article (Deutsche Med. Wochenschr., 1894, No. 12) he states that the number of cases thus treated had doubled since his MS. had been sent to the printer.

In order to imitate as nearly as possible the conditions prevailing in the field, Langenbuch purposely omitted the disinfection of the wound and the surrounding skin, believing, as he does, that the disinfection of the wound is unnecessary, and that of the skin not altogether free from danger. He admits, however, that the hands of the operator, the needles, catgut, and needle-holders were rendered aseptic, but neither hands nor needle-holders were brought in direct contact with the parts.

The observations of Simon and Socin to the effect that gunshot wounds through the kneejoint, when the limb was in semiflexion and in which the injury to the deeper parts became covered over by the healthy skin on the limb being brought back to a straight position, recovered without suppuration, illustrate the advisability of an early hermetic occlusion of such injuries.

The small amount of effusion of blood or serum may safely be left to absorption, and that serum has antiseptic properties sufficient to take care of a few nonpathogenic bacteria has been abundantly proven by bacteriologists.

Gentlemen, these great lessons in military surgery and antisepsis, the results of patient labor and hard-earned experience, coupled with the highest qualities of judgment and accuracy of observation, can not and will not fail to influence our treatment of gunshot injuries, both in the field and the hospital.

The method of Prof. Langenbuch, when used intelligently and with due regard to the principle that the majority of the recent gunshot injuries are primarily aseptic and that the chief aim consists in the exclusion of air, is far in advance of any proposition yet made, and is, moreover, based upon a not inconsiderable amount of experience and fact not sufficiently appreciated in the past.

Military surgery is fast advancing, and light is being thrown upon where chaos was in the days past, and the sons of civilized nations will not go to war with each other merely to be slaughtered and left where they dropped.

If, in the words of the late Prof. Billroth, the youngest military surgeons of to-day will, with clean hands and consciences, accomplish more in a future battle than did in former days the most learned and experienced professor, allow me, in addition, to express my hope, if not conviction, that the "first-aid men" of the future, properly trained and instructed, as I have seen this done on several occasions by the medical officers of our Army, will save more lives than did formerly the most conscientious and careful surgeon.

THE APPLICATION OF THE MEAN VALUES DERIVED FROM A LARGE NUMBER OF MEASUREMENTS TO THE ANNUAL PHYSICAL EXAMINATION OF CADETS OF THE NAVAL ACADEMY.

By HENRY G. BEYER, *Surgeon, U. S. Navy.*

(1) Every medical officer will admit that the physical examination of candidates for a cadetship in either the Military or Naval Academy is a matter of the most profound importance not only to the corps of officers of which these candidates are intended to form a future fractional part, but also to the country at large for the service of which they are to be selected.

The duties of the medical officers engaged in this selection annually may therefore be justly regarded as being among the most weighty and responsible which medical officers can be called upon to perform.

There is, moreover, no other single duty which it is the privilege of a medical man to perform in which that officer acts more directly in the interest of the service he belongs to and the treasury of the country for which he labors than is the duty of examining candidates for cadetships, who should be selected with even greater care and with much more foresight than they are for life insurance.

In fact, the more attention and thought are devoted to this subject the more, also, will it grow in importance, and anything, no matter how slight it may be, that is calculated to aid the medical officer in the better and more conscientious discharge of this duty must, consequently, be looked upon as deserving the most serious consideration.

(2) It will no doubt have occurred to many an examiner long before this that when the object of his examination is compared with the means at his command for making it the latter appear but crude and inadequate. It may even be said that our ideal cadet so far has mainly existed in the personal conception of the medical examiner, aided of course by his experience in the service and by his knowledge of the particular exigencies of that service. But this personal conception, no matter how perfect, must change with every new board that is convened for the purpose, and the few measurements that are taken do not appear sufficient to eliminate it. Hence

what we need seems to lie in the direction of more definite standards of acknowledged value to guide us in our task. Such standards can be worked out from the records that are available at the Naval Academy.

For a number of years the records of the measurements of the cadets at the Academy have accumulated, until now their number seems sufficiently large to extract from them some valuable information. It is a source of regret that the points thus measured have been so few and that the recently introduced method of measuring cadets anthropometrically will as yet not yield numbers sufficiently great to permit of the drawing of safe means and averages from them.

For the purpose of obtaining the "mean values" from the above measurements, in order to apply them to individual cadets or candidates, we must avail ourselves of the time-honored method of Quetelet. This method has been recently so extensively studied and applied by Prof W. T. Porter, of the Harvard medical school, in his exhaustive studies "on the growth of St. Louis children," that it will be difficult to give a precise account of it without using Porter's own language in many places.

(3) Quetelet's method of studying the phenomena of human growth anthropometrically was based upon the following two fundamental propositions, namely: (1) The mean of a great number of individuals of the same class is the type or norm of the class. (2) The deviations of individuals from the type follow the law of accidental causes and are subject to the calculus of probabilities.

From these propositions it follows, that the type in any dimension, e. g., height, at any age in the period of growth, is the mean of a sufficiently large number of observations of that dimension at the given age, and that the degree with which the observed approaches the true mean can be determined by an application of the principles of least squares.

When the means of any one dimension—for example, height at each age in the period of growth—are compared, the law of growth in that dimension is at once apparent and may be expressed graphically in a curve, the abscissæ of which are years and the ordinates of which are inches. Not only is the mean of any age thus fixed, but the probability of any given deviation from the mean is fixed as well.

Thus the mean height of 598 naval cadets, aged 18, was found to be 67.28 inches with a probable deviation of 1.69 inches. This being known, it follows that of the 50 per cent of those who exceed the mean, 25 per cent should fall between 67.28 inches and 68.97 inches; 16 per cent should fall between 68.97 inches and 70.66 inches; 6.7 per cent should fall between 70.66 inches and 72.35 inches; 1.8 per cent should fall between 72.35 inches and 73.94 inches, and 3 per cent should exceed 73.94 inches, while the remaining 50 per cent should deviate from the mean in a precisely similar manner, but in the opposite direction.

But Quetelet's method admits of still another application. It is evident that in the series just given 68.97 is the height of a cadet who is taller than 75 per cent of the cadets of his age and not so tall as the remaining 25 per cent. His position is thus definitely fixed with relation to the mean. He is in fact the type or norm of the 50 per cent who exceed the mean of the whole number. The height of such an individual at any age would equal $M + d$ where M is the mean height of the age and d the probable deviation. The values of $M + d$ determined for each age in the period of growth are comparable and reveal the growth of the type of the 50 per cent who exceed the mean of the whole number at each age. The growth of the type of the 50 per cent who fall below the mean height can be similarly made out and, by continuing the process, the law of growth at any given deviation from the mean can be determined.

The data for these studies can be collected either by the so-called "generalizing" or by the "individualizing" plan. In the former a great number of measurements are made but once on individuals of different ages and the measurements classified according to age, while in the latter the same individuals are measured annually, or oftener, during their period of growth and the measurements also classified by age. It will be seen that the generalizing method is rapidly and easily carried out, whereas the individualizing method demands for its execution exceptional opportunities and exceptional patience, requiring not only that the measurements be made and the records kept through decades, but that the number of individuals measured be very great to begin with, lest death and desertion so thin their ranks that those remaining to the end shall be too few to yield reliable results.

Both methods when applied to the same material give identical results with regard to means, including those of subdivisions as well as those of the whole number of observations at any age. The individualizing method does more. (Porter.)

This method can give information without which the laws derived from means can not, in the present state of our knowledge, be applied to individuals. Before this application can be made, it will be necessary to know the degree of probability that an individual who, at a given age, stands at a deviation from the mean of any dimension, will show the same deviation at other ages; for example, the degree of probability that an individual whose height at the age of 18 is 68.97 inches and who therefore deviates 1.69 inches or $+ d$ from the mean (67.28 inches) of his age, will deviate to the same degree ($+ d$) from the mean height throughout his growth. In that case the law of growth for the type at a deviation of $+ d$ from the mean is his law of growth. Otherwise he is an exception.

This knowledge is furnished by the individualizing method while the generalizing method is of no assistance in this matter. (Porter.)

It was according to the individualizing method that we were able to collect the data with regard to the measurements of 3,415 naval cadets, which measurements form the basis of the calculations embodied in the present paper. By far the great majority of the cadets have been measured annually for four successive years and once again after their two years' cruise, or before their final examination; some of course dropped out before completing their four years' course and hence could not have been measured as many times as those remaining.

In accordance with the above method, the data were arranged according to age, the means for each age determined, as well as the deviations from the mean. The probable deviation from the median value of a series containing many measurements may be calculated by the approximation formula: — $d = \pm 0.8453 \frac{\Sigma\delta}{n}$. Where d = probable deviation, δ = deviation of individual from median value, $\Sigma\delta$ = product of individual deviations, and n the total number of observations. For purposes of illustration see Table I.

TABLE I.—*Calculation of probable deviation* (d) *from average height* (*67.28 inches*) *of 598 naval cadets aged 18.*

Heights at 1 inch interval.	Σ	δ	Σδ	Heights at 1 inch interval.	Σ	δ	Σδ
75–76	1	8.72	8.72	65–66	65	1.28	83.20
74–75	2	7.72	15.44	64–65	28	2.28	63.84
73–74	4	6.72	26.88	63–64	12	3.28	39.36
72–73	15	5.72	85.80	62–63	7	4.28	29.96
71–72	27	4.72	107.44	61–62	3	5.28	15.84
70–71	56	3.72	208.32	60–61	......	......	....
69–70	82	2.72	223.04	59–60	1	7.28	7.28
68–69	95	1.72	163.40				
67–68	96	.72	69.12		598		1,176.76
66–67	104	.28	29.12				

Probable deviation, $d = \pm 0.8453 \frac{1,176.76}{598} = 1.69$ inches.

Table No. II shows the values of the probable deviation (d) for each of the dimensions indicated and calculated for the different years given in one of the columns. In examining the values under "weight," the uniformity is very striking. As to "height standing," the probable deviation will be seen to slightly decrease from year to year until the age of 20 years has been reached. The exception occurs at the fifteenth year, at which the probable deviation is greatest, in accordance with the fact that that year marks the period in a boy's life in which his growth is most rapid, hence also the greater deviation. In a general way the same gradual decrease, with the same exception, up to age 20 may be found in the column of the values under "perineal height." There is likewise a gradual decrease in the probable deviation of the lung capacity up to 20 years of age, except that at age 14. This seems rather small, but the number of observations at that age is so small as not to be as reliable as the rest of the ages. Cadets are not allowed to enter at that age any longer, although they were formerly.

TABLE II.—*Values for probable deviation "d."*

Observations.	Age.	Weight.	Height.		Circumference of thorax.	Lung capacity.	Waist.
			Standing.	Perineal.			
	Years.	*Pounds.*	*Inches.*	*Inches.*	*Inches.*	*Cu. in.*	*Inches.*
23	14	10.31	1.87	1.34	1.20	9.72	1.41
99	15	11.74	2.53	1.51	1.47	25.35	1.37
285	16	10.56	1.85	1.29	1.47	24.51	1.32
497	17	10.14	1.76	1.25	1.46	23.03	1.23
490	18	10.98	1.69	1.22	1.39	22.48	1.51
550	19	10.14	1.57	.86	.93	20.62	1.42
480	20	10.34	1.50	.98	1.30	22.77	1.48
390	21	10.14	1.52	1.69	1.20	21.75	1.46
260	22	10.29	1.60	1.14	1.26	21.13	1.35
186	23	9.51	1.45	1.12	1.15	20.35	1.39
155	24	12.67	1.79	1.25	1.47	21.13	1.53

TABLE III.—*Values of the averages in the following dimensions.*

Observations.	Age.	Weight.	Height. Standing.	Height. Perineal.	Circumference of thorax.*	Lung capacity.	Waist.
		Pounds.	*Inches.*	*Inches.*	*Inches.*	*Cu. in.*	*Inches.*
23	14	98	62.50	31.26	29.00	174	25
90	15	106	63.50	32.50	31.44	180	25.5
285	16	117	65.66	33.20	31.60	200	26
407	17	125	67.00	34.00	32.33	215	27
490	18	132	67.28	34.60	33.30	225	27.4
550	19	139	67.90	35.90	35.00	245	28.3
480	20	139	68.70	35.00	34.00	240	28
390	21	133	68.00	34.00	34.40	241	28
260	22	139	68.50	35.00	34.30	250	28.5
186	23	139	68.05	35.00	34.50	245	28.5
155	24	138	62.20	35.00	32.50	250	28.7

* Midway between inspiration and expiration.

(1) By average (A) is meant the quotient obtained by dividing the same ($\Sigma\delta$) of the values (δ) obtained in the individual measurements by the whole number of measurements (n). $A = \frac{\Sigma\delta}{n}$.

TABLE IV.—*Values of absolute annual increase.**

Age.	Weight.	Height. Standing.	Height. Perineal.	Circumference of thorax.	Lung capacity.	Waist.
Year.	*Pounds.*	*Inches.*	*Inches.*	*Inches.*	*Cu. in.*	*Inches.*
14–15	6	1	1.24	2.44	6	0.5
15–16	11	2.16	0.70	0.14	20	0.5
16–17	8	1.44	0.80	0.73	15	1.0
17–18	7	0.28	0.60	0.97	10	0.4
18–19	7	0.62	1.30	1.70	20	0.9
19–20	0	0.80	0	0	0	0

* The absolute annual increase is the gain in weight or height, etc., during the twelve preceding months. Thus the absolute annual increase in height at age 18 is the gain in height during the twelve months from age 17 to age 18, obtained by subtracting the average or median height at age 17 from that at age 18.

TABLE V.—*Values of relative annual increase (2) in per cent.*

Age to nearest birthday.	Weight.	Height. Standing.	Height. Perineal.	Circumference of thorax.*	Lung capacity.	Waist.
	Pounds.	*Inches.*	*Inches.*	*Inches.*	*Cu. in.*	*Inches.*
14–15	6.12	1.6	4.00	8.41	3.50	2.00
15–16	10.38	3.4	2.14	0.45	11.11	2.00
16–17	6.73	2.2	2.41	2.31	7.50	3.84
17–18	5.60	0.4	1.80	3.00	4.65	1.48
18–19	5.60	0.9	3.75	5.15	8.80	3.28
19–20	....	1.2	....	....	....	....

* Midway between inspiration and expiration.

(2) The relative annual increase is the increase for any year divided by the average value at that year. Thus the relative annual increase in weight at age 15 is the difference between the average weight at age 14 and age 15 divided by the average weight at 14.

The tables IV and V show that there is a gradual decrease taking place after the period of accelerated growth, about the age of 15, in all the dimensions, followed by a corresponding increase toward the end of the period of growth at 19 or 20. This law is apparent in both the absolute as well as the relative annual growth tables.

As a general rule, the relative annual increase gives a truer idea of growth than the absolute annual increase, because the latter is entangled with the size of the individual measured. The absolute annual increase is commonly greater in a big boy than in a small boy, and yet the rate of growth may be the same. The relative annual increase is free of such errors (Porter).

(6) With the assistance of tables such as the preceding it is, comparatively speaking, a simple matter to ascertain the relative position of any individual measured to the mean of his age, and the question so often asked, is this young man above or below the mean of his age in weight, height, circumference of chest, lung capacity, may be easily answered by a reference to the values presented in Table III.

It is, however, not so simple as would appear to determine the probable degree of abnormality of any observed deviation from the mean.

For the solution of this problem Prof. W. T. Porter has proposed the following method:

According to the theory of probabilities, the heights of a thousand individuals of the same class will arrange themselves as follows:

Between.	Individuals.
M + 4d and M + nd........	3
M + 3d and M + 4d........	18
M + 2d and M + 3d........	67
M + d and M + 2d..........	162
M and M + d...............	250
M and M — d...............	250
M — d and M — 2d..........	162
M — 2d and M — 3d........	67
M — 3d and M — 4d........	18
M — 4d and M — nd........	3

Where M = the mean and d = the probable deviation.

Prof. Porter now proceeds to arrange these into seven groups:

Groups.	All between—	Individuals.
I.......	M + nd and M + 3d........	21
II......	M + 3d and M + 2d........	67
III.....	M + 2d and M + d.........	162
IV......	M and M ± d..............	500
V.......	M — d and M — 2d.........	162
VI......	M — 2d and M — 3d........	67
VII.....	M — 3d and M — nd........	21

Prof. Porter says: "The mean height, weight, girth of chest, etc., of each of these groups at any age will be the type of a certain degree of deviation from the mean of the age. That is to say, the weights, etc., of each group will be symmetrically distributed above and below the mean weight, etc., of the group in the manner illustrated for the entire undivided number of observations, e. g., the entire thousand. Each group, therefore, will be characterized by a physical development definitely determined by the means of height, weight, and other physical dimensions. These means, taken together form the type or norm of the group. The individual deviations from this norm follow the theory of probability, and the degree of abnormality presented by any individual deviation can be expressed in terms of this theory.

"For example: A boy H shows deviation in height of + 1.5d from the mean height of his age. He falls, therefore in Group III. The boys of this group possess a mean weight of M kilograms, with a probable deviation of ± d; that is, boys between d and 2d taller than the norm of their age should weigh M ± d kilograms. In like manner they should have a chest girth of M ± d inches and a lung capacity of M ± d cubic inches, and so on. If the weight and height, etc., of the boy H coincide with the means of his group, his physique is normal; if he deviate more than ± d from the mean in one or more dimensions, his development is abnormal, and the degree of abnormality is measured by the amount of his deviation.

"Height, being more stable and less liable to fluctuations than weight, is usually taken as the basis. Excessive weight may be reduced, while height once attained can not be reduced, nor can growth in height be so easily influenced.

"By this system the question whether any deviation is normal or abnormal is answered in two ways: In regard to height, by the degree of deviation from the mean or norm of the whole number of observations; in regard of other dimensions, by the degree of deviation of the weight, girth of chest, etc., from the mean weight or girth of chest corresponding to the height of the individual under examination, this normal weight, etc., being determined with sufficient exactness by taking the means and probable deviations of the group in which the height falls. All cases included within M ± d must be termed normal."

(7) The application of this method to the examination of cadets for entry into the Academy, as well as that of cadets already in the Academy, would be attended with the most beneficent as well as the most practical results. There are every year a certain number of candidates at the Academy to select from, and this selection should be made in accordance with the best principles. It is on account of this selection being possible in this country that its officers must as a whole come out physically superior not only to an equal number of men of their age in their own country, but also to any given number of officers of any other country where this selection from whatever cause is impracticable.

It would, furthermore, be a simple matter, according to this system, to determine whether a cadet at the annual physical examination, as long as he is still within the period of growth, deviates abnormally from the group into which he belongs; in other words, whether the mental strain that has been unavoidably put upon him since his entry into the Academy has interfered with his normal physical development, for it is clear that the normal amount of mental labor can not be exacted from one whose physical equilibrium is thus disturbed without endangering health and causing permanent harm to the individual. No other method does this with so much precision.

(8) While, of course, it must be freely admitted that all measurements are necessarily accompanied with unavoidable errors, and that it would have greatly added to the value of the records from which these calculations were made, had they all been taken by a single examiner, it is also true that many of the errors due to this cause are eliminated by large numbers of observations.

With respect to the work embodied in this paper, I beg leave to add the request that it be looked upon as merely a beginning or as the first attempt at utilizing the large amount of excellent material that is being accumulated at the Academy and as indicating the lines along which it can be and must be worked out for the good of the institution where every act in this direction has received so much encouragement.

ON NORMAL GROWTH UNDER SYSTEMATIZED EXERCISE IN THE GYMNASIUM.

By HENRY G. BEYER, *Surgeon, U. S. Navy.*

The tables accompanying this report represent the tabulated results of this year's work on the cadets in the gymnasium. The items that formed the object for observation are the same that were reported on last year, namely, height, weight, lung capacity and total strength, together with the several important "indices" derived and computed from them.

The number of cadets attending the gymnasium in regular classes this year was 74, and this number is again as was done last year divided between the two tables, A and B, and in accordance with the same principle.

It is eminently desirable that these annual reports should be continued and insisted upon for two very potent reasons, namely: (1) The printing of these tables would insure the better preservation of the constantly accumulating and most valuable records. (2) The compiling of them in the present form will in a few more years furnish a sufficient number for each age to enable us to calculate from them the "probable mean" with the "probable deviation" by the application to each one of these items of the principle of least squares.

Height.—The average height of the 50 cadets of last year, at the beginning of the year, was 1,721; after six months it was 1,729, consequently there was a semi-annual increase of 8 mm., or about one-third of an inch. The average height of the 74 cadets this year, at the beginning, was 1,709 mm., and at the conclusion of the exercises in the gymnasium it was found to be 1,722 mm., consequently the increase was 13 mm. in six months, or one-half inch. It will be noticed that although the average height of the 74 cadets was 12 mm. below that of the 50 cadets of last year, the increase of the former amounted to 5 mm. more than that of the latter; still even after the adding of this increase the average cadet of this year, so far as height is concerned, is 7 mm. shorter than the average cadet of the year before.