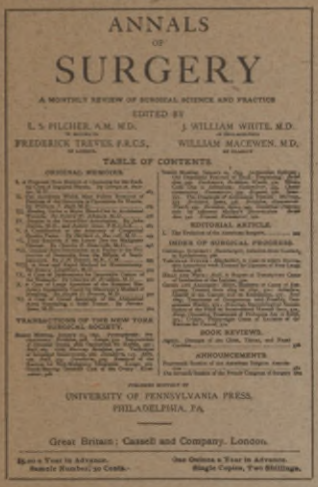
REPRINTED FROM


ANNALS
OF
SURGERY
A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE
EDITED BY
L. S. PILCHER, A.M., M.D. J. WILLIAM WHITE, M.D.
FREDERICK TREVES, F.R.C.S. WILLIAM MACEWEN, M.D.
TABLE OF CONTENTS
EDITORIAL ARTICLE.
INDEX OF SURGICAL PROGRESS.
BOOK REVIEWS.
ANNOUNCEMENTS.
UNIVERSITY OF PENNSYLVANIA PRESS,
PHILADELPHIA, PA.
Great Britain: Cassell and Company, London.

SEPTEMBER, 1897

A PRELIMINARY COMPARISON OF METHODS AND RESULTS IN OPERATIVE SURGERY AT THE SEA-LEVEL (NEW YORK) AND IN PLACES OF HIGH ALTITUDE (DENVER).

By CHARLES A. POWERS, M.D.,
OF DENVER, COLO.,
Professor of Surgery in the University of Denver.

A PRELIMINARY COMPARISON OF METHODS AND RESULTS IN OPERATIVE SURGERY AT THE SEA-LEVEL (NEW YORK) AND IN PLACES OF HIGH ALTITUDE (DENVER).[1]

By CHARLES A. POWERS, M.D.,

OF DENVER, COLO.,

PROFESSOR OF SURGERY IN THE UNIVERSITY OF DENVER.

In July, 1894, it was my fortune to go from the city of New York to Denver, Colorado, there to engage in the practice of surgery. It was found that the climatic conditions of the latter city differed materially from those obtaining in the East. Denver is one mile above sea-level. The mean barometric pressure is only 24.52 inches, so that the air pressure upon the body surface is reduced from fifteen pounds per square inch to twelve pounds. The climate is distinctly a cool one, and bracing. The air is not only thin but very dry, the mean relative humidity being but 50 per cent., and the absolute moisture 1.8 grains to the cubic foot. The sky is for the most part cloudless, there being but sixty days in the year when the sun does not shine. As a result the days have a brilliance which greatly increases the apparent warmth. The sunshine is very hot, even on days when the air itself is below freezing. This dry, clear air, with its increased diathermance, renders the winters mild and pleasant, and the great contrast between sun and shade gives relief and comfort in the summer. Radiation is rapid, and the nights are always cool.

[1] Read at the American Surgical Association, May, 1897.

The effect upon the new-comer, especially if he be an invalid, as so many of the residents are, is immediate and marked. The appetite is improved, the nutritive processes and tissue-metabolism are increased and accelerated. Respiration is deepened and for a time somewhat quickened. The nervous system especially feels the intoxication of the bright, dry, sunny air. The sense of energy and well-being is an immediate and continued pleasure.

The dry air rapidly absorbs the insensible perspiration, so that the skin is always dry and cool. This greater rapidity of evaporation and radiation is very marked, and as the climatic conditions differ so materially from those at the seacoast, it may be surmised that these differences have something of an effect on the field of operative surgery. I have therefore endeavored to make a careful estimate of the value of these factors, but this estimate is only a preliminary one, for my observation has not as yet been sufficiently extensive. While a basis for comparison rests upon eleven years of daily surgical work in the hospitals and dispensaries of New York City, experience in the new region has been limited to 248 operative cases. These were cutting operations done under general anæsthesia, and do not include such procedures as the reduction of dislocations, the putting up of simple or compound fractures under ether or chloroform, the breaking up of joint adhesions and the like, or the minor operations done under local anæsthesia. Two hundred and eleven out of the 248 cases occurred in private consultation practice. The subjoined list[1] indicates the character of the operations.

The cases have the following regional distribution: Head and neck, 54; chest and trunk, 33; abdomen, 36; genito-urinary, 34; rectum and anus, 19; extremities, 72.

There have been eleven deaths; one after exploration of the brain (error in diagnosis, pre-existing suppurative meningitis), one after excision of the upper jaw for cancer (shock and exhaustion), one after excision of the tongue for carcinoma (acute bronchitis), one after operation in two stages for enormous hæmorrhagic cyst of spleen (septicæmia, death on

twentieth day), one after nephrectomy for suppurative kidney (exhaustion), two after operation for general suppurative peritonitis due to appendicitis, two of exhaustion after cystotomy (one perineal, one suprapubic) for cancer of bladder, one from exhaustion after gastrostomy, one from shock and exhaustion after choledolithotomy, and one after operation for general suppurative peritonitis due to abscess of mesentery. In all instances the history has been carefully kept and closely studied. It is felt, therefore, that while the future with its wider observation may lead to a modification of present views, these 248 cases permit of a preliminary comparison.

This comparison is by no means easy to formulate. It must be in large part a personal estimate. Many factors enter into such a broad problem, but the greatest difficulty arises, perhaps, in weighing the general condition of the patient before the operation and at the time of its performance. This estimate can only be made in a general way, and one must rely chiefly on the impressions left upon him as he works from day to day; this to be supplemented by perusal of the histories of the cases.

It would seem that the selection of cases in Denver requires some modification of the laws which one is accustomed to follow in the East. So, in general, it seems proper to refrain from operating on people who have recently come up from tide-water, unless the operation be one of emergency or of very brief duration. The rarefied atmosphere makes necessary increased action of the heart and lungs, and I have on several occasions seen marked embarrassment of the circulation in patients undergoing short operative procedure, they having presented no cardiac evidences before operation, and being people in whom no untoward symptoms would ordinarily be expected. Especially is operation to be avoided in new-comers who show evidence of cardiac weakness. As an illustration may be cited the case of a young gentleman of seventeen years, who, while on a hunting trip in the Rockies, sustained a severe laceration of the face, with compound fracture of the superior maxilla. Wound infection quickly

set in, and was fully developed when the patient arrived within reach of surgical aid. The action of the heart was somewhat irregular and intermittent, and this irregularity was markedly increased when slight anæsthetization was made for purpose of incision and wound cleansing. As half of the upper lip and the entire cheek were torn up a fairly extensive plastic operation was necessary, and for this it seemed best that the patient should return to his home in New York. There a two and one-half hours' operation was safely carried out.

Other cases have served as well to impress on me the provisional thought that patients with marked cardiac weakness had, in the absence of contraindication, best go to the sea-level for surgical operation. But while, as said, the newcomer may well postpone his operation for a few weeks, or return to the sea-level for it, I am inclined to believe that the converse holds good, and that those thoroughly acclimated bear surgical procedure better at the high altitude than at a lower. This is especially true of the pulmonary invalid, for those whose lungs are in any way impaired feel very markedly a depression and an embarrassment of respiration when they encounter increased humidity of the atmosphere, and I can but feel that this embarrassment must be much augmented by the administration of an anæsthetic. Paul Bert, Eggers, and others (Solly), have shown that the number of red blood-cells is materially increased in climates exemplified by Colorado, and I am inclined to think that pulmonary and certain other invalids in whom operation is to be done, but in whom delay is permissible, may perhaps be placed in better condition by a sojourn in a high, dry climate.

The preparation for operation and the organization itself should be the same wherever we are; it should be the very best possible, and no detail is to be overlooked which inures to accuracy in technique or to the rapidity with which a given procedure may be brought to a close. I am much in sympathy with the views set forth by Dr. Dudley P. Allen in the admirable paper read before this association, one year ago, on the relative temperature and moisture of the atmosphere

of the operating room, and had myself formulated the conclusions at which he arrives. I feel that the best atmosphere for the operating room is that in which the patient is wont to live,[2] and that hot, moist air is even more depressing to him than to the operator and by-standers. Especially is this important to those who live in a dry climate, where radiation and evaporation take place so rapidly. Care must be taken to keep the patient well wrapped in woollen garments, to preserve the body heat, and to augment it by appropriate measures in suitable instances. These rules apply with increased force to those who have pulmonary tuberculosis.

In the choice of the anæsthetic a study of my cases would seem to show that ether is, in general, more irritating to the mucous membrane of the respiratory tract than is the case in a moist climate. I have been particularly struck by the frequency of profuse bronchorrhœa during etherization, and find that in thirty-six cases it has been found necessary to change to chloroform during anæsthetization because of this. A rational cause for this would seem, perhaps, to lie in the fact that, as the lungs are normally accustomed to the inhalation of a comparatively dry gas, the moisture of the vapor of ether is particularly irritating. However this may be, I find that I am getting to place more and more reliance on chloroform, and while the rule to employ ether unless there be present some distinct indication for chloroform has not as yet been reversed, the field for the employment of chloroform has certainly been very much broadened in my practice. Of the 248 operations ether was employed in 159 and chloroform in 89. I attribute one of the deaths to the administration of ether. The case was that of a man of sixty-nine years, who was to undergo excision of the tongue. The heart being very weak, ether was thought the safer anæsthetic, but profuse bronchorrhœa necessitated a speedy change to chloroform. A rapidly developing bronchitis proved fatal on the fourth day. This bronchitis was not due to the entrance of blood to the trachea.

The relative amount of surgical shock shown in opera-

tive work at high altitudes is something regarding which difference of opinion obtains among the Denver surgeons. On first taking up work in this city I found a general impression to the effect that shock was more severe than at the sea-level, and that especially active means had to be employed to combat this. My observations do not tend to bear this out. Indeed, a careful scrutiny of my cases thus far has tended to show that under the same conditions, with assistance equally valuable and organization equally complete, patients who possess equal health and strength bear surgical operation rather better in Colorado than in New York. To put this in another and perhaps a plainer way: if two individuals, one of whom had lived for some years in Colorado while the other had lived in New York, and who were found to be in the same general condition, should be subjected to the same severe operative procedure under precisely similar conditions, I am inclined to think that the Colorado patient (operated in Colorado) would bear the operation rather the better.[3] Resistance seems to be greater and reaction more rapid, and this again is especially true of the pulmonary invalid.

Hæmorrhage in general seems to be rather less profuse in the places of high altitude, particularly the oozing from the smallest vessels, and we may well surmise that atmospheric dryness would conduce to capillary hæmostasis. In areas which have for some time been the seat of chronic inflammation, however, the bleeding seems to be somewhat more troublesome than in the same class of people at the sea-level. I refer in this to those who have been residents of the high region for some years; but why this should be so I am unable to say, and it may be that I have encountered a series of exceptional cases, and that further experience may lead to a modification of this thought. I am inclined to think that bleeding is a little better borne by our high altitude people; it seems to me that saline infusion and similar measures are rather less frequently demanded. A reason for this may, perhaps, be found in the increased number of red blood-globules

and the markedly increased chest expansion which more than compensates for the thinness of our atmosphere.

So far as wound-healing is concerned, operations on aseptic fields doubtless yield the same results as do those done under similar precautions at the sea-level. I find that of my 248 operations, 101 were "clean" procedures, and of these ninety-seven, or 96 per cent., healed without suppuration, while in the remaining four cases the infection was but slight (in some part of the suture line), and did not retard convalescence. Cases in which infection has occurred are, I am inclined to think, rather more easy to manage than in moist climates, and, indeed, we may reasonably argue that the drier the atmosphere the less favorable must be the conditions for germ growth.[4]

There is one class of surgical cases which does better in such a climate as that of Colorado than in a lower, moist country, and that class embraces the tuberculous.

Not only am I inclined to the belief that these cases heal more rapidly and that the healing is more permanent, but I am impressed by the small proportion of pulmonary invalids who develop surgical tuberculosis. The percentage is, I feel certain, smaller than obtains under less favorable climatic conditions. Cases of genito-urinary tuberculosis, tuberculosis of the bladder, of the prostate, or of the testes make decidedly better progress than was made by similar cases which were seen in the East. Again, in cases of chest drainage for empyema the greater lung expansion must tend directly towards a more rapid obliteration of the cavity.

It must not be assumed that the differences that have been indicated between operative surgery at the sea-coast and in mountainous regions are marked, for they are not. The majority of cases pursue their course on similar lines, and differences, when present, are as a rule only slight. I have endeavored to indicate in a brief way some of the peculiarities attending surgical work in high altitudes, feeling, as I have said, that my experience is as yet insufficient to permit of more than provisional statements, and in conclusion beg to sum up as follows:

(1) Operative surgery in dry climates, having an altitude of one mile or thereabout, is to be pursued on the same general lines which govern it at the sea-level. However,

(2) Care must be exercised in subjecting those recently from a lower altitude to severe or prolonged surgical procedure, especially if the patient be a pulmonary invalid or if he exhibit cardiac weakness; and

(3) It would seem that those who are thoroughly acclimated bear operation rather better when at home than when they go to tide-water, and this again is particularly true of patients afflicted with pulmonary tuberculosis.

(4) Ether must be employed with greater caution, and is more of an irritant to the respiratory mucous membrane. Chloroform may find wider employment than at the sea-level.

(5) The loss of blood seems to be rather less in the high, dry climate, possibly excepting cases in which the operative field is the seat of chronic inflammation.

(6) Shock, also, seems to be less pronounced, patients rally rather more quickly after operation. In the tuberculous this feature seems to be marked.

(7) Aseptic wound management must be the same in all regions. Infection, when it occurs, doubtless makes less progress in a dry atmosphere than in one containing a greater degree of moisture.

(8) It is believed that accumulated statistics will show that operations for surgical tuberculosis are attended by a greater permanency of healing in the high altitudes, and that patients presenting such lesions, but whose lungs are yet free, do all possible to ward off pulmonary invasion by taking up their abode in such a climate as that of Colorado.

REFERENCES.

[1] *Head and Neck.*—For dermoid cyst of neck, 1; for tubercular glands of neck, 5; for necrosis of skull, syphilitic, 1; excision of upper jaw for carcinoma (death from exhaustion), 1; staphylorrhaphy, 1; staphylorrhaphy and uranoplasty, 1; for deep abscess of neck, 3; blepharoplasty, 1; for acute suppurative glossitis, 1; excision of tongue for carcinoma (death from bronchitis), 1; for epithelioma of lip, 5; for carcinoma of upper jaw, 1; for sarcoma of neck, 1; for calculus in submaxillary gland,

1; for septic wound of face, incision and drainage, 2; for epithelioma of nose, 1; for dermoid cyst of orbit, 1; for necrosis of lower jaw, 3; for dermoid cyst of tongue, 1; for nævus of face, 1; for tuberculosis of tongue, 1; for harelip, 2; for cystic tumor of neck, 1; for tumor of parotid, 1; extirpation of parotid for carcinoma, 1; for osteoma of lower jaw, 1; external œsophagotomy for impacted foreign body, 2; for compound depressed fracture of skull, 3; for supposed abscess of brain, which proved to be suppurative meningitis (died), 1; for old bullet wound of skull, trephining with removal of depressed bone, 1; for gunshot wound of neck, 1; for branchial cyst of neck, 1; plastic on ear, 1; plastic on face, 4.

Chest and Trunk.—Abscess of chest wall, 1; for melanosarcoma of back, 1; for keloid of chest, 1; for cystic tumor of back, 1; for sarcoma of axilla, 1; for sarcoma of anterior chest wall, 1; for empyema, 3; for bullet in chest wall, 1; for carcinoma of breast ("complete" operation), 14; for abscess of breast, 3; for adenoma of breast, 1; for recurrent carcinoma of breast, 1; for fibroma of breast, 1; for tuberculosis of breast, 1; for cyst of breast, 2.

Abdomen.—For acute appendicitis, 14; for appendicitis and general suppurative peritonitis (died), 2; for relapsing appendicitis, 2; for gallstones in cystic duct (died of shock and exhaustion), 1; for abscess of mesentery and general peritonitis (died), 1; for abscess of liver, operation in two stages, 1; exploratory laparotomy, 3; gastrostomy (died in twenty-four hours from exhaustion), 1; for ovarian cyst, 3; for strangulated inguinal hernia, 2; radical cure of inguinal hernia (Bassini), 5; for cyst of spleen, operation in two stages (died of septicæmia and exhaustion on twentieth day), 1.

Rectum and Anus.—For polypoid growth, 1; for adenoma, 1; for hæmorrhoids, 8; for tubercular ulcers, 1; for prolapsus, 1; for fistula in ano, 7.

Genito-Urinary.—Circumcision, 6; external and internal urethrotomy, 6; for carcinoma of bladder, suprapubic cystotomy (died), 1; for varicocele (Bennet's operation), 6; internal urethrotomy, 2; suprapubic cystotomy for foreign body, 1; suprapubic cystotomy for stone, 1; nephrotomy, 2; nephrectomy (died of exhaustion), 1; orchectomy for tuberculosis, 1; orchectomy for sarcoma, 1; for hydrocele (Volkmann's operation), 2; suprapubic cystotomy for tuberculosis, 1; for rupture of urethra and extravasation of urine, 1; plastic on male perineum, 1; perineal cystotomy for carcinoma (died of exhaustion), 1.

Extremities.—For foreign body in knee, 1; Thiersch's skin grafting, 7; for necrosis of tibia, 5; for abscess of thigh, 4; for lacerated wound at wrist, tenorrhaphy and neurorrhaphy, 1; for suppurative arthritis of elbow, drainage, 1; for cystic tumor of thigh, 1; for tuberculosis of tarsus, 4; for malunion of femur, 1; for suppurative arthritis of knee, drainage, 1; for ganglion at wrist, excision, 1; for deep cellulitis of leg, incision and drainage, 4; for necrosis of ulna, 1; for necrosis of femur, 1; for old sinuses of thigh, 1; for bullet in foot, 2; for tubercular osteitis of ulna, 1; for deep abscesses of thigh and leg, 1; for osteomyelitis of tibia, 4; for caries of carpus, 1; excision of elbow for

tuberculosis, 1; for fatty tumor of shoulder, 1; for malunion of bones of forearm, 2; tenorrhaphy and skin grafting, 1; incision for suppurative phlebitis, 1; for gonorrhœal arthritis of elbow, drainage, 1; for hammer-toe, 1; for hallux valgus, 2; for ununited fracture of humerus, 1; amputation of fingers, 4; amputation through forearm, 1; amputation at elbow, 1; amputation through upper third of arm, 1; amputation at shoulder, 2; amputation of toes, 5; amputation at knee, 1; amputation through middle of thigh, 1; amputation of leg, 2.

[2] I have not as yet found abdominal operations to require a special atmosphere.

[3] This is simply a personal opinion. I have carefully studied the interesting paper by Dr. H. G. Wetherill, published in the ANNALS OF SURGERY, April, 1897. The arguments set forth therein are very ingenious, but I find myself unable to agree with either the premises or the conclusions in so far as the latter assert that surgical shock is greater in the higher altitudes.

[4] Dr. E. H. Norton, formerly house surgeon to the New York Hospital and surgeon to the Fitch Accident Hospital at Buffalo, who is in charge of large coal-mines at Rock Springs, Wyo. (altitude 6000 feet), writes me that the severe accidents incident to mine surgery show far less infection than would be probable in a moist climate.