The Sidney Ringer Lecture

ON

STUDIES OF CAPILLARY PULSATION,

WITH SPECIAL REFERENCE TO VASO-DILATATION IN
AORTIC REGURGITATION.*

BY

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THE EFFECTS OF HEAT ON THE HUMAN SKIN.

If the hand of a young subject is soaked in hot water for three minutes at a temperature of between 45° and 47° C. the part immersed becomes of a bright red colour, and this reddening is maintained for a few minutes to even an hour or more after withdrawing the heat. The temperature used is that which begins to produce stinging of the skin, a point which does not vary greatly from subject to subject. In the human skin this colour reaction to heat can be shown to be at least of twofold origin.

First Method.—The circulation to the arm is occluded by an armlet containing a pressure of 200 mm. Hg, and the hand then soaked in hot water at 43° C. for three minutes. The skin is then seen to be cyanosed and the soaked area to be of a darker colour than the unsoaked area, showing that the heat dilates those small vessels, such as capillaries and minute venules, which are responsible for skin colour.

Second Method.—In a similar experiment with a pressure of 70 mm. Hg in the armlet, the unheated skin is seen to be cyanotic, while the heated skin is of a bright red colour, departing little from that of heated skin in which venous pressure has not been raised. The bright colour of the heated skin in this experiment can be accounted for only if, in addition to raised venous pressure, there is a dilatation on the arterial side, chiefly arteriole, for the red skin is sharply marked off from the blue, though dilatation of main arteries in all probability also plays a small part.

The reddening of the hand exposed to heat is a local reaction and independent of the central nervous system. For if a patch of skin is rendered anaesthetic by novocain and the whole arm immersed in hot water as before for three minutes, the anaesthetic skin cannot be recognized by its colour. Thus reddening of the human skin on exposing it to moist heat at 45-47° C. is a local reaction, and due, mainly at all events, to arteriolar dilatation; the depth of skin colour is increased by simultaneous and independent dilatation of the capillaries and small venules.

Effect of Higher Temperatures.—This is tested by much hotter water in a test tube on small areas of skin previously cyanosed by venous obstruction; a bright red patch is then seen on a bluish surface, indicating arteriolar dilatation. Such heat produces pain and is followed by a spreading reaction. The distribution of this reaction suggests its reflex origin, and this is easily shown if the test is repeated on anaesthetized skin. An anaesthetic area is reddened where the hot tube has touched it; spread to distant parts of the skin does not occur.

CAPILLARY PULSATION AS A NORMAL PHENOMENON.

Amongst phenomena originally described by clinicians as physical signs of disease, and consequently regarded as essentially morbid, very many have afterwards been recognized to occur in perfectly healthy people; it would not be difficult to draw up an imposing list in illustration of this statement. It must be said that for the most part such phenomena appear in a more or less limited number of healthy people or in special physiological circumstances. Thus the "extensor response" in infants, and "respiratory arrhythmia" in children, are normal. The "tache cérébrale" is the normal reaction of young and sensitive skins to stroking, so also is whealing of the skin in response to heavier or repeated stroking. Systolic murmurs

are normal and almost usual over hearts accelerated by exercise; the "pulsus paradoxus," as originally defined, is the usual and physiological reaction of blood pressure to breathing in the resting subject. The erroneous categorization of such natural phenomena is brought about by a faulty habit of mind which is content to associate symptoms and signs with particular diseases, without attempting further to analyse causation; it is a postponed and more intimate study, a belated comparison of the disease with controls, the last in sufficient numbers and under varying physiological conditions, which brings us more correctly to interpret the manifestations in question.

It may not be precisely true to state that capillary pulsation is to-day generally regarded as a positive indication of reflux at the aortic valves; it is certainly true to state that this correlation between a phenomenon of skin or mucous membrane on the one hand, and a defective valve on the other, is the only clear impression in regard to the sign which is possessed by the majority of medical men. Yet, as may be shown, capillary pulsation as we witness it clinically is wholly unreliable as a sign of aortic regurgitation and depends more upon strictly local conditions than upon any change of general arterial blood pressures arising out of a damaged valve.

Distinct pulsation can be seen in the lip and facial skin of any normal young subject lying in a warm room. I have seen capillary pulsation so often in the face of out-patients that the list, expressed in terms of disease, has become entirely meaningless.

In the hands the pulsation is less frequent, though by no means rare. Frequently I have found it in my own fingers and in those of my friends, especially so while sitting near a fire. It is much more frequently found in children and young adults than in those more advanced in years; its obvious connexion with warmth of the hand led me to search the influence of temperature systematically. The hand is immersed in water at 45-47° C. for three minutes, dried, and at once examined. Capillary pulsation is then generally to be seen in it. Thirty-nine subjects of ages varying from 17 to 84 were examined in this way. When tabulated the results show that there is no relation between the appearance of capillary pulsation and the pulse pressure; but there is an obvious, though not wholly constant, relation to age. Those who range from 17 to 35 years display capillary pulsation most fully and with much uniformity in its degree. As age advances it becomes less evident, and many instances are found in which it is slight or absent. Capillary pulsation in the heated hand is evidently consequent upon a local change, and is inevitably attributed to dilatation of the blood vessels. The constancy of the reaction in young people, and its inconstancy in the more elderly, indicates that in the latter sufficient dilatation of the particular vessels involved to produce capillary pulsation does not occur on heating, and further suggests that those vessels are incapable of expansion. The idea is put forward that the appearance or non-appearance of capillary pulsation in the circumstances described may serve to test the condition of the vessels in question.

As to the vessels involved, the matter is easy to test in the case of the hand. Dilatation of the main arteries of the limbs plays little or no part. Thus, if the whole arm be laid in a hot bath, with the hand or the fingers projecting above the water level, capillary pulsation is not induced in the unimmersed fingers, although the volume of the radial and ulnar pulses may be noted to be increased. The area which it is necessary to heat in order to produce pulsation is very small. It is clear, therefore, that the vessels involved are amongst the smallest which supply the skin. That those capillaries and minute vessels, which together yield skin colour, do not primarily determine pulsation is shown by the absence of the last from skin which is red in response to cold, and from the skin of elderly subjects in whom capillary pulsation fails to appear on heating; for in the latter the skin may be well reddened by the heat. It is evident that the vessels determining the reaction are the arterioles of the skin.

It may be stated as a general law that when normal blood pressures prevail in the main vessels supplying an

* Being an abstract of the lecture delivered at University College Hospital Medical School on March 6th, 1924. The lecture will appear in full in the next issue of *Heart*, together with appended notes on skin temperature by Sir Thomas Lewis in collaboration with Dr. E. P. Wolf of Chicago.

area of skin, a sufficient dilatation of the smaller vessels on the arterial side will always occasion capillary pulsation in the presence of open capillaries and venules. The latter qualification is necessary, for unless the skin has some flush of colour in it, pulsation will not be seen. The contrary statement, that a flushed skin will necessarily exhibit pulsation, naturally does not hold, for a flushed skin is brought about in one of several ways.

The examples which have so far been cited are all conditions in which vaso-dilatation, local or general, is not to be denied.

Further to illustrate the relation between capillary pulsation and dilated arterioles, small inflammatory lesions of the skin may be instanced. In young healthy men, capillary pulsation may be found confined to the immediate neighbourhood of small cuts, the vesicles of herpes labialis or acne pustules. There is a relation between perceptible throbbing of such lesions and the appearance of capillary pulsation in them.

The inhalation of amyl nitrite will produce capillary pulsation, sometimes vivid, in the lip and facial skin. Distinct pulsation can be seen in areas of bright erythema developing spontaneously on the cheek or neck of young women; in the artificially produced wheals in patients who display "urticaria factitia"; in the skin of febrile patients and in the flushed skin of Graves's disease.

CAPILLARY PULSATION IN AORTIC REGURGITATION.

Areas in which Capillary Pulsation Appears.

The capillary pulsation of aortic disease may appear in any part of the skin of the body under suitable conditions. Thus it can be induced almost anywhere by friction or the application of heat. In free aortic regurgitation distinct pulsation is usually visible in the forehead and cheeks without touching the skin. In some cases it is so vivid that it may be visible at a considerable distance from the patient. More usually the pulsation is detected only after closer inspection. Such spontaneous capillary pulsation is more frequent in patients who are standing than in those who are lying in bed; it is rarely seen in skin other than the facial. The finger tips and palms of the hand show a similar pulsation from time to time, especially when they are held aloft, and I have seen a few instances in which the spontaneous flush was visible over the whole hand, back and front. It is customary to search for capillary pulsation with the aid of a glass slide, the skin or mucous membrane of the lip being pressed until it pales a little. This procedure often discovers pulsation in a surface which otherwise maintains continuously a full colour. When a glass slide is used, capillary pulsation is often found in the hand, though by no means so frequently as in the face. In the hand the pads of the fingers and thumb show it most frequently, and after these the thenar and hypothenar eminences, the skin above the nail bed, and the remaining palmar surfaces of hand and finger in approximately this order. Beneath the nail itself it is not so common or so vivid as in other parts—hardly more common, in fact, than upon the dorsum of the hand. Clinicians use the nail as a rule; they do so because the nail substitutes the glass slide; it is not a very favourable place in which to display pulsation.

Broadly speaking, capillary pulsation occurs only in those parts of the unstimulated skin which are ordinarily exposed to the atmosphere and are particularly vascular—namely, in the skin of the face and hands. The main exception to this rule is the foot. Here pulsation, though far less frequent than in the hand, and still less frequent than in the face, is not very uncommon.

Relation between Capillary Pulsation and Pulse Pressure.

That an increased pulse pressure is not essential to the production of capillary pulsation is shown by the following observations.

Capillary pulsation in a case of arterio-venous aneurysm with high pulse pressure persists when the pulse pressure is restored to normal limits on cutting the A-V anastomosis out of the circulation by compressing the artery running to it (Lewis and Drury).

If a group of aortic cases is examined in the ordinary way it quickly becomes evident that a relation between the magnitude of the pulse pressure in the brachial artery and the degree of capillary pulsation in the hand cannot be demonstrated satisfactorily.

In cases of aortic regurgitation with high pulse pressures capillary pulsation persists in the hand, although the pulse pressure is restored to normal limits by means of a compressing armlet over the brachial artery.

In a case of aortic disease with signs of obstruction in the innominate artery, the pulse in the arteries of the left arm was water-hammer in character, the blood pressure being 149 (systolic) and 35 (diastolic). The pulse in the right arm was small and anacrotic in type, and the blood pressure 104 (systolic) and 48 (diastolic). Thus the pulse pressure was 114 in the left arm and 56 in the right arm. A firm stroke on the skin of each forearm was followed by a red line in which capillary pulsation was to be seen.

When, however, the remaining conditions are suitable to induce capillary pulsation, then this pulsation varies in its degree with the pressure amplitude of the pulse wave. For it is found that when the heated hands of normal men and aortic cases are compared, capillary pulsation is in the rule more intense in the aortic series. It is also the rule that the pulsation becomes more intense and widespread as the pulse pressure increases. Discrepancies occur in older patients and it is evident that in such there is a variant similar to that found in elderly but normal subjects—namely, an arteriolar factor. If we assume that only two factors come into play in producing capillary pulsation—namely, pulse pressure on the one hand and the state of the arterioles on the other—and if we further assume that the arterioles are brought to a sufficiently constant state of dilatation by heating the skin in all healthy young subjects, and in almost all young aortic cases, while it fails to do so in a goodly percentage of older subjects, then we seem to possess an adequate explanation of capillary pulsation as this is displayed by the heated skin.

Skin Temperature and the Arteriolar Factor.

The presence or absence of capillary pulsation in a particular area of skin is closely related to the temperature of that skin. I have noted no exception to the rule that, other conditions being equal, capillary pulsation in free aortic regurgitation is best displayed by areas of skin which feel warm or hot. Spontaneous capillary pulsation does not occur in the skin of the face unless the area showing it feels warm or hot; the warmest part of the face will show it to best advantage, and this is usually the cheek or forehead. The lobes of the ears are often cool or cold; in such, little or no pulsation can be elicited until they are warmed. I could cite a score of cases, examined clinically, in which these broad rules hold true. More precise observations on the relation between skin temperature and capillary pulsation in aortic regurgitation have been made by means of a thermo-electric couple. They amply confirm the clinical observations. It is clear from these observations that unless the presence or absence of capillary pulsation is correlated with the temperature of the part it can have little or no value as a sign. External temperature influences the appearance of capillary pulsation by widening or narrowing the arterioles of the skin. This relation to external temperature is easy to display in cases of free aortic regurgitation. Soak the hand of a young subject for three minutes in baths of water at suitable temperatures and almost any grade of capillary pulsation can be produced. It suffices to warm or cool surfaces of quite small extent locally to modify the degree of pulsation. In aortic cases, as in normal subjects, capillary pulsation is particularly conspicuous where the skin is reddened by small lesions such as cuts on the chin or in acne papules. The temperature of these little inflamed areas is higher than that of the surrounding skin. Temperature affects capillary pulsation in aortic disease as it does in normal subjects. The comparison in its detail serves to demonstrate that a factor governing the degree of capillary pulsation, as we see it in aortic disease, is the condition of the arterioles. The relation between the skin temperature and the condition of the arterioles is open to

two interpretations. On the one hand, a change of external temperature, by changing that of the skin, will alter the size of the skin arterioles; on the other hand, a warm or cold skin may be due primarily to the state and distribution of the arterioles. It may be concluded that in any given case of aortic regurgitation, those areas which present capillary pulsation are areas in which the arterioles are dilated as compared to those of areas which show none. The question now arises, Are there areas of active arteriolar dilatation in aortic disease? It has been already shown that in very distinct pulsation of the fingers, the pulsation may be independent of pulse pressure, and is then due presumably to abnormal widening of the arterioles. Further evidence may now be examined.

Skin Colour and Temperature in Aortic Disease.

Other things being equal, the colour and temperature of the skin are controlled by the state of the arterioles, widening of which flushes the skin if the capillary and venule tone is normal or low. In a case of free aortic regurgitation a skin of normal colour and warmth indicates that the flow of blood through it is normal in amount; but if the mean arterial pressure were below normal in the same case, there would be strong presumptive evidence that the arterioles were dilated. It is not easy to assess the mean pressure in aortic cases. It is probable that when the diastolic pressure is lowered by an amount equal to the rise of the systolic pressure, the mean pressure is reduced. In a case of aortic disease we should expect the colour and temperature of the skin to be higher than normal only when mean blood pressure was normal or above normal. A skin warmer and more flushed than normal would certainly indicate widened arterioles in the presence of a low mean arterial pressure.

Now the traditional description of skin colour in aortic disease is summed up in the word "pallor." This description was written before subacute or chronic infective endocarditis—a disease commonly associated with free aortic regurgitation—was recognized; otherwise it never had been written so. It has for some while been clear to me that aortic regurgitation is a defect in which facial pallor—and it is facial pallor that is understood—does not occur unless it is complicated by infective endocarditis, active rheumatism, or some other recognizable cause of anaemia; since I have learned to diagnose the more obscure forms of infective endocarditis I cannot recall, amongst very many hundred cases of chronic aortic regurgitation, a single instance of unusual pallor of the face in which that pallor could reasonably be attributed to low mean pressure in the arteries. The facial colour in those who suffer from uncomplicated regurgitation is normal or it may be heightened. In an out-patient department the facial colour in cases of aortic regurgitation is conspicuous, if it be conspicuous at all, by its redness and by the arterial tint of this redness. It is usual to see spontaneous capillary pulsation in the forehead and cheeks of these standing patients, and spontaneous capillary pulsation is seen only when the part is flushed, at the least in systole. The heightened colour is, perhaps, less conspicuous in patients long in bed; it varies much in one and the same case from time to time.

Observations have shown that the average facial temperature is 1° C. higher in a group of aortic cases than in a group of controls.

There is a not infrequent type of aortic regurgitation in which the flush is intense and the face and neck are scarlet and hot. The patients themselves feel the heat and often the throb of the skin. It is in such that capillary pulsation is seen at its height. Frequently in these cases the superficial temporal arteries are seen to be tortuous and prominent. These wide and tortuous vessels are usually, and often erroneously, regarded as the products of disease—arteries which have lost their power of elastic recoil. They are common both in young and in elderly cases of free regurgitation, and a simple inquiry proves them capable of changing size. They shrink, often to invisibility, in response to an ice-bag applied for a few minutes; they dilate again readily with heat. Thus, while in free aortic regurgitation there is usually evidence, conveyed by warmth and

colour, that the facial arterioles are dilated, there is often further evidence that the main arteries may be simultaneously involved.

Cyanosis and Arteriolar Dilatation.

Dilatation of the arterioles leads, other things being equal, to a quicker blood flow through the capillaries and venules of the skin, and tends in consequence to maintain the blood of these small vessels in a more oxygenated state, since less haemoglobin is reduced by the tissues in its passage through them. Thus arteriolar dilatation is opposed to cyanosis. Observations have seemed to show that congestion of the arm of an aortic case, showing capillary pulsation in the fingers, leads to less skin cyanosis than does similar congestion of a normal arm which shows none, and that those parts of the hand which originally show distinct pulsation may become least cyanosed when congested artificially. But a few exceptions have been noted and have remained unexplained. Artificial congestion of the head, in which the chief dilatation is suspected, has not been attempted, but clinical experience shows the comparative rarity of cyanosis of the face in free aortic regurgitation, even though there is associated congestion of the venous system.

The cumulative evidence proves that capillary pulsation in aortic disease is intimately connected with the state of the arterioles; it also proves that in the areas of skin which show capillary pulsation the arterioles are dilated by comparison to those of skin failing to show pulsation. It is more accurate to regard capillary pulsation, even in aortic disease, as a sign of arteriolar dilatation than as a sign of high pulse pressure. The cause of the limited vaso-dilatation described remains obscure; to discuss its mechanism, to speak of it as possibly compensatory, would lead us into what, for the moment, would be almost pure speculation.

THE VESSELS INVOLVED IN CLINICAL "CAPILLARY PULSATION."

Usually it has been assumed that "capillary pulsation," as we witness it clinically, is an affair of the capillaries themselves; latterly, however, doubt has arisen, since it has become known that the capillaries are not solely responsible for skin colour, but that the minute venules which collect the capillary blood, and the subpapillary venous plexus into which the last empty, contribute materially. The capillaries probably contribute in the skin of the hands and feet and in the mucous membrane of the lips; the venules play the largest part in the whiter skin of the limbs and trunk and in the skin of the face. The precise extent to which capillaries on the one hand, and minute venules on the other, affect the skin colour is still uncertain, though it becomes more and more evident that the venules are chiefly responsible. Boas has suggested that possibly the venules may be largely concerned in producing so-called "capillary pulsation." There has been some divergence of opinion as to the occurrence of pulsation of the capillaries, but, in extensive observations, I have never failed to see pulsatile capillary flow, or pulsatile expansion of the capillary loops, in any area examined microscopically in which pulsation of colour was visible to the naked eye and in which microscopically the blood flow in a reasonable number of capillaries could be detected. There is little or no doubt in my mind that the clinical pulsation of aortic disease is always associated with pulsatile flow in the capillaries, wherever it may occur. But although the contribution of the capillaries to clinical pulsation must be material, I am in agreement with Boas that it is not the sole factor, and I am able to substantiate his suggestion that the venules also contribute, having actually witnessed pulsation in these on many occasions.

Involvement of Veins and Venules in the Pulsation.

Pulsation of veins in aortic disease is most readily to be seen in the small venules lying superficially in the skin of the cheeks and nose; these veins swell in systole. When, under the microscope, the direction of the flow can be determined I have seen no exception to the rule that the sharp pulsatile movement is in the direction of the current, suggesting its peripheral origin. Observations have also

been made on skin areas from which the horny layer has been removed by blistering. They leave no doubt that "capillary pulsation" is contributed to by the venules, and that often the part played by the venules is no small one; especially in areas where capillaries are relatively scanty, as in the cheek and forearm. I have seen no evidence that the arterio-venule anastomoses described in the deeper layers of the skin by Sucquet play any part in inducing clinical capillary pulsation. The evidence as it now stands seems to warrant us in concluding that in all instances of clinical capillary pulsation the capillaries are directly involved, and that the rhythmical change of colour, seen macroscopically, is due to pulsatile flow in the minute vessels of the skin, involving always the capillaries, and, perhaps, always involving through these the collecting venules and the venules of the subpapillary plexus.

SUMMARY AND CONCLUSIONS.

1. When the human skin is soaked in water at temperatures of 45° to 47° C., the capillaries and venules on the one hand, and the arterioles on the other, independently dilate. These reactions are both local reactions. When higher temperatures are used, a reflex dilatation of the arterioles is observed in addition, and this spreads beyond the heated area.

2. Capillary pulsation is a physiological phenomenon, occurring in the skin or mucous membrane whenever the arterioles are sufficiently dilated, providing that the pulse pressure is normal and capillary and venule tone is not increased. A sufficient dilatation to produce pulsation is usual in the arterioles of the face of young people at room temperatures of 17° to 20° C. Pulsation is brought about in the hand by immersing it in water at 45° C., providing that the arterioles are capable of dilating; it is usual in association with the vaso-dilatation of local inflammatory lesions, however small these may be; it occurs in the facial flush of amyl nitrite, and in other forms of bright erythemas of the skin.

3. If, in the presence of normal or heightened pulse pressures, capillary pulsation in the hand is not produced by soaking the hand in water for three minutes at 45° to 47° C., the arterioles are probably incapable of dilating.

4. In aortic regurgitation, capillary pulsation is often independent of high pulse pressure, though the last increases pulsation when this is present. In patients suffering from the named valvular defect, sufficient dilatation of the arterioles is again the chief determining cause of capillary pulsation. The state of the arterioles not only chiefly determines its presence or absence, but *a fortiori* it determines its varying prominence in different skin areas.

5. The colour of the facial skin in uncomplicated aortic regurgitation is mistakenly described as pale. On the contrary, the facial skin is, if anything, more flushed and warm than normal. In aortic disease in which the mean blood pressure is at or below normal, the arterioles of the face can usually be shown to be wider than normal; this arteriolar dilatation is often associated with arterial dilatation; sometimes, though not usually, the flushing of the face with arterial blood is so excessive that the patient is conscious of heat and throb in the face. The skin of the hands is affected like the face, but in lesser degree.

6. Arteriolar dilatation is opposed to cyanosis.

7. It is more accurate to associate capillary pulsation with dilated arterioles than it is to associate it exclusively with any other causative factor; and this statement is independent of the clinical diagnosis of the case.

8. It is probable that in all cases of macroscopic "capillary pulsation" the phenomenon is due to the pulse passing from the arteries into and through the capillaries, to involve in greater or lesser degree the minute skin venules. The visible pulsation is shown to be due mainly, as Boas has suggested, to pulsation of the venules, at all events in the skin of the face, trunk, and upper parts of the limbs. Pulsation of the capillaries themselves contributes little in these areas; it probably contributes more in the skin of the palm and sole and in the mucous membrane of the lip.

9. There is no evidence that pulsation is conveyed from arterioles to venules through the arterio-venule anastomoses originally described by Sucquet.

A British Medical Association Lecture ON THE TREATMENT OF FRACTURES.*

BY

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Few cases in practice cause so much care and worry as fractures. The difference between the good and the bad result may mean so much to the patient. Mal-union is so permanent and so aggressively apparent that any sure and simple methods of avoiding the bad results are worthy of consideration. Of late years we have begun to recognize that the standard of result which it was our custom to demand of ourselves in the treatment of fractures must be raised. When, some years before the war, as the result of an inquiry by the British Medical Association, it was realized that even in the larger teaching hospitals the late results obtained in the treatment of fractures of the lower limb, and particularly those of the femur, were far short of the ideal, an endeavour was made to revise our methods of treatment and to set as our goal full functional restoration of the injured limb. The stimulating examples of Sir Arbuthnot Lane on the one hand and Sir Robert Jones on the other in the operative and bloodless methods of treatment demonstrated that an almost complete restoration to full functional activity was possible in the vast majority of cases of fracture of bones of the extremities. The development of orthopaedic surgery in America, with a more intensive study of fractures and their treatment, brought fresh light to bear on this subject, whilst the systematic control of treatment by x-ray examinations had a chastening effect on all who submitted their results to this acid and heartless test of surgical efficiency. Finally, the experience of the war demonstrated that by systematic and concentrated effort a standard of cure never previously obtained was possible even in gross forms of injury. How, then, are we to apply the accumulated experience of the last two decades to our treatment of fractures to-day? I propose to confine myself to fractures of the extremities, and particularly to the commoner varieties which one may be called on any day to treat.

Treatment of Compound Fractures.

No problem calls for more care or gives more anxiety than this. The name of Lister must ever be associated with the treatment of the open fracture. The principles which he propounded and the methods which he practised have been, and doubtless will be still further, improved; they can never be entirely superseded. Whilst Lister directed attention to the primary factor in infection—the contamination of the wound by bacteria—and demonstrated how by means of chemical antiseptics the organisms which had gained entrance might be killed and further infection prevented, he was not unaware of the other important factor—the soil on which the bacteria might grow and multiply. It was not until the later years of the war, however, that we began to realize the great importance of endeavouring to remove not only the bacteria but the damaged and devitalized tissues on which they may grow and feed and in which they multiply. The resistance to infection of undamaged tissues is considerable, and the brilliant results which attended the primary excision of wounds during the latter half of the war demonstrated for all time the importance of removing the damaged tissue in dealing with all accidental wounds. The method of wound excision is one which we should strive to apply to all cases of compound fractures in civil practice.

From personal experience I can say that nothing in surgery has given me greater satisfaction than the result of bold and painstaking excision of the tissues exposed in the wound, followed by an immediate and complete closure. Where the wound is large and ragged, as in so many cases of motor accident, etc., a complete excision may

* Abstract of a lecture delivered before the Northern Counties of Scotland Branch. The lecture was illustrated by lantern slides.