THE "PILOMOTOR" OR "GOOSE-SKIN" REFLEX.

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IN the careful examination of the skin of patients one frequently comes across a number of phenomena that are extremely difficult to understand. By accurate and minute observation of every detail, light is gradually shed upon the problems involved. They become all the clearer when these phenomena occur in definite areas which one can associate with the distribution of the nerve or blood vessels. When I first found out the occurrence of hyper-æsthesia in visceral disease, it appeared that there was a distinct connection between these areas and the distribution of the spinal nerves. These subjective symptoms sometimes bore a distinct relation in their distribution to those objectively presented in the eruption of herpes zoster. Similar data have been worked up by Dr. Head, into an elaborate delimitation of the fields of cutaneous distribution of the nerves from each spinal segment over the trunk and limbs. The deficiencies in one method of examination were frequently made good by the symptoms present in the other. While the hyper-æsthesia depends for its interpretation on the reliability of the patient, the occurrence of the eruption in herpes zoster, so far as it goes, affords striking and indubitable evidence independent of his sensations. It is very commonly found that patients are extremely inaccurate in regard to their sensations; and one has to be constantly on guard, not

only against the patient's misleading statements, but against one's own preconceived ideas. On the other hand, the eruption of herpes zoster is often unreliable on account of the imperfect manner in which one area is affected by the eruption, and also because we can never be certain when an attack of herpes is limited to one nerve root or one spinal segment,—according as we view the situation of the disease. For this reason, studying the subject of the cutaneous distribution of the spinal nerves from the purely clinical aspect, we are left in a somewhat indeterminate position. It behoves us therefore to be on the outlook for any other method that can help to strengthen our position. The results of injuries and lesions of the cord, while affording much valuable evidence, yet often fail us when we desire accurate and minute substantiation, on account of the impossibility of determining the exact limits of the effect of any lesion upon the cord. There are, however, several other phenomena which, if properly understood, can still throw light upon obscure points and substantiate doubtful results obtained in other ways.

The most striking of these is the occurrence of that condition commonly known as goose-flesh or goose-skin (*cutis anserina*). To me it is surprising that a phenomenon so common, and yet so instructive in its manifestations, should have been so universally ignored. All the text books on general medicine, skin diseases and physiology, as well as the larger encyclopædias, either contain no references whatever to this subject, or dismiss it with the briefest notice. Within recent years, two very interesting and instructive articles have been published by Langley and Sherrington,¹ based upon experimental researches, which shed much light on the relationship between the nerves, spinal and sympathetic, and the muscles of the hairs. What goose-skin is does not seem clear. In the New Sydenham Society's Lexicon *cutis anserina* is defined as "a term for that condition of the skin produced by cold and other causes in

¹ Drs. Langley, J. N., and Sherrington, C. S., "On Pilomotor Nerves," *The Journal of Physiology*, vol. xii, p. 278, 1891; also Langley, J. N., "The arrangement of the Sympathetic Nervous System based chiefly on observations upon Pilomotor Nerves," *ibid.*, vol. xv., p. 176, 1893.

which the papillæ become rigid and erect, resembling the skin of a plucked goose: goose-skin." According to the same authority goose-skin and goose-flesh are terms applied "to the condition of the skin called *horripilatio*, from its likeness to the skin of a plucked goose." In the same lexicon horripilation is defined as follows: (Latin, *horripilatio*, a bristling of the hair—from *horreo*, to stand on end, *pilus*, a hair) A sensation of creeping in the skin or as if each hair was stiff and erect in different parts of the body, producing *cutis anserina*." In Billings' "National Medical Dictionary" *cutis anserina* is "goose-skin; condition produced by contraction of pilar muscles over a large area," while horripilation is "shivering, with *cutis anserina*, with bristling of the hair."

These various definitions are too vague, and they scarcely embrace the full significance of the phenomenon. What all are agreed upon is that the symptom is due to a contraction of the pilar muscle with which each hair follicle is supplied. The symptom, however, need not, and frequently does not, produce a visible erection of the hair; but it usually does cause a projection of the glands or follicles above the skin, giving rise to the peculiar pimply condition that we associate with goose-skin. It also gives rise to that peculiar sensation which is associated with the production of goose-skin. This sensation is peculiar to itself, and to what it is entirely due I am not certain. The mere traction and shrinking of the skin does not appear to be its sole cause, because I find it present in areas where there is no evident goose-skin produced; and it even extends to areas where the hair follicles do not exist. Again, the goose-skin may be present when no such sensation exists. So far as my inquiry into the subject has extended, I find that I am far from having exhausted the information which is to be obtained from the study of this symptom. While it is capable of production in nearly all people, yet it varies individually, both as to extent of distribution and degree of excitability, and even in the same individual at different times. But its extent and limitation offer valuable and unique opportunities for the study of the distribution of the

nerve supply, in a manner which no other clinical phenomenon, with which I am acquainted, does so clearly. Thus it reveals certain definite boundaries in the distribution of the spinal nerves considered according to the distribution of each spinal segment. It also shows in suitable cases, the distribution of the nerve supply, considered according to the disposition of the peripheral nerve in a longitudinal or vertical direction, on the dorsal, lateral, and ventral surfaces of the body. It also brings out the dissemination of nervous impulses, in cases of visceral disease. Numerous as my observations have been, they are as yet far from complete; and I am unable to deal exhaustively with the information to be got from the study of this symptom. My object here is to call attention to a valuable symptom, affording a new method of investigation of a subject which has been recently discussed in these pages; I refer to the distribution of cutaneous nerves, and the sensory symptoms associated with visceral disease.

Every one, I suppose, is conscious in their own person of the production of this symptom over large areas of the skin. The sudden exposure of the warm body to the cold air, produces it most extensively. Under certain conditions, apparently consistent with perfect health, the symptom can be produced reflexly by stimulating the skin. The appearances when resulting from such reflex stimulation are either limited to the immediate neighbourhood of the part stimulated, or spread in a diffuse but still definite manner. Thus in stroking the skin firmly with a round, blunt, or broad-pointed instrument of one-quarter to half-an-inch in breadth, the goose-skin appears in the immediate tract of the part stroked and usually extends for some millimetres beyond on either side. (I am speaking now of the skin of the chest and abdomen; other parts do not usually manifest the symptom so readily.) From the area stimulated, the goose-skin may extend over a large tract of skin, but it does so in a very definite manner, the direction varying somewhat in different individuals. Usually it takes place along the areas of distribution of nerves, whose central connections are in close contiguity to those of the nerves supplying the

area stimulated, thus manifesting itself on successive fields of skin along a very definite path. When the stimulus is applied to the skin, one can observe each successive tract of skin becoming involved, although it occurs usually with such rapidity that one can scarcely determine the exact limitation at a given moment. In rare cases, the extension is so slow that one can follow it with fair certainty. In the observations I have made on the limited distribution, the methods of stimulation have been usually by stroking the skin with a blunt pencil-case, or by the finger covered with flannel or rough linen. At other times the whole trunk would be gently and equally rubbed with a towel while the goose-skin would appear only in very well-defined areas. I have said that the sudden exposure of the body to the cold atmosphere suffices to produce goose-skin, but it seems as if the slight friction produced in lifting the bed-clothes from the skin, is sufficient to set up a very wide-spread horripilation. I have tried to stimulate with cold, dry and wet—with pieces of ice direct, in an ice bag, and in test tubes—but without result.

So far as my observations go, I have found the goose-skin extend over the whole body, except the ears, hands, and wrists, feet and ankles. In one patient, the raising of the bed-clothes produced it over the whole body with the above exceptions, and also with the exception of the neck and upper part of the chest—an exception of some importance to be dealt with presently.

After the junction of the posterior and anterior roots of a spinal nerve, the nerve divides practically into three divisions which respectively supply the posterior, lateral, and anterior surfaces of the trunk. Among the limb plexuses certain modifications arise, but as my results do not yet permit me to discuss the distribution of the nerves in the limbs from a consideration of the pilomotor nerves, I shall not particularly refer to the extremities in relation to their nerve supply from this point of view. In figs. 5 and 6 of Ross's paper¹ the areas supplied by these divisions of the nerves are mapped out, and

¹ Ross, J. "On the Segmental Distribution of Sensory Disorders," *BRAIN*, 1888, p. 344.

agree fairly well with the areas marked out in fig. 1. Voigt¹ had indeed long ago demonstrated somewhat similar areas.

The reason I draw attention to this method of studying the distribution of the spinal nerves is because I have found occasionally that stimulation of a limited area of the skin will produce goose-skin, that spreads and fills exactly one or other of these areas. I have under observation two cases in which the goose-skin can occasionally be made to arise only in the area of the distribution of the anterior division, in the one case, and in the area of the distribution of the lateral division, in the other; and in neither case can it be produced in any of the other areas.

FIG. 1.

On the left side the dotted area represents the distribution of the goose-skin in the region supplied by the anterior divisions of the spinal nerves as in Case 1. On the right side the limits of the distribution of the goose-skin, back and front in the region supplied by the lateral divisions of the spinal nerve, are shown as in Case 2.

Case 1.—Male, aged 30. When the clothes are removed and he lies on his back, the temperature of the room being about 65°, stimulation by stroking the skin transversely in any part of the anterior surface of the left side of the abdomen, produces a typical goose-skin in a quick wave-like manner over the left side of the chest and abdomen. This area is limited *laterally* by a line

¹ Voigt, C. A., "Beiträge zur Dermato-neurologie; nebst der Beschreibung eines Systems neu entdeckter Linien an der Oberfläche des menschlichen Körpers," *Wien*, 1864.

drawn from the anterior part of the axilla to immediately internal to the anterior superior iliac spine, *internally* by the middle line, *superiorly* by the second rib, and *inferiorly* it fades away into the groin. Stimulation of any other part of the chest or abdomen produces no goose-skin. This area is extremely well-defined, and no difficulty is found in noting its extent. When this patient was stripped for examination in the out-patients' room, the goose-skin was much more universal. But it frequently happens that the areas most responsive to stimulation, vary from time to time.

Case 2.—Male, aged 29, complains of pain in his back, the result of a strain five years ago. When any portion of the skin of the chest or abdomen is stroked, the goose-skin spreads wave-like over the following area; it is limited *in front* by a line in the exact situation of that which bounded laterally the goose-skin in the preceding case, and *posteriorly* the limitation is equally abrupt in a line drawn through the angle of the scapula to behind the posterior crest of the ilium. *Superiorly* the goose-skin is lost in the axilla while *inferiorly* it descends over the hip, embracing the skin over the great trochanter (fig. 1).

Nothing could be more striking than the manner in which these areas were marked off. So distinct was the limitation of the goose-skin that one can but attribute it to some central cause. I incline to the view that the stimulation of the skin radiates along the paths that give rise to least resistance; and that in such cases as these, the central connections of the cutaneous nerves appear to be more easily excited longitudinally than transversely. That is to say, the excitation passes with more facility from portions of nerve roots supplying contiguous areas in the anterior or lateral aspect of the skin, as the case may be, rather than spread over the whole field of supply of one nerve. This view is strengthened by the consideration of what happens in the hyper-æsthesia in visceral diseases to which I shall presently refer. More commonly stimulation of a limited area causes the goose-skin to arise and extend by advancing over the whole half of the circumference of the trunk, although even here in its advance it sometimes shows a tendency to affect first, say, the anterior area for a limited extent, next the lateral, then the posterior, and then again a limited extent of anterior area and so on. This, however,

occurs so rapidly, that it can occasionally be detected only on its being specially looked for. The usefulness of the goose-skin reflex as a feature for observation is demonstrated in studying the manner in which it is limited, its boundaries presumably coinciding with the areas of distribution of definite nerves. Thus it very frequently happens that, in stimulation of one side of the chest or the abdomen, the goose-skin limits itself to one half of the body, ascending on the chest to a certain extent, then, instead of extending over the clavicles, passing down the arm in a remarkable and instructive manner. But not only does the goose-skin extend in this way, giving information by the limits of its distribution over a large area, but occasionally localized stimulation will produce the phenomenon in distant areas, which we know to be in anatomical relation. Thus stimulation of the upper part of the chest will produce the goose-skin over definite tracts in the arm; again, stimulation of the arm may sometimes produce it in certain definite areas on the chest, front and back. The following case first showed me the importance of the goose-skin as an object for study, and reveals features of such interest, that I quote it in full.

Case 3.—Female, aged 20, admitted into the Victoria Hospital, complains of loss of power in the legs. The patient got wet through three months ago, and her legs felt stiff the following day. Since then her power of walking has gradually become more impaired till now she cannot stand. On careful enquiry, she admits that there was weakness and a feeling of numbness in the left foot and leg, before the date on which she says she got wet. She also admits having had pain in the lower part of the spine. The patient is pale and fairly well nourished. She lies in bed with the legs bent at the knees, the right generally lying upon the left. She cannot voluntarily move the toes and ankle, but can, to a limited extent, move the leg at the knee and hip joints, but this she does stiffly. When forcibly bent, the knee offers considerable resistance, and gives rise to the clasp-knife phenomenon. The knee-jerks are exaggerated on the right side, normal on the left. Ankle clonus is readily developed in both legs. The plantar reflexes are greatly exaggerated, and the lower abdominal reflexes are absent. She has very little power over the bladder and rectum. Over both legs the sensation to

touch and pain is impaired and slightly perverted as high as the lower limit of the goose-skin in fig. 2, but there is no distinct border to be made out. The difference between heat and cold cannot be made out in the legs. The muscular sense is impaired. Over the lower third of the sacrum there is a diffuse swelling in the subcutaneous tissues, and the bone here is thickened with an indentation in the spine. The eleventh dorsal vertebra is tender to pressure. Goose-skin appears in certain areas on stimulating the skin. Thus, in testing for the sense of touch on the left side, by lightly stroking with a pin-head from the groin upwards along the abdomen, when the skin midway between the symphysis pubis and umbilicus was reached, the goose-flesh appeared over the abdomen at the part stimulated, and quickly spread in a wave-like manner up the chest, and into the left arm, over an area like that dotted in fig. 2. The lower limit extended irregularly round

FIG. 2.

The dotted area on the left side represents the distribution of the goose-skin in Case 3. The portions above the interrupted lines in front and behind are those that were produced on stimulating the inner surface of the left upper arm. On the right side the dotted area represents the goose-skin in the distribution of the cervical plexus as in Case 5.

to the second lumbar vertebra. The lower margin was abruptly limited, and before it could disappear it was marked by a dermographic pencil presenting the same peculiar limitation as in fig. 2. The upper limit presented an interesting variation. As one watched the goose-skin ascend, it reached the level of the nipple, coursed round the upper border of the axilla, and descended down the inner surface of the arm for a short extent; then it reappeared

on the chest over an area extending from the level of the nipple to the first rib, at the same time descending further down the inside of the arm, and appearing on the back and outer side of the arm, not affecting the forearm nor ascending into the shoulder. If after it had subsided, we repeated the stimulation and observed the progress in the back, we noticed that when the goose-skin reached the level of the second dorsal vertebra, from which the upper limit extended outwards in a straight line, the goose-skin appeared next on the arm, then suddenly reappeared as a band above the previous limit, as high as the seventh cervical vertebra, while it extended lower on the arm and appeared on its outer and posterior aspect.

As it was evident that the goose-skin followed the distribution of the spinal nerves, numerous observations were made of the results of localized stimulation. It was not always easy to make out what the result was, except in one instance, which was frequently verified. If the inner surface of the upper arm was stroked (at various points which it was difficult to localize accurately) there appeared areas of goose-skin on the chest and the back, in the places situated above the interrupted lines drawn in fig. 2, representing presumably the distribution of the second dorsal nerve. Sometimes on the back and front of the chest, on stimulation of the anterior surface of the arm, the goose-skin appeared on the chest in a rounded patch over the second, third, and fourth costal cartilages, next round the nipple, then higher up, from the outer side of the breast to the anterior fold of the axilla; leaving an unaffected area above the nipple of about two inches in breadth. Stimulation of the inner surface of the arm would then produce the goose-skin in this unaffected area, followed by the extension over the whole half of the chest as in fig. 2. Stimulation of the outer aspect of the arm produced no goose-skin on the chest. These phenomena could be elicited also on the right side of the chest, except that the goose-skin never appeared so high on the outer aspect of the arm as it did on the left.

I was inclined at first to consider this excitability of the pilomotor reflex as dependent on the lesion in the cord; but that this is not so is evident from the study of a number of other cases with presumably healthy centres, of which the following is a most noteworthy example:—

Case 4.—Male, aged 35. Admitted to the Victoria Hospital on August 25, 1893, with a compound comminuted fracture of

the lower third of the femur. On October 25 it was found that there was no union, and the leg was encased in plaster of Paris. The patient is a man of ruddy countenance, well-nourished, and of powerful muscular development. Except for the fracture, he is in perfect health. In him the goose-skin is extremely active on first exposure of the skin to the air. After it has subsided, stimulation of the skin on the outer surface of the abdomen readily excites it, spreading rapidly over the left side of the chest and down the inner side of the arm and ulnar border of the forearm to the wrist. It leaves unaffected the radial border of the arm, but spreads over the outer and back part of the upper arm. The limits of the eruption are shown in fig. 3. On other occasions I

FIG. 3.

Distribution of goose-skin on stimulating any portion of the chest or abdomen on the left side. Case 4.

found that stimulation of the skin of the chest as low as the epigastrium on the front and side, produced the goose-skin over a limited area on the inner side of the arm, but not on the chest. This was repeatedly verified. There were some sensory phenomena produced, to which I shall refer later.

One very striking feature in these two cases, is the limitation of the area affected by the goose-skin. In the meantime I will only deal with the upper limit on the chest which is practically the same not only in both these cases, but also in a number of others I have observed.

It is evident, I think, that we have here the demarcation of the upper limit of the distribution of the dorsal nerves in

the chest, the area above this limit being supplied by the cutaneous branches of the cervical plexus. It happens, not infrequently, that one meets with cases in which the goose-skin is manifested only in the neck and upper part of the chest. The following is a fair specimen of this class :—

Case 5.—Female, aged 31 ; examined October 13, 1893, was seized yesterday with shivering and sore throat. The tonsils are slightly swollen, and inflamed with pus exuding from numerous follicles. As there was a case of scarlet fever in the house I exposed the chest to see if there was any rash, when I was struck with a well-marked appearance of the goose-skin that arose all over the neck and upper part of the chest. It was limited above to the hair-roots and under the ear and chin, while below it descended in front as low as the level of the second costal cartilage at the sternum, whence it extended outwards in a straight line reaching the level of the third rib in the nipple line, to the shoulder. Behind, the inferior boundary extended along the level of the first dorsal vertebra (see the dotted area on the right side of fig. 2). The goose-skin was much more easily excited on the *right* side than on the left ; and the *right* tonsil was the more severely affected. After a few days the throat condition improved, but the goose-skin could still be obtained, though not so readily as before. A fortnight later the throat was still a little painful, and a faint goose-skin could still be perceived in response to stimulation. During the whole time the patient was under observation, it never tended to spread to any other region.

Before entering more minutely into the question how far the goose-skin reflex assists in determining the fields of cutaneous nerve-distribution, there are a few points which require elucidation, before we can confidently employ this phenomenon for such a purpose. At present I will do little more than indicate two of these points, namely, the question of overlapping, and the relation of the goose-skin to areas of skin exhibiting certain sensory disorders.

In regard to the question of overlapping, the study of this subject offers a very conclusive answer, so far as it concerns the pilomotor nerves. When the goose-skin is limited to one side, two conditions are present in regard to its relation to the middle line. If it be well-marked, it distinctly crosses the middle line and affects the opposite side to an

appreciable extent. This varies not only in different individuals, but in different places on the same individual. Thus in Case 3, in the epigastrium the goose-skin extended irregularly for one inch to the right of the middle line, when it was well-marked in the left half of the body. Above and below the epigastrium it extended across from one-quarter to half-an-inch. The method employed to demonstrate this with certainty, was to induce the goose skin in the left half of the body, then quickly to mark its boundary by the dermographic pencil. The right side was next stimulated, and the limits of the goose-skin thus produced mapped out in the same manner. It was found that a narrow strip of varying breadth down the centre of the body was affected, when the phenomenon appeared on either side. This overlapping could also be inferred from the further fact that, where the goose-skin on one side was but scantily present, it never quite approached the middle line; so that on stimulating one side, then the other, there was a narrow strip down the middle of the body in which the goose-skin did not appear. This was usually most evident on the back, where the goose-skin does not always manifest itself so distinctly as it does on the anterior aspect of the trunk. On account of this overlapping, the exact fields cannot be marked out on the skin of the body, where neighbouring areas of skin are supplied by neighbouring nerve roots. But when neighbouring areas of skin are supplied by nerve roots whose spinal origins are wide apart, then a very good opportunity is afforded for this method of studying the question of overlap. Thus the skin in the upper part of the chest is supplied by the branches of the cervical plexus, being conterminous with the area supplied by the second and third dorsal nerves—the intervening nerves supplying the arm. I have pointed out the striking manner in which the wave-like production of the goose-skin passes from the chest into the arm, leaving the upper part free. Now it so happens that this limit of distribution is very common and can be readily mapped out. On the other hand, it is not uncommon to find the goose-skin limited to the distribution of the cervical plexus. While, therefore, I have not been able to demonstrate these indepen-

dent areas in one individual, I have made careful observations of the exact limits in a number of people who presented either the one or the other localization. In these I found a remarkable agreement. In front the upper limit, where the chest was affected, extended usually to the level of the first costal cartilage and from thence outward to the top of the shoulder (figs. 2 and 3). On the other hand, where the area supplied by the cervical plexus was carefully marked out, it descended as low as the level of second costal cartilage and ran out transversely to the shoulder a little below the acromial process (fig. 2). Similarly behind, the upper limit of the goose-skin, when the chest was affected, ascended as high as the seventh cervical vertebra (fig. 2), while the lower limit reached as low as the first dorsal vertebra (fig. 2). These limits were not very abrupt, and at the margins the goose-skin faded away; but I have marked the limits where it could be demonstrated to exist without any doubt.

I have endeavoured to find out if there be any relationship between areas of disordered sensation and those exhibiting the pilomotor reflex. In Case 3, where the area of anæsthesia affected the legs and the lower part of the trunk, there certainly does appear to be a distinct connection, inasmuch as the reflex does not extend much beyond the limits of the healthy skin. But while the area invaded by the goose-skin is very distinctly limited here, that of the anæsthesia is not so distinct, there being a border of slight but varying breadth where it is difficult to determine whether the sensation is normal or otherwise. This border follows in its general contour the line round to the spine, indicating the lower limit of the goose-skin area. The latter never spreads into the parts where the anæsthesia is undoubted and permanent. From my investigations into the relationship of the pilomotor reflex with the hyper-æsthesia and pain of visceral disease, no definite conclusion can so far be drawn; but certain phenomena would lead one to expect that, in some cases at least, very instructive results may yet be obtained. Thus in a case of aortic disease, with well-marked attacks of angina pectoris in the left chest and arm, the hyper-æsthesia affects the front of the chest from the level of the

second rib to the epigastrium. Behind the anterior axillary line the hyper-æsthesia becomes less distinct, its lower border slanting upwards to the spinal column about the level of the third dorsal vertebra. The hyper-æsthesia also extends down the inner surface of the upper arm, ulnar border of forearm, to the little finger. The pilomotor reflex, when induced by gently rubbing the abdomen and chest of both sides, appears only on the left side. Its upper limit is situated as high as the second costal cartilage, and extends thence to the inner side of the upper arm, on which it descends as low as the elbow. But the upper limit of the goose-skin on the chest does not correspond exactly to the area mapped out by the hyper-æsthesia, inasmuch as the latter extends outwards to the axilla in an almost straight line from the second costal cartilage, while the upper limit of the goose-skin area curves down to below the third rib in the nipple line, rising again to the same height as the hyper-æsthesia in the anterior axillary fold. Below the goose-skin extends down the abdomen, fading away in the thighs in a manner too indefinite to be mapped out with certainty. No cutaneous hyper-æsthesia exists, and no goose-skin can be induced, in the area supplied by the cervical plexus.

In a case where there were a number of somewhat obscure symptoms which at first I thought were probably symptomatic of erythromelalgia, there were a number of patches of hyper-æsthesia following certain definite nerve tracts in the trunk and limbs, which it is not necessary to my purpose to give here in detail. Stimulation of the skin produced the goose-skin on the chest and abdomen, limited above as in figs. 2 and 3, and this was also the upper limit of an area of hyper-æsthesia that affected the chest. But the point to which I desire to draw attention here, is that when I stroked the skin with a blunt pencil, beginning on the side of the neck, downwards over the middle of the clavicles and down the chest to the level of the nipple, there appeared in the tract of the pencil a streak of goose-skin beginning abruptly at the line previously marked as the upper limit to which the goose-skin and hyper-æsthesia extended, that is, at the level of the second rib.

Above the second rib no signs of the goose-skin could be observed, neither on the chest nor on the neck. This experiment was repeated many times and always with the same result.

That the pilomotor nerves over a limited area may be rendered abnormally sensitive in cases of disease of an internal organ, in the same manner as the sensory nerves, appears likely from Case 5, and such observations as the following :—

Case 6.—Female, aged 59, has suffered from severe pains across the upper part of the abdomen occurring at intervals for the past twelve years. During the last three years she has suffered with increasing frequency, and for the last three months she has scarcely been without pain. She also suffers frequently from attacks of jaundice. I saw her in consultation, and as the symptoms pointed to gall-stone disease, recommended the advisability of an operation, for which purpose she was admitted into the Victoria Hospital, on October 31, 1893. Since her admission she has remained quite free from pain, and the jaundice from which she suffered is gradually disappearing. The attacks of pain are localized across the middle line of the abdomen, midway between the umbilicus and ensiform cartilage, extending well round to the right side. There is no cutaneous hyper-æsthesia; but there is an area of tenderness of indefinite extent, elicited by pinching the deeper structures of the abdominal walls (subcutaneous fat and muscles). On lightly rubbing the chest and abdomen with a piece of flannel, the goose-skin appears in a band three inches broad, extending across the abdomen above the umbilicus, to the left as far as the anterior axillary line, and to the right as far as the middle axillary. The area widens out on the right side, extending over the chest as high as the nipple, but not passing further back. A week after this observation, the patient having still been free from pain and the deep tenderness having nearly disappeared, the area of goose-skin obtained by stimulation was limited entirely to the right side, and covered an area less extensive than in the previous observation.

In another case of gall-stone disease under observation a somewhat similar relationship of exalted sensibility of the external body-wall and of the excitability of the pilomotor reflex can be demonstrated.

In several other cases, I have observed areas of goose-

skin limited to regions in which pain and hyper-æsthesia had been felt, but so far I have not yet been able to determine the exact harmony, or otherwise, of these manifestations. There is one feature about the distribution of these areas of goose-skin, that resembles the distribution of the hyper-æsthesia in visceral disease. Frequently the area does not correspond to the distribution of one or more spinal segments in their entirety, but spreads somewhat diffusely into portions of the area supplied by several spinal nerves. In my contribution on the sensory phenomena associated with visceral disease (BRAIN, Autumn Number, 1893, p. 321-374), I pointed out this characteristic both in the hyper-æsthesia of visceral disease and in that associated with herpes zoster. I am not sure whether the irritation tends to spread more along longitudinal paths, affecting the roots supplying the anterior, lateral or posterior aspects of the body (fig. 1), rather than to affect one spinal segment; but I incline to such a view. It may also be that whilst the segmentation of the cord is not so definite as to permit precise division of the cutaneous surface according to nerve supply, excitations spread from any given centre in the cord more readily along paths in a longitudinal than in a transverse direction.

A difference in the distribution of sensory and pilomotor nerves is also evident from the following observation. The chest of a woman whose breast had been excised a year before, presented a long cicatrix about the level of the third rib, extending from the sternum out into the axilla. On exposure of the skin to the air, the goose-skin spread over the chest and arm; but while it extended down to the upper margin of the cicatrix, it left quite free a band of about one-and-a-half inches below and parallel with the cicatrix. On testing the sensation of the skin below I found it quite normal. In another case, an adenoid tumour was removed from the breast. After stitching up the wound (the incision being about five inches in length and situated horizontally near the anterior axillary line), I observed the goose-skin spread over the whole chest, leaving an area about an inch broad internal to the line of incision quite unaffected; the skin was after-

wards found quite normal. The sensation caused by, or rather associated with the production of goose-skin, appears to be peculiar in its nature. Most people are acquainted with the sensation; and in Case 4 I made a curious observation. Once while testing for the goose-skin on the chest, I was looking for it near the point of stimulation. The patient called my attention to the fact of its production on the inner side of the upper arm. I asked him how he knew, and he said he felt it coming. On going further into this point, I found that, on certain areas of the chest being stimulated, he felt the sensation extend down the arm to the little finger where no goose-skin was visible. I asked him what kind of sensation it was, and he said, "It is a curious sensation as if goose-lumps were coming out." But when I called his attention to the fact that there was no such appearance on his wrist and hand, he examined the part and appeared surprised. Being somewhat doubtful of his veracity, I put him to the following test. I lightly stimulated the skin by drawing the pencil case transversely across the skin of the neck, gradually descending over the clavicle on to the chest; he said that no sensation whatever was produced; but directly I touched the skin below the first rib, he at once exclaimed that he experienced the sensation. It was also noticed that the sensation arose exactly where the line was crossed, which I had marked along the upper limit of the goose-skin on the chest. Similarly, on testing the skin from the level of the umbilicus and gradually ascending whenever I touched the skin above the nipple, the same sensation was experienced. Excitation of any area between the nipple and first rib produced the feeling. The latter always quickly spread onwards from the chest to the inner surface of the arm, and down the ulnar border of the forearm to the little finger, occasionally with the accompaniment of goose-skin on the inner surface of the arm. The patient could have no knowledge of the distribution of the spinal nerves; but his sensation indicated their course so distinctly that I have no hesitation in giving credence to his expressions. The experiments were often repeated on both sides of the body, and these results verified.

My object in writing this paper is merely to call attention to a method of studying the nerve distribution, which is free from many objections that vitiate other methods. I would have liked to have compared the results obtained by clinical investigations, with those of Langley and Sherrington; but my observations are still far too few. From what I have seen, I feel convinced that very instructive results are obtainable, particularly with reference to the nerve distribution in the limbs, and to the diffusion of irritation to nerve centres in visceral disease. I must, however, remain content with presenting these suggestions, other matters preventing me from pursuing this inquiry for the present.