrefactive material is brought in contact with an open wound. There is also a difference in individual susceptibility in animals of the same race. As a rule, young animals are more susceptible than adults, and susceptibility to infec-

tion is increased by depressing influences, such as insufficient food, excessive exertion, bad air from overcrowding or putrid emanations, etc.

It is under such depressing influences that epidemics of hospital gangrene have commonly had their origin. That the disease may originate independently of pre-existing cases seems to be well established by the history of independent outbreaks in distant parts of the country during the war, in new hospitals and among wounded men brought directly from the field of battle.

Billroth, in his "Surgical Letters from the War-hospitals in Weissenburg and Mannheim" (1870), says:

"While I was at Mannheim but a single case of hospital gangrene occurred. This was in barrack J of the hospital which had been placed under my direction. The medical officer of the day did not recognize the disease and first called my attention to it on the third day. Fortunately no other cases had become infected. I cauterized the wound (a gunshot fracture of the upper arm) with fuming nitric acid and after separation of the slough it was again healthy. In Darmstadt, in the great barrack hospital, two or three cases occurred which were treated the same way and isolated. So far as I am informed this was the end of the trouble."

In discussing the origin of these cases Billroth says:

"Where did the contagion come from for the one case in Mannheim and for the cases in Darmstadt? That I really cannot say, but I suspect that the infectious material was attached to lint which had been made from hospital linen, or had been scraped in a hospital in which hospital gangrene existed. This suspicion may appear very singular to many physicians, but will serve to show how thoroughly I am convinced of the specific origin of hospital gangrene."

To the writer it appears far more probable that these were cases of the *de novo* origin of gangrene as a result of the introduction into a suppurating wound of saprophytic bacteria which, owing to favoring conditions in the wound itself or to slight resisting power on the part of the tissues, had acquired sufficient pathogenic virulence to enable them to invade living tissues. It may be that there is some particular saprophyte, which is widely distributed, to which this result is commonly due; or it may be that there are a number of putrefactive bacteria which under favorable conditions may acquire this power of invading living tissues. The result is probably due, to some extent, to the development of toxic ptomaines in the secretions of the wound by putrefactive bacteria present in these secretions, which, being absorbed, lower the vital resisting power of the tissues. Deep and profusely suppurating wounds, and especially gunshot fractures of the larger bones, in which pockets and sinuses occur from which it is difficult completely to remove accumulations of pus, furnish the conditions most favorable for the development of such pathogenic virulence as may suffice to make a saprophytic bacillus a facultative parasite.

The greater liability to the development of hospital gangrene in wounds complicated by fracture of bones is shown by the accompanying table, which is taken from the "Medical and Surgical History of the War." (Third Surgical Volume, p. 824.)

It is a remarkable fact that while the larger number of cases occurred in wounds attended with fracture, the greatest mortality resulted in simple flesh wounds.

From our point of view the etiology of hospital gangrene does not differ materially from that of

traumatic erysipelas so far as general conditions are concerned, but the two diseases are doubtless due to different microorganisms. That which is the usual cause of erysipelas is now well known to bacteriologists under the name of streptococcus pyogenes, or streptococcus erysipelatos.

SUMMARY OF 2,642 CASES OF GANGRENE, INDICATING THE RESULT AND RELATIVE FREQUENCY.

Seat of Injury.	Recovery.	Fatal.	Undetermined.	Total.	Per cent. of Fatality.	Per cent. of Relative Frequency.
Flesh wounds of head, face, and neck	5	7	..	12	58.3	60=2.2%.
Fractures and penetrating wounds of head, face, and neck	32	16	..	48	33.3	
Flesh wounds of trunk	36	32	7	75	47.0	216=8.2%.
Fractures and penetrating wounds of trunk	44	97	..	141	68.7	
Flesh wounds of the upper extremities	47	50	12	109	51.5	2,306=89.6%.
Fractures of the upper extremities	476	245	14	735	33.9	
Flesh wounds of the lower extremities	125	127	92	344	50.3	
Fractures of the lower extremities	596	568	14	1,178	48.7	
Aggregates	1,361	1,142	139	2,642	45.6	

Whether hospital gangrene is a specific infection in the same sense that erysipelas is, i. e., an infection due to a specific microorganism has not been determined, but it seems probable that such is the case. It does not follow from this, however, that all cases of these traumatic infectious diseases originate by direct or indirect transfer of the infectious agent from previous cases. Erysipelas does not necessarily result from the introduction of streptococcus pyogenes into an open wound. This streptococcus is frequently found in the pus of acute abscesses unattended with any erysipelatos inflammation. But under favorable conditions it may develop virulent properties, which are manifested especially by a tendency to invade the tissues by way of the lymph channels and along cellular planes, producing a dilation of the capillary vessels and more or less serous effusion, leading often to suppuration and sometimes to necrosis of the invaded tissues. The development of first cases of either disease probably depends upon predisposing causes relating to the individual or his environment. A traumatism is more likely to be followed by erysipelas in a man whose vitality is below par on account of intemperance, insufficient food, bad hygienic surroundings, etc., and the same is true as regards hospital gangrene. Under such conditions the comparatively harmless streptococcus pyogenes may overcome the barriers established by nature to resist invasion by saprophytic bacteria, and having acquired the power to multiply as a parasite in tissues enfeebled by the causes mentioned it soon attains a pathogenic virulence which enables it to invade healthy tissues when transferred by accidental inoculation to another individual.

The view here advanced with reference to the *de novo* origin of erysipelas is supported by the fact that solitary cases frequently occur at remote military posts. Thus during the past year twenty-eight cases are reported as having occurred among the enlisted men of the United States army. Of these eighteen occurred at eighteen different posts, while three posts had two cases each and one post had four.

The facts relating to the etiology of pneumonia correspond with those referred to as relating to

that of erysipelas. In this disease, also, the specific cause has been shown to be a micrococcus (*Mic. pneumoniae crouposæ*) which is frequently found in the salivary secretions of healthy persons, and which varies greatly as to its pathogenic virulence. Solitary cases of the disease occur at our military posts, as elsewhere, as a result, no doubt, of predisposing and exciting causes which give the specific cause the mastery over the resources provided by nature for resisting the local infection which constitutes the disease in question.

The total number of cases of traumatic erysipelas reported as occurring in the armies of the United States during the war was 1,097, with a mortality of 41 per cent.

The micrococcus which is now recognized as the usual cause of erysipelatos inflammations is capable of growing either in the presence or absence of oxygen; i.e., it is an *aërobic* and facultative *anaërobic* microorganism. We infer that the same is true as regards the microorganism which produces hospital gangrene. But in the case of tetanus, which has been proved by recent researches to be an infectious malady due to a bacillus widely distributed in the superficial layers of the soil, it has been shown that this bacillus is a strict *anaërobic*. It does not grow in the presence of oxygen and could not thrive in superficial wounds. This probably accounts for the fact that epidemics of tetanus are not common. The cases which occur are for the most part sporadic cases, due in each instance to infection, resulting from the introduction of surface soil or dust containing the tetanus bacillus. Such material in an open wound might be innocuous. But introduced into the depths of a gunshot wound, into a closed amputation wound, or into a punctured wound made by a rusty nail, for example, the tetanus bacilli (spores) present find the conditions favorable for development and this fatal infectious malady results.

Sporadic cases of hospital gangrene probably occur in a similar way, but as there is a free escape of virulent material from the infected wound, the danger of the disease being transmitted to other wounded individuals is infinitely greater.

The total number of cases of tetanus reported in the "Medical and Surgical History of the War" is 505, or a little more than two per thousand of the total number of injuries by weapons of war. More than one-fourth of the cases followed operations upon the extremities; 116 after amputations, and fifteen after excisions. We can scarcely doubt that a majority, at least, of these cases would have been prevented by modern methods of treatment—antiseptic or aseptic.

The same statement applies to the considerable number of cases reported under the heading pyemia. It seems probable that of the 2,818 cases reported under this heading a large proportion were in fact cases of septicemia resulting from wound infection. The very great mortality, and the results of post-mortem examinations made, indicate this; but as it was before the days of bacteriological research there is no direct evidence on record showing the presence of bacteria in the blood and in the metastatic abscesses found in the lungs, the liver, the kidneys, spleen or joints in those cases in which an autopsy was made. Doubtless septic toxemia occurred in numerous cases but, as stated, we infer that a majority of the cases reported under the heading

pyemia were in fact cases of septicemia resulting from infection through the wound, by the pathogenic micrococci which are commonly concerned in this form of "blood poisoning," and especially by *staphylococcus aureus*. The mortality in the class of cases under consideration exceeded 97 per cent. Out of the total number of deaths (2,747) but twenty-one are reported to have resulted from other complications,—viz., hemorrhage seven, gangrene six, tetanus two, erysipelas one, peritonitis one, and typhoid pneumonia four.

One of the questions to be settled by the military surgeon in the next great war, which we earnestly hope will not occur on this continent, is to what extent the large mortality which has heretofore occurred from traumatic infections can be prevented by antiseptic methods of treatment. Certainly there will be no excuse for the occurrence of septicemia after amputations, or for the appearance of erysipelas or hospital gangrene in wounds made by the knife of the surgeon. But how far it may be practicable to prevent such complications in gunshot fractures remains to be seen, and the proper treatment of such injuries is an important point for consideration. If such cases could at once receive skillful surgical treatment, including the removal of splinters, foreign substances carried into the wound by the bullet, and antiseptic dressings, no doubt many would be saved without loss of life or limb. But the changing fortunes of the battlefield often make it impossible for medical officers to give such prompt attention to the wounded. It is generally conceded that on the firing line nothing more should be attempted than the arrest of hemorrhage, and such support to the fractured limb as will enable the wounded man to bear transportation to the field hospital with the least possible suffering. It is here that the fate of the unfortunate victim of war will often be decided, and the responsibility resting upon the military surgeon under such circumstances cannot be overestimated. His decision with reference to operative interference must be prompt, and will often be governed by circumstances other than those laid down in surgical textbooks. How far must the man be transported before he will reach a resting place at a permanent hospital? What are the means of transportation? Is he to be left at the mercy of the enemy as a prisoner of war? Shall his case be passed by because of others more urgently requiring attention? Many a leg must be sacrificed which might be saved under more favorable conditions, and conservative surgery must often yield before the inexorable contingencies of the battlefield.

In future wars the question will be decided as to the propriety of performing laparotomy at the field hospital in penetrating wounds of the abdomen, for the purpose of exploration, and suturing the intestine if it is found to be wounded. This is so important a question that I have attempted to make it the most prominent surgical topic for discussion at the present meeting, and trust that as a result of this discussion we may arrive at definite conclusions as to what our action should be if called upon to treat such cases.

What has been said will suffice to indicate to the young medical officer that much is expected of him; and that in view of recent additions to our knowledge relating to the etiology of the more common camp diseases, and of traumatic infections, and to our resources for preventing and curing such dis-

eases, we have a right to expect a great reduction in the mortality from sickness and wounds in the armies engaged in future wars.

MEDICAL EDUCATION IN THE UNITED STATES.

An Address delivered before the Section on Pedagogy of the Pan-American Medical Congress.

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GENTLEMEN:—The work of this Section is of a character which does not usually form a prominent part in the proceedings of medical gatherings.

In almost any department of education, pedagogy or the science of teaching is a recognized specialty.

The rapid progress which has been made in medical education in this country within the last few years has brought about such profound changes in methods of instruction, and the strides which medical science is making all over the civilized globe are bringing into view so many new fields of work, that the teachers of to-day have a far more complex and difficult task than was presented to their predecessors. The art of teaching medicine has not been taught, in this country at least; the time has arrived to take up the subject.

In introducing such a subject as this, it seems appropriate to take a brief retrospective glance at the history of medical education in this country.

There lies before me as I write, a quaint little volume entitled, "A Discourse upon the Institutions of Medical Schools in America," published in 1765. It bears the following inscription:

"To Doctor John Warren, Physician in Boston, This Copy is presented by his respectful and affectionate Friend, John Morgan, Philad'a, Feb. 27, 1783." This book may be safely regarded as the first contribution to the subject which we are to discuss to-day and the two dates are memorable; the former indicating the foundation of the medical department of the University of Pennsylvania, and the latter the birth of the medical department of Harvard University.

Dr. Morgan justly remarks that "medicine is a science as important in its object as it is difficult in the acquisition. It is very extensive in its researches and presupposes the knowledge of many other sciences. The cultivation of it requires no small abilities, and demands of those who engage in the arduous pursuit an enlarged and benevolent mind."

It is interesting to note that one whom we might justly look upon as the father of medical education in this country and who "had spent five years in Europe under the most celebrated master in every branch of medicine," should have taken so optimistic a view of the knowledge of medicine at that time as to say: "The industry of many centuries has already been employed to bring Physic to that degree of perfection at which it is now arrived." Fortunately he adds: "It will still require a long time to remove the obscurities which yet veil many parts of it."

Three years after this book was written, Pennsylvania held her first medical commencement and the provost justly remarked: "This may be considered the birthday of medical honors in America."

The men who started this movement had received much encouragement from across the ocean and the

remark of one of their teachers, Dr. John Fothergill of London, is of special interest to those concerned in the work of this congress. Writing to James Pemberton in 1762 he recommends Drs. Shippen and Morgan as men well qualified for the work of teachers, "both of whom," he says, "will not only be useful to the province in their employment but if suitably countenanced by the legislature will be able to erect a school of physic among you that may draw students from various parts of America and the West Indies."

During the colonial period of our history it was the custom for young men who entered upon the study of medicine to become regularly apprenticed to some practitioner for a term of three or four years during which time the preceptor was entitled to the students' services in preparing and dispensing medicine and serving as an assistant in minor surgical operations. As a return for this, the physician was obliged to give the student detailed and thorough instruction in all the branches of medicine. Many of the leading men frequently had several students in their office, constituting a small class, who were drilled as regularly in their studies as they would be in college. In some instances the term of apprenticeship was extended even to six or seven years.¹

When the medical school sprang into existence it was at first intended merely to supplement the apprentice system, and as means of communication of one part of the country with another were exceedingly limited it was found desirable to concentrate school work into as small a part of the year as possible. Hence the origin of the short term of four months which has clung so persistently to the American system.

I will not undertake to weary you with a detailed account of the history of the development of our system of education. Suffice it to say that the close of the century found schools established not only in Pennsylvania and Massachusetts but in New York, Maryland and Vermont. There were, however, in 1810 only five medical schools in existence with an aggregate number of medical students of about 650, of whom 100 received the degree either of bachelor or doctor of medicine. The bachelor's degree was given to those who had attended one full course of college instruction. It was hoped that such students after a short period of practice would eventually return to take the higher degree, but as this expectation was not fulfilled the degree of bachelor of medicine was soon wisely abolished.

A noticeable feature of the education of that early period in our medical history were the requirements for a high standard of general education. Those students who did not possess a college degree were expected to pass an examination in Latin, mathematics and "Natural and Experimental Philosophy."

To obtain the degree of doctor of medicine it was necessary that the applicant should have been a bachelor of medicine for at least three years, should have attained the age of twenty-four years and should write and defend a thesis publicly in the college.²

When we consider how imperfect was the knowledge of chemistry, physiology and even anatomy, and many other branches of medical science, and how

¹ N. S. Davis, *Med. Ed. and Med. Institutions in the United States of America*. 1877.

² William Pepper. *Higher Medical Education*. 1877.