A CLINICAL REPORT

ON

INTRAVENOUS SALINE INFUSION

IN THE

WARDS OF THE NEW ORLEANS CHARITY HOSPITAL

FROM JUNE, 1888, TO JUNE, 1891.

BY RUDOLPH MATAS, M. D., VISITING SURGEON.

Reprinted from the July, 1891, number of the New Orleans Medical and Surgical Journal.

L. GRAHAM & SON, 99, 101, 103 GRAVIER ST., N. O.

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While the records of the Charity Hospital point to the fact that intravenous saline infusion was practised during the earlier and devastating cholera epidemic that prevailed in this city, and a dim indication is also met here and there of the direct and indirect transfusion of blood in the surgical practice of this institution (though I have no official information or record to that effect), it is, I believe, historically correct to state that no attempt prior to July, 1888, had been made to infuse intravenously a saline solution for the relief of acute anæmia.

I have undertaken, therefore, as a matter of domestic history as well as of general medical interest to present the records of all the cases that have been subjected to this procedure since that time, in this institution, and to draw from them such conclusions as the nature of the cases and the results warranted. In so doing I have gathered nineteen observations of a purely surgical character, which represent all the instances in which, after diligent inquiry, I have been able to ascertain that this method of treatment had been practised. I have, furthermore,

*Read before the Louisiana State Medical Society, May, 1891.

included one medical case occurring in my own practice, which I have added to sum up the total of my personal experience with the method which is represented by five cases, all of which are embodied in this report. The other remaining cases occurred in the services of other members of the staff to whose courtesy I am indebted for the reports, especially as they are almost all unpublished histories from the ward books.

In several cases the conditions which gave rise to the indication for saline infusion were rare and of unusual interest, and outside of their therapeutic aspect are worthy of record, and for this reason I regret that in some instances I was not able to obtain more full and detailed information.

After the presentation of the clinical observations I shall avail myself of the text furnished by them to direct your attention to the indications, the advantages and life saving properties of saline infusion, believing that after the recital of several of these critical experiences you will concur with me in the belief that it is impossible to overestimate the great value of this mode of therapeutic relief in all cases in which its exhibition is appropriately called for.

I.

OBSERVATION I.—SERVICE OF DR. R. MATAS (WARD 8).

Mixed Cavernous Sarcoma of Thigh, Simulating Aneurism of the Femoral—Amputation at Upper Third—Profound Shock—Saline Infusion Twice Repeated—Death.

R. C., æt. 26, admitted July 12, 1888; Louisianian; farmer; temperate; no hereditary history; no syphilis. History: about fifteen years ago patient fell from a pine tree and drove a sharp stump about four inches deep into the flesh of the inner side of thigh. Three years ago noticed a small tumor at a spot corresponding to the apex of Scarpa's triangle. It was seen by Dr. F. (a practitioner in his native place who first examined him and who is here now and confirms the statement), who noticed a pulsation and believes he also heard a murmur. The doctor was so thoroughly convinced that the tumor was an aneurism that in sending him to the hospital later he advised the patient to carry with him a strong elastic

bandage, with the instruction to constrict the limb above the tumor in case it should burst before reaching surgical assistance.

Status Præsens: The patient is thin, apparently poorly nourished and careworn from anxiety, but not noticeably cachectic. He is a man of moderate height, about 5 feet 6 inches, and shows traces of a past robust and vigorous physique. On examination of right thigh, a large tumor at once attracts attention, lying with its longitudinal axis parallel to the long axis of the thigh and right over the course of the femoral.

The tumor is ovoidal in shape, projects considerably above the thigh; the skin over the tumor is tense, adherent, and over the center presents a livid color. The tumor measures in length over 9 inches, beginning at a point 3½ inches from Poupart's ligament, and reaches a point 4 inches above the internal condyle. The transverse diameter is over 9 inches. The tumor did not appear to spring from the bone, though it originated deeply in the thigh and, though very well outined in the soft parts, was not distinctly encapsulated, but blended gradually with them at the periphery; in the most prominent portion of the tumor a slight bloody ooze was noticeable, owing to a fissure in the tense and livid skin. The tumor, though quite firm throughout, had, in some parts, a semi-solid feel just like a sac filled with clot. No pulsation was visible, or recognizable by palpation; no thrill; no murmur. Firm pressure over the femoral at groin causes very little difference in size of tumor, but the application of the elastic bandage reduces it considerably, fully 3½ inches, by measuring the circumference of the limb.

Puncture with an exploring needle draws a syringeful of pure blood.

This last result of the examination causes considerable hesitation in the diagnosis. The traumatic history, the statements of the first medical attendants and above all the reductibility of the growth by elastic compression all seem to point to aneurism; still the size of the tumor, the absence of all pulsation, thrill, murmur and above all the slight effect of the compression of the femoral above the tumor and absence of varicose veins tend to discredit the diagnosis of aneurism and rather favor that of malignant disease.

With considerable doubt in my mind as to which was the real condition, I decided to give the patients the benefit of an operation that would first clear the diagnosis, and second permit of an attempt to remove radically either an aneurism or malignant tumor.

The apparent break in the most prominent part of the tumor and its bloody discharge indicated the necessity for prompt action. Therefore, on July 14, 1888, the patient was taken to the amphitheater, where, with the aid of Dr. Laplace and other members of the staff, the patient was anæsthetized (chloroform followed by ether) and an Esmarch bandage applied from the foot to the groin, where it was secured just below the groin. An exploratory incision was now made, following the long axis of the tumor, which at once penetrated to the center of the growth and revealed its true neoplastic character. The appearance of the section, however, was rather novel. As the knife entered the tumor a considerable amount of dark venous blood spurted out in a surprising manner.

Sponges were instantly applied, and as they were cautiously removed it was seen that the hemorrhage had stopped, and that large cavities existed in the tumor, which had evidently contained the blood that had given rise to the alarming hemorrhage.

It was evidently a cavernous growth, the large spaces being occupied by a serous, in some by a colloidal, and in most by a venous fluid. The caverns were hollowed in a stroma consisting of mixed osseous, chondroid and soft sarcomatous tissue.

In attempting to dissect the integument from the surface of the tumor it was found that the two were thoroughly adherent throughout the convex surface of the growth, and that a very large loss of skin would have to be incurred, even if the tumor allowed of enucleation in its deeper surfaces. On further exploration it became evident that the whole femoral sheath was involved and imbedded in the neoplastic mass. The tumor, however, appeared to be independent of the femur. In the presence of the complications, it was plain that conservatism was out of the question, and I decided to amputate

the thigh at its extreme upper third. Fearing that any slip in a constrictor at the thigh would prove fatal to the already exhausted subject, the ligature of the common femoral at the level of Poupart's ligament was undertaken and quickly accomplished. The elastic constrictor was now removed and the thigh amputated by a short anterior and long posterior mixed flap amputation (Lister's).

The hemorrhage was comparatively slight (not over three ounces) the vessels in the posterior flap being readily controlled with the able assistance of Dr. Laplace. The patient was kept under the influence of the anæsthetic (chloroform followed by ether) over one hour and fifteen minutes.

Notwithstanding the really small loss of blood (excepting that first loss when the loculi of the tumor were first opened) the patient was in a condition of profound shock when he was placed in bed; the pulse being then very small, shallow and rapid. Brandy and ammonium carbonate were administered and heat applied to the body and extremities. The patient recovered consciousness in the course of an hour and spoke intelligently; he vomited, or rather strained, with nausea considerably.

Six hours after the operation I visited the patient and found him perfectly rational and talkative, though profoundly prostrated, the pulse being intermittent and exceedingly shallow and rapid. Notwithstanding the persistent application of heat the patient was growing colder, and a clammy sweat bathed the surface. I now decided to try the effects of an intravenous saline injection.

Two pints of a common salt solution, made by boiling one drachm of common salt in a pint of distilled water, were slowly injected into the right median basilic. The fluid was infused warm (about 100° F.) A few seconds after the injection had commenced the patient gave utterance to expressions of increasing comfort and grateful well being. He had complained of a "fire" or "heat" which was consuming his vitals, "and a great, burning thirst." Now, as the water flowed into the vein, he felt as if a delightful cool wave was gently spreading over his body, and was giving him new strength and life and wonderfully appeasing his thirst. The

pulse in the meantime improved immensely; it became fuller, more resistant to the finger, then slower, and finally quite strong and regular, the pulsation having been reduced from 150 to 100, and less when the injection was stopped.

Next day, July 15, the patient had been very cheerful and expressed himself as having passed a comfortable night, but toward morning the prostration had reasserted itself and he had slept but little; he was not as thirsty as yesterday, but the extremities were cold and his pulse was evidently undergoing a change for the worse. It was again shallow, compressible and rapid, about 128-130, and showed a tendency to rapid deterioration. Nourishment— beef tea, brandy, milk, and digitalis, had been regularly given during the night and had been kept up since.

Evening.—The patient is evidently relapsing into the same condition as before saline injection, the beneficial effects of which are now no more perceptible; the pulse is practically imperceptible at the wrist and a cold, clammy sweat bathes the surface; he is manifestly sinking. I again inject nearly two pints of the same saline solution into the left median basilic. This time the pulse responds more slowly to the influence of the injection and it requires more fluid than the first time to fill it up. After the second pint the pulse, however, rallies and becomes hard and the patient revives.

The beneficial effects of this injection are more transitory than the first. The newly improved pulse is maintained only a quarter of an hour, the pulse becoming rapidly faster and weaker so that in the course of three or four hours it becomes imperceptible, consciousness lost and the patient expires in the morning of the 16th. The wound at no time after the operation gave reason for anxiety. After death the stump was found in excellent condition.

Remarks: In this case we must note (1) that the cause of the prostration was mainly shock and not hemorrhage, the latter being insufficient alone to account for death.

(2) That the man had been for a long time prior to the operation in a state of great nervous tension and worry, and that this added to the legitimate shock of the prolonged operation and were the true factors that led to the fatal result.

(3) The relief afforded by the saline infusion was prompt and decided, and without the two injections it is certain that life would have ended at least 36 hours before the time that it did take place.

(4) That not only was life prolonged, but great comfort given the patient by the saline infusions.

(5) That no attempt was made to regulate the quantity of liquid by a predetermined dosage, but that quantity injected was regulated by the visible or perceptible effect on the general condition and particularly by the pulse.

OBSERVATION 2.—SERVICE OF DR. A. B. MILES, HOUSE SURGEON.

Stab Wound of the Right Axillary Artery—Axillary Abscess —Profuse and Repeated Hemorrhage after Opening Abscess—Syncope—Intravenous Infusion of Saline Solution – Recovery.

"H. M., æt. 26 years, bricklayer, white, came to the hospital November 28, 1888, with large pectoral abscess and partial paralysis of left arm. Patient gave a history of having been stabbed two weeks previously; knife entering about one inch from insertion of great pectoral muscle. Abscess was opened and found to contain a large quantity of pus and blood clots. About two hours after opening of abscess patient had a hemorrhage from this wound. Compress applied and patient put to bed. Several hours later a second hemorrhage occurred, and like the first appeared to be venous in character. Compress was reapplied more firmly, and hemorrhage temporarily checked. Patient complained of intense thirst and was given to drink warm milk and tea. Three hours later a third hemorrhage occurred, much more profuse than either of the others, and unmistakably arterial. Patient was almost in a state of collapse.

"Dr. Miles was summoned and decided to ligate bleeding vessels immediately, as compresses would not check the hemorrhage. On opening the axilla the knife was found to have divided the median nerve and cut half through the axillary artery, which was gaping wide and bleeding profusely. Hemorrhage was controlled by pressure upon the subclavian and a ligature put around each end of the wounded vessel.

* * * * * * Patient's pulse was now 170 per minute and scarely perceptible at wrist. At the suggestion of Mr. Borde, R. S., one pint of saline fluid (ʒi to pint of warm water) was injected through the median basilic vein. This had an immediate and beneficial effect; pulse became full, more regular and less frequent.

"Patient was taken back to the ward. No further hemorrhage occurred. Wound had almost healed and he will soon be restored to his normal state of health.

"There is no doubt that the injection had much to do with saving the patient's life. The hemorrhage had been profuse, and there was scarcely blood enough in his body to stimulate the heart to proper action. * * * In this case, as soon as the fluid was injected a marked change was perceptible."

[Extract from hospital report by Dr. E. D. Martin, then Ambulance Surgeon, Charity Hospital, in New Orleans MEDICAL AND SURGICAL JOURNAL, February, 1889.]

OBSERVATION 3.—AMBULANCE CASE, ATTENDED BY DR. A. B. MILES.

Idiopathic Epistaxis.—Simply a note in the preceding report by Dr. Martin to the effect that infusion had been practised in the case of a little girl, aet. 12, who had lost so much blood from nasal hemorrhage, that no pulse could be detected at the wrist. Half a pint of saline fluid was injected and almost immediately the pulse was restored, the patient recovering permanently.

OBSERVATION 4.—SERVICE OF DR. R. MATAS (WARD 2).

Syme's Amputation for Tubercular Arthrites of Ankle and Tarsus—Secondary Hemorrhage—Syncope—Intravenous Injection of 12 oz. of Saline Solution—Recovery.

J. C., negro, male, æt. 42. Admitted in ward 2, July 5, 1889. Ankle and foot very much swollen; pus in the ankle, one or two sinuses leading to tarsal bones. Shortly after admission Syme's amputation was performed. The cavity of the stump is stuffed with iodoform gauze, the operation having been performed with careful antiseptic and aseptic precautions.

There were few spouting vessels after the removal of the Esmarch, but more than the usual general ooze. Hot water sponging appears to control this. The day after the operation the dressings are removed because of much soaking with blood. On removal of gauze considerable hemorrhage in region of posterior tibial which seemed to be of a venous character. The interne of the service packs the wound carefully with iodoform gauze and apparently the hemorrhage is arrested.

The dressing is removed two days after and is still found considerably soaked with blood. In removing the dressing serious hemorrhage again takes place, which still presents the same dark color; packing again resorted to and with apparent success. Owing to continued oozing Dr. M. removes the dressings and makes a careful search for a bleeding vessel, but the attempts made to control the points of greatest oozing with catch forceps fail, and owing to excessive pain complained of by the patient the attempt is abandoned and a firm tamponnade and dressing to the stump is applied, while preparations are made to administer an anæsthetic and permanently arrest the hemorrhage by ligating the bleeding points. Before the anæsthetic is administered the patient sinks in syncope, with a faint, collapsed, irregular pulse, the body being bathed in a profuse cold and clammy sweat. Stimulants, ether, auto-transfusion by bandaging the extremities, digitalis and brandy, hypodermatically, are resorted to promptly, but the patient gives no sign of rallying, and death appears imminent from collapse. Infusion is now appealed to; the left median basilic is exposed and twelve ounces of the saline solution (warmed) same as used in Case 1 are injected. The effect is magical; the pulse improves, *pari passu* with the flow of the solution in the vein, and the patient awakens rapidly, expressing himself as infinitely improved. The pulse having been brought from 150-160 to 90.

The stump was not touched; no further search made for bleeding points, as no further tendency to hemorrhage was manifested by stump from that day.

This patient finally left the hospital completely restored to health and walking on a very firm and excellent stump.—[From notes furnished by Dr. Saizan, R. S., then interne of service.]

OBSERVATION 5.—SERVICE OF DR. A. B. MILES.

Gunshot Wound of Arm and Head—Meningitic Symptoms—Profuse Epistaxis—Saline Infusion—Transitory Benefit—Death.

J. B., male, æt. 32, admitted April 15, 1889. The wound in the arm was of little consequence. The wound of the head very serious, the ball penetrating below right orbit, and ranging upward and inward, passing deeply to base of skull, probably penetrating through the basilar process of occiput. Some pieces of bone were removed through wound in face; the eye did not appear to be injured, yet the patient had been blind since the injury; he could not even see a candle held before him. There had been some epistaxis on admission. Temperature for a week following admission oscillated between 102 deg. and 104 deg. F., but was declining, when a tremendous epistaxis occurred. The posterior nares were plugged and the hemorrhage finally stopped. The next day it commenced again in spite of plugging, and as he was sinking from vascular depletion, Dr. Bloom, assistant house surgeon, infused over three pints of an extemporized saline solution into the arm. While the injection was flowing the patient appeared to rally, but Dr. Bloom discontinued the injection when he saw almost the pure and colorless salt water coming through the nose. The vascular depletion appears to have been extraordinarily complete, and it is almost incomprehensible how the patient survived long enough even to receive the intravenous injection. Notwithstanding this profound oligohæmia it is remarkable that the temporary plethora produced by the infusion kept the patient alive for several hours after the operation.

It is much to be regretted that no autopsy could be obtained in this case, and that the true cause of the tremendous and fatal epistaxis could not be positively ascertained; still the venous character of the blood and the course of the ball lead the attendants to suspect the hemorrhage to come from one of the sinuses at the cranial base

Strange to state, the amaurosis which had existed on admission disappeared some time before death, as the patient

could see plainly before the epistaxis took place, just as the fever began to decline. No autopsy was granted in this case. —[From notes kindly furnished by Dr. Cocram, then interne, and Dr. Bloom.]

OBSERVATION 6.

Avulsion of Right Arm by a Propeller After Falling from a Skiff into the River.

[Ambulance case attended by Dr. Bloom, Assistant House Surgeon.]

A white man, aged about 50 years, was upset while in a skiff in the Mississippi river and was caught by the rapidly rotating propeller of a steamer. The right arm was completely torn away in a perfectly circular manner about the middle third of the arm. The patient had lost a very large quantity of blood and was nearly drowned when rescued. When brought to the hospital he was practically pulseless from the profound shock, anæmia and asphyxia. Dr. Bloom availed himself of one of the large gaping veins in the stump, and, after securing the main arteries, injected about 20 ounces of extemporized saline solution. The pulse was temporarily restored, and while the vascular distention lasted the patient appeared to rally and improve. The tonic action of the injection was not sustained, however, as the patient again sank and died several hours after the infusion. In this case shock appeared to be the prominent factor in determining the *exitus letalis*. The temporary and decided benefit of the infusion in this case was very marked, as the patient was practically dead when brought to the hospital.

[This case is reported from a verbal communication of Dr. Bloom].

OBSERVATION 7.—SERVICE OF DR. E. LAPLACE.

Overlapping Fracture of the Femur—Refracture with Chisel through External Incision—Profuse Venous Hemorrhage—Grave Syncopal Symptoms—Saline Infusion—Recovery.

This case is reported in detail by Dr. E. Laplace, visiting surgeon, who performed the operation, in the *Medical News* for November 2, 1889. In this case the hemorrhage appeared to come directly from the chiseled bone, and the beneficial effect of the injection was truly remarkable. Sixteen ounces of the saline solution were injected.

OBSERVATION 8.—SERVICE OF PROF. E. S. LEWIS, M. D.

Ovarian Fibro-cystoma—Ovariotomy—Hemorrhage and Shock during Operation—Threatened Collapse in Spite of Energetic Stimulation—Saline Infusion—Recovery.

L. F., white, age 43, admitted in hospital Oct. 29, 1889. Abdominal tumor of three years' duration. The tumor had attained enormous proportions, interfering with respiration, digestion and defecation. Patient exceedingly weak, emaciated, with a very poor, small, pulse at time of operation. Operation performed about ten days after admission by Prof. Lewis. The cyst was multilocular and contained over (?) gallons. It was universally adherent. In consequence of these adhesions much unavoidable hemorrhage occurred and operation prolonged.

At the conclusion of operation, the pulse could not be felt at the wrist; the arteries of the neck appeared to be carrying hardly any blood. Stimulation with hypodermatic injections of ether, brandy and ammon. carb. and digitalis did some good while operation was in progress, but at its conclusion failed totally to revive the patient. Saline infusion was practised by Dr. Miles, and nearly two pints of an extemporized salt solution were injected into the median cephalic. The effect was magical; in five minutes her pulse could be felt at wrist, and in ten minutes could be counted very easily and beating about 86-90 per minute. The patient left the hospital December 15, 1889, perfectly restored to health.—[Notes kindly furnished by Dr. Wm. Armstrong, then interne.]

OBSERVATION 9.—SERVICE OF DR. MATAS (WARD 2).

Multiple Radiating and Comminuted Fracture of Cranium from Blow in Right Temporal Region—Laceration of Main Trunk of Right Arteria Meningea Media—Coma with Diffuse Cortical Symptoms—Trephining and Removal of Large Fragments of Vault—Threatened Collapse during Operation—Saline Infusion—Temporary Improvement—Death.

B. C., negro, adult, aged 29 (about); was struck in dispute with a heavy club on right side of head. The man was struck senseless by the blow and brought in an unconscious

state to the hospital, where he was seen several hours after admission by Dr. Matas.

The patient lay motionless in apparent sleep; no stertor; could not be roused by questioning or pinching him; could swallow a little water when placed in his mouth with a spoon. By pricking skin of feet or legs reflex movements were elicited, which after deeper and more vigorous stimulation with the pin gradually extended to upper extremities. These reflex movements appeared to be particularly active in the right half of the body, corresponding to injury; the left side did not respond as actively as right when thus stimulated. There appeared to be a slight paresis of the two extremities; the pupil on the same side appeared to be a little more dilated, though both were widely dilated and responded indifferently to lights; the pulse was slightly irregular, but pretty full; no spontaneous evacuation of fæces or urine had taken place since admission.

On examination of the head it was noticed that the right eye and lids were slightly ecchymotic and puffy; the right temple also fuller than the left. No external visible wound could be detected, but on percussion a decided "crack-pot" sound was elicited over the right temporal and parietal regions. No distinct depression could be felt, nothing certainly pointed to the enormous fracturation subsequently detected. After consultation with Dr. Bloom and with his assistance I proceeded to perform an exploratory operation. After due antiseptic preparation of the field of operation a curvilinear incision was made in temporal region over the line of the superior temporal ridge, extending from the external process of the frontal to a point about half an inch above the base of the mastoid. A perpendicular incision carried down vertically to the zygoma bisected the original curved line. By these incisions the temporal aponeurosis was detached almost completely above and bisected at its most resistant portion; the temporalis was also divided to the bone and readily peeled away from the temporal fossa. As soon as this was done the extensive character of the injury was immediately recognized. The squamous plate had been completely fractured, and was the starting point of several long fissures which radiated toward the vertex—one to bregma, another toward parietal foramen, extending across

the sagittal line, and another shorter, backward in the direction of the lambda. A number of large fragments, which were readily detached, represented the squamous portion of the temporal; some of these fragments were much depressed and imbricated. All the fragments were liberated; trephining had to be resorted to in two places to facilitate the elevation of a larger piece, after the removal of all the broken fragments.

A large space, representing the squamous area of the temporal, existed in the lateral region of skull and exposed a considerable mass of clot and the underlying dura mater; this was washed out and gently sponged, and it was seen that the dura was not resistant and flabby. An incision was made through it, which allowed a little sero-sanguinolent fluid to escape and revealed the temporo-sphenoidal lobe almost in a state of pulpification. The finger could be readily pushed into the brain substance almost to the lateral ventricles. The brain substance had almost a mushy consistence. After this revelation I hastened to wash gently with warm, boiled water, replace some of the fragments and sew the wound. As the man had shown a disposition to restlessness during the operation some chloroform was given to quiet him. It was not necessary to administer much. The hemorrhage was readily controlled, as the vessels were divided by the pressure of assistant's finger and by artery forceps; the hemorrhage was certainly moderate considering the excessive vascularity of this region. Still while the sutures were being introduced the assistants in charge of the pulse remarked that the pulse was becoming very irregular, more shallow and almost imperceptible.

The patient was very cold and clammy and appeared to be in collapse, and it was plain that he was about to die on the table. Heat, stimulants and digitalis were applied hypodermatically, but without any effect. Infusion was then resorted to and I injected over 20 ounces of extemporized saline solution into the median basilic vein. The result on the pulse was extraordinary; it was reduced to its normal beat and strength, and though the patient was unconscious he ceased to present his former collapsed and moribund appearance. The dressing was finished leisurely and the patient returned to his ward.

He survived till the next day, over 18 hours after the exploratory operation.

OBSERVATION 10.—MEDICAL CASE, ATTENDED BY DR. MATAS.

Acute Dysentery in an Aged Male Subject—Profound Exhaustion—Apparent Death—Saline Infusion—Restoration to Consciousness—Life Prolonged Five Hours.

Dr. S., male, white, about 60 years; much exhausted by mental worry and physical work. Came to the city for treatment, suffering with a most violent and fœtid dysentery of over one week's duration. When seen by writer, patient was pinched, shriveled and cadaverous in appearance; had small, strained, mucous actions of a most offensive character and dark color every fifteen or twenty minutes. Patient had attempted to treat himself, but very ineffectually, with enemas of morphia solution and no internal treatment. Pulse exceedingly small and rapid, over 130 per minute. Placed at once on stimulants, ether and digitalis, with small doses of saline and morphia. Enemata of Labarraque's solution and suppositories of opium, belladonna and iodoform. Temporary relief. Seen with Dr. Castellanos in consultation later, next day, and strychnia added to treatment. The evacuations appear to be improved considerably, but the pulse is growing weaker in spite of the most systematic stimulation. The mind becomes perceptibly affected; some delirium with lucid intervals. The dysentery becoming apparently better, almost all therapeutic efforts are directed toward restoring the cardiac strength. At night, find patient in stupor, cold and clammy, pulse imperceptible at wrist, evidently moribund.

In response to the distressing appeals of family to try something, the writer practises saline injection, assisted by Mr. Parker, R. S. A very large quantity of saline solution is injected while the patient is absolutely pulseless in the extremities and the respiration is barely perceptible; the patient being totally unconscious. Over two pints were injected before a decided impression could be noticed in the patient, but after this the pulse came back rapidly, filling up and becoming tense and regular as the third pint was being emptied. The pulse now

beat about ninety times per minute; the respiration was about twenty-five, and the patient revived sufficiently to ask "What is the matter?" and to survey his surroundings. Nearly three pints had been injected when this occurred and the canula was withdrawn from the median basilic vein. As was feared, the beneficial effect of the injection was only temporary. In half an hour the pulse became more rapid, the lethargic stupor began to reassert itself, and the moribund state returned. Life was prolonged, however, until 2 A. M., when death took place, five hours after the infusion had been practised.

OBSERVATION II.

Wound of the Internal Mammary Artery Complicated with Penetration into the Pleura and Pericardium with enormous Hæmo-thorax—Syncopal Symptoms Preceded by Great Dyspnœa—Saline Infusion—Temporary Benefit—Death.

A. B., male, negro, æt. 25,was brought in the ambulance. suffering with a stab wound of the chest, implicating some large vessel. Much external hemorrhage had taken place at the time the stab had been inflicted. When brought to hospital patient very pale and evidently in profound shock; breathing short, rapid; pulse intermittent, very rapid and almost imperceptible. Consciousness retained. Complains of a feeling of great oppression in chest. Messrs Armstrong and Martin, Ambulance Surgeons, immediately injected an extemporized salt solution into the median cephalic. The pulse improved as fast as the fluid flowed in veins, and almost the normal rhythm and number of beats had been reached when the injection was stopped. About two pints were injected. Though the pulse was very notably improved the respiration still remained quite rapid and short. The general effect on the patient was most remarkable, he appeared greatly relieved of his previous distress and he expressed himself as being very much better. The effects of the injection were only temporary, however; the patient succumbed about four and a half hours after.

The post mortem examination revealed an enormous hæmothroax, caused by a completely divided left internal-mammary artery. The pericardium had also been perforated,but the

heart was intact. In this case vascular depletion, anæmia and apnœa from the complete disability (from compression) of the left lung were the causes of death. Still, in spite of these eminently lethal conditions, it can not be doubted that life was prolonged at least three or four hours.—[From notes furnished by Dr. Armstrong, R. S.]

OBSERVATION 12.—SERVICE OF PROF. E. S. LEWIS, M. D.

Supra Vaginal Hysterectomy for Enormous Uterine Myoma of Nine Years' Duration—Profuse Hemorrhage from General Adhesions—Profound Shock—Collapse—Saline Infusion—Marked Temporary Improvement—Survival of Three Days After Operation.—Death from Exhaustion.

(Clinical History by Dr. Saizan, R. S., then Interne of Service.)

Mr. B., aet. 46; married; Ipara. Noticed small swelling in hypogastrium nine years before admission into hospital. Admitted February 5, 1890. Tumor grew slowly the first five years, but in the last two it enlarged in a very rapid manner. The abdomen is enormously distended, and there is great interference with the respiratory functions. On February 11, 1890, laparotomy was performed under ether. Incision extended from above umbilicus to pubis; universal adhesion with abdominal walls and viscera. Much hemorrhage and time required to separate the mass from its connections. The uterus amputated on level with *cervix;* this portion being attached as pedicle to the abdominal wound. Operation lasted one and one-half hours. During the latter part of operation, and after the tumor had been removed, the patient became pulseless at wrist, pulsations barely perceptible at carotids, and could hardly be counted, and estimated at about 160 or 170. liq. ammon. carb., brandy, digitalis, etc., were injected hypodermatically, but with little benefit. The breathing was very shallow at this time, and the heart failing most rapidly.

Saline infusion was immediately practised by Dr. Bloom, who assisted Dr. Lewis. The solution was extemporized (℥i—Oj). After the introduction of a small quantity of solution there was a marked improvement in the patient's general condition, the pulse commencing to show the beneficial effect first. When six ounces had been injected, the beats came

down to 104 per minute; and after eight more ounces had been infused, the pulse beat at the rate of 84 per minute, the respirations 23.

The pulse continued good for two or three hours after operation, though it again showed an ugly tendency to rise six hours after, when it rose to 130 per minute; the temperature 99 1-2° F.

On the third day, at 2 P. M., she expired apparently from exhaustion.

OBSERVATION 13.—SERVICE OF DR. MATAS—(WARD 2).

Laparotomy for Perforating Gunshot Injury of Abdomen—Perforation of Liver, Stomach, Duodenum and Pancreas, the Bullet Lying in the Retroperitoneal Connective Tissue over the Left Crus of Diaphragm—Secondary Shock—Infusion of Saline Solution—Death—Autopsy.

A. B., negro, male, æt. 36 or 38, brought to the hospital in the Charity wagon, Tuesday, September 23, 1890, at 10:30 A. M. The patient, a strong, healthy, muscular laborer. He stated that on the night preceding admission he had eaten a hearty supper at 7 P. M. At 11 P. M. (three hours after) he became involved in a difficulty and was shot in the abdomen, at a very short distance, with a revolver carrying a 32-caliber bullet. Shortly after the shooting he repeatedly vomited large quantities of a black coffee-ground stuff mixed with some ingesta. The vomiting was repeated often during the night and continued the next morning when admitted to the ward.

Shortly after admission he was carefully examined by the writer together with Drs. Parham, Michinard and Bloom, with the following result:

A bullet wound was found in the upper epigastrium situated at a point midway between the xyphoid cartilage and the tip of the left tenth rib. This was the only visible wound in the body. On percussion and palpation the whole epigastrium was found full, tympanitic and tender, especially in the vicinity of the wound.

The remainder of the abdominal surface appeared to be normal. The pulse was full and regular, beating at the rate of 98 to 100 per minute. Temp. 100° F. The urine clear.

Mind fully conscious and intelligent. The general condition in every way favorable.

In view of the evidence of perforation and signs of beginning peritonitis we decided that there should be no delay in opening the abdomen. The dangers of his condition were fully explained to the patient and with his consent he was anæsthetized (chloroform) and placed on the operating table.

After a thorough preliminary antiseptic preparation of the abdominal surface, a slightly curvilinear incision, four inches in length, was made, starting from a point slightly below the xyphoid cartilage, extending downward in a direction parallel with the costal arch. This immediately exposed the lower margin of the left lobe of the liver, and at once exposed a perforation situated about three-quarters of an inch from the margin and one inch to the left of the median line. The anterior surface of the stomach then rolled into view immediately, presenting a perforation about the center of the body of the organ, which allowed a probe to pass into it. The stomach was moderately distended with gas. Some blood was found diffused in the peritoneum, but no perceptible ingesta. The wounded surface having been gently drawn over, the wounded area was isolated by large abdominal sponges and the wound readily closed with a few Lembert stitches. After closing this wound it became necessary to examine the posterior surface, and for this purpose the great omentum was torn through posteriorly, with the result of exposing a bullet wound which perforated the posterior wall of the stomach, which, being larger and more irregular than the first, allowed gases and ingesta to escape freely into the lesser cavity of the peritoneum.

Further examination of the lesser cavity revealed that some extravasation of blood and ingesta had taken place, though not in large quantity. It was furthermore discovered that the bullet had again perforated the ascending layer of the transverse meso-colon and had found its way into the retro-peritoneal space at a point immediately over the abdominal aorta, which had, however, miraculously escaped injury. A ragged and ugly wound was also seen to involve the very terminus of the duodenum and the pancreas close to the superior

mesenteric artery, and allowing the escape of chymous matter into the peritoneal and retro-peritoneal tissues.

Further examination through an enlarged incision (two inches more) revealed considerable accumulation of blood in the infra-colic and left lumbar region. A careful search was made for a bleeding vessel, but as none was found and there being no evidence of active hemorrhage it was deemed advisable to close the duodenal wound. This was done with some difficulty owing to the great depth of the wounded parts, but was finally accomplished. The abdominal peritoneal toilette was then attended to with scrupulous attention, the whole cavity being repeatedly flushed with hot sterilized water. About one hour was consumed in this work and the patient's condition grew unfavorable. The pulse was tolerable, but meteorism of the stomach and intestines was developing visibly and causing considerable respiratory disturbance and annoying tension in the wounded area.

After carefully drying the abdomen, a glass drainage tube was inserted at the lower angle and the wound sutured. After the dressings had been completed the patient, who had been on the operating table over two hours, was bathed in a profuse sweat, the pulse over 120 and small.

The patient was now put to bed and warmed with artificial heat and hypodermatic injections of brandy. Seven hours after, the pulse was 98, very regular, strong and fine, and the temperature 100 F.

The patient was quite conscious but restless, and was very thirsty. Every half hour the abdominal glass drain is tested with a glass syringe, and any excess of fluid in the tube is drained away, and in this manner a considerable quantity (about 4 to 6 ounces) of bloody serum is removed from the cavity; the bloody serum also flows freely from the drain into the dressings, showing its efficiency.

September 24 (second day), at 6 A. M., Mr. Fortier, interne of the service, noticed that the pulse was becoming more rapid and compressible, and patient more restless. A teaspoonful of hot water is given every hour and a hypodermic of 10 minims of tincture of digitalis. Temperature, subnormal.

At 11 A. M. Patient is evidently moribund; stuporous state; pulse could be counted at wrist, and skin covered with a profuse sweat. I decided to infuse salt solution. With the able assistance of Dr. Bloom and other members of the house staff, over 50 ounces (about 3 pints 3 ounces) of warm salt solution (1 teaspoonful to a pint) are injected into the right basilic vein.

The immediate effect of the infusion in this case was not as favorable as anticipated. The patient was roused from the stupor into which he had fallen, but constantly complained of *thirst* and a great heat all over his body, which appeared to increase rather than diminish with the steady flow of the infused fluid. The pulse became slower but could not be reduced lower than 120 in spite of the large quantity of fluid that had been poured into the vascular system; finally the agitation and sensation of general heat increasing to even alarming extent the further injection of fluid was stopped. About ten minims each of the tr. digitalis and aromatic spirits of ammonia were injected thirty minutes before and thirty minutes after the saline infusion.

The immediate effect of the saline infusion was decidedly puzzling in this case, specially the remarkable sensation of "burning heat" complained of by the patient, and the increasing restlessness. The behavior of this patient was indeed a striking contrast to patient No. 1, who appeared to be delighted with the cool and soothing stream that diffused itself all over his body, and so kindly quenched his burning thirst.

In this case I was certainly surprised at the results, and expected that the patient would die one or two hours after the injection.

Sept. 25. Third day after operation. Much to my surprise I learned that the patient was still alive, though he had been very delirious during the night. In fact, late at night he eluded the vigilance of the night nurse and jumped out of bed, saying that he was all right and only wanted to eat and drink. He had been forced back to bed with difficulty and had been strapped down to keep him there. Of course he was now much more exhausted. The pulse is 140 and shallow, yet

the general condition of the patient, especially the mind, is apparently much better than it was yesterday either before or after the infusion of the salt water. The temperature since the operation has never risen above 100 deg. F. There has been no vomiting and no tympanites or abdominal tenderness.

In spite of all the great excitement there was no unfavorable change in this respect. The dressings were changed, but the drain allowed to remain, though partially plugged with a Micülicz's iodoform gauze drain. The condition of the wound appeared to be satisfactory.

Black coffee and Ducro's Elixir were given with tr. digitalis by enema every three hours. Notwithstanding this and other efforts at stimulation, the man succumbed at 6 P. M., about fifty-four hours after the laparotomy and about thirty hours after the infusion of saline solution.

A careful autopsy held by Dr. P. E. Archinard, deputy coroner, confirmed the condition of affairs reached at the time of the operation. The bullet was found lying loosely in the retroperitoneal connective tissue behind the transverse duodenum to the left of the vertebral column. There were evidences of slight peritonitis limited to the lower cavity and no hemorrhage.

In this case the direct cause of death was not peritonitis, not hemorraage, but circulatory failure, which came on, not as shock comes, immediately after the operation, but fully four hours after complete and satisfactory post-operative reaction had taken place.

Furthermore, this circulatory failure appears to have been benefited by saline infusion sufficiently to prolong life at least twenty-four hours, though the immediate effects of the infusions were far from comprehensible in that light.

OBSERVATION 14.—SERVICE OF DR. F. W. PARHAM.

Fracture of Olecranon—Phlegmonous Erysipelas—Disarticulation at Shoulder—Shock—Exhaustion—Saline Infusion—Death.

(Clinical History by Mr. E. D. Fenner, R. S., Interne of Service.)

I. C. S., male, æt. 24. Patient fell and fractured the olecranon of right arm, on November 6,.1890. Arm was put upon a slightly flexed anterior tin gutter splint, which had to

be reapplied on third day on account of pain and swelling with great ecchymosis. On sixth day he returned, very pale and weak, with marked fever which was found to be due to erysipelas of the broken arm and the whole right side of the trunk. He was transferred to erysipelas ward, where he remained till November 26, when he was sent down to ward 9.

At this time his condition was pitiful. He was emaciated and very weak, with a distressing cough which brought up extremely offensive sputum. Long incision in the arm gave exit to quantities of dirty, creamy pus. The elbow joint was opened and the brachial artery exposed and its outer coat sloughing for several inches. Suspension and the bi-chloride drip was tried for two days, when it became apparent that amputation at the shoulder was his last chance. Ether was given, preceded by atropine, grain $\frac{1}{80}$ and brandy ʒss, subcutaneously. The parts were then quickly cleansed and digital pressure made upon axillary vessels. A vertical incision was made down the outer side of shoulder, and from this an ellipitical cut was carried around the arm just below the joint, but not severing the axillary vessels. The bone was now rapidly disarticulated, the vessels grasped in the flap, the circular incision completed and the vessels seized with forceps.

Meanwhile the patient had become very weak. Respirations were very feeble and shallow; pulse very weak and 200 to the minute. Large injections did not improve his condition, and saline infusion was done, the stump being stuffed with gauze and covered with hot towels. After a pint of fluid had been introduced, pulse became much stronger and a great deal slower and the operation was completed, the stump being packed with gauze and a few retentive sutures put in. Patient was put to bed, and surrounded by hot cans. He died, however, in a few hours.

OBSERVATION 15.—SERVICE OF DR. SAMUEL LOGAN.

Compound Comminuted Fracture of Femur—Amputation—Shock—Hemorrhage—Prophylactic Saline Infusion—Recovery.

[Clinical report by Dr. H. J. Scherck, chief of clinic.]

John McC., æt. 31 years, white, was conveyed to the Charity

Hospital by the ambulance, on January 6, 1891, suffering from compound comminuted fracture of thigh, having been run over by wheels of baggage car. Before the arrival of the ambulance he had lost a very large amount of blood, so much indeed that upon examination in the amphitheatre he was nearly pulseless and unconscious; there was also an element of shock in his case, but the extreme condition was without doubt due to the hemorrhage that had taken place; his pulse could barely be felt, but it was about 190 per minute.

The assistant house surgeon considered that the operation of amputation, under the existing circumstances, would be useless, so it was determined to give him the benefit of intravenons injection of saline solution to see if his condition could be benefited sufficiently to operate. Between three and four pints were thrown into the circulation through the median basilic vein; the effect was immediately perceptible, indicated by his pulse, which soon fell to 90 per minute. It was then that amputation was performed, at the upper third of the thigh; he regained consciousness before the beginning of the operation and chloroform was administered. His general condition for several days afterward was only fair, occasionally unconscious, but after the fourth or fifth day he gained strength and his condition improved steadily. His temperature at the time of operation was $99\frac{2}{5}$, which reached $103\frac{2}{5}$ on the night of the same day, but this steadily came down to normal on the fifth day.

The stump did fairly well, a small portion of the under flap sloughing; other than this there was no particular trouble with it.

This case furnishes another link in the chain of good results following the intravenous injection of saline solution. This patient would, beyond a shadow of a doubt, have died from exhaustion from hemorrhage had it not been for the injection. Again, the great and prompt effect of this agent as a reactive agent or stimulant is beyond question; further than this it is without danger and should be employed in like cases.

OBSERVATION 16.—SERVICE OF DR. F. W. PARHAM.

Compound Fracture of Leg Communicating With Ankle Joint —Fracture of Ribs and Destruction of Right Eye—Secondary Hemorrhage from Seat of Fracture—Amputation of Leg—Prophylactic Injection of Saline Infusion —Death.

(Clinical history by Mr. E. D. Fenner, Interne of Service.)

Thos. Byrnes, male, 42 years, white. Patient suffered a badly comminuted compound fracture of leg, communicating with ankle joint. Several of his ribs were broken, and his right eye so badly injured as to require enucleation. Suppuration occurred, and on January 6, under chloroform, the openings were enlarged and numerous fragments of bone removed. Amputation was advised and was now urged, but was stoutly refused. On the 12th the man was told that his leg must come off or he would lose his life. He then consented to have it done next day.

During the night, secondary hemorrhage took place, and nearly drained the circulation before it was discovered, at about 7 o'clock in the morning. The man was then unconcious and almost pulseless. Digitalis was given beneath the skin, and hot bottles put around him; at 9 o'clock his pulse was somewhat better, but he was still unconscious. He was now taken to the amphitheatre and the limb was amputated just below the tibial tubercle. Prior to the operation infusion of saline solution was commenced, and continued during the operation; after about a pint had been injected in the right median basilic, the vein became occluded with a clot. The canula was removed and inserted in the other arm, into which nearly as much more fluid was allowed to flow. Digitalis and whiskey were injected, too, and under the influence of these stimulants the man regained consciousness for a while. He was taken back to the ward with a forlorn hope for life, but died in about an hour.

OBSERVATION 17.—SERVICE OF DR. E. S. LEWIS—PYOSALPINX

Laparotomy—Hemorrhage—Shock—Exhaustion—Saline Infusion—Death.

(Clinical history by Mr. A. G. Bloch, R. S., Interne of Service.)

L. S., a frail, delicate woman æt. 23 years, entered the

gynæcological ward of the Charity Hospital, February 11, 1891, complaining of severe pelvic pains. Upon examination a large fluctuating tumor was found in the left side, apparently attached to the uterus; on the right was another but freely movable. The diagnosis being unquestionable, Dr. L. suggested the removal of the diseased organs as the only means of cure. Having received the consent of the patient, on February 16 she was anæsthetized and her abdomen opened. A large pus tube was found on the left side, bound securely to the pelvic floor by strong, adhesive bands. The intestines were also bound to it by similar bands, making its removal exceedingly difficult. During the process of enucleation the tube burst, and, though every precaution had been taken, a small quantity of pus escaped into the abdominal cavity. The abdominal cavity was thoroughly irrigated, the corresponding ovary and tube were also removed for disease though not near as extensive.

The pelvic and abdominal cavities were closed, a glass drainage tube left in situ, and an antiseptic dressing placed over the wound. Patient experienced no shock from the operation; she was free from pain, though no anodyne had been given. Three hours after the operation my attention was called to the patient by the nurse, who stated that blood was running through the dressing. Upon removing same I found there was a constant flow of blood through the tube; I removed this with a syringe, cleansed the cavity with hot water, and gave ergot and digitalis hypodermically.

This I found of no benefit. Every two hours two to three drachms of blood were drawn; the patient was becoming very weak and exsanguinated. Having exhausted all means of controlling this hemorrhage except re-opening the abdomen, on February 19, with the permission of the house surgeon, I proceeded to infuse salt solution intravenously, patient's pulse being 178 and her temperature 96½. I injected 1½ pints of a salt solution into the cephalic vein; the heart immediately improved to the increased pressure, the pulse falling in fifteen minutes to 140, and changing from a thready, almost imperceptible pulse to a full, though a still compressible one. The following day patient, while being momentarily unattended, arose from her bed and ran across the

ward. Being so weak, she fell; she was put immediately to bed, but her fall was irremediable. She was badly shocked; in the fall she must have struck the drainage tube; her pulse almost disappeared, and there was a decided hemorrhage again from the wound. From that time patient grew steadily worse and died on the night of February 21. The *post mortem* showed a cavity full of pus. There was a large blood clot around the left pedicle, the intestines were infected—in fact, patient died of both hemorrhage and suppurative peritonitis.

OBSERVATION 18.—AMBULANCE CASE ATTENDED BY DR. J. D. BLOOM.

Stab Wound of Arm at Bifurcation of Brachial, Severing Vessels and Median Nerve—Profuse Hemorrhage—Saline Infusion—Recovery.

(Clinical history by Mr. J. J. Ayo, R. S., Interne of Service.)

Governor Jackson, colored, born in Catahoula parish, æt. 18, and for the last three months a student at the Leland University, New Orleans, was brought to hospital by ambulance, Tuesday, April 8, 1891, at about 3 o'clock in the evening. The following history was obtained: While engaged in a fight with one of his schoolmates, patient was stabbed just below the bend of the elbow. When ambulance arrived patient was bleeding profusely, and was very much exhausted, and pulseless at the wrist. A tourniquet was applied and brandy and digitalis were administered hypodermatically.

When patient arrived at hospital, Dr. Bloom's assistance was immediately called for. Dr. B. immediately resorted to saline infusion. The patient's pulse at the temporal was 130 to the minute. About thirty ounces of a solution of common table salt and water were infused. Each time that six ounces were transfused a remarkable difference was noticed in the pulse, it having fallen respectively from 130 to 114, 108, 100, 90, 84. The wound having been thoroughly examined, it was ascertained that all the important veins had been severed; also, that the radial and ulnar arteries had been cut at their origin;

the median nerve aud pronator radii teres being likewise divided. All the vessels injured were ligated, the muscle and median nerve sutured, while the wound was closed and dressed antiseptically.

Patient was sent to ward, put to bed, and his arm was surrounded by cans filled with hot water. Shortly he regained his strength, his pulse never rising above 120 to the minute. Three or four days after accident, patient had fever ranging between 101 deg. and 102 deg.; this led us to suppose that pus had accumulated in the wound, and the dressings were removed. None of the sutures had united, and considerable pus escaped. Patient was afterward dressed daily, and when he was discharged the wound was nearly completely healed up, but there was slight impairment of motion in the thumb, index and middle fingers.

OBSERVATION 19.—SERVICE OF DR. MATAS (WARD 2).

Gunshot Wound of Thigh, with Comminuted and Radiating Fracture of Femur—Dissecting Purulent Infiltration—Fourneaux Jordan's Disarticulation at Hip—Shock—Saline Infusion During Operation—Death from Shock Two Hours After Operation.

(From notes furnished by Mr. J. J. Ayo, Interne of Service.)

Albert C., male, æt. 36, colored, laborer; native of Indiana; strong and vigorous. While on his way to New Orleans he was shot with a pistol bearing a 38-calibre ball. The ball penetrated the middle of the thigh in antero-posterior direction, shattering the middle third of the femur. When patient was admitted in the hospital, May 11, 1891, the day following the accident, the patient was immediately attended by Dr. Bloom, assisted by members of the ambulance corps. A small opening of entrance was discovered from which considerable venous blood oozed; there was no aperture of exit, the ball being evidently imbedded in the thigh. A marked semi-solid swelling of the thigh had taken place and there was considerable lividity of the limb, indicating that considerable

concealed hemorrhage had taken place. The circulation of the foot and leg was well maintained, however, and as the pulsation of the dorsalis pedis could be faintly felt it was decided that only venous hemorrhage had taken place and that the main vessels had not been directly injured. After carefully applying an occlusive iodoform-bichloride dressing to the wound, a padded Liston's splint, permitting of extension by weights and adjusted with a liquid glass dressing, was applied by Dr. Bloom, assistant house surgeon.

The next day the swelling of the thigh increased and the oozing of the blood through the opening continued, indicating that hemorrhage had continued. The liquid glass bandage which covered the thigh became intolerably tight and had to be divided to give comfort to patient and avoid risk of strangulation. The antiseptic dressing over wound was also soaked with blood and had to be removed. A flat bag of shot being placed directly over the dressing was, by its weight, able to control excess of ooze.

The general condition of the patient was comparatively fair considering the gravity of the injury, the pulse and temperature simply indicating a subdued condition of irritability, which was remarkably disproportioned to the great devastations that were subsequently revealed.

On the 20th the wound had not healed, and for the first time discharged a purulent ooze that called for immediate action.

The patient was anæsthetized (chloroform followed by ether) and a free exploratory incision carried to the seat of fracture was made by Dr. Matas. About one quart of grumous, bloody pus at once escaped through the incision, several fragments of bone were disengaged and removed by the exploring finger, which at once discovered that the pus had burrowed upward toward the adductor region and backward to the interspace between the hamstrings. It was further discovered that the femur had sustained a longitudinal fracture which split it almost in two halves and extended in a direction upwards toward the great trochanter. In the presence of these revelations, the parts were packed with antiseptic dressings and the anæsthesia stopped.

The exploratory operation had been conducted in the ward and it was now decided to take the patient to the amphitheatre where the disarticulation of the femur at the hip could be more advantageously performed. Here the patient was stimulated with whiskey and the anæsthesia renewed. The Esmarch was applied, and aided by Wyeth's needles hemostasis secured to groin. Fourneaux Jourdan's incision was adopted, the circular division of the thigh being effected a short distance above the the seat of fracture. The vessels were secured without any loss of blood and the bone enucleated from the soft parts without difficulty. The disarticulation was very difficult, however, even after a complete separation of all the external ligamentous attachments. After the disarticulation the patient gave evidences of profound shock verging on complete collapse. About one and a half quart of saline solution was now infused by Dr. Bloom into the left median basilic vein. In the meantime, ether, ammonia, digitalis and brandy were exhibited liberally both *per os* and hypodermically. The patient's pulse improved very markedly as the saline fluid was injected and fell from 160 to 110 per minute.

When the pulse reached this point an attempt was made to introduce a few deep silver sutures in order to hold together the lips of the huge wound left by the disarticulation, but the patient commenced to scream with pain and had to be given a few inhalations of chloroform-ether. The effect of the anæsthetic on the pulse was immediate and most depressing, a few inhalations raised it to 140, and of course they had to be discontinued.

The wound was therefore packed with iodoform and sublimate gauze and the stump covered with the usual dressings.

The patient was quickly brought to bed and efforts made to restore him with dry heat and stimulants.

He became conscious shortly after returning to bed and pulse appeared to improve markedly. About half hour after the operation it beat at about 120 per minute and he gave encouraging evidence of positive improvement. Two hours afterward, however, he suddenly collapsed and died.

No.	Immediate indication.	Sex.	Age.	Race.	Immediate effect.	Final result.	Quantity of fluid.	Operators.	Nature of injury or operation.	Date.	Remarks.
1	Shock—hemorrhage.	M.	26	W.	Very good.	Death	Oj; Oij	Matas	Sarcoma of thigh. Amp. upper third.	July 12, 1888.	Injected twice at different sittings.
2	Hemorrhage.	M.	26	W.	Very good.	Recovery	Oj	Miles	Wound of axillary art. Secondary hemorrhage.	Nov. 28, 1888.	
3	Hemorrhage.	F.	12	W.	Very good.	Recovery	8 ozs.	Miles	Idiopathic epistaxis.	——, 1888.	
4	Hemorrhage.	M.	42	C.	Very good.	Recovery	12 ozs.	Matas	Syme's amp. Secondary hemorrhage.	July 5, 1889.	
5	Exhaustion—hemorrhage.	M.	32	W.	Good	Death	48 ozs.	Bloom	Gunshot wound of head; wound of cerebral sinus.	April 15, 1889	Hemorrhage uncontrollable. Effect of infusion very temporary.
6	Shock—hemorrhage.	M.	50	W.	Good	Death	20 ozs.	Bloom	Avulsion of arm	——, 1889	Shock the dominating element of danger.
7	Hemorrhage.	M.	40	W.	Very good.	Recovery	16 ozs.	Laplace	Overlapping fracture of femur; osteotomy.	——, 1889.	
8	Hemorrhage.—shock.	F.	43	W.	Very good.	Recovery	43 ozs.	Lewis	Ovariotomy—for fibro cystoma.	Oct. 29, 1889.	
9	Shock	M.	29	C.	Very good.	Death	32 ozs.	Matas	Multiple fracture of skull with laceration; of arteria meningea media.	June, 1890.	Infusion practically resurrected this patient and prolonged lif 24 hours.
10	Exhaustion (acute).	M.	60	W.	Very good.	Death	50 ozs.	Matas	Acute dysentery	July, 1890.	Life prolonged over 5 hours by infusion.
11	Hemorrhage.	M.	25	C.	Good	Death	32 ozs.	Armstrong-Martin	Stab of int. mammary artery.	1890 (?)	Lesion only discovered *post mortem*.
12	Shock—hemorrhage.	F.	46	W.	Very good.	Death	16 ozs.	Lewis	Supra-vaginal hysterectomy for myoma.	Feb. 5, 1890.	Survived 3 days after infusion.
13	Shock	M.	36	C.	Unsatisfactory.	Death	56 ozs.	Matas	Laparotomy for gunshot of abdomen.	Sept. 23, 1890.	While the pulse appeared to be favorably impressed toward the end of infusion, the patient appeared disagreeably affected.
14	Exhaustion—shock.	M.	24	W.	Good	Death	(?)	Parham	Fracture of olecranon; erysipelas, suppuration. Disarticulation of shoulder.	Nov. 28, 1890.	
15	Hemorrhage—shock.	M.	31	W.	Very good.	Recovery	O 3-4	Logan	Amputation upper third of thigh.	Jan. 6, 1891.	The amputation was performed in this case *after infusion*.
16	Exhaustion—hemorrhage.	M.	42	W.	Good	Death	Oij	Parham	Comp. fracture of leg; secondary hemorrhage. Amputation.	Jan. 12, 1891.	*Prophylactic* infusion; 1 pint in each arm.
17	Exhaustion—hemorrhage.	F.	23	W.	Good	Death	Oiss	Lewis	Pyosalpinx; laparotomy.	Feb. 16, 1891.	Infusion practiced by Mr. Bloch, Feb. 19, for hemorrhage and exhaustion.
18	Hemorrhage.	M.	18	C.	Very good.	Recovery	30 ozs.	Bloom	Stab of brachial at elbow.	April 7, 1891.	
19	Shock	M.	30	C.	Good	Death	Oiij	Matas	Disarticulation of hip for multiple, comminuted gunshot fracture of femur.	May, 1891.	Infusion allowed patient to be removed alive from operating table.

SUMMARY OF THE CLINICAL REPORT.

1. Total number of cases, 19.
2. Most urgent indication.*

Hemorrhage	
Hemorrhage-shock	2
Shock-hemorrhage	3
Shock	3
Exhaustion, acute	1
Exhaustion—hemorrhage	3
Exhaustion—shock	1
Total	19

(6) Hemorrhage: 5 recoveries; 1 death (uncontrollable hemorrhage)	= 6
(2) Hemorrhage-shock: 2 recoveries	= 2
(3) Shock-hemorrhage: 3 deaths	= 3
(3) Shock: 3 deaths	= 3
(1) Exhaustion: 1 death	= 1
(3) Exhaustion-hemorrhage: 3 deaths	= 3
(1) Exhaustion-shock: 1 death	= 1
Total	19

Recoveries, 7; deaths, 12. Percentage recoveries, $36\frac{8}{19}$; percentage deaths, $63\frac{3}{19}$. Sex, males, 15; females, 4. Age, from 12 to 60 years; average, 33.+ years. Race, 13 white, 6 colored. Quantity of fluid injected from 8 to 50 ounces. Immediate effects, always good, with one solitary exception, in which, while the objective result was good, the subjective sensations were not satisfactory.

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* In specifying the immediate indications that led to the saline infusions, the writer has adopted the method of classifying the dominant indication in mixed or complicated cases, by prefixing the most obvious cause of depression in a complicated condition.

PART II.—REMARKS.

Reprinted from the August, 1891, number of the New Orleans Medical and Surgical Journal.

In the preceding clinical report it will be noticed that in no case has a real transfusion been performed, and that in all cases in which transfusion of blood would possibly have been indicated intravenous saline infusion has been uniformly substituted and preferred. The practical and theoretical reasons for this preference while admitted by many are still the subject of contention, and deserve, if for this reason alone, some passing consideration and explanation.

It should also be remembered that the term *transfusion* should be restricted, as Roussel first indicated, to that method of intravascular medication by which the blood of one person or animal is transferred from the vascular system of one into the vascular system of the other and that the term *infusion* (*intravenous*, *intra-peritoneal* or *subcutaneous*) should be restricted to all cases in which other solutions or media than blood are introduced. The injection of blood also, if not done directly into vascular system as in the subcutaneous injection of blood (e. g., Karst's or V. Ziemessen's method), can not properly be called transfusion.

* * *

Long ago, in the earlier years of the century, the need for a liquid and neutral menstruum that would be able to dilute the thick clogging blood of choleraic patients who were manifestly dying *asphyxiated* not for a want of oxygen-carrying corpuscles but simply because these could not be floated to their destination, owing to the dehydration of the blood and tissues, suggested the use of intravenous saline infusions which were first sucessfully practised by Jœnichen, of Moscow, in 1830.*

But the later experiments of Schiff and Gaule, which

* *Vide* Menard, Art. Transfusion, Dict. Dechambre.

proved the stimulating and re-animating influence of saline solutions on the frog's heart when severed from the body, and the subsequent experiments on exsanguinated animals by Jolyet and Laffont, and the still later and confirmatory observations of Kronecker, Hayem and Fournac, led to the clinical adoption of saline infusion as a restorative method in cases of acute surgical anæmia. Bischoff, who saved a woman moribund from post-partum hemorrhage, after injecting 1250 grammes of salt solution, and the subsequent successes achieved by Kustner, Kocher, Kussmaul, Pellacani, and W. Bull, not only established the clinical utility of saline infusions, but also demonstrated that the respiratory and hæmic value of transfused blood was not as essential to the complete restoration of persons dying from the effect of acute traumatic anæmia as had been at first supposed.

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Without attempting to establish a lengthy parallel between the older practice of transfusion and the more modern method of saline infusion for the restoration of patients threatened with death from the rapid depletion of their vascular system, we may at once ask: is this saline infusion a true rival or a mere succedaneum of blood transfusion? We must answer *yes* and *no*, according to certain circumstances.

We must at once state that *mechanically* or *physically*, saline infusion are the rivals or equivalents of blood transfusion, while *physiologically* they never can rival or equal the value of blood.

In speaking of blood as a medium for transfusion we mean, of course, only pure, entire, living blood and not the altered pathological material known as defibrinated blood. We also mean blood of the same species and not that derived from heterogenous sources.

Now the superiority of entire and living blood is based on three qualities, viz: Its nutritive. 2. Its respiratory. 3. Its hemogenic value.

None of these qualities, except the last perhaps, are possessed by the inorganic saline solution. Consequently we need not discuss further the physiological superiority of blood which is here unhesitatingly admitted.

But it happens in surgical practice that in many, if not the vast majority of the cases of acute anæmia in which fatal syncope threatens life through vascular depletion, that the cry of the moment is not for physiological restitution so much as for the *mechanical* dilution of the blood remaining in the vascular system and tissues of the individual; under these circumstances, the true value of saline solutions is made clear and its position as a true rival of the more costly blood can be readily appreciated.

* * *

The question of the utility of neutral saline solutions and their ability to save the life of patients apparently moribund from loss of blood having been decided in the affirmative by superabundant clinical experience a more important problem remained to be solved and that was, what was the limit of this life-saving power. When could the action of the saline solution be expected to be permanent and when only transitory or ephemeral?

This problem was easily solved by the physiologist in his experimental laboratory but not so readily by the clinician.

The physiological limit of blood loss compatible with life has been the object of interesting and serious experimental study. From the earlier studies of Herbst (1822) to those of Renaut, Hayem, Wanner and Kermisson to the latest calculations of Rosenberg, we may admit that animals can survive the rapid loss of two-fifths of the total quantity of their blood, while the loss of more than two-fifths and less than one-half is *usually*, and more than one-half *absolutely* fatal. In his experimental use of the .7 per cent. salt solution this investigator was led to think that the injections only *temporarily* prolonged life in hemorrhages beyond one-half the total quantity of blood. This, he believed, was due to the reduction of the absolute number of corpuscles in a given bulk, resulting in a *qualitative* anæmia.

If we calculate with Bayard Holmes on Rosenberg's data, "and assume that a loss of one-half of the blood is ultimately fatal, even if infusion and resuscitation is practised, we should have a reduction in the corpuscular elements to one-half, a fatal reduction. As there are ordinarily 5,000,000 corpuscles to a cubic millimeter of blood, a loss of one-half the blood and a restoration by infusion of its bulk to the full amount would re-

duce the corpuscles to 2,500,000. This number has been found clinically to be compatible with life, and a fair degree of vitality. Patients recover with a presence for months of less than 2,000,000 corpuscles per cubic millimeter. But a reduction beyond 1,500,000 is usually rapidly fatal, and death occurs before the number falls below 1,000,000 to a cubic millimeter."

While this estimate of Holmes may be correct for an acute experimental or surgical anæmia it is possible that the number of corpuscles may even suddenly be reduced below these figures, and the condition be still compatible with life. In this connection the interesting observation of William Hunter should be remembered, as he has found that in certain hæmolytic diseases of the blood, such as chlorosis and pernicious anæmia, "the number of red corpuscles may be reduced to 500,000 or 600,000 instead of the full 5,000,000 to the cubic millimeter which characterize health, and yet the respiration of the individual will not appear to be perceptibly affected."

* * *

But while admitting that the physiologist may determine the precise limit of life compatible with blood loss, and thus equally determine the critical conditions in which life may be permanently or ephemerally maintained by simple dilution, it is otherwise with the clinician, who is almost invariably called upon to rescue a patient who is laboring under a complexity of conditions that are far from representing the simple condition of the laboratory experiment.

It must be generally conceded that there are few cases, indeed, of acute traumatic anæmia in which death is threatened from pure asphyxia due to corpuscular defficiency and the consequent *respiratory* inadequacy of the blood. Death, in the majority of the cases, we repeat, is threatened and will actually take place long before the corpuscular limit has been reached. It is *syncope*, *initial circulatory failure*, and not asphyxia from lack of corpuscular respiration, that kills in acute traumatic anæmia and it is this condition that the clinician endeavors to antagonize by the timely exhibition of the saline plethorifacient.

Hunter,* a justly eminent English authority, has very cor-

*On Transfusion; its Physiology, Pathology, Practice, three lectures delivered before the Royal College of Surgeons, by Wm. Hunter, M. D., etc. British Med. Jour., April 10, 1889.

rectly stated the case in a recent contribution: (1) "The value possessed by transfused blood in such cases is almost solely in virtue of its *physical* properties. The chief physical property of blood for purposes of transfusion is undoubtedly its volume. The immediate source of danger from sudden loss of blood is the fall of the blood pressure to a point where the circulation is unable to be maintained. The obvious indication, therefore, is to raise the pressure within the vessels. In health, the blood pressure is dependent mainly upon peripheral resistance.

"The effect of the loss of blood on the blood pressure is, up to a certain point, completely neutralized by an increase in the peripheral resistance, due to the stimulation of the vaso-motor centers. It is only after very severe hemorrhage that the relation between the vessels and the amount of fluid they contain necessary for carrying on the circulation is disturbed. The pressure then falls rapidly and suddenly, and death will ensue unless means be taken to meet the threatened failure of the circulation. The readiest way in which this can de done is to replace the lost blood with a certain bulk of fluid. To meet the danger thus arising the amount of blood is more important than its quality.

"In an emergency, the infusion of ordinary water (Coates) has been followed by results as successful as any ever obtained after transfusion of blood. Bulk for bulk, pure or defibrinated, blood must possess certain advantages over neutral saline solutions free from organic constituents. This doubtless possesses a certain physiological as well as physical value, inasmuch as blood must have a greater and more immediate effect in restoring the tone of the vaso-motor centers than saline solution.

"These advantages are more than neutralized by other and greater disadvantages, namely, (1) The difficulty of obtaining blood in sufficient quantity or with sufficient rapidity as compared with the ease with which simple saline solution can be prepared. (2) The dangers attending the transfusion of blood compared with the absolute freedom from danger possessed by the solution, and (3) the doubtful value of the transfusion, whether hæmogenic or physical, when compared with saline solution."

The physiological need of blood as a medium for the restoration of the vascular equilibrium in acute traumatic hemorrhage having been largely disproved and the physical reason for intravascular injection in such cases being better understood, we can easily appreciate the growing popularity and general substitution of salt water for blood media.

* * *

Returning now to the clinical aspect of this subject we must note that a certain amount of shock is almost inseparable from the acute anæmia that the surgeon is called upon to meet, and we may at once state that it is the proportion in which this element of shock is added to the anæmic element that, as a general rule, decides the permanency of the therapeutic benefit obtained by saline infusion. From the limited experience furnished by the nineteen cases reported in the first part of this paper, and a careful consideration of many other cases scattered in the literature of this subject, I have been struck with the importance of the role played by shock in deciding the final issue of the case. So forcibly have I been impressed with this observation that I believe we may safely formulate this proposition, viz: That the greater the shock complicating a case of surgical anæmia the less the benefit of infusion and conversely, the more uncomplicated the anæmia the greater the probabilities of final and permanent recovery with infusion. The reasons for this fatal influence of shock is readily understood when we consider that the most striking manifestation of this condition is a cardio-vascular inhibition, amounting to a true circulatory paresis or even complete paralysis in the fatal cases. Shock not only weakens the cardiac pump itself but interferes most injuriously with the contractility of the peripheral vessels, and thereby with the compensating mechanism which plays so important a part in maintaining a safe degree of vascular tension in uncomplicated hemorrhage.

Previous exhaustion preceding operative procedures from acute or chronic suppurative and septic processes are also certain to neutralize the permanent benefits of saline infusion when applied for the relief of the vascular depletion consequent upon traumatisms.

These statements are well illustrated in the cases detailed

in the preceding pages. Thus the effect of pure shock complicating hemorrhage is well shown in cases 1 (Amputation of Thigh for Sarcoma), 8 (Multiple Fracture of Skull), 6 (Avulsion of Arm), 12 (Supra-vaginal Hysterectomy for Myoma), 13 (Laparotomy for Gunshot Injury of Abdomen), 19 (Disarticulation of Hip for Comminuted Gunshot Fracture of Femur). While the exceedingly transitory benefit of infusion in *uncontrolled* hemorrhage is particularly well exhibited in cases 4 (Gunshot of Head, Wound of Cerebal Sinus), 11 (Unrecognized Stab of Internal Mammary Artery).

The effect of acute or chronic exhaustion (from suppuration or sepsis, etc.) as unsuccessfully met by infusion are also shown in cases 9 (Acute Dysentery), 14 (Disarticulation of Shoulder for Fractured and Suppurating Limb), 17 (Amputation of Leg for Fractured and Suppurating Limb).

On the other hand, the brilliant and permanently beneficial effects of saline infusion in cases of syncope from pure and less complicated hemorrhages are admirably illustrated in cases 2 (Wound of Axillary), 3 (Idiopathic Epistaxis), 4 (Secondary Hemorrhage after Syme's Amputation), 7 (Secondary Hemorrhage after Osteotomy for Overlapping Fracture of Femur), 18 (Stab of Brachial Artery).

From the further analysis of the cases here reported it is seen that the immediate or temporary effects of saline infusion were always good, no matter what was the cause of the vascular depletion. In the majority of the cases patients apparently moribund were revived, and in at least two instances practically dead patients whose hearts had ceased beating perceptibly, and who even had ceased breathing, were resurrected and made to return to life and consciousness by the timely stimulation of the circulatory centers and organs through the agency of the infusion. This impressive result was obtained in case 9 especially, though in both instances the brilliant result was only temporary, though sufficiently prolonged to have permitted the patients to recognize their surroundings and to have made a final disposition of their affairs, had they so desired it.

It can not, furthermore, be doubted from the evidence furnished by these observations that in all cases in which life is threatened by cardiac syncope, *i. e.*, in which the arteries are

empty, whether due to vascular depletion or to loss of the contractile energy of the heart, whether from hemorrhage, shock or exhaustion, that saline infusion is a most potent restorative, producing almost invariably an immediately favorable effect. The question of the permanency of this effect is, however, as already indicated, far from being so satisfactory, as is also well shown by this report. Here so many factors of a physiological and pathological character intervene in the solution of the problem that it is practically impossible, in many cases, to be able to foresee with certainty the ultimate effect of this mode of therapeutic intervention. Nevertheless, *a priori* reasoning and the results of experience have taught us what to expect from saline infusion in the majority of cases, so that the indications and final prognosis may be pretty accurately defined, as we have attempted to do, in the following conclusions which we have drawn as the result mainly, of our hospital experience.

CONCLUSIONS.

1. In all cases in which life is threatened by circulatory failure, from any cause, saline infusion may be depended upon as a *temporary* restorative.

2. Saline infusion will act as a *permanent* as well as temporary restorative in all cases of syncope due to simple and uncomplicated hemorrhage.

3. In all cases of uncontrollable hemorrhage, in which the flow of blood can not be arrested, the beneficial effect of saline infusion must necessarily be ephemeral, though even under these circumstances an artificial circulation of short duration will be maintained which may sustain life long enough to be of value.

4. Saline infusion *may* restore permanently, as well as temporarily, in cases in which syncope threatens life from mixed vascular depletion (hemorrhage) and cardio-vascular paresis (shock) though the permanency of the effect will depend largely on the degree of the shock. The greater the shock the less permanent the beneficial effect.

5. In all cases in which syncope is due only to cardio-vascular paresis or paralysis (shock) the effect of infusion is of

very doubtful value and is almost always extremely ephemeral and rarely permanent.

6. In all cases in which syncope is due to organic (nutritive) as well as dynamic alterations in the cardio-vascular apparatus (e. g., exhaustion from disease) the effect of infusion will always be ephemeral and never permanent, though even in these cases the restorative effects of infusion are worthy of remembrance.

* * *

Having stated the reasons for preferring the method of saline infusion for that of blood infusion, and its indications, let us now consider its technical application.

Much stress has been laid lately on the superiority of subcutaneous infusion over the intravenous method. My friend, Dr. Bayard Holmes, of Chicago,* has proven himself an able advocate of the subcutaneous method, and there is no doubt that by availing ourselves of the Allen surgical pump, which he recommends for the purpose, the injection of salt water into the subcutaneous tissue is indeed an easy and safe procedure. But while admitting that subcutaneous infusion is an easier and possibly safer procedure in the hands of the inexperienced, I can not admit that it is altogether superior, or even equal in any way to intravenous infusion when this is practised by a careful operator. Among the now salient advantages of the intravenous method we must recognize, (1) its immediate penetration into the circulation and certainty of absorption; (2) it is almost unrestricted in its possibilities, as far as the quantity injected; (3) it is comparatively much less painful than the subcutaneous method; (4) it requires the simplest and most readily improvised apparatus for its performance. In our hospital practice we have generally used a very simple contrivance, which was first mounted by Dr. F. W. Parham when assistant house surgeon of the institution. It consists simply of a large glass funnel to which a long drainage tubing is attached, the lower end being inserted to an elongated metallic tip which serves as a nozzle.† The flow in the tube is controlled either by the finger of an assistant or by an ordinary wooden spring clamp. The tip also may be improvised very

* *Vide New Orleans Medical and Surgical Journal* for March, 1891, p. 695-701.

† The use of a glass funnel with these accessories is probably a very old one. The instruments of Bellina, Colin, Galabin and Cripps suggest the same plan.

successfully by utilizing the fine end of a long, narrow glass nozzle, such as is found in most fountain syringes. Nothing, therefore, can be easier to prepare than this simplest of transfusion instruments.

Now as to the *modus operandi*. This is equally simple: (1) *Disinfect* thoroughly the bend of the elbow with soap, hot water, ether and sublimate. (2) Expose a subcutaneous vein, the most prominent in sight, either the median cephalic or basilic. The exposure should be effected by making a linear incision 2½ inches parallel to the vein, so that the cut can be readily placed over the vein by simply sliding the loose skin over the vein. (3) *Isolate* the exposed vein by passing a groved director under it. (4) Ligate the vein with catgut one inch below (peripheral side of) the proposed puncture. (5) *Introduce* a silk or catgut ligature under the vessel about one-half an inch above (cardiac side of) the proposed puncture and leave it without tying. (6) Open the exposed vein by making a small valvular nick in it with sharply-pointed scissors, the anterior vein-wall being pinched up for the purpose by a fine-bladed dissecting forceps. (7) *Introduce* the canula of the apparatus, after having previously allowed the saline solution to flow out of the tip, so as to secure the complete exclusion of air. (8) Tie the proximal end of the vein with the second ligature that was ready for the purpose, and include the tip of the apparatus in the ligature. (9) Now allow the liquid to flow.

In the practice of saline infusion it is also important that (1) the receptacle destined to contain the fluid be perfectly aseptic; (2) that the fluid to be injected be throroughly sterilized; (3) that the solution be clear and heated to about 100°; 100⅘° F., (Hayem); 104° F., (Esmarch); 104° F., (Lorain); 107.6° F., (Lotta); (4) that the solution of salt in water do not exceed 7 to 1000 parts; (5) the fluid should not be injected too rapidly, the velocity of the stream being regulated by the length of the conveying tube and the height of the apparatus. Esmarch estimates that three fluid drachms per second should constitute the rate of injection; (6) the quantity injected should depend upon the general effect, especially upon the circulation, guided by the pulse. The rule should be to inject for the effect; *i. e.*, the return of

the normal arterial tension without special regard to quantity, fifteen to thirty ounces being usually the quantity required in adults to produce a satisfactory impression.

In this connection, I should notice that larger quantities of salt solution are required and tolerated by the vascular system than in blood transfusion. Worm-Müller, Landois, Lesser, have been able to double, even treble the total amount of the systemic blood mass without dangerously increasing the intra-vascular pressure. In these cases the injections have been made very slowly. Oré (Jaccoud's Dict.) as a result of numerous experiments on dogs established the fact, based on the circulation that the total blood weight is equal to 1-10 the total body weight, that 1-20 of the total blood (or 1-200 of body weight) could always be *transfused* without any perceptible inconvenience.

Any way, in saline solution there are none of the dangers encountered in the injections of blood, and for this reason the amount injected should be almost entirely regulated by the effect on the pulse. When the pulse becomes nearly normal in frequency and volume, then stop.

No more striking illustration of the receptive capacity of the vascular system with reference to saline infusion could be quoted than the case recently reported by Dickinson to the London Medical Society, February 28, 1890. (British Medical Journal, March 8, 1890.)

The case was one of diabetic coma in a woman aged 25 years. Intravenous infusion with a solution consisting of sodium chloride, potassium chloride, sodium sulphate and bicarbonate dissolved in water. This was slowly injected by means of a syringe, first into the right arm, then into the left until, in the course of one hour and a half, 106 ounces had been introduced. About ten minutes after the conclusion of the operation consciousness began to return and soon became so complete that the patient was able to converse with her friends and was able to take food in a natural manner.

But she relapsed into drowsiness, and the next day was as comatose as before the operation. The injection was now repeated into one of the veins of the leg, into which the fluid was allowed to flow from a funnel. Under the operation which

required a little chloroform, the patient's condition appeared to improve, and with this encouragement the injection was continued until increasing fullness of the superficial veins and some general appearance of conjestion were taken as indications to stop; there was as yet no return to consciousness, in the hope of which, the proceeding had been continued. It was now found that no less than 350 ounces, or 17½ imperial pints, had passed in. This was a much larger quantity than had been intended, but the process was allowed to go on under the encouragement which the former attempt seemed to afford, and in the absence of prohibitive symptoms until the increasing conjestion was thus interpreted. Three-quarters of an hour after this second injection, consciousners returned and lasted without drowsiness for nine hours, after which, she became drowsy, but was for the most part sensible; thirty hours after which there was a lapse into coma, which was final and fatal. In this case, therefore, a total of 456 ounces of saline solution were infused into one patient in the course of about twenty-four hours.

This is certainly more than the estimated average total amount of blood in the adult body and bears out thoroughly the experimental evidence furnished by Müller, Landois and Lesser.

Finally, to conclude with the technique, I will state that the best results have been obtained in our practice with extemporized solutions of common salt (about one teaspoonful to one pint) and in view of this experience it is unnecessary to refer to the numerous and complicated formulæ that have been recommended by various authors, (*e. g.* Schmidt's, Lotta's, Colson's, Beaumetz's, Jenning's, Hayem's, Schwartz's, etc.), anything more than a neutral solution of common salt being in all probability superfluous.

We should also add that at the end of the operation the wound in the arm should be accurately closed and dressed antiseptically. By the careful observance of these rules none of the cases in our hospital practice have been followed by the least sign of phlebitis or local disturbance, the operation being so free from complications and operative sequelae that it may be regarded as being practically innocuous.